Icicle Strategy

Icicle Creek Water Resource Management Strategy

DRAFT

Programmatic Environmental Impact Statement

Grant No. WROCR-VER1-ChCoNR-00002

DEPARTMENT OF ECOLOGY
State of Washington

CHELAN COUNTY NATURAL RESOURCES
EST. 1899

May 2018

Ecology Publication No: 18-12-004

May 31, 2018

RE: Draft Programmatic Environmental Impact Statement for the Icicle Creek Water Resource Management Strategy, Chelan County, Washington

Dear Interested Parties, Jurisdictions, Tribes and Agencies:

Enclosed for your review and comment is the Draft Programmatic Environmental Impact Statement (PEIS) for the Icicle Creek Water Resource Management Strategy (Icicle Strategy), prepared jointly by Chelan County and Washington State Department of Ecology. The objective of the Icicle Strategy is to improve instream flows, improve the sustainability of Leavenworth National Fish Hatchery, protect tribal and non-tribal fish harvest, improve domestic supply, improve agricultural reliability, enhance Icicle Creek habitat, and comply with State and Federal Law, including the Wilderness Acts within the Icicle Creek Subbasin, Chelan County, Washington.

This Draft PEIS was prepared in compliance with Washington's State Environmental Policy Act (SEPA), Chapter 43.21C RCW and the SEPA Rules Chapter 197-11 WAC. In 2016, Chelan County and Washington State Department of Ecology issued a determination of significance on February 9, 2016 and formally initiated the SEPA scoping process. An open house was held in April 2016, with a 90-day SEPA scoping comment period that concluded May 11, 2016. Following scoping, several alternatives were developed in response to comments received. This Draft PEIS evaluates five action alternatives to improve water management in Icicle Creek, as well as a No-action Alternative. The following table outlines the various alternatives analyzed in the Draft PEIS.

Oral and written comments will be accepted on this Draft PEIS through July 30, 2018. Oral comments will be accepted at a public hearing which is being held at Leavenworth Festhalle, 1001 Front Street, Leavenworth, Washington on June 27, 2018, from 4:00 pm to 8:00 pm. Additionally, comments can be submitted in writing via mail or email to Mike Kaputa at Chelan County Natural Resource Department (see contact information on following page).

Comments on this document must be postmarked July 30, 2018, to ensure inclusion into the Final PEIS. Before including your name, address, phone number, email address or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time.

You can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

For further information regarding this document or to submit comments, please contact:

Mike Kaputa
Director, Natural Resource Department
Chelan County
411 Washington Street, Suite 201
Wenatchee, WA 98801
(509) 670-6935 / nr.iciclesepa@co.chelan.wa.us

The Draft PEIS is available for viewing on the Internet at:
https://fortress.wa.gov/ecy/publications/SummaryPages/1812004.html

And

http://www.co.chelan.wa.us/natural-resources/pages/icicle-work-group?parent=Planning

For information on obtaining a printed document or an e-copy on flash drive, please contact Chelan County's Water Resource Manager, Mary Jo Sanborn, at (509) 667-6532 or Maryjo.sanborn@co.chelan.wa.us.

Additional information regarding the Icicle Strategy may be found at:
http://www.co.chelan.wa.us/natural-resources/pages/icicle-work-group?parent=Planning

Sincerely,

G. Thomas Tebb, L.H.g., L.E.G.
Director, Office of Columbia River
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1250 West Alder Street
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Mike Kaputa
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411 Washington Street, Suite 201
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Enclosure: Icicle Strategy Draft PEIS

Icicle Strategy PEIS Alternatives Table

Projects	Proposed Alternatives					
	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Conservation						
IPID Irrigation Efficiencies	○	●	●	●	●	
COIC Irrigation Efficiencies (Piping)	●	●	●	●	●	●
Domestic Conservation Efficiencies	○	●	●	●	●	●
LNFH Conservation and Water Quality Improvements	●	●	●	●	●	●
Pump Exchange						
IPID Dryden Pump Exchange	○	○	●	●		
Full IPID Pump Station						●
COIC Irrigation Efficiencies (Pump Exchange)	●	●	●	●	●	●
Modification/Restoration of Existing Storage						
Alpine Lakes Reservoir Optimization, Modernization and Automation	○	●			●	●
Eightmile Lake Storage Restoration	○	●	●	○	●	●
New Storage						
Eightmile Lake Storage Enhancement					●	
Upper Klonaqua Lake Storage Enhancement					●	
Upper and Lower Snow Lakes Storage Enhancement					●	
Habitat/Fisheries Improvements						
Tribal Fishery Protection	○	●	●	●	●	●
Habitat Protection and Enhancement	○	●	●	●	●	●
Fish Passage	●	●	●	●	●	●
Fish Screening	●	●	●	●	●	●
Legislative/Administrative Tools						
Water Markets		●	●	●	●	●
Instream Flow Rule Amendment	○	●	●	●	●	●
OCPI legislative fix from instream flow impacts				●		

○ *Represents projects that might proceed if funding becomes available. However, under the No-action Alternative, project beneficiaries may be different and project timelines are unknown.*

● *Represents projects that are likely to occur as described, but could be replaced by another project that fulfills the same guiding principles if a design, funding, or permitting fatal flaw is identified.*

Fact Sheet

Project Title

Icicle Creek Water Resource Management Strategy (Icicle Strategy)

Brief Description of Proposal

Chelan County (County) and the Washington State Department of Ecology (Ecology) prepared this Draft Programmatic Environmental Impact Statement (PEIS) to evaluate the Icicle Strategy alternatives designed to meet Guiding Principles (improve instream flows, improve the sustainability of Leavenworth National Fish Hatchery, protect tribal and non-tribal fish harvest, improve domestic supply, improve agricultural reliability, enhance Icicle Creek habitat, and comply with State and Federal Law, including the Wilderness Acts) within the Icicle Creek Subbasin, Chelan County, Washington. This Draft PEIS was prepared in compliance with the Washington State Environmental Policy Act (SEPA). The County and Ecology are acting as co-lead agencies.

The SEPA non-project action is the adoption of a program called the Icicle Strategy. The strategy is a program of integrated, long-term, water resource management actions. The PEIS evaluates how combinations of actions could function together to meet the Icicle Creek Guiding Principles. The PEIS includes five action alternatives, which are characterized by different combinations of water management elements that cumulatively would meet all of the Guiding Principles. In addition, a No-action Alternative is included, which is intended to represent the most likely future expected in the absence of implementing an action alternative. Under the No-action Alternative, actions to improve instream and out-of-stream water supplies would continue to a lesser extent or for a different beneficiary than in the action alternatives. Additionally, implementation would be conducted by individual project proponents rather than as part of an integrated management strategy, and on unknown timelines.

Contacts

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Permits, Licenses, and Approvals Required

Implementation of the alternatives in the EIS would require compliance with regulations and plans at federal, state, and local levels. To implement the action alternatives or their elements, the lead agencies and project proponents would need to comply with applicable laws, regulations, and Executive Orders. This proposal is a non-project action, and the specific nature of projects that would be proposed under the Icicle Strategy is not yet known, so it is not possible to present a complete list of permits, licenses, and approvals that could be required for the components of the strategy. However, potential requirements identified to date include the following:

- State Environmental Policy Act
- National Environmental Policy Act
- Clean Water Act Section 404
- USFS Special Use Permit
- Endangered Species Act
- Magnuson-Stevens Fishery Conservation and Management Act
- National Historic Preservation Act
- Fish and Wildlife Coordination Act
- FEMA Flood Rise Analysis
- CWA Section 401 Water Quality Certification
- FCC Licensing
- Ecology Dam Construction Permit/Review
- Ecology Water Right Permit
- Ecology Sand and Gravel Permit
- WDNR Burn Permit
- WDFW Hydraulic Project Permit Approval
- WDNR Aquatic Use Authorization
- Ecology NPDES Construction Stormwater Permit
- EPA NDPES Discharge Permit for Operations
- Chelan County Shoreline Substantial Development Permit/Conditional Use Permit
- Chelan County Fill and Grade Permit
- Chelan County Building Permit

Authors and Contributors

A list of the individuals from the County, Ecology and consulting firms who participated in the EIS evaluation is provided in Chapter 7.

Date of Issue

May 31, 2018

Public Comment on the Draft Programmatic Environmental Impact Statement

In accordance with Washington Administrative Code (WAC) 197-11-455, a public comment period is being conducted from May 31 to July 30, 2018. All comments on the Draft PEIS received during the comment period will be addressed in the Final PEIS, which is expected to be issued in Fall of 2018. Comments on the Draft PEIS can be submitted in-writing via mail or email:

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Public Hearing

The co-leads will conduct a public hearing to receive comments on the DPEIS in combination with an informational open house. The public hearing and open house will be held at Leavenworth Festhalle, 1001 Front Street, Leavenworth, WA on June 27, 2018 from 4pm to 8pm.

Timing of Additional Environmental Review

The purpose of this Programmatic Environmental Impact Statement (PEIS) is to evaluate the potential environmental impacts of implementing a comprehensive water resource management plan in the Icicle Creek Subbasin, with the Guiding Principles as the water management objectives. In accordance with State Environmental Policy Act (SEPA), the proposal includes preparation of a PEIS (this document) to identify potential environmental impacts, mitigation strategies, and a preferred alternative.

The alternatives identified as potentially meeting the Guiding Principles are generally not at a project-level environmental review because they are still in the planning phase. In accordance with Chapter 197-11-704 WAC, this PEIS evaluates non-project actions such as policies, plans, and programs at a programmatic level. However, where project level information is available, the co-lead agencies for this PEIS have attempted to include it. Additionally, the PEIS will serve as the basis for future project-level environmental review that may be required if additional adverse impacts not identified in this document are probable and NEPA reviews that would be required for projects that receive federal funding or permitting.

Following the selection of a preferred alternative, some projects and actions could be advanced and ready for additional environmental review or project implementation in Spring 2019.

Document Availability

The Draft PEIS for the Icicle Strategy is available online:

https://fortress.wa.gov/ecy/publications/SummaryPages/1812004.html

And

http://www.co.chelan.wa.us/natural-resources/pages/icicle-work-group?parent=Planning

Print copies or e-copies of the document may be obtained at the following locations:

Washington State Department of Ecology
Central Regional Office

1250 West Alder Street,
Union Gap, WA 98903-0009

Or

Chelan County Natural Resource Department
411 Washington Street, Suite 201,
Wenatchee, WA 98801

Or by contacting Chelan County's Water Resource Manager, Mary Jo Sanborn, at (509) 667-6532 or maryjo.sanborn@co.chelan.wa.us.

To ask about the availability of this document in a format for the visually impaired, call the Office of Columbia River at 509-454-4241. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Location of Background Materials

Background materials used in the preparation of this Draft PEIS are available online at:
http://www.co.chelan.wa.us/natural-resources/pages/icicle-work-group?parent=Planning

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List of Acronyms and Abbreviations

Abbreviation	Definition
7	
7DADmax	7-Day Average Daily Maximum
A	
ac-ft	acre feet
afy	acre feet per year
ALWA	Alpine Lakes Wilderness Area
asl	above sea level
B	
BA	Biological Assessment
BIA	Bureau of Indian Affairs
BiOp	Biological Opinion
BMPs	Best Management Practices
BNSF	Burlington Northern Santa Fe Railway
C	
CAA	Clean Air Act
CAO	Critical Area Ordinance
CatEx	Categorical Exclusion
CELP	Center for Environmental Law and Policy

Abbreviation	**Definition**
C	
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIG	Climate Impacts Group
COIC	Cascade Orchards Irrigation Company
CPUE	catch per unit effort
CSZ	Cascadia subduction zone
CTCR	Confederal Tribes of the Colville Reservation
CWA	Clean Water Act
D	
DAHP	Washington State Department of Archeological and Historic Preservation
dBA	A-weighted decibels
dbh	diameter breast height
DDD	dichloro-diphenyl-dichloroethane
DDE	dichloro-diphenyl-ethane
DDT	dichloro-diphenyl-trichloroethane
DMR	Discharge Monitoring Reports
DO	dissolved oxygen
DOI	United States Department of Interior
DPS	distinct population segment
DS	Determination of Significance
DSO	Dam Safety Office

Abbreviation	Definition
E	
EA	Environmental Assessment
Ecology	Washington State Department of Ecology
EDNA	environmental designation for noise abatement
EFH	essential fish habitat
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
ERU	Equivalent Residential Unit
ESA	Endangered Species Act
ESD	Washington Employment Security Department
ESU	Evolutionarily Significant Unit
F	
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
G	
GEO	Governor’s Executive Order
GHG	greenhouse gas
GHOD	Geologically Hazardous Overlay District
GP	Guiding Principle
gpd	gallons per day
gpm	gallons per minute

Abbreviation	Definition
H	
HPA	Hydraulic Project Approval
I	
ICIFS	Icicle Creek Instream Flow Subcommittee
ICWC	Icicle Creek Watershed Council
IFIM	Instream Flow Incremental Methodology
IPID	Icicle-Peshastin Irrigation District
IID	Icicle Irrigation District
ITAs	Indian Trust Assets
IWG	Icicle Work Group
J	
JARPA	Joint Aquatic Resources Permit Application
L	
Ldn	average sound level
Leq	equivalent sound pressure levels
LNFH	Leavenworth National Fish Hatchery
LWD	large woody material
M	
MCRFRO	Mid-Columbia River Fisheries Resource Office
MOA	Memorandum of Agreement
MSA	Magnuson-Stevens Act
MSA	Metropolitan Statistical Area
MWG	Montgomery Water Group Inc.

Abbreviation	Definition
N	
NAAQS	National Ambient Air Quality Standards
NHPA	National Historic Preservation Act
NEPA	National Environmental Policy Act
NF	National Forest
NMFS	Nation Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSD	Natural Systems Design
NWP	Nationwide Permit
NWS	National Weather Service
O	
O&M	operation and maintenance
OCPI	Overriding Consideration of the Public Interest
OCR	Office of the Columbia River
OFM	Washington Office of Financial Management
OHWM	ordinary high water mark

Abbreviation	Definition
P	
PA	Proof of Appropriation
PCBs	polychlorinated biphenyls
PCN	preconstruction notification
PEIS	Programmatic Environmental Impact Statement
PEM	palustrine emergent
PFO	palustrine forest
PHABSIM	Physical Habitat Simulation
PHS	Priority Habitat and Species
PID	Peshastin Irrigation District
PM	particulate matter
POTW	publicly owned treatment works
PUD	Public Utility District
PSS	palustrine scrub-shrub
Q	
Qa	annual quantity
Qi	instantaneous quantity
R	
RAS	recirculating aquaculture system
RCW	Revised Code of Washington
RM	River Mile
ROE	Report of Examination
RV	recreational vehicle

Abbreviation	Definition
S	
SAAQS	State Ambient Air Quality Standards
SEPA	State Environmental Policy Act
SIP	State Implementation Plan
SMA	Shoreline Management Act
SMP	Shoreline Master Plan
SUP	stand-up paddleboard
SWPPP	Stormwater Pollution Prevention Control Plan
T	
TCPs	Traditional Cultural Properties
TDH	total dynamic head
TMDL	Total Maximum Daily Load
TWRA	Trust Water Rights Agreement
TWRP	Trust Water Rights Program
U	
U&A	Usual and Accustomed
UCSRB	Upper Columbia Salmon Recovery Board
UGA	urban growth area
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USC	United States Code
USDA	United States Department of Agriculture

Abbreviation	**Definition**
U	
USFWS	United States Fish and Wildlife Service
USFS	United States Forest Service
USGS	United States Geological Survey
UW	University of Washington
UWCLP	Upper Wenatchee Community Land Plan
W	
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
W	
WISAARD	Washington Information System for Architectural and Archaeological Data
WMSA	Wenatchee Metropolitan Statistical Area
WRIA	Water Resource Inventory Area
WSP	water system plan
WUA	weighted usable area
WWPU	Wenatchee Watershed Planning Unit
Y	
YN	Yakama Nation

EXECUTIVE SUMMARY

This Executive Summary reviews the analysis conducted in the programmatic environmental impact statement (PEIS) for proposals to improve water management in the Icicle Creek Subbasin. Per Washington Administrative Code (WAC) 197-11-400, the purpose of this PEIS is to provide discussion of the environmental impacts and to inform the Icicle Work Group (IWG), regulators, funders, and the public of reasonable alternatives and mitigation measures. A PEIS evaluates the effect of broad proposals and planning-level decisions, and thus the level of knowledge on project detail varies. The proposed alternatives and impacts discussed here are based on the current knowledge and understanding of project details. Per WAC 197-11-406, the co-leads initiated State Environmental Policy Act (SEPA) as early in the process as possible so that the PEIS could be used effectively as part of the decision-making process.

Introduction

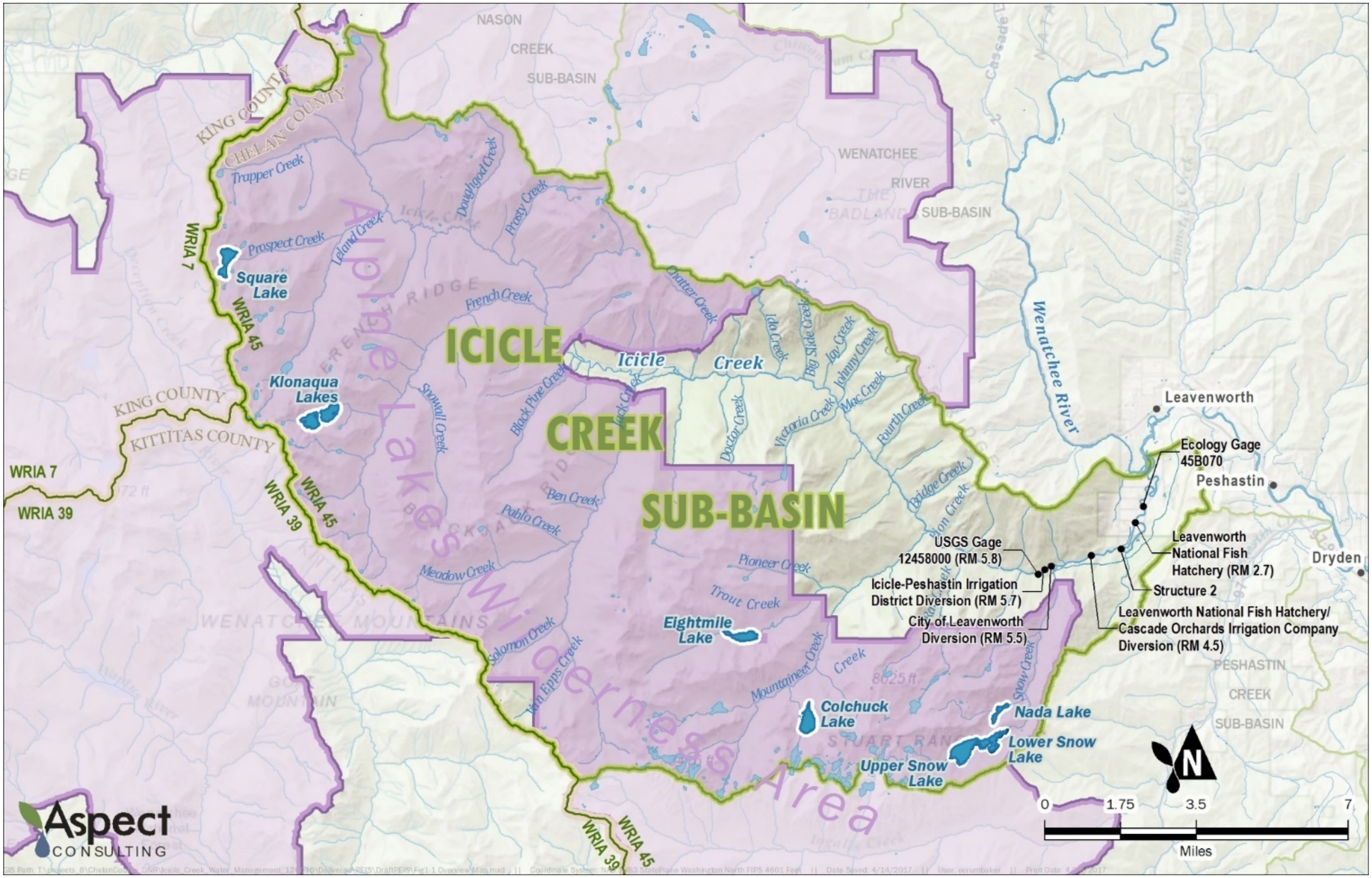
Icicle Creek is a major tributary to the Wenatchee River and is located entirely within Chelan County, Washington. Flows from Icicle Creek supply a variety of demands, including domestic water supply (e.g., City of Leavenworth and rural Chelan County residents), agricultural irrigation (e.g., Icicle-Peshastin Irrigation District (IPID) and Cascade Orchards Irrigation Company (COIC)), artificial aquatic habitat for hatchery fish raised at the Leavenworth National Fish Hatchery (LNFH), natural aquatic habitat for wild (non-hatchery) fish, and recreation. Figure ES-1 provides an overview of the Icicle Creek Subbasin. Taken together, water needs in the Subbasin are often greater than the available supply.

To find solutions for water management within the Subbasin, the Chelan County Natural Resource Department (Chelan County, County) and the Washington State Department of Ecology's (Ecology) Office of the Columbia River (OCR) co-convened the IWG (Work Group) in December 2012. The IWG comprises a diverse set of stakeholders representing local, state, and federal agencies, tribes, irrigation and agricultural interests, municipal/domestic water managers, and environmental organizations. Since 2012, the IWG has been studying and negotiating an integrated water resource management strategy for the Icicle Creek Subbasin. The proposal discussed in this document is the result of this effort.

Purpose and Need for Action

The current water management practices in the Icicle Creek Subbasin fail to consistently meet the demand for instream and out-of-stream water uses. This has been demonstrated by the minimum instream flows established in Chapter 173-545 WAC not being met, interruptible water users not receiving irrigation water, and litigation over water rights. There are additional issues in Icicle Creek surrounding fish habitat and passage, tribal fishing rights, and sustainable operation of the Leavenworth National Fish Hatchery (LFNH). The following sections summarize some of the key issues in water resource management and watershed function within Icicle Creek that lead to a need for a comprehensive water resource management plan within the Subbasin.

Figure ES-1. Icicle Creek Subbasin



These problems have created a need to improve ecological function in Icicle Creek and to provide reliable water resources for agriculture and domestic water users. With the additional pressures on water resources that will likely result from a changing climate, it is imperative to address these problems in a way that considers potential future impacts of climate change. The Icicle Strategy seeks to address these issues while considering the potential climate impacts and ensuring all actions comply with state and federal law, including the Wilderness Acts.

The Icicle Strategy and Guiding Principles

The Icicle Strategy is a comprehensive water resource management plan designed to balance and meet out-of-stream and instream water demand and resolve habitat and fisheries issues in the Icicle Creek Subbasin. The IWG developed the Icicle Strategy using stakeholder input and best available science. The crux of the Icicle Strategy is the Guiding Principles, which are a set of objectives that all members of the IWG agreed were in their mutual best interest to collaborate on and achieve. Over a 2-day work session facilitated by the U.S. Bureau of Reclamation (USBR) in December 2012, the IWG developed a list of shared goals to guide them in developing a strategy to meet the needs of the various stakeholders in the Subbasin. This list became known as the Guiding Principles, which have evolved since their initial development. These Guiding Principles, as they exist today, are described below:

Improve Instream Flow: This principle seeks to improve and enhance instream flows in the Icicle Creek historical channel. The goal is to modulate the flow in a way that enhances fish passage and fish utilization and promotes healthy habitats, serves channel formation function, meets aesthetic and water quality objectives, and is resilient to climate change.

The metric for this principle calls for 60 cubic feet per second (cfs) in drought years. To meet drought year goals, a minimum of 40 cfs will need to be protected instream. The short-term goal is for 100 cfs minimum flows in non-drought years, with a long-term goal set at 250 cfs. A maximum flow of 2,600 cfs can pass through LNFH’s “Structure 2”, which is located at River Mile (RM) 3.9 and is used to divert flows into the LNFH’s Hatchery Channel. Based on work conducted by the IWG’s Instream Flow Subcommittee, this flow maximum will remain in place.

Improve Sustainability of LNFH: This principle aims to enhance and maintain a healthy, sustainable LNFH that produces fish in adequate numbers to meet *U.S. v. Oregon*, which specifies fish production requirements. It also aims to produce diverse source availability to maximize fish health. To do this, calls for a 57 cfs supply to be protected long-term with a conservation goal of at least 20 cfs. It also includes appropriately screened diversions and minimizing unintended barriers to fish passage.

Protect Treaty/Non-treaty Harvest: Treaty harvest by the Yakama Nation, the Confederated Tribes of the Colville Reservation, and non-treaty fishing are important parts of the Icicle Creek Subbasin. This principle maintains that tribal and non-tribal, federally protected fishing and harvest rights must be met at all times regardless of season or drought conditions. It aims to improve the catch per unit effort (CPUE) and maintain multispecies harvest opportunities.

Improve Domestic Supply: As the population inside the Icicle Creek Subbasin grows, more water will be needed by the City of Leavenworth and surrounding areas in Chelan County. This principle calls for 1,750 acre-feet of reliable year-round supply, with 3 to 6 cfs on average and 6 to 12 cfs during peak flows to provide for projected growth through 2050. Additionally, this principle aims to improve domestic reliability for rural water users in the Icicle Creek Subbasin who depend on domestic wells to supply their drinking water.

Improve Agricultural Reliability: With agriculture vital to the health and prosperity of the region, this principle calls for projects to improve agricultural reliability that are operational, flexible, decrease risk of drought impacts, and are economically sustainable. It ensures current interruptible agricultural users have a firm supply in average water years.

Enhance Icicle Creek Habitat: This principle seeks to improve ecosystem health by protecting and enhancing aquatic and terrestrial habitat in the Icicle Creek Subbasin. This includes investments in physical habitat improvements that consider high-flow habitat and low-flow refuge, along with minimizing impediments to fish passage and improving limiting factors for spawning/rearing. It also offsets project-related terrestrial impacts with land acquisitions/easements.

Comply with State and Federal Law, and Wilderness Acts: Projects developed under the Icicle Strategy must comply with both Washington State and federal laws, including The Wilderness Act of 1964, the Alpine Lakes Wilderness Act of 1976, and the Alpine Lakes Wilderness Management Plan of 1981. The IWG actively identified and engaged regulators in the process of creating the approaches and projects for the Icicle Strategies.

Alternatives

The Icicle Strategy seeks to improve water resources management in the Icicle Creek Subbasin and achieve the specific metrics outlined in the Guiding Principles. This PEIS evaluates four alternatives that meet the Guiding Principles, along with a No-action Alternative. Each alternative is composed of a package of several projects developed to help meet the IWG's Guiding Principles. In summary, the four alternatives and the No-action Alternative include:

- **No-action Alternative:** The No-action Alternative is presented to show the impacts of not implementing the Icicle Strategy. Under the No-action Alterative, some projects may be developed, although it is unlikely all would be implemented. Funding for projects may be harder to obtain without an integrated solution, resulting in slower implementation of projects that do succeed without IWG support.
- **Alternative 1:** The first alternative consists of 12 projects that work in concert to achieve the Guiding Principles. The package is a mix of conservation and storage projects, including automating and optimizing reservoir releases at seven Alpine Lakes; efforts to make hatchery, irrigation, and domestic use more efficient; enhancement of habitat, fish passage, and fish screening; and protection of tribal and non-tribal fisheries. The suite of projects proposed under Alternative 1 is estimated to cost $81.7 million, which includes a 25 percent contingency. These projects are anticipated to provide 85 cfs and 30,419 acre-feet of water.

- **Alternative 2:** This alternative builds on the foundation of Alternative 1, but replaces the Alpine Lakes Optimization project with the IPID Pump Exchange project. Alternative 2 is estimated to cost $91 million, which includes a 25 percent contingency, and provide 80 cfs and 26,438 acre-feet of water.
- **Alternative 3:** This alternative also builds on the foundation of Alternative 1, but focuses on project selection outside the Alpine Lakes Wilderness Area through the inclusion of greater reliance on conservation and pump exchange projects. Because supply and demand cannot be matched well without storage, it also includes a legislative change for instream flow impacts that would occur when conserved water is not able to fully meet demand in-time and in-place. This is a requirement given recent Supreme Court clarity in the *Foster v. Yelm* case. Alternative 3 is estimated to cost $89 million, which includes a 25 percent contingency, and provide 67 cfs and 22,838 acre-feet of water.
- **Alternative 4:** This alternative provides a greater emphasis on development of water supplies, with enhancements to Eightmile Lake and storage improvements at the Upper Klonaqua and Snow Lakes. This alternative was selected to evaluate the value of greater flexibility in shaping water availability to meet future changes in both supply and demand. Alternative 4 would cost the most and provide the most water. The estimated cost, which includes a 25 percent contingency, is $96 million. This alternative would provide 153 cfs and 35,383 acre-feet of water.

The SEPA co-leads, in consultation with the IWG, will select a preferred Alternative after public comment on this Draft PEIS is closed. The Final PEIS will identify the preferred Alternative.

No-action Alternative

The No-action Alternative represents what might happen if no integrated, comprehensive strategy for managing water resources in Icicle Creek is adopted and implemented by the IWG to meet the Guiding Principles established by the IWG. Under the No-action Alternative, some projects may still be developed, but projects would be developed on separate timelines and for different purposes than those outlined in the Guiding Principles. Projects would likely be developed independently by members of the IWG or by proponents other than the IWG. Funding for projects would likely be delayed and projects may be less competitive for funding without an integrated strategy. Projects could be delayed or not implemented at all because of the lack of consensus-building at the local level. The No-action Alternative would fail to meet the instream flow Guiding Principle.

It is difficult to predict which of the projects might be constructed, delayed, or not implemented. However, based on the level of study and potential funding available for the various projects at the time of this PEIS, the following projects[1] are likely to implemented in some form under the No-action Alternative.

[1] Refer to Section 2.5 for full descriptions of projects.

- **Alpine Lakes Optimization, Modernization, and Automation** modernizes and automates the outlet works and gate infrastructure at seven lakes. Under the Icicle Strategy, this project would be implemented for instream flow benefit. However, if the Icicle Strategy does not advance, it is probable that at some point IPID would implement this project to improve their operations as part of routine reservoir maintenance that all infrastructure owners consider. However, if IPID pursues modernization and automation of the gates on its own, releases for the purposes of benefiting instream flow would not be guaranteed and would more likely be optimized for agricultural use.

- **IPID Irrigation Efficiencies** would likely continue to be explored and implemented if funding were available because IPID has continually worked to improve efficiency within the District. However, funding may be more limited if not included as part of an integrated water resource management strategy, which could limit the scope and magnitude of efficiency projects. Additionally, all water saved through irrigation efficiency upgrades would likely assist IPID in meeting agricultural reliability purposes only, rather than bolstering instream flows, unless funding is used for a specific project that requires a trust water right transfer or some other commitment to instream flows.

- **COIC Irrigation Efficiencies and Pump Exchange** funding opportunities will likely exist for this project if the Icicle Strategy is not implemented. The COIC project is already proceeding with design and environmental permitting based on the strength of consensus built by the IWG over the last 5 years. Funding for the project is primarily based on the potential benefit the project offers to Icicle Creek. The project would shift the point of diversion for COIC from Icicle Creek to a location near the confluence of Icicle Creek and the Wenatchee River. The project would also improve efficiency. The project would benefit Icicle Creek and assist in providing more reliable service to COIC.

- **Domestic Conservation** would likely continue to be explored and implemented if funding were available because the City of Leavenworth has already invested in conservation in the past and is required to pursue water use efficiency measures as part of conservation planning required by Municipal Water Law. The County also has addressed continuing rural conservation options by teaming with local water purveyors on how to incentivize or promote this idea. However, funding may be more limited if not included as part of an integrated water resource management plan, which could limit the magnitude of conservation projects. Regardless, water saved under the No-action Alternative would benefit the domestic uses in a similar manner as although potentially to a lesser degree than would occur for the other alternatives.

- **Eightmile Lake Storage Restoration** will occur because IPID has a long-term responsibility to maintain its infrastructure to provide reliable water service to its irrigation customers, while protecting public safety of those downstream of their dams. While the Eightmile Lake Dam is in need of repair, the District has prioritized other capital improvements over this project in recent years, including conservation and other dam maintenance, in part to allow for this project to be evaluated in more detail by the IWG. However, the need to make improvements has become more urgent because the outlet is collapsing and losing capacity. In addition, a fire in 2017 burned to the shoreline of the lake, likely changing the hydrology of inflow to the lake and raising concerns about the condition and safety of the dam. IPID declared an emergency on March 13, 2018, as a result of the 2017 fire and is actively coordinating with local, state, and federal agencies on this project. If not implemented or funded as part of an integrated strategy, IPID would not be obligated to release any of this water for instream flow or domestic benefit as envisioned under multiple Alternatives considered in this PEIS. Instead that water would be retained for agricultural reliability and drought resiliency.
- **Habitat Protection and Enhancement** may occur at a reduced level. Prior to the IWG, Chelan County has worked on habitat improvements in lower Icicle Creek. This would likely continue, although funding may be more limited if not included as part of an integrated water resource management plan project and the extent of the habitat protection and enhancement could be lower.
- **Instream Flow Rule Amendment** may be sought if other required projects are completed (e.g., LNFH improvements and habitat enhancement), as envisioned under the original rule language in WAC 173-545-090. However, this may occur over a longer timeline.
- **LNFH Conservation and Water Quality Improvements** focuses on projects to reduce surface water use and improve access to groundwater. Projects required in the Biological Opinion (BiOp) would continue without the Icicle Strategy. These include consideration of water reuse, groundwater augmentation, and a pump back that would allow for changing operations at Structure 2 and the division of water between the historic and hatchery channels.
- **Fish Screen Compliance** upgrades will likely continue if the Icicle Strategy is not implemented. These upgrades are required by law, and grant funding has already been expended on the design of screening improvements for the City of Leavenworth and IPID diversions. Screening for COIC is included in the COIC Irrigation Efficiencies project, while screening for LNFH is required under the BiOp and will be the subject of National Environmental Policy Act (NEPA) environmental review. However, implementation may occur on a slower timeline based on funding and would not necessarily occur in a way that would benefit other projects included in the Icicle Strategy, such as Habitat Protection and Enhancement.

- **IPID Dryden Pump Exchange** may be implemented under the No-action Alternative. However, the project would likely be rescaled and focused, at least initially, on reducing diversions from Peshastin Creek and improving the reliability of water supply to the Peshastin Irrigation District (PID) Main Canal, which could result in no benefit or less benefit in Icicle Creek.

Alternative 1

Alternative 1, also referred to as the Base Package, meets all the objectives defined in the IWG's Guiding Principles. These projects have been agreed to and moved forward by the IWG for review in this PEIS. While IWG members have reserved a final recommendation on Alternative 1 until resolution of the PEIS and consultation with the co-leads in 2018, this alternative represented the best recommendation available after four years of study by IWG members.

Alternative 1 includes the following projects[2]:

- **Alpine Lakes Reservoirs Optimization, Modernization, and Automation** modernizes and automates the outlet works and gate infrastructure at seven lakes. The intent is to improve management and releases of stored water at seven lakes in the Icicle Creek Subbasin based on changing conditions to meet the Subbasin's needs. It increases streamflow for fish and improves reliability and operation of stored water for agricultural use and the LNFH.
- **IPID Irrigation Efficiencies** explores options to improve irrigation delivery and on-farm efficiencies. Projects may include canal piping or lining and on-farm efficiency upgrades, which would improve drought resiliency and reliability to district users. This project also benefits fish by increasing streamflow.
- **COIC Irrigation Efficiencies and Pump Exchange** proposes to change COIC's point of diversion from its existing location at RM 4.5 on Icicle Creek to a location on the right bank of the Wenatchee River near its confluence with Icicle Creek or on the left bank of Icicle Creek near its confluence with the Wenatchee River and implement other water saving measures, such as piping the delivery system. The augmented streamflow has the potential to improve reliability of water supply for agriculture, benefit fish passage and habitat, and maintain treaty and non-treaty harvests.
- **Domestic Conservation Efficiencies** focuses on conservation projects in the City of Leavenworth and Chelan County and implements municipal and rural water efficiency projects such as leak detection and repair, meter installation, and water use conservation to improve domestic supply.
- **Eightmile Lake Storage Restoration** rebuilds the Eightmile Lake dam to restore usable storage to the historical and permitted high water storage elevation. This would increase streamflow for fish and meet the domestic water needs of the City of

[2] Taken from Icicle Strategy SEPA Checklist: http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA/Icicle%20Strategy%20SEPAChecklist%20Signed.pdf

Leavenworth and surrounding rural areas in Chelan County and improves the reliability and drought resiliency for agricultural users.

- **Tribal and Non-Tribal Fisheries** ensures that projects and actions taken do not have negative effects on tribal fishery activity in the Icicle Creek Subbasin. It monitors fishery effectiveness and implements actions for improvement, while protecting Tribal Treaty and federally protected harvest rights and non-tribal harvest at all times.
- **Habitat Protection and Enhancement** identifies and implements stream restoration and protection projects such as riparian plantings, engineered log jams, and conservation easements to improve stream habitat and ecosystem health.
- **Instream Flow Rule Amendment** modifies the instream flow rule's interim domestic reservation of 0.1 cfs to a final level of 0.5 cfs. This helps meet domestic water needs through 2050. As described in Chapter 173-545 WAC, the rule amendment requires instream flow and habitat restoration. This will improve domestic supply in the Icicle Creek subbasin.
- **LNFH Conservation and Water Quality Improvements** focuses on projects to reduce surface water use and improve access to groundwater. These projects may include onsite reuse, an effluent pump back, and wellfield enhancements for year-round benefits. It would also increase streamflow for fish and improve access to reliable water for the hatchery's operations. These projects also improve water quality in Icicle Creek.
- **Fish Passage** improves passage by assessing and removing barriers, so fish have better access to healthy habitats. This could include improved operation at Structure 2 and modification of channel morphology at the Boulder Field. Improved passage will increase the amount of habitat fish can access within the subbasin.
- **Fish Screening** upgrades fish screens on diversions to meet current standards. This will bring the major diverters on Icicle Creek into compliance with Washington State and NMFS screening requirements and bring LNFH into compliance with the screening requirements set in the BiOp (Nation Marine Fisheries Service (NMFS), 2015). These projects reduce fish mortality, which ultimately improves fish passage.
- **Water Markets** creates an Icicle Water Market and seeds it with an initial 1,000 acre-feet of water for agriculture use in the Icicle Creek Subbasin and Wenatchee River Basins during shortages.

Additional projects may be pursued outside of the Icicle Strategy if Alternative 1 is selected as the preferred alternative, such as the IPID Dryden Pump Exchange. However, project beneficiaries may be different and project timelines are unknown.

Alternative 1 addresses all the IWG's Guiding Principles. This suite of projects is expected to cost $82M, provides 89 cfs and 31,958 acre-feet of total water benefit (88 cfs and 28,458 acre-feet of instream benefit).

Alternative 2

The IWG developed Alternative 2 in response to SEPA scoping comments that requested examination of pump station options and omission of the Alpine Lakes Optimization, Modernization, and Automation project. This alternative includes most of the projects from the Base Package (Alternative 1)—with the exception of the Alpine Lakes Optimization, Modernization, and Automation—and adds the IPID Dryden Pump Exchange project.

Alternative 2 includes the following projects:

- **IPID Dryden Pump Exchange** would install a pump station on the right bank of the Wenatchee River near Dryden and a delivery pipeline that would extend through private orchards and driveways to the IPID canals. Water pumped from the Wenatchee River would allow for a corresponding reduction in diversions from Icicle and Peshastin Creeks, which would improve streamflow. The augmented streamflow has the potential to improve reliability of water supply for agriculture, benefit fish passage and habitat, and maintain treaty and non-treaty harvests.
- IPID Irrigation Efficiencies
- COIC Irrigation Efficiencies and Pump Exchange
- Domestic Conservation Efficiencies
- Eightmile Lake Storage Restoration
- Tribal Fisheries Protection
- Habitat Protection and Enhancement
- Instream Flow Rule Amendment
- LNFH Conservation and Water Quality Improvements
- Fish Passage
- Fish Screening
- Water Markets

Additional projects may be pursued outside of the Icicle Strategy if Alternative 2 is selected as the preferred alternative, such as the IPID Dryden Pump Exchange. However, project beneficiaries may be different and project timelines are unknown.

Alternative 2 addresses all the IWG's Guiding Principles. This suite of projects is expected to cost $91M, provides 84 cfs and 27,978 acre-feet of total water benefit (instream and out-of-stream).

Alternative 3

Alternative 3 is a response to SEPA scoping comments that expressed a desire for an alternative that excluded projects within the Alpine Lakes Wilderness Area. Alternative 3 includes most of the projects from the Base Package presented in Alternative 1, with the exception of the Alpine Lakes Optimization, Modernization, and Automation and the

Eightmile Lake Storage Restoration. It calls for a legislative change to waive impacts to instream flows when conservation and pump-exchange-based supplies cannot perfectly meet demand required to provide domestic reliability. For example, conservation supplies are available from April to October in this Alternative, but the Guiding Principle for domestic reliability requires year-round supplies. Because instream flows are at times not met from November to March, this would impair instream flows if legislative approval was not provided. Ecology no longer has the authority to waive these kinds of impacts through an Overriding Consideration of the Public Interest (OCPI) determination under RCW 90.54.020 given clarity from the Supreme Court in cases like *Swinomish* and *Foster/Yelm*.

Alternative 3 includes the following projects:

- IPID Dryden Pump Exchange
- IPID Irrigation Efficiencies
- COIC Irrigation Efficiencies and Pump Exchange
- Domestic Conservation Efficiencies
- Tribal Fisheries Protection
- Habitat Protection and Enhancement
- Instream Flow Rule Amendment
- LNFH Conservation and Water Quality Improvements
- Fish Passage
- Fish Screening
- Water Markets
- Legislative Change for Instream Flow Impacts. Under this project, the IWG would seek a legislative change that would allow impairment to the Instream Flow Rule when increased flow from conservation do not line up temporally with demand. (GP4)

Additional projects may be pursued outside of the Icicle Strategy if Alternative 3 is selected as the preferred alternative, such as the Eightmile Lake Storage Restoration Project. However, project beneficiaries may be different and project timelines are unknown.

Alternative 3 addresses all the IWG's Guiding Principles. This suite of projects is expected to cost $86.9M, provides 71 cfs and 24,378 acre-feet of total water benefit (instream and out-of-stream).

Alternative 4

Alternative 4 was created as a response to SEPA scoping comments that requested increased storage in the Icicle Creek Subbasin as an adaptive measure to climate change uncertainty and to better react to changes in future demand. This alternative has all the same projects as the Base Package presented in Alternative 1, but calls for increasing storage at Eightmile Lake to above the historical high water mark and enhancing storage and release at Upper Klonaqua and Upper Snow Lakes. Conservation was not reduced over that identified in Alternative 1 because it was necessary to meet other Guiding Principles (e.g., LNFH hatchery reliability, agricultural reliability).

- Alpine Lakes Reservoirs Optimization, Modernization, and Automation
- **Eightmile Lake Storage Enhancement** differs from the Eightmile Lake Storage Restoration project included in the Base Package in Alternatives 1 and 2. It calls for increasing the useable storage to approximately 3,500 acre-feet by rebuilding the dam to raise the high-water storage elevation and increasing the available drawdown.
- **Upper Klonaqua Lake Storage Enhancement** takes advantage of potential storage in Upper Klonaqua Lake by installing infrastructure to draw down the lake. Options for drawdown include tunneling, pumping, and siphon. Bathymetry suggests up to 2,448.2 acre-feet of water could be available for release.
- **Upper and Lower Snow Lakes Storage Enhancement** would raise the dam on Upper Snow Lake to increase storage capacity by 1,079 acre-feet.
- IPID Irrigation Efficiencies
- COIC Irrigation Efficiencies and Pump Exchange
- Domestic Conservation Efficiencies
- Tribal Fisheries Protection
- Habitat Protection and Enhancement
- Instream Flow Rule Amendment
- LNFH Conservation and Water Quality Improvements
- Fish Passage
- Fish Screening
- Water Markets

Additional projects may be pursued outside of the Icicle Strategy if Alternative 4 is selected as the preferred alternative. However, project beneficiaries may be different and project timelines are unknown.

Alternative 4 addresses all the IWG’s Guiding Principles. This suite of projects is expected to cost $83.8M, provides 132 cfs and 35,385 acre-feet of total water benefit (instream and out-of-stream).

Alternative 5

The IWG developed Alternative 5 in response to continued stakeholder input that suggested completely removing IPID's diversion from Icicle Creek to the Wenatchee River. As part of its irrigation comprehensive plan update, IPID completed a very cursory review of a project that would replace the IID and PID canal systems with a pressurized pipe delivery system supplied by pump stations on the Wenatchee River at three locations, referred to herein as the IPID Full Piping and Pump Exchange project. Alternative 5 includes the same projects as Alternative 1, except the IPID Irrigation Efficiencies project is replaced by the IPID Full Piping and Pump Exchange project. This alternative would not eliminate the need for operation and management of storage within the Alpine Lakes Wilderness. IPID would need to continue to store and release water from reservoirs within the Alpine Lakes Wilderness to ensure water was available in the Wenatchee River for their use because instream flows are insufficient on both Icicle Creek and the Wenatchee River in the summer to meet IPID out-of-stream uses without storage. Alternative 5 would provide up to 195 cfs of instream flow benefit in Icicle Creek in both drought and non-drought years.

Alternative 5 includes the following projects:

- **IPID Full Piping and Pump Exchange** would fully replace the IPID canal systems with a pressurized pipe delivery system. Three intake and pump station facilities would be constructed on the Wenatchee River to supply the new system. The existing surface water diversion facilities on Icicle Creek and Peshastin Creek would be removed. This project would increase stream flow in Icicle Creek by up to 117 cfs, improve reliability of water supply for agriculture, benefit fish passage and habitat, and maintain treaty and non-treaty harvests.
- Alpine Lakes Optimization, Modernization, and Automation
- COIC Irrigation Efficiencies and Pump Exchange
- Domestic Conservation
- Eightmile Lake Storage Restoration
- Tribal Fishery Preservation and Management
- Habitat Protection and Enhancement
- Instream Flow Rule Amendment
- LNFH Conservation and Water Quality Improvements
- Fish Passage
- Fish Screen Compliance
- Water Markets

Alternative 5 addresses all the IWG's Guiding Principles. This suite of projects is expected to cost $174.4M, provides 196 cfs and 55,458 acre-feet of total water benefit (instream and out-of-stream).

Impacts to Resources

The following is a summary of the overall impacts to resources within the project area based on current evaluation. These impacts are organized based on short-term, construction related impacts, and long-term impacts anticipated for the operation and maintenance of projects. Table ES-1 and Table ES-2 provides a summary of impacts to each resource evaluated in this PEIS.

Overall Impacts and Benefits of the Icicle Strategy

The overall impacts of the Icicle Strategy are expected to be beneficial, although some localized adverse impacts could occur from the Program Alternatives. The Icicle Strategy is expected to provide benefit to the Icicle Creek Subbasin, as laid out in the Guiding Principles. The integrated planning approach developed for the Icicle Strategy is intended to improve water resource and the riverine ecosystem on a watershed scale.

Short-Term

Construction activities required for many of the project elements comprising the Program Alternatives would cause short-term impacts. These impacts include erosion and sedimentation, construction dewatering, vegetation removal, construction emissions and dust, noise, aesthetic impacts for equipment and stock piles, and traffic delays. Construction may also temporarily block access to areas near construction sites, resulting in temporary disruption to activities in those areas, such as fishing or recreational use. Additionally, other impacts such as increased noise and dust or aesthetic changes might create a disturbance for recreationalists and wilderness users. Noise and vibrations could also temporary disturb fish and wildlife species. Cultural resources could also be disturbed during construction and access to Usual & Accustomed Fishing sites could be temporary restricted, especially for any construction near the plunge pool in front of the LNFH. These access impacts would be temporary and could be minimized by scheduling construction after the fishing season. Table 4-7 provides short-term impacts of implementation for the five Program Alternatives and the No-Action Alternative.

Implementation of the various projects under the Program Alternatives would be phased overtime depending on the design process, environmental review, and available funding. Because of this, construction impacts for various projects under an alternative are not likely to occur at the same time, minimizing the cumulative impact at any given time. Additionally, some project may be phased specifically to reduce recreational, Indian Trust Assets, and wilderness user impacts.

Table ES-1
Summary of Short-term Impacts of No-Action Alternative and Program Alternatives

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Earth	Construction-related erosion and sedimentation from ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Surface Water Resources	Use of cofferdams and dewatering during construction of on-going project.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Groundwater Resources	Dewatering impacts during construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Water Quality	Construction of ongoing projects could result in temporary water quality impacts. Impacts include risk of erosion and contamination from construction activities.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Water Use	Potential construction related impacts to surface water diversions. Work would be coordinated to minimize impacts.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Fish	Temporary habitat disturbance, construction-related impacts.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Vegetation	Some vegetation removal from construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Wildlife	Temporary disruption of habitat during construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Threatened and Endangered Species	Temporary disruption of habitat during construction from noise and disturbance. Construction would generally occur outside breeding season, reducing impacts.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Aesthetics	Construction activities and equipment of ongoing projects would generally create impacts on visual settings.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Air Quality	Construction related emissions from ongoing projects including transportation and use of heavy equipment.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Climate Change	Minor amounts of greenhouse gas emissions related to construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Noise	Increased noise from construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Recreation	Access restriction, nuisance noise, and aesthetics impacts during construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Land Use	Temporary access restrictions during construction of ongoing projects. Private owner access would be maintained.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Wilderness Area	Ongoing projects would likely be outside ALWA. No wilderness impacts are anticipated.	Temporary impacts to wilderness character related to construction activities include noise, construction equipment transport and staging, and presence and housing of construction workers.	Less than Alternative 1	Projects would likely be outside ALWA. No wilderness impacts are anticipated.	Greater than Alternative 1	Less than Alternative 1
Shorelines	Increased potential for shoreline erosion related to ground disturbing activities.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Utilities	Potential temporary disruption in water service related to instream construction activities near diversions.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Transportation	Traffic delays associated with equipment transport and construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Cultural Resources	Ground disturbing activities and construction work on culturally significant structures could result in impacts. Compliance with regulations and coordination with affected tribes would ensure any potential issues and mitigation measures would be addressed prior to construction.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Indian Sacred Sites	Ground disturbing activities would have the potential to impact sacred sites. Ongoing coordination with potentially affected tribes and compliance with regulations would ensure any potential issues would be addressed prior to construction.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Indian Trust Assets and Fishing Harvest	Potential to temporarily block access to Usual & Accustomed fishing areas.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Socioeconomics	Increased construction jobs from ongoing projects. Impacts would be smallest of all alternatives because fewer projects would be constructed.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Greater than Alternative 1

Table ES-2
Summary of Long-term Impacts of No-Action Alternative and Program Alternatives

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Earth	Some potential for erosion, and sediment transport resulting from long-term operation of ongoing projects. These impacts are expected to be minor.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Surface Water Resources	Ongoing projects would likely increase stream flow by 20 to 30 cfs. Benefits would be localized.	Similar but greater impacts compared to No-action. Would increase stream flow by 85 cfs. Increases expected when flow is naturally at its lowest. Flexibility in flow management to respond to low-flow conditions.	Similar to Alternative 1. Would increase stream flow by 80 cfs. Increases expected when flow is naturally at its lowest.	Less than Alternative 1. Would increase stream flow by 67 cfs. Increases expected when flow is naturally at its lowest.	Greater than Alternative 1. Would increase stream flow by 85 cfs. Increases expected when flow naturally at its lowest. Flexibility in flow management to respond to low-flow conditions.	Great than Alternative 1. Would increase streamflow by 195 cfs. Increases expected when flow is naturally at its lowest.
Groundwater Resources	Groundwater recharge near Icicle Creek is expected to decrease compared to other alternatives. Groundwater recharge could increase in some areas compared with other alternatives because some conservation projects (piping canals or fix leaky pipes) would not be implemented.	Increased groundwater use; increased groundwater recharge near Icicle Creek; reduced groundwater recharge resulting from conservation projects.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Water Quality	Localized benefits from ongoing water quantity and quality improvements. Expected benefits include increased dissolved oxygen and cooler temperatures.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Water Use	Water use would be relatively unchanged. Localized instream flow benefit from ongoing conservation projects. No water made available for projected domestic growth.	Increased water available for instream and out-of-stream uses. Water available to meet projected domestic growth.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Fish	Ongoing projects could provide localized habitat and flow improvements. However, critical low-flow periods would likely persist in some reaches, which would continue to impact habitat availability and passage.	Increased stream flow, passage improvements, and habitat improvements. Flow releases from Alpine Lakes would be managed to provide greatest fisheries benefit and minimize any impacts.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alterative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Vegetation	Localized benefits to riparian vegetation from ongoing projects.	Improvements to riparian habitat resulting from increased flows and riparian habitat restoration efforts. Relatively small negative impacts from increased Eightmile Lake level; however, this is within historical range. Installation of pump station may also have small impacts.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Wildlife	Largely beneficial for wildlife dependent on Icicle Creek because ongoing projects would seek to improve instream flows during low-flow season. Benefit is more limited than under other alternatives	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Threatened and Endangered Species	Ongoing projects would provide localized habitat and flow improvements.	Similar but great impacts compared to No-Action. Overall positive impacts from habitat improvements. Minor changes in shoreline associated with Eightmile and new pump station project not anticipated to impact threatened and endangered species.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Aesthetics	Anticipated to be largely beneficial for aesthetics because the projects likely to be implemented are expected to improve habitat and upgrade aging and degraded infrastructure.	Similar but great impacts compared to No-Action. Potential visual impacts from pump station project, which would be mitigated. Less than significant impacts of increased lake bed exposure.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Air Quality	No significant long - term impacts identified	No significant long - term impacts identified	No significant long - term impacts identified	No significant long - term impacts identified	No significant long - term impacts identified	No significant long - term impacts identified

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Climate Change	Water supply shortages and critically low stream flow conditions would likely become worse. Limited ability to respond to climate change-induced impacts.	Increased instream flow and water supplies. Ability to adaptively manage flow to respond to impacts of climate change. Meets 100cfs streamflow goals in 2080 under low, medium, and high climate change scenarios.	Similar to Alternative 1	Less than Alterative 1	Greater than Alternative 1	Similar to Alternative 1
Noise	Increased noise related to pump station operation. Construction measures would ensure compliance with Chapter 137-60 WAC.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Recreation	Increased streamflow resulting from implementation of ongoing projects expected to improve water-based recreation.	Similar but greater impacts compared to No-action. Increased lake levels may have some impacts on current location of campsites and trails at Eightmile Lake. However, these impacts are expected to be limited because lake level increase would be modest.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Land Use	Easements or property acquisition could be required for some ongoing projects. Long-term impacts on current land use trends.	Similar but greater impacts compared to No-action. Potential land use change from market reallocation of water and increased water for domestic supply. Conversion of some upland areas from private to public ownership.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Wilderness Area	Ongoing projects would likely be outside ALWA. No wilderness impacts are anticipated. Maintenance activities by IPID and USFWS in ALWA would remain unchanged.	Long-term impacts to wilderness character would include installation result from project in ALWA. Concealing equipment and implementing architectural style to complement the area would minimize impacts.	Similar to Alternative 1	Same as No-action.	Greater than Alternative 1	Similar to Alternative 1
Shorelines	Long-term impacts on shorelines would be mitigated by complying with the terms and conditions of local, state, and federal regulations.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Utilities	No anticipated impacts on water-based utilities associated with this project. Power demand is not expected to significantly increase because of ongoing projects.	Increased water service potential related to increased domestic supply. Power demand is not expected to significantly increase because of projects.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Transportation	No long-term impacts to transportation anticipated.	Reduced helicopter supported transport in the Wilderness Area related to IPID maintenance activities	No long-term impacts to transportation anticipated.	No long-term impacts to transportation anticipated.	Similar to Alternative 1	Similar to Alternative 1
Cultural Resources	For all projects, coordination with DAHP and mitigation measures would be required.	Alpine Lakes dams are eligible for listing under the National Register of Historic Places. Mitigation measures would be required to avoid significant adverse impacts. For all projects, coordination with DAHP and mitigation measures would be required.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Indian Sacred Sites	No expected adverse impacts to Indian Sacred Sites.	Ongoing coordination with potentially affected tribes and compliance with regulations would ensure any potential issues would be addressed prior to construction.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Indian Trust Assets and Fishing Harvest	No significant long-term impacts as required by Guiding Principles.	No significant long-term impacts as required by Guiding Principles	No significant long-term impacts as required by Guiding Principles	No significant long-term impacts as required by Guiding Principles	No significant long-term impacts as required by Guiding Principles	No significant long-term impacts as required by Guiding Principles
Socioeconomics	Assumed lowest socioeconomic benefits because fewer projects would be implemented.	Lowest construction costs, job creation, and long-term economic benefit of Program Alternatives.	Highest construction costs, job creation, and long-term economic benefit of Program Alternatives.	Higher construction jobs and long-term economic benefit than Alternatives 1 and 4.	Higher construction jobs and long-term economic benefit than Alternative 1.	Highest construction costs, job creation, and long-term economic benefit of Program Alternatives.
Environmental Justice	Ongoing projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.

Many of the projects proposed under the Program Alternatives could advance under the No-action Alternative. Ongoing projects would likely include work at LNFH to implement water re-use, water quality improvements, and groundwater augmentation. Additionally, Fish Screening Compliance, COIC Irrigation Efficiencies and Pump Exchange, and some fish passage would likely continue. The construction level, short-term impacts for these project elements would be the same under the Program Alternatives and the No-action Alternative. But because fewer projects would likely be implemented, overall construction-related impacts would be lowest under the No-action Alternative compared with other alternatives. IPID and USFWS would likely maintain and upgrade their storage facilities under the No-action Alternative, and construction level impacts could be similar to those discussed in the Program Alternatives.

The short-term impacts identified for Alternatives 1, 2, 3, and 5 are similar because they contain many of the same projects. The most significant difference is there would be fewer construction-related impacts in the Alpine Lakes Wilderness Area under Alternative 2, 3, and 5 and more along the Wenatchee River corridor. This could lead to increased impacts to fish and shorelines with the construction of a Wenatchee River pump stations under Alternative 2, 3, and 5, but fewer impacts to other threatened and endangered species and wilderness users. Alternative 3 would have no construction-related short-term impacts in the Alpine Lakes Wilderness Area.

Alternative 4 would have the greatest construction impacts because it is made up of the most projects. In addition to the short-term impacts identified for Alternative 1 in common with Alternative 4, there would be additional impacts from building two additional storage enhancement projects, and expending storage at Eightmile Lake. In addition to Alternative 4 having more projects, the scale of the storage projects is relatively larger than the scale of other water development projects proposed in Alternative 1.

Long-Term

Implementation of the Icicle Strategy would provide benefit to Icicle Creek Subbasin by meeting the Guiding Principles. The Guiding Principles, which are discussed in detail in Section 1.2, The Icicle Strategy Guiding Principles, of this document, include improved instream flows, improved sustainability of LNFH, protection of the tribal and non-tribal fish harvest, improved domestic supply, improved agricultural reliability, enhancement of Icicle Creek habitat, and compliance with state and federal laws and Wilderness Acts. All Program Alternatives would meet the Guiding Principles and provide these benefits; although there are important differences, which are summarized below. Additionally, all the Program Alternatives would increase resiliency to stream impacts resulting from climate change. Table 4-8 provides an overview of long-term impacts for each Program Alternative and the No-action Alternative.

The No-action Alternative would not meet the goals and provide the benefits prescribed in the Guiding Principles, although some instream flow, LNFH, fish passage, and screening improvements would be made. Under the No-action Alternative, ongoing projects could increase streamflow by approximately 32 cfs, with localized benefit in water quality, fish habitat, and improved riparian vegetation. Impacts of the No-action Alternative would include decreased ability to respond to climate change and conflict between water users would not be resolved. Under the No-action Alternative, IPID would still manage, operate, and repair their dam sites, so long-term impacts identified by these activities would still likely occur under the No-action Alternative.

Alternative 1 would provide 88 cfs of instream flow benefit and meet all the Guiding Principles. Additionally, Alternative 1 would allow flexibility in flow management and allow the instream flow goal of 100 cfs to be met in 2080 under low, medium, and high climate change scenarios. Additionally, under Alternative 1 there would be net-benefit water quality improvements, increased available water for out-of-stream users, improved habitat benefit for fish and wildlife, and improved water-based recreational opportunities. Impacts of Alternative 1 would include noise disturbance resulting from the operation of a pump station, and aesthetic impacts resulting from increased drawdown at Eightmile Lake and installation of modernized equipment in the ALWA, which could be minimized by construction design.

Alternative 2 would provide 83 cfs of instream flow benefit and meet all the Guiding Principles. Additionally, Alternative 2 would allow the instream flow goal of 100 cfs to be met in 2080 under low and medium climate change scenarios, but not under a high climate change scenario. Many of the net benefits to water quality, water use, habitat, and recreation that would exist under Alternative 1 would also exist under Alternative 2 because of the commonality of projects. Additionally, Alternative 2 would have many of the same impacts as Alternative 1. The impact of Alternative 2 compared to Alternative 1 is reduced flexibility in flow management that would result from not implementing the Alpine Lake Optimization, Modernization, and Automation Project.

Alternative 3 would provide 71 cfs of instream flow benefit and meet all the Guiding Principles. Many of the net benefits to water quality, water use, habitat, and recreation that would exist under Alternative 1 would also exist under Alternative 3 because many projects are common to both alternatives. In addition, many of the impacts under Alternative 1 would also occur under Alternative 3. The primary impacts of Alternative 3 compared to Alternative 1 would be less resiliency to climate change and no flexibility in flow management.

Alternative 4 would provide 131 cfs of instream flow benefit and meet all the Guiding Principles. Alternative 1 would allow flexibility in flow management and allow the instream flow goal of 100 cfs to be met in 2080 under low, medium, and high climate change scenarios. As with other alternatives, there would also be net benefits to water quantity, water use, and water-based recreation. Alternative 4 would have the greatest impact on wilderness character and recreation in the Wilderness Area. This is because more infrastructure would be built or expanded in the Wilderness Area. Additionally, this would have an increased impact on shoreline vegetation and habitat.

Alternative 5 would provide 195 cfs of instream flow benefit and meet all the Guiding Principles. Additionally, Alternative 5 would allow the instream flow goal of 100 cfs to be met in 2080 under low, medium, and high climate change scenarios. Many of the net benefits to water quality, water use, habitat, and recreation that would exist under Alternative 1 would also exist under Alternative 5 because of the commonality of projects. Additionally, Alternative 5 would have many of the same impacts as Alternative 1.

Environmental Commitments

Environmental commitments are measures or practices to reduce or avoid adverse effects resulting from project operations (long-term impacts). The projects elements proposed in the Program Alternatives are at various stages in the planning process, so the detail of specific mitigation measures varies. Additional measures would be developed during project level environmental review if needed. The following sections summarizes major environmental commitments for the Icicle Strategy.

Earth, Surface Water, Water Quality, Shorelines, and Fish

The primarily long-term impact associated with the Program Alternatives is increased flow, habitat, and improved water quality. Increased erosion and sedimentation resulting from increased streamflow was identified as a potential impact. However, this increased potential for erosion and sedimentation is expected to be non-significant given that increased flows will remain within the natural flow range, which high flows in Icicle creek already have scour forming flows. The potential for these impacts would be mitigated by following the required regulatory permits for construction and operation of projects. Benefits to vegetation, riparian habitat, floodplain function, and the riverine ecosystem are anticipated to also counter act these impacts. Additional impacts include fish and redd stranding associated with releases for the Alpine Lakes. Alpine Lake releases can be timed and managed to minimize these impacts.

Aesthetics, Recreation, and Wilderness

Potential impacts to aesthetics could result from construction of the COIC and the IPID pump exchange projects. The COIC pump exchange is included in all Program Alternatives. Some form of an IPID pump exchange is included in Alternative 2, Alternative 3, and Alternative 5. Potential impacts can be minimized based on siting or use of vegetation screen.

Aesthetic impacts are also possible under the Alpine Lakes Optimization, Modernization, and Automation Project. This project is included in Alterative 1 and Alternative 4. The greatest potential long-term impact is from new equipment installed to automate lake releases. This equipment also has the potential to impact ALWA wilderness character[3]. Designing structures to camouflage into the natural environment and using local construction materials can minimize these impacts. The actual impacts of the drawdown on aesthetics is expected to be less than significant because this conditional already exists, although less frequently.

The Eightmile Lake Storage Restoration Project also has the potential to create visual impacts. This project is proposed under Alternative 1 and 2. One potential impact is the new dam structure. This also has the potential to impact wilderness character. Involving an architect in the design of the facility to ensure it matches the look of the current dam structure and blends into the natural environment will help minimize this impact. The

[3] As established in the 1964 Wilderness Act, wilderness preservation is "for the protection of these areas, the preservation of their wilderness character."

increase in lake level also has the potential to impact current camp locations at Eightmile Lake. However, with the modest rise in lake level, this impact would be minor.

Storage enhancement projects proposed under Alternative 4 have the potential to impact aesthetics, wilderness character, and recreation. These impacts and specific mitigation measures would be addressed in project-level environmental review.

Land-Use

All land acquisitions or easements for projects proposed in the four Program Alternatives would need to provide appropriate compensation in accordance with applicable State or Federal regulations. Any land acquired under the Habitat Enhancement project, which is included in all Program Alternatives, would require a willing seller.

Climate Change

Changes in streamflow and water availability caused by climate change will constrain instream and out-of-stream uses. The Program Alternatives would provide for increased streamflow and the flexibility to adaptively manage flow in response to conditions.

Cultural Resources

Four of the five dams and water release structures at the Alpine Lakes are eligible for listing on the National Register of Historic Places. To reduce cultural resources impacts associated with the Alpine Lakes Optimization, Modernization, and Automation Project and the Eightmile Storage Restoration Project coordination with DAHP would occur to identify appropriate mitigation. With implementation of mitigation, these projects are not anticipated to result in any significant impacts on cultural resources. Mitigation measures might include maintaining some historical infrastructure and ensuring structure design is consistent with the historical structures.

For all projects that involve ground disturbance, additional cultural resource review would be required once specific locations for project elements are identified. Coordination in affected tribes and DAHP would help minimize any potential impacts. Prior to construction, any potential long-term impacts affecting cultural resources would be addressed.

Consultation and Coordination

The concluding sections of this Executive Summary briefly describes the public Involvement process and the numerous agencies coordinated and consulted with leading up to and during the SEPA process for the Icicle Strategy.

Public Involvement

Public involvement allows interested and affected individuals, organizations, agencies, and other governmental entities to be consulted and included in the decision-making process. The IWG has incorporated public involvement into their quarterly meetings, which are open to the public, and have made numerous presentations at conferences, to local community groups, and individual stakeholder groups to raise awareness of the Icicle Strategy and the PEIS process. The IWG co-leads Chelan County and Ecology also solicited comments from the public on the proposed Icicle Strategy through the SEPA scoping process to help shape the alternatives considered in this document and the analysis of the impacts. Formal and informal input was used.

The SEPA Scoping process began on February 9, 2016, when the co-leads issued a threshold determination of significance on the Icicle Strategy. Scoping is the process of soliciting input on a proposal to define the scope of the EIS. The comments received during the scoping process allowed the co-leads to identify significant issues, identify elements of the environment that could be affected, develop alternatives, and determine the appropriate environmental documents to be prepared.

Under WAC 197-11-410, the co-leads elected to expand the scoping process, and held a public open house in Leavenworth, Washington on April 20, 2016. Approximately 70 participants attended the open house. At the meeting, the co-leads provided a presentation that included an overview of the SEPA process, the Icicle Strategy, and Alternative 1. Additionally, display materials and handouts were available. Public comments were accepted at the meeting and until May 11, 2016.

Agency Consultation and Coordination

Chelan County and Ecology are the co-lead agencies responsible for the preparation of the Programmatic Environmental Impact Statement (PEIS) and meeting lead agency obligations required by SEPA. The co-lead agencies discussed the Icicle Strategy with National Marine Fisheries Service, US Fish and Wildlife Service, US Forest Service, US Bureau of Reclamation, US Army Corp of Engineers, Washington Department of Fish and Wildlife, Washing Department of Natural Resources, Washington Department of Archaeology and Historic Preservation, Confederated Tribes and Banks of the Yakama Nation, and Confederated Tribes of the Colville Reservation. Several of these agencies are represented on the IWG. The co-lead agencies will continue to coordinate and consult with these agencies regarding other applicable regulatory requirements as an alternative is selected and individual projects begin to move forward.

CHAPTER 1.0 INTRODUCTION

1.1 PROGRAMMATIC SEPA Review

The purpose of this Programmatic Environmental Impact Statement (PEIS) is to evaluate the potential environmental impacts of implementing a comprehensive water resource management plan in the Icicle Creek Subbasin, with the Guiding Principles as the water management objectives. In accordance with State Environmental Policy Act (SEPA), the proposal includes preparation of a PEIS (this document) to identify potential environmental impacts, mitigation strategies, and a preferred alternative.

The alternatives identified as potentially meeting the Guiding Principles are generally not at a project-level environmental review because they are still in the planning phase. In accordance with WAC 197-11-704, this PEIS evaluates non-project actions such as policies, plans, and programs at a programmatic level. However, where project level information is available, the co-lead agencies for this PEIS have attempted to include it. Additionally, the PEIS will serve as the basis for future project-level environmental review that may be required if additional adverse impacts not identified in this document are probable.

SEPA applies to all decisions made by state and local agencies in Washington State. Under SEPA, one government agency is typically identified as the lead agency for identifying and evaluating the potential adverse environmental impacts of a proposal. This evaluation is documented and sent to the public and other agencies for their review and comment.

The EIS provides critical information to all agencies in the environmental review and approval process. This information also helps to determine if avoidance, minimization, or compensatory mitigation measures will address any probable significant impacts.

For the Icicle Creek Water Resource Management Strategy (Icicle Strategy), the co-conveners (Ecology and Chelan County) entered into a Memorandum of Understanding to act as SEPA co-lead agencies per Chapter 43.21 RCW to conduct an environmental review of the Icicle Strategy.

See Section 1.9 for an overview of the SEPA process.

1.1.1 Document Organization

This PEIS discusses the development of the Icicle Strategy and analyzes five alternatives for implementing the Icicle Strategy as well as a no-action alternative. This document is organized into five main chapters, a comments and responses section, a references section, and appendices:

- Chapter 1 provides background information on the proposed Icicle Strategy, describes the program, the purpose and need for the action, relevant background information on the study area, history of water management in the Icicle Subbasin, prior studies and activities dealing with water management issues, and a brief description of public involvement.

- Chapter 2 presents a description of all proposed alternatives reviewed under this PEIS. The chapter also summarizes how the alternatives were developed and describes alternatives eliminated from detailed evaluation.
- Chapter 3 describes the affected environment and existing conditions in the Icicle Subbasin.
- Chapter 4 evaluates the potential short-term (construction) and long-term (operational) effects and proposed mitigation measures for all alternatives.
- Chapter 5 describes the public involvement, consultation and coordination, and compliance with other laws that have and will occur.
- Chapter 6 will provide references used throughout the documents.
- A Comments and Responses (Appendix A) follows Chapter 6 that includes all the comments received on the Draft PEIS as well as responses to those comments.

The references used in the document follow the Comments and Responses section. Appendices to accompany information presented in this PEIS are attached at the end of the document.

1.2 Purpose and Need for Action

The purpose and need for this PEIS is the goal of the co-leads and supporting stakeholders to develop an Icicle Creek Water Resource Management Strategy (Icicle Strategy) through a collaborative process that will achieve diverse benefits defined by adopted Guiding Principles for the subbasin. The current water management practices in the Icicle Creek Subbasin fail to consistently meet the demand for instream and out-of-stream water uses, including minimum instream flows for fish, municipal and domestic water supply, and agricultural water supply. This has been demonstrated by the minimum instream flows established in Chapter 173-545 WAC not being met, interruptible water users not receiving irrigation water, and litigation over water rights and Leavenworth National Fish Hatchery (LNFH) operations. There are additional issues in Icicle Creek surrounding fish habitat and passage, tribal fishing rights, and sustainable operation of the LNFH. The following sections summarize some of the key issues in water resource management and watershed function within Icicle Creek that lead to a need for comprehensive water resource management within the Subbasin.

Instream Flows: Instream flows in Icicle Creek are an important component of the local and regional environmental value system. Benefits of adequate instream flows include healthy aquatic and riparian ecosystems, protection of ESA-listed fish species, water quality, aesthetics, and recreation. Instream flow protection has been promoted through instream flow rules and watershed planning initiatives, with high importance assigned to improving habitat for salmonids. However, instream flows in late summer often drop below those set in WAC 173-545-040. The rule sets minimum flows in the lower reaches of Icicle Creek at 275 cfs, but in drought years flow can be less than 20 cfs in the historical channel near the LNFH. These low stream flows effect water quality and limit habitat diversity for aquatic species, and have contributed to exceedances of state and federal standards for temperature. Icicle Creek supports three ESA-listed species: Upper Columbia spring Chinook salmon, steelhead, and bull trout.

Leavenworth National Fish Hatchery: The United States Bureau of Reclamation (USBR) funds the operation and maintenance of LNFH as mitigation for fish losses resulting from the construction of Grand Coulee Dam and creation of the Columbia Basin Project. LNFH is operated by the United States Fish and Wildlife Service (USFWS) on behalf of USBR. Water supply to the hatchery is from a combination of Icicle Creek flows and groundwater wells with reservoir storage (Snow Lakes and Nada Lake) located in the Alpine Lakes Wilderness Area. To ensure current production goals of 1.2 million fish are met annually, LNFH needs a reliable supply of cool, pathogen-free water year-round.

Operations at LNFH have resulted in lawsuits and a Biological Opinion (BiOp) under the Endangered Species Act (ESA) Section 7 Consultation process. These actions are discussed in more detail later in this Chapter.

Tribal and Non-Tribal Harvest: The Yakama Nation and the Wenatchi Band of the Colville Confederated Tribes have federally-recognized and adjudicated harvest rights in lower Icicle Creek.

Adult spring-run Chinook salmon return to LNFH between mid-April and mid-July each year. A tribal fishery is permitted during this time if run size is large enough to both meet the hatchery broodstock goal of ~1,200 spawners and provide fish in excess of hatchery needs. The broodstock goal is a function of the hatchery’s obligation under U.S. v. Oregon to produce 1.2 million juvenile spring Chinook salmon (Parker, 2014).

The success of the tribal fishery is dependent on the concentration of returning adult salmon in the pool at the base of the fish ladder, the location where the majority of tribal fishing currently occurs (Parker, 2014). Tribal members fish with traditional dipnets or with modern rod-and-reel from scaffolds/platforms erected along the streambank. As demonstrated in Table 1-3, tribal fish harvest has declined considerably since 2001.

Domestic Supply: Icicle Creek and groundwater in the Icicle Creek Subbasin are important water sources for municipal and domestic uses. The City of Leavenworth has a population of ~2,000 (Census, 2010) and is an internationally renowned tourist destination, attracting millions of visitors each year. The City of Leavenworth has water rights to withdraw 1.5 cfs from Icicle Creek and 2.2 cfs from groundwater for municipal use. Chelan County currently supplies exempt wells under the reserve created in WAC 173-545-090. However, these collective urban and rural water rights are not sufficient to support population projections out to 2050. The City of Leavenworth and Ecology have litigation on hold while they find a non-litigious solution to water management in Icicle Creek.

Agricultural Reliability: Agriculture is an important component of the Chelan County economy. In 2012, over 75,000 acres were in agricultural production, generating $206,000,000 in market value in Chelan County (USDA, 2012). The waters of the Icicle Creek Subbasin play an important role in this agricultural production by providing water to IPID and COIC, which supply water to nearly 9,000 acres. These 9,000 acres are predominantly planted in tree fruit. In total, 137 cfs of irrigation diversions are authorized from Icicle Creek.

IPID manages five lakes in the watershed to augment natural water supplies from Icicle Creek during drought and non-drought years. In a drought year, the storage from all the lakes are used to provide water to IPID. In non-drought years, the district drains one lake rotationally for maintenance activities and for additional irrigation supply. Since not all droughts are the same, in some dry years a combination of lakes (1 to 5) are drawn down.

Despite the importance of agriculture and irrigation, there is not enough water to supply all of the irrigation demand. For example, in many drought years, IPID partially curtails its use even with reservoir releases. Additionally, in the Icicle Creek Subbasin and Wenatchee Basin, there are water rights that are regularly curtailed based on low streamflow in the Wenatchee River. On average, these water users face curtailment at least 7 out of every 10 years.

Habitat: The Upper Columbia Revised Biological Strategy (Biological Strategy, 2017) identifies the following factors affecting habitat conditions for ESA-listed salmonids in Icicle Creek:

- Land development downstream of LNFH has affected stream channel migration, recruitment of large wood, and off-channel habitat.
- There is a barrier to migration in the boulder field.
- Water withdrawals in Icicle Creek (primarily between Rat Creek and the hatchery) likely contribute to low flows and high temperatures.
- The Icicle Road upstream of Chatter Creek may confine the stream channel and affect floodplain function in certain places.

Additional passage barriers exist at the hatchery that are used for operation, including water management, broodstock collection, and to maintain the tribal fishery. These are discussed in more detail in Section 1.2.1.2.

These problems have created a need to improve ecological function in Icicle Creek and to provide reliable water resources for agriculture and domestic water users. With the additional pressures on water resources that will likely result from a changing climate, it is imperative to address these problems in a way that considers potential future impacts of climate change. The Icicle Strategy seeks to address these issues while considering the potential climate impacts and ensuring all actions comply with state and federal law, including the Wilderness Acts.

1.3 Icicle Creek Subbasin Background and History

Icicle Creek is a major tributary of the Wenatchee River and is a significant water resource subbasin of WRIA 45 (Wenatchee River Basin). Basin-wide planning is founded on the Instream Flow Rule (1983), adopted Watershed Plan (2006), and the Detailed Implementation Plan (2008).

1.3.1 Location and Setting

Icicle Creek is the largest subbasin in WRIA 45, covering 136,916 acres. Icicle Creek joins the Wenatchee River at RM 25.6, contributing 20 percent of the Wenatchee River's annual flow. Precipitation ranges from 120 inches at the Cascade crest to 20 inches at the mouth of the Icicle. Elevation ranges from approximately 9,000 feet at the Cascade crest to 1,102 feet at the mouth.

The U.S. Forest Service (USFS) manages 87 percent of the land in the Subbasin, of which 74 percent of the subbasin is located within the Alpine Lakes Wilderness Area. The remaining 13 percent of land in the subbasin is in other federal government, state, local, or private ownership.

Other than forestry and wilderness protection, land use within the Subbasin includes residential and agriculture uses, which occur in the lower portion of the watershed. The major water diversions are in the lower 5 miles of Icicle Creek for in-basin and out-of-basin irrigation, domestic water use, and fish propagation.

1.3.2 Project Area

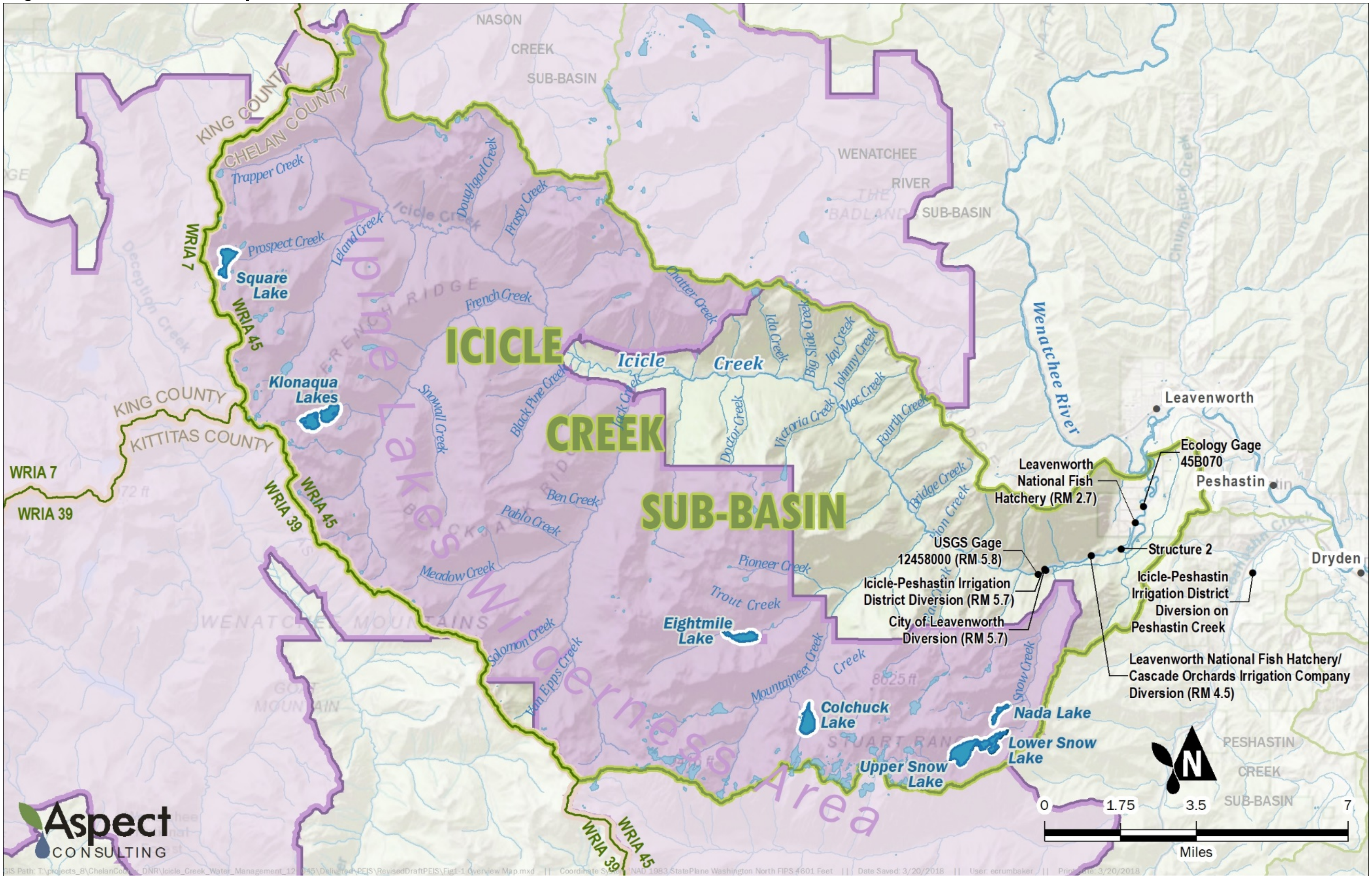
The Icicle Strategy focuses on the entire Icicle Creek Subbasin (see Figure 1-1). In this document, the Icicle Creek Subbasin is defined as the Icicle Project Area. However, there are three primary areas within and outside of the Icicle Project Area that could likely be affected by the proposal. These areas include the Alpine Lakes area, Icicle Creek, and downstream in the Wenatchee River Corridor downstream of the confluence with Icicle Creek. These areas are described in greater detail below.

1.3.2.1 Alpine Lakes Area

The Alpine Lakes Area encompasses the headwaters of Icicle Creek. These include several lakes located within the Alpine Lakes Wilderness Area, that are actively managed as reservoirs to supply IPID and LNFH. These lakes include Upper and Lower Snow Lakes and Nada Lake, which make up the Snow Lakes system, and Colchuck Lake, Eightmile Lake, Klonaqua Lake, and Square Lake. These Lakes are highlighted on Figure 1-1.

Also, included in the Alpine Lakes Area are the tributaries of Icicle Creek. Of primary interest are those that drain the above listed lakes. These tributaries include French, Leland, Eightmile, and Snow Creeks.

Figure 1-1. Overview Map of Icicle Subbasin



1.3.2.2 Icicle Creek

This 31.8-mile area includes Upper and Lower Icicle Creek, from Josephine Lake to the confluence with the Wenatchee River. This area includes most of the water resource diversions, fish passage barriers, and degraded habitat that the Icicle Strategy seeks to improve. This is also the area where critical low flows occur in the late summer and early fall. The location of Icicle Creek can be seen in Figure 1-1.

1.3.2.3 Wenatchee River Corridor

The Wenatchee River corridor describes the area downstream of Icicle Creek with its confluence with the Wenatchee River that could be impacted by water management changes in the Icicle Creek Subbasin. This area starts at the location where Icicle Creek is intercepted by the Wenatchee River, slightly upstream where the City of Leavenworth has wells in continuity with the River, and extends downstream to the confluence of the Wenatchee River and the Columbia River near the town of Wenatchee.

1.3.3 History of Water Management

Water supply in the Icicle Creek Subbasin is heavily dependent on snow pack in the upper reaches of the watershed. Combined with storage water from reservoirs in the upper watershed, snowmelt is crucial for summer flows and providing water for out-of-stream uses. The storage in the upper watershed occurs in seven reservoirs located within the Alpine Lakes Wilderness Area. Four of these reservoirs, Colchuck, Eightmile, Klonaqua, and Square, were built in the 1920s to 1940s by IPID. The water stored in these reservoirs is conveyed in Icicle Creek and its tributaries and diverted for irrigation at RM 5.7. The dams on Upper and Lower Snow Lakes and Nada Lake were originally constructed by Icicle Irrigation District (IID) in the 1930s and later expanded in the 1940s by USBR. The water stored in the Snow Lake system is conveyed in Icicle Creek and its tributaries and diverted for irrigation and fish propagation at RM 5.7 and 5.5, respectively.

Diversions from Icicle Creek were established in the early 1900s. By 1927, a water rights adjudication was underway in the Icicle Subbasin. Generally, adjudications arise when streamflow is insufficient to satisfy all out-of-stream demand every year. Today, there are four large diversions on lower Icicle Creek: IPID (RM 5.7), City of Leavenworth (RM 5.7), LNFH (RM 4.5), and COIC (RM 4.5). The location of these diversions is shown in Figure 1-1. Three of these diverters, IPID, COIC, and the City of Leavenworth, hold adjudicated certificates that were confirmed during the 1927 adjudication.

Adequate streamflow has long been a problem in Icicle Creek. In 1983, Ecology implemented the Wenatchee Instream Flow Rule (Chapter 173-545 WAC), which protects flows in Icicle Creek and other rivers and streams in the Wenatchee Basin. The recommended flows in this rule were revised in 2007 based on watershed planning. The revised rule prescribes flows between 267 and 650 cfs of water in Icicle Creek, depending on the time of year (Figure 1-2). The instream flow rule is discussed in more detail in Section 3.6 of this PEIS. Currently, these instream flows are not always met. Figure 1-3 shows the Wenatchee instream flow rule compared to different flow scenarios from 1981 to 2011 on the mainstem Wenatchee. Flows in Icicle Creek near the historic channel are much lower than in the Wenatchee River, on the order of 60 cfs in average years and less than 20 cfs in drought years.

Figure 1-2. Chapter 173-545 WAC Prescribed Flows (1983 rule compared to 2007 revised rule).

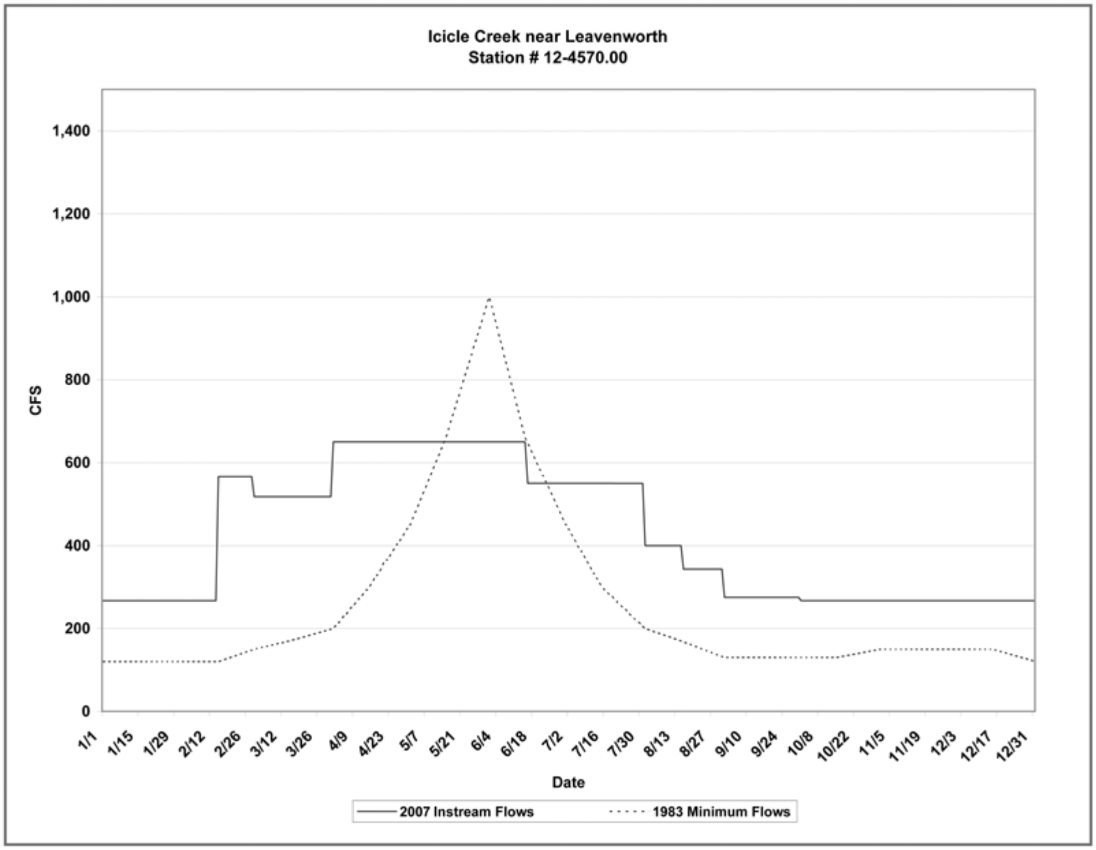
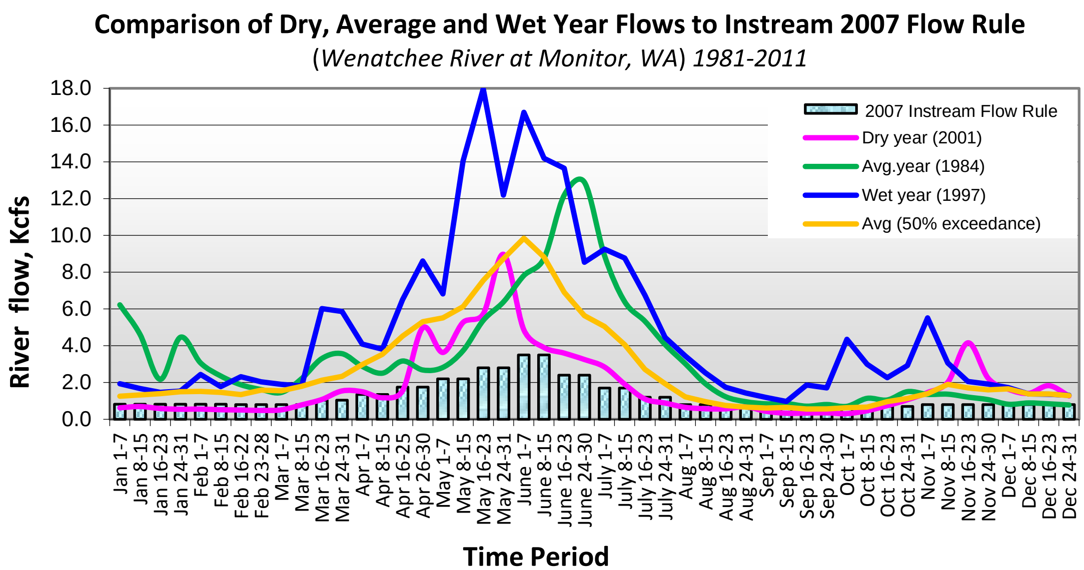


Figure 1-3. Instream Flow Rule Compared to Streamflow



The Icicle Creek Subbasin and the areas downstream that are affected by its water management have been identified as a critical area within the watershed planning process (through the Wenatchee Instream Flow Study, Total Maximum Daily Load (TMDL) Study, and Watershed Assessment) for meeting all of the needs it serves. Improved flow understanding and projects envisioned by the IWG will significantly improve this current instream flow imbalance.

1.4 The Icicle Work Group

To find solutions for water management within the Icicle Subbasin, the Chelan County Natural Resource Department (Chelan County, County) and the Washington State Department of Ecology's (Ecology) Office of the Columbia River (OCR) co-convened the Icicle Work Group (IWG, Work Group) in December 2012. The IWG comprises a diverse set of stakeholders representing local, state, and federal agencies, tribes, irrigation and agricultural interests, municipal/domestic water managers, and environmental organizations (Table 1-1).

Table 1-1
List of Icicle Work Group Members

Organization	Interest
Confederated Tribes & Bands of the Yakama Nation	Tribal Fisheries
Confederated Tribes of the Colville Reservation	Tribal Fisheries
U.S. Bureau of Reclamation (USBR)	Hatchery
U.S. Fish and Wildlife Service – LNFH	Hatchery
NOAA – Fisheries	Fisheries
Washington State Department of Fish and Wildlife	Fisheries & Wildlife
Washington State Department of Ecology	Co-convener/Water Manager/ Water Supply Developer
Icicle and Peshastin Irrigation District	Irrigation Water
City of Leavenworth	Domestic Water
Chelan County	Co-convener/Domestic Water/ Watershed Plan Implementer
Cascade Orchards Irrigation Company	Irrigation Water
Icicle Creek Watershed Council	Environmental
Washington Water Trust	Fisheries/Environmental
Trout Unlimited – Washington Water Project	Fisheries/Environmental
U.S. Forest Service	Land Manager
City of Cashmere	Domestic Water
Cascadia Conservation District	Environmental
Agricultural Representatives (two)	Irrigation Water

The IWG seeks to find collaborative solutions for water management within the Icicle Creek Subbasin. This includes balancing out-of-stream water uses, such as domestic and agricultural uses, with instream uses, such as fish habitat, recreation, and ecosystem processes while protecting treaty and non-treaty fishing interests. The IWG's purpose is to develop a comprehensive Icicle Creek Water Resource Management Strategy (Icicle Strategy) that uses best available science to identify and support water management solutions that lead to implementation of high-priority water resource projects within the Icicle Creek Subbasin. The IWG adopted operating procedures that include membership selection, expectations for members, dispute resolution, conflict of interest criteria, subcommittee procedures, and decision-making procedures.[1]

The IWG meets quarterly to make decisions on implementing and monitoring progress made on the Icicle Strategy. As needed, the IWG forms subgroups that meet and inform the IWG of the best available science to meet Icicle Strategy objectives. One key subgroup is the IWG Instream Flow Subcommittee, which comprises local, state, federal, and tribal fish biologists that help evaluate how additional Icicle Creek instream flow quantities and habitat improvements made available from project implementation can be maximized for fish benefit in Icicle Creek and its tributaries. A Steering Committee chaired by the Washington State Department of Fish and Wildlife (WDFW) and consisting of eight voting members of the IWG also meets regularly to help implement IWG decisions, coordinate funding efforts, and prioritize emerging issues for IWG consideration.

After 3 years of study, stakeholder coordination, project investigations, and collaboration the IWG determined that the PEIS was the next appropriate step in implementing the Icicle Strategy. This would allow greater input by the public on the Guiding Principles and the potential projects that could collectively meet them, and help understand benefits and impacts associated with implementation of the strategy.

1.4.1 Icicle Work Group Authority

The authority for the IWG comes from the Washington State Legislature in the form of the Watershed Planning Act (Chapter 90.82 RCW) and the Columbia River Basin Water Management Act (Chapter 90.90 RCW). The IWG generally consists of parties who have come together in a collaborative and volunteer manner to help improve Icicle Creek's ability to meet multiple, and at times conflicting, water needs.

1.4.1.1 Watershed Planning

In 1998, the Washington Legislature passed the Watershed Planning Act (Chapter 90.82 RCW). The purpose of the Watershed Management Act is to conduct watershed scale planning for managing water resources by local entities and stakeholders. The objectives of watershed planning are to "meet the needs of a growing population and a healthy economy statewide, meet the needs of fish and healthy watersheds statewide, and advance these two principles in increments over time."

[1] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/FINAL%20IWG%20Operating%20Procedures%202016.pdf

1.4.1.2 OCR's Authority

In 2006, the Legislature tasked and funded Ecology to develop new water supplies for both instream and out-of-stream uses. Ecology created OCR whose purpose is to develop new water supplies using a variety of tools/project types, including; storage, conservation, and voluntary regional water management agreements.[2]

The Legislature provided OCR with five directives (Chapter 90.90 RCW):

- Develop water supplies for instream as well as out-of-stream uses (RCW 90.90.020(1)(a)(ii)).
- Secure alternatives to groundwater for agricultural users in the Odessa subarea aquifer (RCW 90.90.020(3)(a)).
- Find sources of water supply for pending water right applications (RCW 90.90.020(3)(b)).
- Find a new uninterruptible supply of water for the holders of interruptible water rights on the Columbia River mainstem (RCW 90.90.020(3)(c)).
- Develop water sources for new municipal, domestic, industrial, and irrigation water needs within the Columbia River Basin (RCW 90.90.020(3)(d)).

1.5 The Icicle Strategy and Guiding Principles

The Icicle Strategy is a comprehensive water resource management plan that contemplates climate change and is designed to balance and meet out-of-stream and instream water demand both now and into the future. The water management and watershed conditions that led to the Icicle Strategy are discussed in Sections 1.3 and 1.4. The IWG developed the Icicle Strategy using stakeholder input and best available science. The centerpiece of the Icicle Strategy is the Guiding Principles, which are a set of objectives that all members of the IWG agreed were in their mutual best interest to collaborate on and achieve. Over a 2-day work session facilitated by USBR in December 2012, the IWG developed a list of shared goals to guide them in developing a strategy to meet the needs of the various stakeholders in the Subbasin. This list became known as the Guiding Principles, which have evolved since their initial development. The following is a list of the Guiding Principles, as developed during the December 2012 work session:

1. Streamflow that:
    a. Provides passage,
    b. Provides healthy habitat,
    c. Serves channel formation function,
    d. Meets aesthetic and water quality objectives, and
    e. Is resilient to climate change.

[2] http://www.ecy.wa.gov/programs/wr/cwp/cr_overview.html

2. Sustainable LNFH that:
    a. Provides healthy fish in adequate numbers,
    b. Is resource efficient,
    c. Significantly reduces phosphorus loading,
    d. Has appropriately screened diversion(s), and
    e. Does not impede fish passage.
3. Tribal treaty and federally protected fishing/harvest rights are met at all times.
4. Provide additional water to meet municipal and domestic demand.
5. Improved agricultural reliability that:
    a. Is operational,
    b. Is flexible,
    c. Decreases risk of drought impacts, and
    d. Is economically sustainable.
6. Improve ecosystem health, including protection and enhancement of aquatic and terrestrial habitat.
7. Comply with state and federal law.
8. Protect non-treaty harvest.
9. Comply with the Wilderness Act of 1964, the Alpine Lakes Wilderness Act of 1976, and the Alpine Lakes Wilderness Management Plan.

Over the following 3-years, these Guiding Principles evolved to seven principles that have both qualitative and quantitative descriptions. The following section, Section 1.2.1, describes the process of fine-tuning these Guiding Principles through scientific study and consensus-based stakeholder negotiations. Section 1.2.2 describes the Guiding Principles as they are today.

1.5.1 Refining Guiding Principles and Developing Metrics

The IWG agreed that before a set of projects could be identified to accomplish the objectives established in the Guiding Principles, quantitative metrics and more qualitative descriptions would be required to help define the magnitude of the gap between current river operations and the values expressed in the Guiding Principles. Through 3-years of scientific study and project feasibility development along with Work Group discussion, the IWG developed metrics for their objectives. Additionally, the IWG honed their list of nine principles into a list of seven: improve instream flows, improve sustainability of LNFH, protect tribal and non-tribal harvest, improve domestic supply, improve agricultural reliability, enhance Icicle Creek habitat, comply with state and federal law, and Wilderness Acts. The following sections describe the process for developing these metrics for each Guiding Principle.

1.5.1.1 Improve Instream Flow

To determine streamflow restoration goals, the IWG formed a technical subcommittee of experts on instream flow and fish habitat to provide technical guidance on establishing instream flow goals for the Guiding Principles. This group is known as the Icicle Creek Instream Flow Subcommittee (ICIFS). Much of the methodology used by the ICIFS to make its recommendation is summarized in its presentation to the IWG in 2014[3]. To make flow recommendations, the ICIFS reviewed existing reports that discussed flow and habitat in Icicle Creek and reviewed their collective understanding of how to improve flows in Icicle Creek:

- Instream Flow Study Report for Icicle Creek (Cates, 1985)
- Icicle Creek Target Flow Report for Leavenworth National Fish Hatchery (2004)
- U.S. Bureau of Reclamation, Technical Memorandum, Instream Flow Assessment of Icicle Creek, Washington, Ron Sutton and Chelsie Morris (2005)
- U.S. Fish and Wildlife Service, Icicle Creek Fish Passage Evaluation for the LNFH (2013)
- U.S. Fish and Wildlife Service, Icicle Creek Instream Flow and Fish Habitat Analysis for the LNFH (2013)
- U.S. Bureau of Reclamation, LNFH Icicle Creek Rapid Geomorphic Assessment (2014)

These reports are summarized later in this chapter under Section 1.5– Prior Investigations and Activities in the Icicle Basin.

The effort was complicated because different portions of Icicle Creek and its tributaries are used by different fish species and have different limitations (e.g., flow, passage, and habitat). To address these differences, the ICIFC researched the flow and habitat information as well as fish utilization in different portions of the river. Based on this research, the IWG identified the following target reaches:

Reach 1 – RM 5.7 to headwaters (upstream of major diversions)

Reach 2 – RM 5.7 to 4.5 (IPID/City of Leavenworth point of diversion to LNFH/COIC point of diversion)

Reach 3 – RM 4.5 to 3.9 (LNFH/COIC point of diversion to Structure 2)

Reach 4 – RM 3.9 to 2.7 (the historical channel)

Reach 5 – RM 2.7 to 0.0 (downstream of LNFH outflow to the Wenatchee River confluence)

The ICIFC then documented fish presence and life history in each of the reaches. Table 1-2 and Figure 1-4 illustrate the presence and life history of each species in Icicle Creek.

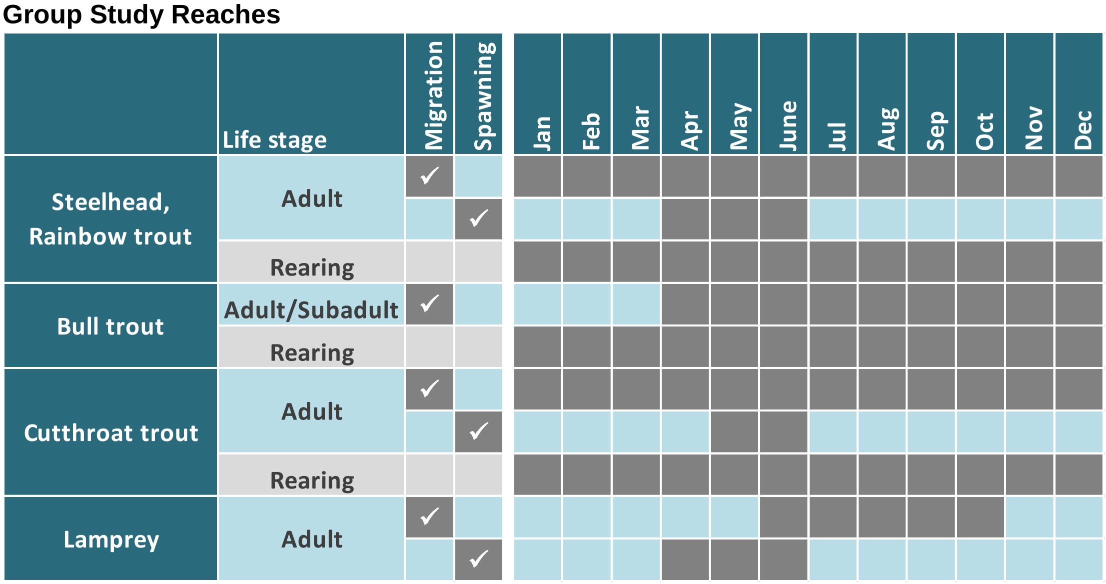
[3] http://www.co.chelan.wa.us/natural-resources/pages/icicle-creek-instream-flow-committee

Table 1-2
Focal Fish Species by Reach

Reach	River Mile	Life History & Stage by Species
1	Headwaters to RM 5.7	Steelhead – P, S, R Rainbow trout – S, R Bull trout – P, S, R Cutthroat trout – R
2	RM 5.7 to RM 4.5	Steelhead – P, R Bull trout – P
3	RM 4.5 to RM 3.9	Steelhead – P, R Bull trout – P
4	RM 3.9 to RM 2.7	Steelhead – P, R, S Bull trout – P Lamprey – P
5	RM 2.7 to RM 0.0	Steelhead – S, R Bull trout – P Lamprey – P

Note – P = Passage, S = Spawning, R = Rearing
Assumptions: 1) No spring Chinook salmon assessment; 2) Assumed steelhead production is present

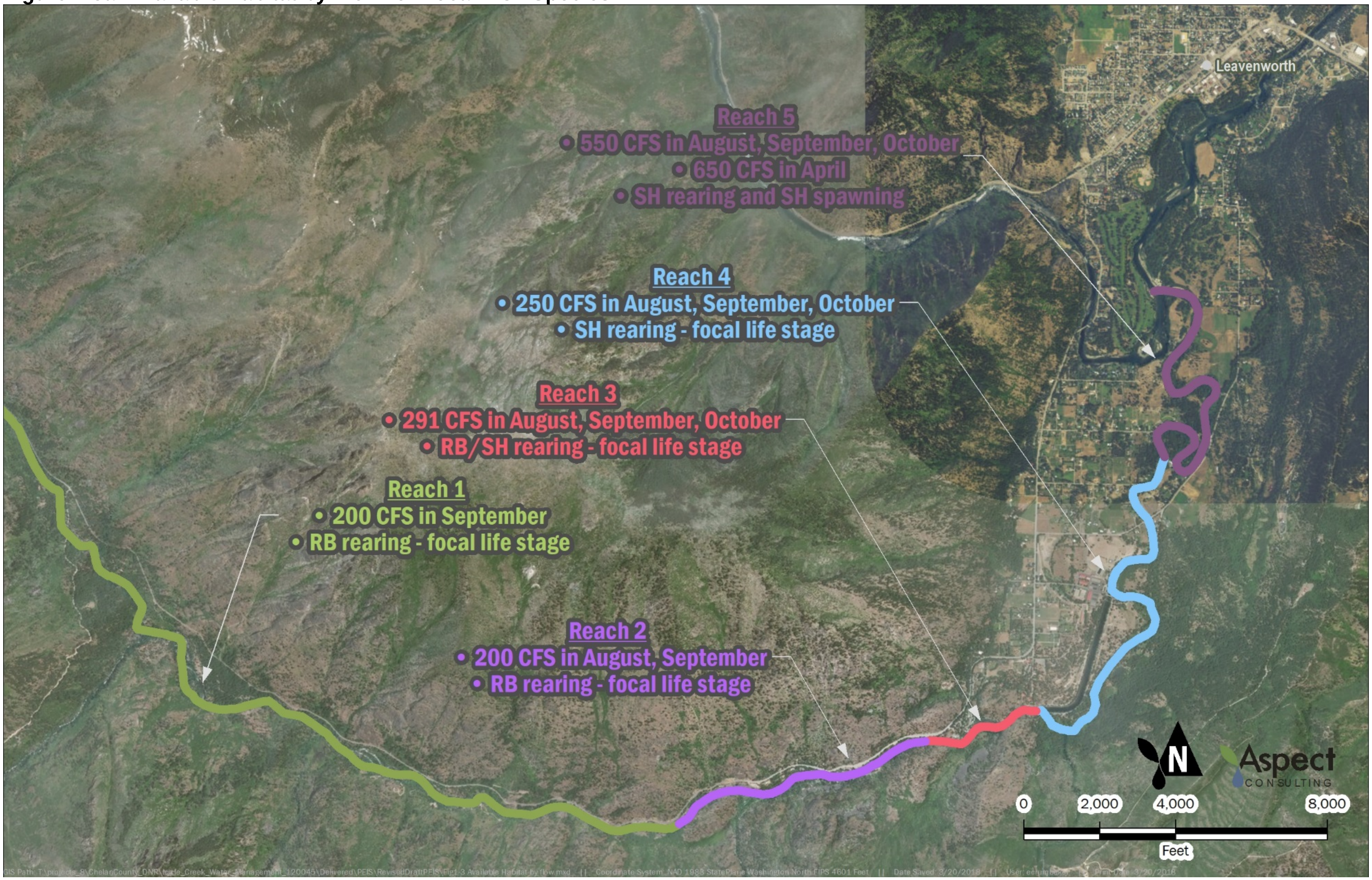
Figure 1-4. Focal Fish Species and Relevant Life Stages Periodicity within Icicle Work Group Study Reaches



(Source: USFWS 2013 draft)
Note: Gray shading indicates utilization for each month.

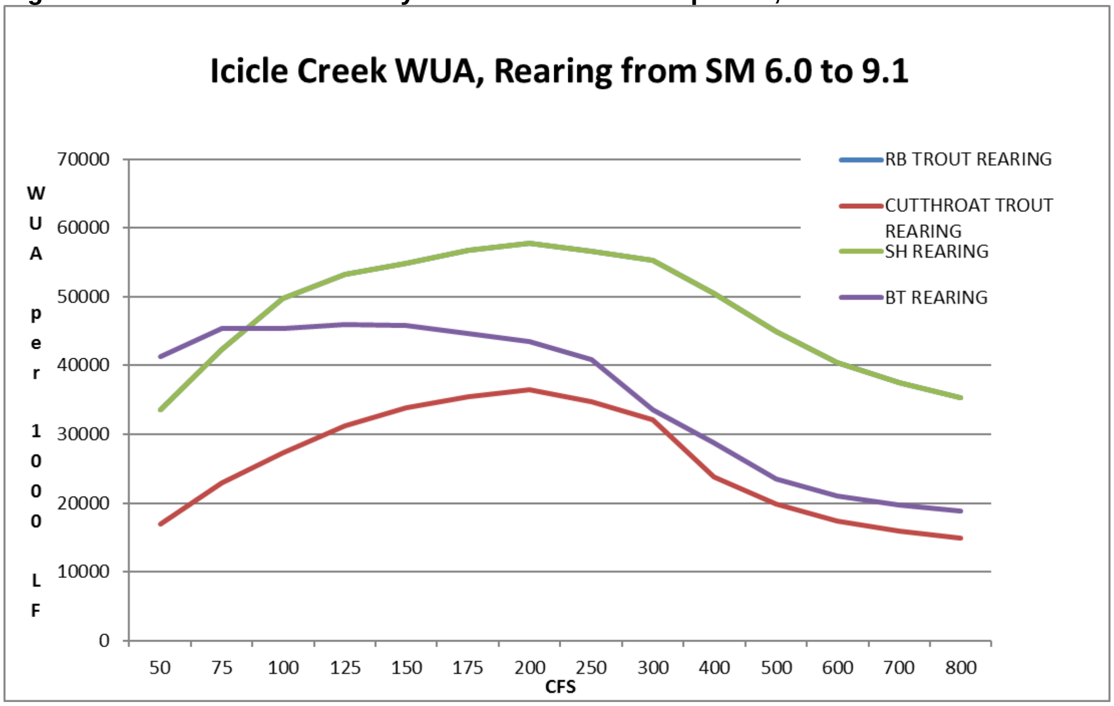
For each reach, the ICIFS summarized available habitat flow relationships for likely target species by reach as weighted usable area (WUA) by reach (Figures 1-5a through 1-5e). WUA is the stream surface area weighted by habitat suitability variables, such as velocity, depth, and substrate.

Figure 1-5a. Available Habitat by Flow for Focal Fish Species



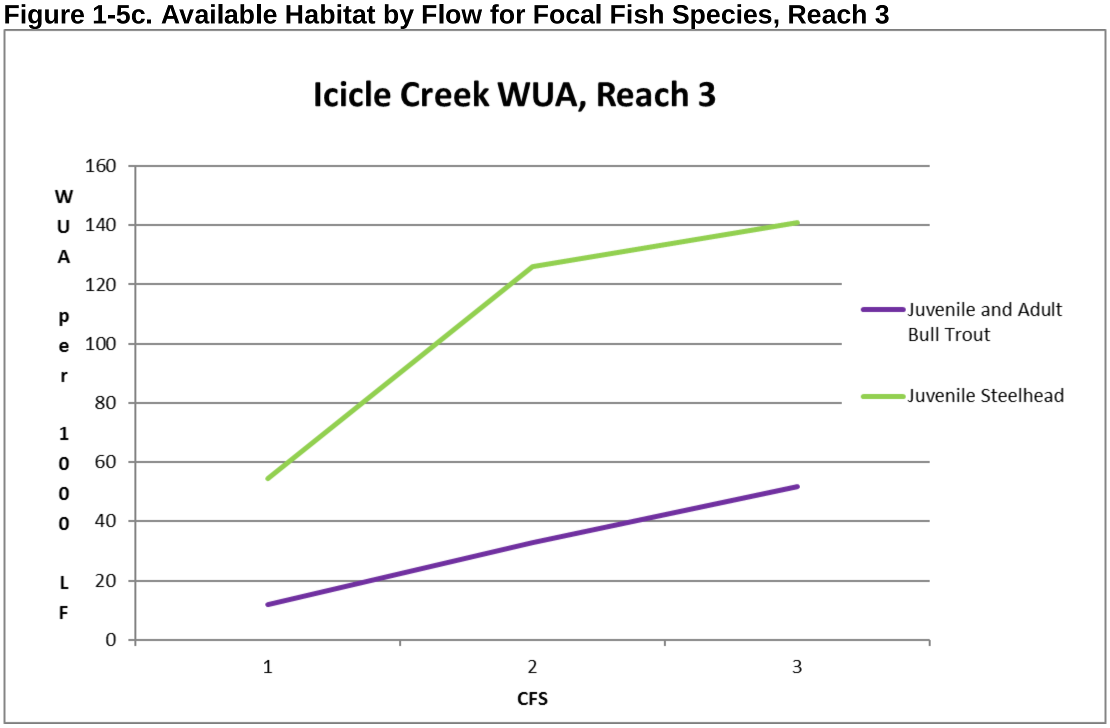
Notes: CFS = cubic feet per second; RB = Rainbow Trout; SH = Steelhead

Figure 1-5b. Available Habitat by Flow for Focal Fish Species, Reach 1 and 2



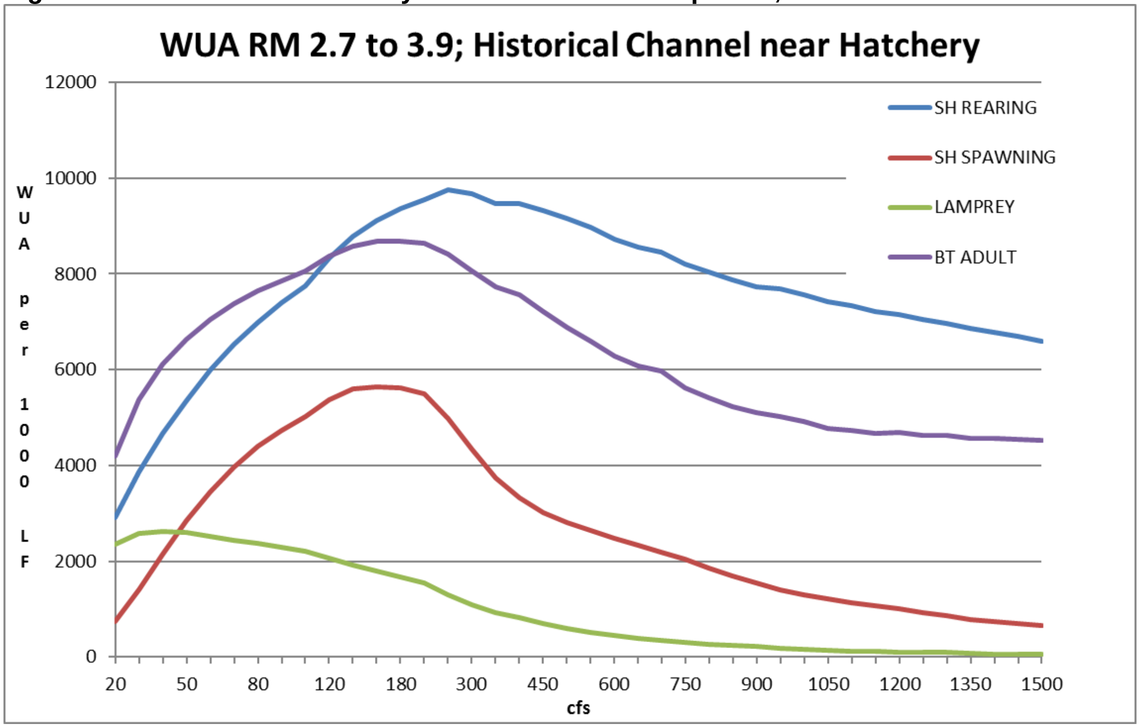
Source: US Army Corp of Engineers, 1985
Notes: LF = linear feet; BT = Bull Trout

Figure 1-5c. Available Habitat by Flow for Focal Fish Species, Reach 3



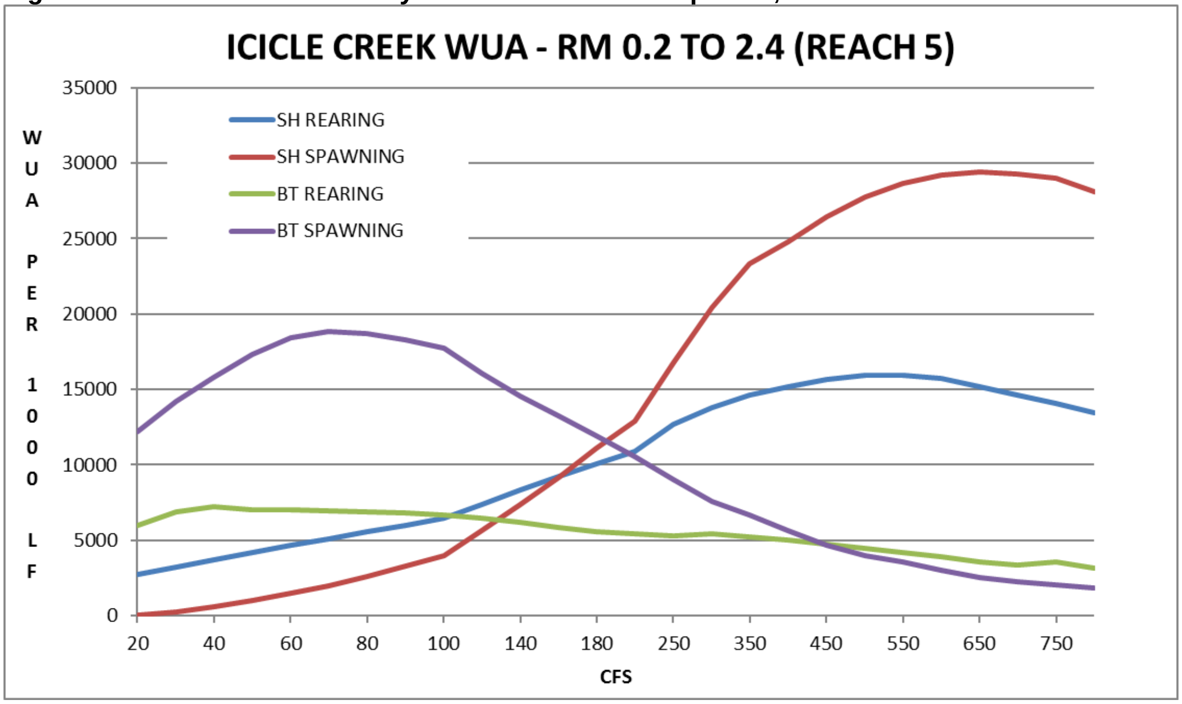
Source: Montgomery, 2004

Figure 1-5d. Available Habitat by Flow for Focal Fish Species, Reach 4



Source: USFWS, 2013

Figure 1-5e. Available Habitat by Flow for Focal Fish Species, Reach 5



Source: USBOR, 2005

After considering all of this information, the ICIFS decided to select a key reach of the river, fish species, and fish life stage on which to base flow recommendations. This approach presumed that if projects were constructed that met that reach/fish/life stage pairing, then the health of the rest of the Icicle Creek fishery would also be proportionately improved. Flows necessary to improve steelhead rearing in the historical channel (Reach 4) became the reference to evaluate flow improvement targets.

Maximum habitat benefit (100 percent WUA) for steelhead rearing in Reach 4 would be achieved with a flow of 250 cubic feet per second (cfs) and the IWG adopted this as their long-term goal. However, the IWG recognized a diminishing return on investment above 100 cfs when considering additional habitat achieved for each 1 cfs of flow improvement. The IWG also recognized that funding may be a constraint, at least initially, to achieve the highest level of flow improvement. Therefore, the IWG endorsed an initial flow restoration target of 100 cfs, which increases WUA by nearly four-fold compared to the current low flow scenarios, while maintaining the long-term restoration goal of 250 cfs.

1.5.1.2 Improve Sustainability of LNFH

The IWG recognizes that improving sustainability of LNFH is important to the watershed. This includes ensuring the hatchery provides healthy fish in adequate numbers, is resource efficient, achieves improved water quality, and does not impede fish passage. In determining metrics for this Guiding Principle, the IWG deferred to fish production goals established in U.S. v. Oregon, which is an ongoing federal lawsuit regarding fishing rights, and consulted with Work Group members who have expertise in hatchery operations, ichthyology, and watershed processes. Additionally, concurrent with the adoption process of a Guiding Principle for a sustainable hatchery by the IWG, NOAA Fisheries was developing a new biological opinion for the hatchery, which is discussed in more detail in Section 1.5.2.

Based on the instream flow and habitat restoration goals, and the potential for conservation and source upgrades at the hatchery that would assist in maximizing fish health, the IWG set several metrics for this Guiding Principle. These metrics include a water conservation goal of 20 cfs to be left in the historical channel, operating/modifying the passage barriers at Structure 2 and LNFH diversion (called Structure 1) to minimize passage impediments, and ensuring cool, pathogen-free water for hatchery operations. The location of Structure 2 and LNFH diversion are provided on Figure 1-1.

1.5.1.3 Protect Treaty/Non-treaty Harvest

The fishery of the Lower Icicle Creek is a traditional fishing site for the Yakama and Colville Tribes (Wenatchi band) traditionally known as the Wenatshapam fishery. Both tribes exercise federally recognized fishing rights at this location, targeting adult Chinook salmon returning to the LNFH, generally from May to late July. The Wenatshapam fishery serves as important cultural and subsistence resources, and is one of the few locations in the Upper Columbia River where tribal spring Chinook harvest occurs. The rights of the Yakama and Wenatchi band to the Wenatshapam fishery has been upheld and affirmed in US v. Oregon. All changes to water management in Icicle Creek must maintain this fishery.

In addition to the tribal fishery on Icicle Creek, the area is popular for recreational fishing. Consequently, the IWG has set protecting the non-treaty fishery as a Guiding Principle of the

Work Group. Trout fishing occurs in the stream from near the IPID footbridge to Leland Creek, and throughout the Leland Creek catchment. The trout fishery is open from late May through the end of October and the primary trout species caught is rainbow trout. There is also a non-tribal, hatchery spring Chinook season that occurs on Icicle Creek from mid-May through July when the number of returning salmon are sufficient to meet broodstock collection goals at the LNFH. The average number of anglers participating in the spring Chinook fishery is approximately 2,688 (WDFW Creel Survey, 2016). WDFW does not conduct surveys of the trout fishery, so the average number of participating anglers is unknown.

Generally, the flow and habitat improvements endorsed by the IWG in other Guiding Principles were thought to have a neutral to positive effect on the tribal and non-tribal fishery. However, over the past several years, there have been documented declines in catch per unit effort (CPUE) in the tribal harvest. Per data provided by the Yakama Nation, tribal harvest peaked in 2001, and has been declining since. Catch numbers from 2014 indicate a 90 percent decline from the 2001 peak harvest (Table 1-3). As such, any further modifications to Icicle Creek could have unintended consequences and would need to be monitored closely. Therefore, the IWG sponsored some initial evaluations (e.g., a bathymetry survey of the current fishing area and sediment transport study) and included an adaptive management program as part of the Guiding Principles to ensure that this important fishery is not adversely affected.

Table 1-3
Icicle Creek Spring Chinook Fishery

Return Year	Trapped @ Hatchery	Sport Harvest	YN Harvest	CCT Harvest	Percent Tribal Harvest	Remaining in River	Total Run
1999	2,103	108	175		7.2	45	2,431
2000	4,457	1,606	3,238		34.2	163	9,464
2001	6,259	2,260	5,075		33.6	1,488	15,082
2002	6,459	1,201	3,796		30.9	828	12,284
2003	4,825	935	1,852		22.7	549	8,161
2004	2,308	347	863		23.1	214	3,732
2005	2,560	103	1,063		28.0	67	3,793
2006	1,957	529	588		18.7	73	3,147
2007	1,708	115	751		28.6	48	2,622
2008	3,229	347	1,036		21.2	283	4,895
2009	3,232	640	617	210	13.2	195	4,684
2010	11,307	993	683	310	5.2	237	13,220
2011	4,970	873	233	365	3.8	77	6,153
2012	3,749	971	287	123	5.6	131	5,138
2013	2,094	323	42		1.6	134	2,593
2014	4,375	TBD	547		10.4	357	5,279

Note – all fish are of hatchery origin
YN = Yakama Nation; CCT = Colville Confederated Tribes
Blank boxes represent absence of data

1.5.1.4 Improve Domestic Supply

For long-term economic and water security for both urban and rural residents, and to settle existing litigation between the City of Leavenworth and Ecology, the IWG made meeting current and future domestic water supplies through at least 2050 a priority.

To determine domestic need through 2050, the IWG relied on the Wenatchee Watershed Plan (2006) to predict rural development in the Icicle Creek Subbasin. The Wenatchee Watershed Plan, projected 31 new homes in the Icicle Creek Subbasin through 2014. The Wenatchee Watershed Plan predicted demand in the Icicle subbasin for additional rural development at 4.7 homes per year. From 2014 to 2050 (36 years), approximately 169 additional homes are anticipated for this time period. The total projected rural residential demand through 2050 is 200 homes. Based on average indoor use of 200 gallons, as estimated in the Wenatchee Watershed Plan, and an estimated consumptive outdoor water use during the critical low flow month of September of 0.15 acre-feet (Aspect, 2013), the per unit rural domestic demand is 0.37 acre-feet per unit. The total rural domestic demand through 2050 is estimated at 74 acre-feet.

The water need for the City of Leavenworth was determined in two phases. The first phase was the determination of current need, as demonstrated in litigation over water rights with the Department of Ecology. This litigation is over the rights to 800 acre-feet of water. The second phase was to determine the future demand through 2050 using the City of Leavenworth Water System Plan (2011). This plan predicts the additional future water need at 867 acre-feet. Based on the average per unit use of 304 gallons per day, or 0.34 acre-feet per year (Water System Plan, 2001), this would provide water to 2,546 new residential and commercial connections (Table 1-4). The total water needed to meet future demand thru 2050 in the City of Leavenworth is 1,667 acre-feet.

Table 1-4
Projected Municipal & Domestic Water Demand through 2050

	acre-feet/unit[1]	Projected & Current Need (acre-feet)	Total Additional Units
City of Leavenworth	0.34	1,667	2,546
Exempt Wells, Icicle Basin[2]	0.37	74	199

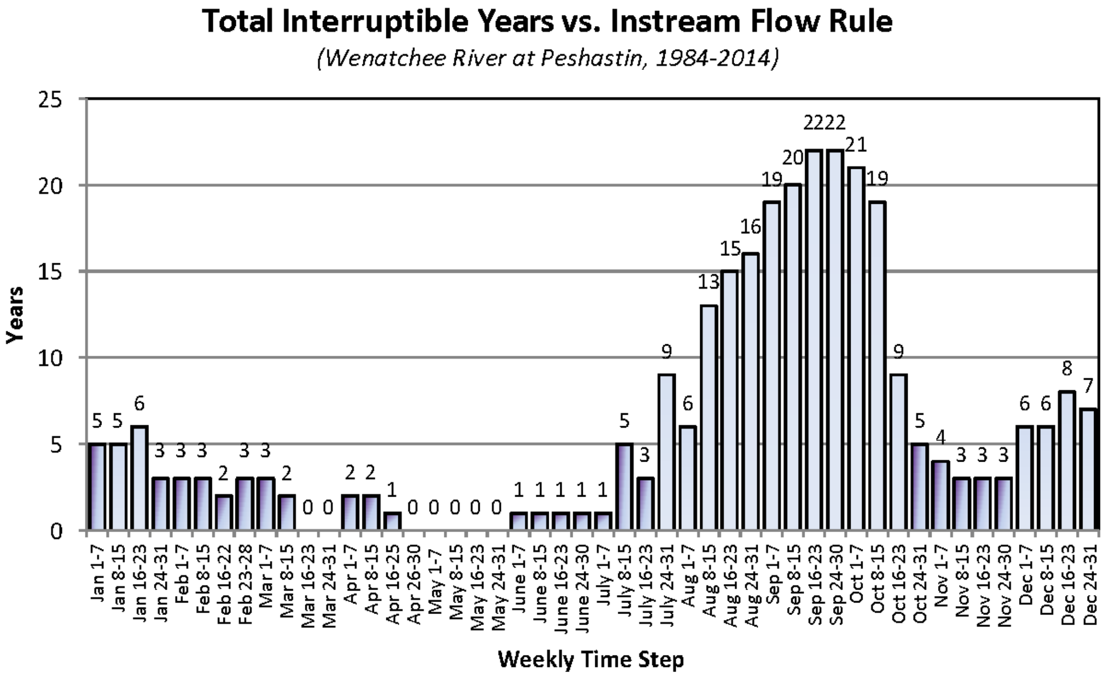
[1]City of Leavenworth gpd/unit is the City of Leavenworth Water System Plan (2011)

[2]Exempt Wells use is Wenatchee Reserve Account Review (Aspect Consulting, 2013)

1.5.1.5 Improve Agricultural Reliability

Improving agricultural reliability is focused on giving interruptible water users a firm water supply. An interruptible water user is a water user whose water right has a later priority date than the instream flow rule, making the water right junior to the instream flow rule. An instream flow rule, which is discussed in more detail in Section 1.4.2, is a water right to protect environmental flows in a river or stream. If a water right is junior to the instream flow rule, it can only be used when the instream flow rule is met. In Washington water law, a water user can only exercise their water right when senior water rights in the basin are fully satisfied. To determine the extent of the interruptible water user issue, we reviewed all water right holders with an interruptible provision within the Wenatchee Basin and found 47 interruptible water users. Of these 47 interruptible rights, 34 have irrigation as a purpose of use. This equates to 5.6 cfs and 1,150 acre-feet per year. Figure 1-6 shows when and how often the instream flow rule is not met and interruptible water users are told to cease diversions in the Wenatchee Basin (bars represent number of interruptions for a specific week out of a 30-year record (1984-2014)).

Figure 1-6. Time Frame and Frequency Instream Rule is Not Met in the Wenatchee River



In addition to providing water to interruptible water users, the IWG decided to look for opportunities to improve infrastructure and operations for agricultural water users with major diversions on Icicle Creek. These infrastructure improvements have focused on modernizing and repairing the dams owned and operated by IPID, and improving operations for COIC. These infrastructure improvements add to long term reliable water supplies for agriculture users especially in drought years when use has been curtailed, which endangers commercial agriculture.

1.5.1.6 Enhance Icicle Creek Habitat

The IWG adopted habitat enhancement as a Guiding Principle in response to recommendations for habitat and passage improvements in the Wenatchee Watershed Plan. To identify potential habitat and passage improvements the IWG relied on their ICIFC to conduct a reach-by-reach assessment of passage barriers and habitat conditions. This reach-by-reach approach resulted in identifying the boulder field located at RM 5.6 and several structures related to operations of LNFH as passage barriers. The LNFH passage barriers include Structure 5, Structure 2, and Structure 1, however some of these barriers have dual functions. For example, Structure 5 is an intentional barrier that protects the tribal fishery, another Guiding Principle. Similarly, Structure 2 protects the historical channel from flows above 2,600 cfs that would otherwise degrade existing habitat. The IWG considered options on where barriers should be considered for modification, removal, or retention given, in some cases, their multi-purpose functions.

Additionally, the group identified several habitat improvement opportunities in lower Icicle Creek and the historical channel (Reach 4 and Reach 5). Chelan County and the IWG have commissioned more habitat and passage studies to identify and prioritize habitat restoration and passage improvement projects, which are discussed in the *Lower Icicle Creek Geomorphic and Hydraulic Assessment for the Identification of Protection and Restoration Actions* prepared by Natural Systems Design for the County (Natural Systems Design, 2017).

1.5.1.7 Comply with State and Federal Law, and Wilderness Acts

All actions taken by the IWG must comply with state and federal law. All members of the Work Group agreed that a project cannot move forward if it is out of compliance with laws. Laws of specific interest include:

- The Wilderness Act
- The Alpine Lakes Area Management Act
- The Clean Water Act
- Magnuson-Stevens Fishery Conservation and Management Act
- Fish and Wildlife Coordination Act
- National Historic Preservation Act
- Chapter 90.03 RCW – State Surface Water Code
- Chapter 90.44 RCW – State Groundwater Code
- Chapter 77.57 RCW – Fishways, Flow, and Screening

Table 5-1 in Section 5.3 provides a complete list of permits and laws applicable to the proposed projects under the Icicle Strategy, and Section 1.9 describes permits, actions, and laws related to the Icicle Strategy.

1.5.2 Final Guiding Principles

The result of the processes described above was the fine-tuning of the Guiding Principles into what they are today. As discussed above, this involved combining some principles, adding qualitative descriptions, and adding quantitative metrics. Below is the description of the IWG's Guiding Principles today, after 3-years of scientific study and negotiation.

1.5.2.1 Improve Instream Flow

This principle seeks to improve and enhance instream flows in the Icicle Creek historical channel. The goal is to modulate the flow in a way that enhances fish passage, fish life and promotes healthy habitats, serves channel formation function, meets aesthetic and water quality objectives, and is resilient to climate change.

The metric for this principle calls for drought year and non-drought year minimum flows, as well as an interim and long-term flow restoration goal.

During drought years, the instream flow goal is set at 60 cfs. To meet drought year goals, a minimum of 40 cfs will need to be protected instream, assuming a drought year base flow of 20 cfs.

The short-term, non-drought year goal is 100 cfs minimum flows, which would provide 90-percent WUA for steelhead. The long-term goal was set was at 250 cfs (100 percent WUA for steelhead). A maximum flow of 2,600 cfs can pass through Structure 2. Based on work conducted by the IWG's Instream Flow Subcommittee, this flow maximum will remain in place to preserve habitat function.

1.5.2.2 Improve Sustainability of LNFH

This principle aims to enhance and maintain a healthy, sustainable LNFH that produces fish in adequate numbers to meet U.S. v. Oregon, which specifies fish production requirements. Meeting this goal requires sufficient, diverse water source availability to maximize fish health, with groundwater supplies providing cool, pathogen free water. This principle calls for a 57 cfs supply for fish production from groundwater and surface sources. This principle also calls for LNFH to conserve at least 20 cfs compared to current usage. It also includes appropriately screened diversions and minimizing unintended barriers to fish passage.

1.5.2.3 Protect Treaty/Non-treaty Harvest

Treaty harvest by the Yakama Nation, the Colville Confederated Tribes, and non-treaty fishing are important parts of the Icicle Creek Subbasin. This principle maintains that tribal and non-tribal, federally protected fishing and harvest rights must be met at all times regardless of season or drought conditions. It aims to improve the CPUE and maintain multispecies harvest opportunities.

As part of this principle, the IWG is developing a Tribal Impacts Assessment and Adaptive Management Plan that addresses attraction flows, sediment transport, fish migration/straying, and site access and amenities.

1.5.2.4 Improve Domestic Supply

As the population inside the Icicle Creek Subbasin grows, more water will be needed by the City of Leavenworth and surrounding areas in Chelan County. This principle calls for 1,750 acre-feet of reliable year-round supply, with 2.5 to 5 cfs for peaking. Additionally, this principle aims to improve domestic reliability for rural water users in the Icicle Creek Subbasin who depend on domestic wells to supply their drinking water.

1.5.2.5 Improve Agricultural Reliability

With agriculture vital to the economic health and prosperity of the region, this principle calls for projects to improve agricultural reliability that are operational, flexible, decrease risk of drought impacts, and are economically sustainable. It ensures current interruptible agricultural users have a firm supply in average water years.

1.5.2.6 Enhance Icicle Creek Habitat

This principle seeks to improve ecosystem health by protecting and enhancing aquatic and terrestrial habitat in the Icicle Creek Subbasin. This includes investments in physical habitat improvements that consider high-flow habitat and low-flow refuge, along with minimizing impediments to fish passage and improving limiting factors for spawning/rearing. It also offsets project-related terrestrial impacts with land acquisitions/easements.

1.5.2.7 Comply with State and Federal Law, and Wilderness Acts

Projects developed under the Icicle Strategy must comply with both Washington State and federal laws, including the Wilderness Act of 1964, the Alpine Lakes Wilderness Act of 1976, and the Alpine Lakes Wilderness Management Plan of 1981. The IWG actively identified and engaged regulators in the process of creating the alternatives and projects for the Icicle Strategy. Section 1.9 provides a more detailed description of applicable permits and laws.

1.5.3 Current Water Resources Conditions in the Icicle Subbasin

Seasonal low flows in lower Icicle Creek between the major diversions and the hatchery return are a common problem. Figure 1-7 shows low flow conditions that commonly occur during late summer. These low flows diminish water quality and limit habitat diversity for salmonids and are the leading issues in the Icicle Creek Subbasin. Water withdrawals in Icicle Creek (primarily between Rat Creek and the hatchery) likely contribute to low flows and high summer temperatures in lower Icicle Creek. Icicle Creek has exceeded state and federal water quality standards for temperature and dissolved oxygen (DO)/pH. Salmonid populations are at risk because of limited habitat diversity and quantity, obstructions, and increased sediment loads. The change in the landscape and vegetation after the 1994 Rat Creek Fire has contributed to increased sediment loads in Icicle Creek (MWG, 2006).

Figure 1-7. Low Flows at Structure 2 in 2015 (16.4 cfs)

As described in the previous section, Chapter 173-545 WAC sets flow requirements in lower Icicle Creek. Additionally, Chapter 173-545 WAC provides for a reservation of water for future uses. Based on Chapter 173-545 WAC, the control point for stream flow targets in the Icicle Subbasin is at the East Leavenworth Bridge. This control point is monitored by Ecology Gage 45B070. There is also a USGS gage located upstream of the major water right diversion at RM 5.8. All water rights issued after the establishment of the instream flow rule are considered junior to the rule and must not be exercised when instream flows at the Ecology gage are not met (unless the water right is debited from the reserve).

1.6 Prior Investigations and Activities in the Icicle Basin

This PEIS builds on a foundation of historical planning and scientific studies completed in the Icicle Subbasin. The following sections provide brief summaries of this work, which is incorporated by reference into this evaluation. The References section at the end of this document can be used to obtain greater detail.

1.6.1 Watershed Plan

As previously discussed, the Washington State Legislature passed the Watershed Management Act (formed under ESHB 2514; Chapter 90.82 RCW) in 1998. Chelan County, the Wenatchee Reclamation District, and the City of Wenatchee assembled late in 1998 and determined they would pursue watershed planning under Chapter 90.82 RCW. The Wenatchee Watershed Planning Unit (WWPU) formed in 1999; Chelan County was designated Lead Agency for grant management purposes and to provide administrative, facilitation, and technical support to the process. Participation on the WWPU has always been open to include “anyone who has an interest in the Wenatchee River Watershed” (WWPU, 2003). Active Planning Unit members are grouped as governmental or non-governmental based on their ability to implement specific and tangible elements of the plan. Much of the watershed planning work in WRIA 45 has been (and continues to be) performed by several key technical subcommittees under the direction of the Planning Unit. These committees address technical and policy issues associated with each of the technical elements and develop alternative approaches for the Planning Unit’s consideration. The Water Quantity/Instream Flow/Water Storage, Water Quality, and Habitat Technical Subcommittees include a broad range of representation from those with special technical expertise or an interest in the subject area.[4]

The Wenatchee Planning Unit produced the Wenatchee Watershed Plan in 2006. This plan identifies issues with water quality, water quantity, instream flow, and habitat within the watershed and provides recommendations for addressing those issues. The Planning Unit produced a Detailed Implementation Plan in 2008 to provide implementation

[4] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/Wen_Planning/Wen_Watershed_Plan/text/final_watershed_plan.pdf

pathways for the recommendations in the Watershed Plan. The Planning Unit has also commissioned several reports and studies to address water management in the basin.

1.6.2 Biological Opinion

In 2006, a Biological Assessment (BA) for Operation and Maintenance of LNFH was conducted by the U.S. Fish and Wildlife Service (USFSWS, 2006). The focus of the BA was to provide updated information on the hatchery's operation and maintenance, and an updated assessment on the potential effects of the hatchery on federally listed, proposed, and candidate species as well as designated critical habitat. The BA outlined the project location, affected action area, foreseeable future actions in the Icicle Creek Watershed (including the Icicle Creek Restoration Project and LNFH's Water Supply System Rehabilitation Project), operation and maintenance of the LNFH (historical and current), description of species and critical habitat, current condition of the habitat, integration of species and habitat condition, analysis of potential effects to ESA-listed species, analysis of potential effects to the current condition of the habitat, cumulative effects, and effect determination and response requested. The critical species and habitat included bull trout. The BA included an assessment of the current condition of the habitat, including water quality, habitat access and elements, channel condition and dynamics, flow and hydrology, and watershed conditions. The results of the assessment indicated that of the species and habitat considered, the bull trout habitat had an indicator of degraded and was determined to be adversely affected by current LNFH operations. This resulted in formal consultation with Nation Marine Fisheries Service (NMFS).

The most recent consultation with NMFS resulted in a Biological Opinion published in May 2015. Key proposed operations, maintenance, and construction at LNFH required in this Biological Opinion included:

- Install recirculating aquaculture system (RAS) tanks to reduce surface water needs
- Reduce surface water diversions by as much as 20 cfs annually
- Work towards collective instream flow goal of 100 cfs in Icicle Creek
- Evaluate to determine the efficiency and scope of expanded use of Snow Lake and Nada Lake Supplemental Reservoirs as a means to ensure flow for the LNFH's surface water right and improve instream flows outside of the current supplementation period
- Reduce use of Structure 2 for recharge by exploring effluent pump back and development of well fields
- Discontinue use of Structure 2 for aquifer recharge in August
- Limit diverted quantities at Structure 2 if certain flow requirements aren't met in September
- Limit use of Structure 2 in March when adult steelhead are detected
- Screen Structure 1 so it meets current NMFS screening standards

Many of these elements were integrated into the Guiding Principle for a sustainable LNFH (Section 2.1.2.2). The Biological Opinion set an 8-year timeline to accomplish these upgrades. However, LNFH and NMFS have re-opened consultation and are preparing a new Biological Opinion as a result of the Wild Fish Conservancy v. Irving case, which concluded in the U.S. District Court, Eastern District of Washington remanding the Biological Opinion for not fully considering climate change.

1.6.3 Habitat, Passage and Instream Flow Studies

Several entities have worked on or commissioned reports regarding fisheries and instream flows in the Icicle Subbasin. These entities include Chelan County, Ecology, LNFH, as well as numerous local and non-profit organizations. These investigations are summarized in this section. Full reports can be accessed from Chelan County's Icicle Work Group webpage.[5]

1.6.3.1 Icicle Water Temperatures (All Reaches)

There are several salmonid species in lower Icicle Creek that could be impacted by changes in water temperature. Bull Trout require cooler water than most other salmonid species, preferring temperatures between 9 and 13 °C. Other salmonids found in lower Icicle Creek have a tolerance for higher temperatures, being found in waters up to 22 °C (Ringel, 2007).

USFWS' Mid-Columbia River Fisheries Resource Office (MCRFRO) has monitored water temperature in Icicle Creek since 2005 when Ecology set a temperature Total Maximum Daily Load for Temperature (TMDL) to evaluate the impact of LNFH operations on stream temperatures (Ecology, 2005[6]; Fraser, 2015). Temperature loggers are deployed upstream, adjacent, and downstream of LNFH and in two tributary streams (Snow Creek and Jack Creek) (Hall and Kelly-Ringel, 2011).

For the Wenatchee Basin, mean summer and 7-Day Average Daily Maximum (7DADmax) values were calculated for each site and day using the running average of the previous 7 days (Hall and Kelly-Ringel, 2011). Between 2005 and 2010, the warmest mean high 7DADmax overall was 20.4 °C (range 19.4 to 22.1 °C), occurring in the Wenatchee River. The warmest mean high 7DADmax within Icicle Creek was 19.4 °C (range 18.9 19.8 °C), occurring downstream of the LNFH. The warmest mean high 7DADmax upstream of LNFH influence was 18.5 °C (range 17.4 to 19.8 °C) occurring upstream of Snow Creek.

The summer season coolest mean high 7DADmax of 15.8 °C (range 14.7 to 17.3 °C) occurred in Jack Creek. Within the LNFH operational influence, the summer season coolest mean high 7DADmax of 16.9 °C (range 16.2 to 18.3 °C) occurred in the LNFH spillway pool. In Snow Creek, the mean high 7DADmax for the years sampled was 17.3 °C (range 15.9 to 18.5 °C).

[5] http://www.co.chelan.wa.us/natural-resources/pages/icicle-work-group?parent=Planning
[6] https://fortress.wa.gov/ecy/publications/documents/0503011.pdf

1.6.3.2 Instream Flow Study and Report for Icicle Creek (Reach 1)

In 1985, the U.S. Army Corps of Engineers produced an instream flow study in support of a hydropower feasibility study on Icicle Creek. This study used Instream Flow Incremental Methodology (IFIM) to study flows and consider the potential impacts to fish habitat that could occur as a result of changes in instream flow caused by the potential project. The primary species of interest for this report were rainbow trout, cutthroat trout, brook trout, and bull char (bull trout). The results found that some spawning and juvenile habitat occurs in Reach 1 for all species listed above. Table 1-5 provides details of optimum flows for each species in Reach 1.

Table 1-5
Optimum Flows by Species and Life Stage for Reach 1

Species	Life Stage	Optimum Flow (cfs; approx.)
Rainbow Trout	Spawning	400
	Adult	500
	Juvenile	200
Cutthroat Trout	Spawning	400
	Adult	250
	Juvenile	200
Brook Trout	Spawning	400
	Adult	100
	Juvenile	100
Bull Trout	Spawning	400
	Adult	125
	Juvenile	125
Whitefish	Spawning	300
	Adult	500
	Juvenile	200
Steelhead	Spawning	400
	Adult	-
	Juvenile	200
Spring Chinook	Spawning	250
	Adult	-
	Juvenile	175

1.6.3.3 Icicle Creek Boulder Field Fish Passage Assessment (Reach 2)

In 2013, EcoAssets and Trout Unlimited produced an assessment of passage at the boulder field (RM 5.6). The purpose of this study was to document the extent of anthropogenic impact on fish passage and identify fish passage options at this location. The study found that the “Anchor Boulder”, which is the largest boulder in the boulder field, is the primary impediment to passage in this reach. The study also found evidence that there are anthropogenic impacts on the development of the boulder field and suggested several alternatives to improve passage, including channel profile adjustment, roughened channel, various types of fishways, and constructed riffle.

1.6.3.4 Icicle Creek Target Flows (Reach 3)

Montgomery Water Group produced a report in 2004 for LNFH on target flows. The purpose of the report was to summarize the analysis of target flows for the reach of Icicle Creek downstream of the LNFH diversion (Reach 3) because of low flows during late summer. The primary concerns with flow through this reach were passage and rearing habitat. This study found that passage is likely in Reach 3 at flows as low as 20 cfs, which was consistent with the findings of a similar report produced in 2001 (USFWS, 2001). This study also found that maximum habitat benefit was likely for adult and juvenile bull trout and steelhead at 291 cfs. However, an optimal flow was not estimated for this reach because of data gaps.

1.6.3.5 Icicle Creek Fish Passage Evaluation for the Leavenworth National Fish Hatchery (Reach 4)

In 2013, the U.S. Fish and Wildlife Service conducted a fish passage evaluation for the LNFH to characterize physical and hydraulic conditions associated with a range of streamflow's at Structures 1, 2, and 5, and open-channel flows in the historical channel in Icicle Creek adjacent to the LNFH (Anglin et al., 2013). These structures are used to operate LNFH: Structure 1 is the surface water diversion located at RM 4.5, Structure 2 bifurcates flows at RM 3.9 to direct part of Icicle Creek into the hatchery channel for groundwater recharge and some into the historical channel, and Structure 5 is a barrier structure operated for broodstock collection and to impede upstream migration during tribal harvest.

Results of this study indicated variable limitation of fish passage associated with unique conditions involved with each structure or location. Passage criteria, species periodicity, and stream flows ranging from 90 percent to 10 percent exceedance flow (Icicle Creek) were integrated by month to identify depth and velocity passage limitations at the structures and in the historical channel. Detailed tables were generated to allow managers and stakeholders to determine when passage limitations occur, and whether options exist to eliminate barriers or improve passage conditions at these sites. Because fish passage is not a binary situation, interpretation of the results and development of improved fish passage options should be conducted jointly by technical experts, managers, tribes and other stakeholders to determine actions that will meet the multiple goals for Icicle Creek.

Key outcomes of this study included the installation of independent radial gates and the re-operation of Structure 2 to improve passage, continuation of capturing and moving non-target fish species at Structure 5, as well as velocity targets at both structures. Additionally, this report suggested improvements to the design and location of the fishway at Structure 1 and recommended maintaining 60 cfs in the historical channel for improved passage conditions.

1.6.3.6 Lower Icicle Creek Reach Assessment (Reach 5)

In 2005, USBR produced an Instream Flow Assessment of Icicle Creek, Washington. The purpose of the study was to characterize the relationship between stream flow and fish habitat in Icicle Creek downstream from the LNFH (Reach 5). This assessment included a Physical Habitat Simulation (PHABSIM) and IFIM to assist the Planning Unit with instream flow recommendations for Icicle Creek. The primary outcome of this report was WUA charts for each life stage and species of interest. The study found optimum flow between 70 cfs (bull trout) and 670 cfs (steelhead) for spawning species of interest, and approximately 50 cfs (bull trout) and 240 cfs (steelhead) for juvenile species of interest.

In 2017, a geomorphic and hydraulic assessment of the lower 4.3 miles of Icicle Creek, starting from the confluence with the Wenatchee River and extending up-valley through the Historic Channel at the LNFH, was completed to provide a scientific basis for identification and development of stream restoration and protection actions for lower Icicle Creek (NSD, 2017). The assessment included a review of background information, field surveys, and computer modeling to characterize existing conditions. Hydraulic modeling used to evaluate reach hydraulics and floodplain connectivity incorporated bathymetric survey data and floodplain topography based on 2015 LiDAR data. Habitat Suitability Modeling examined the value of existing habitats related to juvenile Chinook salmon and steelhead rearing, and adult steelhead spawning.

Results of this assessment found that rearing habitat in lower Icicle Creek is poor and limited by lack of cover due to widespread loss of large wood in the system and lack of connectivity to off-channel habitat areas during high flows. The assessment identifies and prioritizes project opportunities by sub-reach designed to protect existing floodplain, increase rearing habitat by providing cover and improving floodplain connectivity, and restore riparian vegetation.

1.6.4 Climate Change

The IWG is considering whether the Guiding Principles can be met in response to long-term changes in water supply associated with climate change. Four climate change evaluations are considered in this PEIS, including work by USFS, OCR/WSU, the Icicle Watershed Council/Trout Unlimited, and the UW Climate Impacts Group. Below is a summary of these reports. Section 3.12 discusses climate in more depth.

1.6.4.1 USFS Report

The USFS published a report on climate change in the North Cascades region in 2014 to better understand upcoming resource management issues related to climate change in the North Cascades. In the Pacific Northwest, the current warming trend is expected to continue, with average warming of 2.1 °C by the 2040s and 3.8 °C by the 2080s; precipitation may vary slightly, but the magnitude and timing are uncertain. This warming will have far-reaching effects on aquatic and terrestrial ecosystems. Hydrologic systems will be especially vulnerable as North Cascades watersheds become increasingly rain dominated, rather than snow dominated, resulting in more autumn/winter flooding, higher peak flows, and lower summer flows. This will greatly reduce suitable fish habitat, especially as stream temperatures increase above critical thresholds. In forest ecosystems, higher temperatures will increase stress and lower the growth and productivity of lower elevation tree species on both the western and eastern sides of the Cascade crest, although growth of high elevation tree species is expected to increase. Distribution and abundance of plant species may change over the long term, and increased disturbance (i.e., wildfire, insects, and invasive species) will cause rapid changes in ecosystem structure and function across broad landscapes, especially on the east side of the Cascades. This in turn will alter habitat for a wide range of animal species.

1.6.4.2 Columbia River Basin Long-term Supply and Demand Forecast Report

OCR has a legislative mandate to produce a Supply and Demand Forecast once every 5 years to understand future water supplies and demands that factors in changes to climate, regional and global economics, Columbia River hydrology and hydropower operations and irrigation practices/technology. Previous editions were published in 2006 and 2011. This section focuses on the 2016 report that provides a forecast to help OCR strategically fund water supply projects by improving understanding of where additional water supply is most needed, now and in the future. This most recent forecast offers a generalized, system-wide assessment of how future environmental and economic conditions will likely change water supply and demand over the next 20 years. The report evaluates surface water supply and demand for the Columbia River Basin, including the Wenatchee Basin. The impacts of climate change, regional and global economic conditions, and state-level water management actions on surface water supplies and irrigation demands were evaluated. Irrigation, municipal, and hydropower demands were forecasted, as well as instream flow requirements for fish stock status and habitat utilization, fish habitat condition, and stream flow. These evaluations were made for the entire Basin as well as by Water Resource Inventory Areas (WRIAs). The current and future forecasts will build on and expand current knowledge and understanding and serve as a planning tool to maintain and enhance the region’s economic, environmental, and cultural prosperity.

Icicle Creek is in WRIA 45 (Wenatchee). The tributary surface water forecast for WRIA 45 is characterized by substantial increases in flow from fall through early spring, and decreases in flow in June and July. Instream flow requirements are the largest water demand, with smaller irrigation demand and even smaller municipal demand. In WRIA 45, the Supply and Demand Forecast predicts a shift in crops, which will increase irrigation demand in May and decrease demand in late summer and fall, with little change in June and July. Modeling of curtailment of interruptible irrigation water rights indicated that curtailment occurred in 90 percent of the years between 1977 and 2006. The forecast shows more frequent and higher magnitude of curtailment events during the early irrigation season. Additionally, there is a predicted 11 percent increase in demand by 2035.

1.6.4.3 Icicle Creek Watershed Council

Icicle Creek Watershed Council (ICWC) has conducted several studies examining the water budget in response to climate change. This work assumed a 35 percent decrease in streamflow (compared to 1994) as a result of climate change. This research found that reductions in streamflow would require additional inputs of up to 60 cfs in September, a critical low flow month, to offset the impacts of climate change in Icicle Creek. Examining the storage available in the upper Icicle Creek Watershed, the ICWC concluded that supplying 60 cfs from storage was possible to offset impacts of climate change with the assumed 35 percent decrease in streamflow.

1.6.4.4 UW Climate Impacts Group Icicle Creek Study

UW Climate Impacts Group issued a report in 2017 that examines the changing streamflow in Icicle and Peshastin Creeks as the result of climate change. The objective was to develop estimates of projected changes in monthly streamflow for the seven alpine lakes and changes in daily streamflow for Icicle and Peshastin Creeks. Projections for the alpine lakes have allowed the IWG to assess the alternatives for managing the reservoirs, which is discussed in detail in Section 3.12 and 4.12. The daily flow projections allow an understanding of changes in extremes (high and low flows) and their implications for water management.

1.6.5 Water Storage

1.6.5.1 Water Storage Report, Wenatchee River Basin

This report provided a summary of potential water storage projects and other water resource management strategies intended to increase water supply and instream flow in the Wenatchee River Basin. The Wenatchee River Basin is part of Ecology's WRIA 45, which is expressed by the drainage basin for the Wenatchee River. The primary water needs in the Wenatchee River Basin include irrigation, municipal and domestic water supply, and instream flows for fish passage and habitat. This report builds on information provided in the Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed (MWG 2006) and other planning studies that have identified opportunities for improved management of water resources in the Wenatchee River Basin. A comparison of the costs and benefits of potential water storage projects with other water management strategies, such as water conservation on irrigation systems and acquisition of water rights, is also included. This report was prepared for Chelan County under a grant from the Columbia River Water Management Development Account administered by Ecology.

This report provides a preliminary summary of potential water storage projects and other water resource management strategies intended to improve the availability of water in the Wenatchee River Basin for both instream and out of stream water needs. This section includes a brief summary of the projects and strategies that were evaluated in this report.[7]

1.6.5.2 Needs and Alternatives Analysis

The Needs and Alternatives Analysis for Icicle Creek Subbasin Storage Study (2007), reviewed reach-by-reach water supplies and demands in the Subbasin. This analysis split Icicle Creek into four reaches. Work by the IWG recognizes five reaches, splitting the reach identified as Reach 3 in this study into two separate reaches, with Structure 2 being the new dividing point. Water needs were estimated by comparing the available water supply to the water demands in the Icicle Subbasin. The water demands include irrigation diversions, municipal and domestic demand, LNFH diversions, and instream flows.

Reach 1, the most upstream reach of Icicle Creek, has little demand because of lack of population in this reach and no other diversions. The primary water demand is the instream flow needs. A surplus of water occurs during the spring melt, while a deficit occurs in August through October during the period of annual low flows. However, the flows in this reach are natural and slightly enhanced by discharge from high alpine lakes operated by the Icicle and Peshastin Irrigation District.

Reach 2 has a large seasonal demand coming from the Icicle and Peshastin Irrigation Districts at their diversion dam (RM 5.7). Reach 2 also contains the City of

[7] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/Basin_Wide_Studies/2011WenStorageRpt.pdf

Leavenworth's surface water diversion (RM 5.7). Snow Creek flows into Icicle Creek in this reach and its water supply was added to the water supply provided by Icicle Creek. A surplus of water occurs during the spring melt, while a deficit occurs in August through October during the period of annual low flows. Slight deficits also occur in January through April. The primary need is for additional water in August and September.

Reach 3 has a large demand from the LNFH and a seasonal demand from the Cascade Orchards Irrigation Company (both at RM 4.5). This reach spans the IWG reaches identified as Reach 3 and Reach 4. Although the LNFH demand is non-consumptive, Reach 3 flow is reduced. This document provides proposed flows for Icicle Creek and do not represent the flow that may be provided by LNFH in this reach as a result of negotiations with USFWS and NOAA Fisheries.

Reach 4 has no major diversions but all non-purveyor domestic water use, and all non-district irrigation use are assumed to take water from Icicle Creek in this reach because the majority of the population is located within this reach. The LNFH outflow adds supply to Icicle Creek at RM 2.7. Domestic irrigation demands are small enough that neither can be visibly seen on the graph. A surplus of water occurs during the spring melt, while deficits occur in August through October during the low flow period. Deficits also occur during the February through April time period due to icing. The primary need is for additional water in August and September.[8]

1.6.6 IPID Pump Exchange

A Pump Exchange project was examined as an alternative water supply to the Icicle and Peshastin Irrigation Districts, moving their Icicle Creek diversion to the Wenatchee River, which would increase streamflow in Icicle and Peshastin Creeks downstream of the current diversions. In 2012, Anchor QEA produced the Peshastin Irrigation District (PID) Pump Exchange Project Appraisal Study (Anchor, 2012) which evaluated five alternatives and selected a preferred alternative (Alternative 1) along with a second (Alternative 5) as a backup. In 2014, Forsgren and Associates produced a report for Trout Unlimited examining six pump station locations for IPID, including those examined in the Anchor report and additional locations at Monitor, the Cashmere Wastewater Treatment Plant, the Cashmere Mill Site, and at the Dryden Reclamation District Diversion. In 2015, Anchor QEA attempted to combine the findings of these studies into a report titled Summary of Additional Analysis, Icicle and Peshastin Irrigation Districts Pump Exchange (Anchor, 2015). The two most feasible plans proposed to pump water from the Wenatchee River immediately west of Dryden, Washington and near Leavenworth, Washington. Although both plans had pros and cons, they were both estimated to cost approximately $8.5 million.

Chelan County received grant funding in 2016 from the Salmon Recovery Funding Board to proceed with preliminary design and feasibility of the pump station. The work proposed under this grant would result in preliminary design of a preferred pump exchange project that would deliver water from the Wenatchee River to the PID Canal to provide instream flow benefit in Peshastin Creek during the late summer. The preliminary design would consider the potential for designing the project to be scalable to

[8] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/Icicle_Studies/DraftNeedsandAlts.pdf

expand delivery to IID to benefit Icicle Creek in the future, if appropriate. The preliminary design work would also evaluate operations and determine whether supplemental flows from the IID Canal could be reduced and whether operational discharges of Icicle Creek water to Peshastin Creek could be reduced.

1.7 Fish Recovery Efforts

The Wenatchee Watershed is home to a variety of aquatic species, including the following salmonids: spring- and summer-run Chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), steelhead/rainbow trout (*O. mykiss*), westslope cutthroat trout (*O. clarki lewisi*), and migratory and resident bull trout (*Salvelinus confluentus*). The documented, presumed, and potential distributions of anadromous salmonids in the Icicle Creek Subbasin are shown in Figure 1-8. Pacific lamprey (*Entosphenus tridentatus*) and re-introduced coho salmon (*O. kisutch*), two species of cultural importance to the Yakama Nation and Colville Confederated Tribes, are also present in the Wenatchee Basin.

Much of the planning, protection, and restoration/enhancement work in WRIA 45 has focused on the needs of salmonids listed under the ESA. Upper Columbia River spring-run Chinook salmon were listed as endangered in 1999 (64 FR 14308), Upper Columbia River steelhead were listed as endangered in 1997 (62 FR 43937) and reclassified as threatened in 2006 (71 FR 834), and Columbia River bull trout were listed as threatened in 1998 (63 FR 31647). NOAA Fisheries adopted the *Upper Columbia Spring Chinook and Steelhead Recovery Plan* (UCSRB, 2007) as its recovery plan for these species. Table 1-6 provides a list of priority projects from the recovery plan, as identified in appendix M1 of the report. As illustrated in the status column, the IWG and their partners have completed several of the identified projects. The USFWS finalized its recovery plan for bull trout in 2015 (USFWS, 2015).

Figure 1-8. Icicle Creek Subbasin Distributions of Anadromous Salmonids

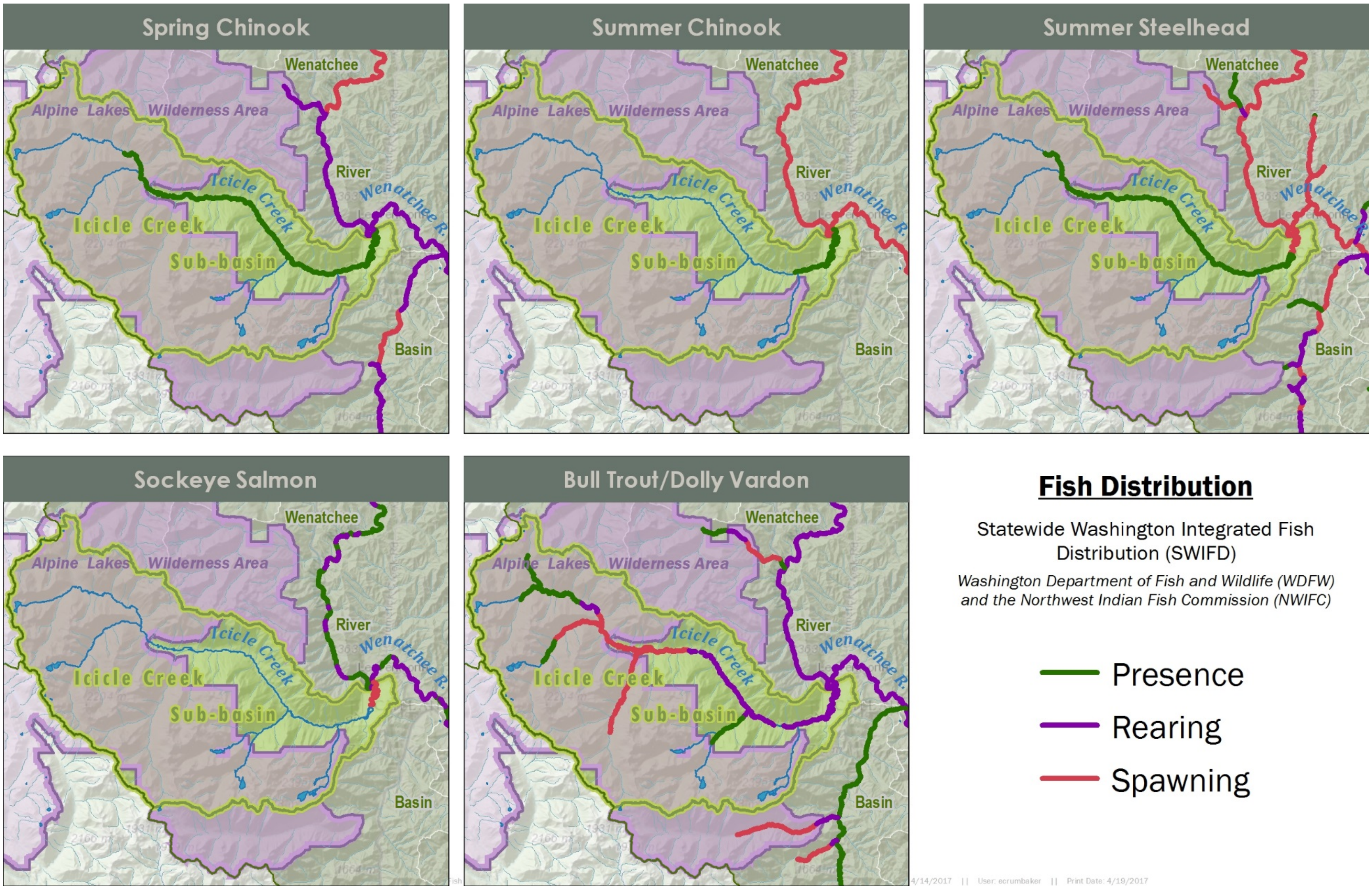


Table 1-6
Icicle Creek Projects Identified in the Upper Columbia Spring Chinook and Steelhead Recovery Plan

Project Name	Status	Ecological Concern
USFWS LNFH Icicle Creek Restoration Project	Active	1 Habitat Quantity - Anthropogenic Barriers
ICTU Icicle Creek Reach Level Analysis	Completed	
CCNRD Icicle Revegetation	Completed	4 Riparian Condition - Riparian Vegetation
CCNRD Wenatchee Instream Flow Habitat Project	Completed	
CDLT Lower Icicle Creek Habitat Conservation	Completed	5 Peripheral and Transitional Habitats - Floodplain Condition
CDLT Icicle Creek Conservation Opportunities Outreach	Completed	
CCNRD Lower Icicle Riparian Initiative	Completed	4 Riparian Condition - Riparian Vegetation
TU-WWP Icicle Creek Alternatives Analysis	Conceptual	9 Water Quantity - Decreased Water Quantity
CDLT Icicle Creek Copper Notch Conservation Easement	Completed	5 Peripheral and Transitional Habitats - Floodplain Condition
USFS Icicle Creek Minimum Roads Analysis and Road System Improvements	Proposed	
CCNRD Icicle Irrigation District Efficiencies	Proposed	
CDLT Lower Wenatchee Leavenworth Audubon Center Acquisition	Completed	5 Peripheral and Transitional Habitats - Floodplain Condition
TU-WWP - Icicle Creek Boulder Field Assessment	Completed	1 Habitat Quantity - Anthropogenic Barriers
CCFEG Salmon Lifecycle Landscape	Completed	
TU-WWP Icicle Boulder Field Passage Design	Proposed	

1.8 Litigation Related to Water Management in the Icicle Creek Subbasin

Several water management challenges and conflicts have led to the development of the IWG and subsequently the Icicle Strategy, as laid out throughout this chapter. Many of these issues revolve around conflict over limited water resources, insufficient instream flows, and the need to meet future water demand. These conflicts have led the IWG to believe an integrated water resource management approach is the best option to address insufficient streamflow and conflict over water rights. Below is a synopsis of some of this conflict bared out through past litigation in the Icicle Creek Subbasin.

City of Leavenworth v. Washington State Department of Ecology
The City of Leavenworth's surface water certificate authorizes an instantaneous quantity (Qi) of diversion of 1.5 cfs from Icicle Creek. According to the City, the certificate does not list a specific time limit or maximum annual quantity (Qa) and contends that the Qa should be 1,085 acre-feet per year, which is based upon year-round, continuous diversion. Ecology states the City of Leavenworth has previously agreed to limit Qa to 275 acre-feet per year based upon a prior settlement before the PCHB. The City of Leavenworth filed a declaratory judgment action in Chelan County Superior Court seeking a determination of maximum Qa. In 2012, the court ruled in favor of Ecology, which the City of Leavenworth appealed to the Court of Appeals. Subsequently, the City of Leavenworth and Ecology have agreed to stay the litigation, or temporarily put on hold, while Ecology and the City of Leavenworth worked cooperatively to identify and fund projects in the Wenatchee River Basin that would augment Leavenworth's water rights for future growth.

Wild Fish Conservancy v. Salazar et al
USFWS operates a surface water diversion from Icicle Creek to supply water to the Leavenworth National Fish Hatchery for various uses. In 2009, the Wild Fish Conservancy and a local resident, Harriet Bullitt, filed a complaint for declaratory and injunctive relief in the Eastern District of Washington, United States District Court against Kenneth Salazar (in his official capacity as the Secretary of the United States Department of Interior), USFWS, USBR, United States Department of Interior (DOI), and LNFH on the basis that they have allegedly violated the State of Washington's Water Code by diverting water into the hatchery channel. The U.S. District Court, Eastern District of Washington, and the Ninth Circuit Court of Appeals ruled in favor of the defendants (2013).

Wild Fish Conservancy v. Irving et al
Additional litigation has occurred between Wild Fish Conservancy and LNFH regarding the adequacy of the Biological Opinion. The U.S. District Court, Eastern District of Washington order granted in part and denied in part the plaintiff's and defendant's motions. The court found that the Biological Opinion was arbitrary and capricious because it failed to discuss the potential effects of climate change. However, the court sided with LNFH and NMFS regarding whether an environmental impact statement was required for the Biological Opinion. The Biological Opinion was remanded back to NOAA to address climate change impacts.

Wild Fish Conservancy v Washington State Department of Ecology
In 2010, Wild Fish Conservancy and Center for Environmental Law and Policy (CELP) appealed Ecology's issuance of a Clean Water Act (CWA) Section 401 Certification for LNFH. Based on this litigation, Ecology rescinded the January 2010 Section 401 Certification and is currently working on issuing a new certification.

Center for Environmental Law and Policy v. USFWS
In CELP v. USFWS (2016), CELP and Wild Fish Conservancy sued the LNFH for allegedly operating without an NPDES permit. In this case, the courts found that the hatchery's National Pollutant Discharge Elimination System (NPDES) permit expired in 1979, and that the hatchery has been discharging pollutants into Icicle Creek without an NPDES permit since that time, in violation of the CWA. A draft of a new NPDES permit is currently circulating for public comment.

1.9 Overview of SEPA Process

SEPA applies to all decisions made by state and local agencies in Washington State. Under SEPA, one government agency is typically identified as the lead agency for identifying and evaluating the potential adverse environmental impacts of a proposal. This evaluation is documented and sent to the public and other agencies for their review and comment.

Under SEPA, project proponents are asked to complete an environmental checklist. The checklist asks questions about the proposal and its potential impacts on the environment. After the checklist has been completed, the lead agency reviews it and other information about the proposal. If more information is needed, the lead agency can ask the applicant to conduct further studies. Public meetings and outreach events are used to share information about the proposal and seek feedback from interested parties. When a proponent has gathered and submitted enough information about their proposal, the lead agency will make a threshold determination:

- A determination of non-significance – also called a DNS – if it finds the proposal is unlikely to have a significant adverse environmental impact.
- A determination of significance if the information indicates the proposal is likely to have a significant adverse environmental impact. This requires the preparation of an EIS that evaluates the environmental impacts of the proposal and reasonable alternatives.
- A determination of mitigated non-significance – also called an MDNS – if it finds the proposal, with specific mitigation measures, would allow a DNS. This would allow the proposal to be clarified, changed, or conditioned to include those mitigation measures.

The EIS provides critical information to all agencies in the environmental review and approval process. This information also helps to determine avoidance, minimization, or compensatory mitigation measures will address any probable significant impacts.

For the Icicle Strategy, the co-conveners (Ecology and Chelan County) entered into a Memorandum of Understanding to act as SEPA co-lead agencies per Chapter 43.21 RCW to conduct an environmental review of the Icicle Strategy.

The following timeline lists the SEPA review process for the Icicle Strategy:

- February 2016: submitted SEPA checklist and issued threshold determination of significance; launch PEIS SEPA scoping
- April 2016: Public meeting
- May 2016: End of SEPA scoping comment period
- June 2016 to Spring 2018: Develop draft PEIS
- Spring 2018: Publish draft PEIS with a 60-day comment period
- Summer 2018: Public meeting in Leavenworth
- Fall 2018: Issue final PEIS
- Fall 2018: Begin project level environmental review or permitting, as required

1.9.1 SEPA Scoping

SEPA scoping launched on February 9, 2016. The lead agencies, Ecology and Chelan County, elected to expand the scoping process in accordance with WAC 197-11-410 to promote interagency cooperation, public participation, and innovative ways to streamline the SEPA process. To support this, a public open house was held in Leavenworth, Washington on April 20, 2016, and public comments were received through May 11, 2016. Comments received during this period can be reviewed at: http://www.co.chelan.wa.us/ natural-resources/pages/icicle-strategy-sepa-comments (Appendix A).

1.9.2 SEPA PEIS

At the conclusion of the SEPA scoping process, the co-lead agencies reviewed and summarized the scoping comments submitted. The co-lead agencies decided to consider several different alternatives based on comments received during the scoping process, including the base package (a suite of projects previously identified by the IWG that can meet the Guiding Principles), along with a no-action alternative, and three other alternatives that were responsive to the scoping comments. The alternatives considered are described in Chapter 2 of this document. Descriptions of the affected environment can be found in Chapter 3, with analysis of potential impacts, cumulative impacts, and mitigation measures discussed in Chapters 4 and 5.

1.9.3 Next Steps in the Environmental Review Process

In considering future project implementation, government agencies responsible for issuing permits on projects covered by this PEIS will perform one of the following actions under WAC 197-11-600:

- Rely on the analysis presented in this PEIS unchanged.
- Issue an addendum “that adds analyses or information about a proposal but does not substantially change the analysis of significant impacts and alternatives” in the PEIS.
- Prepare a Supplemental Project EIS if there are “substantial changes to a proposal so that the proposal is likely to have significant adverse environmental impacts” or there is “new information indicating a proposal’s probable significant adverse environmental impacts.” “A new threshold determination or SEIS is not required if probable significant adverse environmental impacts are covered by the range of alternatives and impacts analyzed in the existing environmental documents.”

1.9.3.1 Project Level Environmental Review

If the IWG receives authorization and funding to carry the Icicle Strategy forward, the first steps in the process would be to undertake additional project definition, design, modeling, feasibility study review, and other appropriate technical analyses. Once the projects and actions have received adequate definition and design, they would undergo project-level environmental if new significant impacts are likely. Projects for which adequate environmental review is covered in the PEIS would proceed to permitting. The project-level evaluations could include detailed analysis of impacts and development of project-specific mitigation, including an assessment of the anticipated effectiveness of mitigation measures to avoid or attenuate impacts. Projects carried forward would comply with permit requirements, as described in Section 1.9 of this chapter.

1.9.3.2 NEPA Requirements and Integration

The National Environmental Policy Act (NEPA) requires federal agencies to assess the environmental effects of their proposed actions prior to making decisions (EPA, 2016[9]). Using the NEPA process, agencies evaluate the environmental and related social and economic effects of their proposed actions. Agencies also provide opportunities for public review and comment on those evaluations.

NEPA is only required on projects with a federal permitting nexus. Several projects under the various alternatives may require federal permitting and a federal level environmental review. NEPA can occur concurrently with the SEPA process. Conversely, SEPA and NEPA can occur on separate timelines. When this occurs, the subsequent review can adopt the finding of the previous review. For example, if NEPA precedes SEPA, the findings of the NEPA analysis can be adopted (WAC 197-11-610). Alternatively, in some instances a federal agency may use existing SEPA documents to meet NEPA requirements depending on the adopted NEPA policies of that agency, as was the case with USBR adopting the SEPA review of the Lake Roosevelt Incremental Storage Releases project.

For projects related to LNFH, the USBR and USFWS are currently reviewing proposals on Snow Lake valve replacement and automation, screening and upgrading the intake structure, water conservation measures at LNFH, and groundwater development. USBR has already initiated an Environmental Assessment (EA) for the Snow Lake Valve Replacement Project and is considering additional EA and EIS work for the other projects.

1.9.3.3 Summary Timeline of All Environmental Review

The process of environmental review of Icicle Strategy projects is ingrained in each step of the various projects. As indicated in Table 1-7 some aspects of environmental review, such as weighing the impacts of each step on consistency with the Guiding Principles, are taken into consideration on a continuous basis and are always underlying any decision made. Other, more specific aspects of the environmental review process are enacted at key junctures in a project's timeline. The SEPA process began in the end of 2015 and will progress through 2018. At the same time, meetings with local, state, and federal government agencies occurred to put together a package of interagency agreements and common goals to incorporate into the SEPA scope. The various steps in the Environmental Review can be seen in Table 1-7.

1.9.3.4 Future Opportunities for Public Input

Public review and comment is an important part of the IWG decision making process. The public is a valuable stakeholder and the IWG aims to make decisions that benefit the greatest number of people. A 90-day comment period on scoping for the Programmatic EIS took place from February to May 2016. In addition, a draft of the Programmatic EIS will be circulated for a 60-day comment period. Additional comment periods will be scheduled and conducted for subsequent NEPA and project level environmental reviews and permitting. IWG meetings are also open to the public and IWG members make numerous presentations to stakeholder groups on the Icicle Strategy.

[9] https://www.epa.gov/nepa, accessed September 15, 2016

Table 1-7
Environmental Review Timeline

Task	Description	Dates
IWG Process		
IWG Meetings	Determine framework for resolving any additional guiding principle deficiencies, project selection, and environmental review	Quarterly, 2012- Present
Guiding Principle Metric Resolution	Resolve any unmet guiding principle metrics to allow project selection and level of investment determination	2012 through Mid-2017
Integrated Project List Deliberation	IWG Steering Committee or Project Subcommittee weighs benefits, risk, impacts, and consistency with Guiding Principles	2012 through Present
Environmental Review		
SEPA Scoping	SEPA Scoping	January 2016 through June 2016
Lead Agency Determination	Meet with local, state, federal agencies to determine leads, scoping goals, interagency agreements, existing documents	January 2016 through June 2016
Determination of Significance	Distribute DS and all studies assembled to-date to agencies and the public	February 2016
Publish scoping comments/summary	Identify key issues to be addressed in Programmatic EIS	June 2016
Data Gaps	Identify and resolve data gaps, supplemental environmental studies	June 2016 through April 2017
Develop Programmatic EIS	Develop draft document, including Guiding Principles, Alternatives, and Affected Environment	June 2016 through June 2017
Draft PEIS Internal	Draft PEIS to lead agencies	June 2017
Circulate Draft EIS for Comment	Draft PEIS circulated for 60-day comment period	May 2018 through July 2018
Public Comment	PEIS Comment period closes	July 2018
Produce Final Programmatic EIS	PEIS Final document published	September 2018
Finalize NEPA Integration Strategy	Budget and coordinate NEPA integration strategy	September 2018 through January 2019
Begin Project Level Environmental Review	Project Level EIS's will likely follow same steps above, although other options exist (e.g., SEPA Addendum, Adoption of PEIS)	September 2018 through September 2020
Project Development		
Begin Feasibility Studies	Feasibility study funding is provided in the 2015-2017 OCR Capital Budget, federal budget matches needed for some projects	2015 through May 2018

1.10 Related Permits, Actions, and Laws

This section describes key federal and state regulations applicable to the Icicle Creek Strategy and program alternatives.

1.10.1 Endangered Species Act

The Endangered Species Act of 1973 (ESA; 16 United States Code [USC] 1536) is a federal law designed to protect and prevent the extinction of species of fish, wildlife, and plants, and their critical habitats, that are listed as threatened or endangered under the Act. The ESA is administered by the USFWS for terrestrial species and some freshwater fish species and NMFS for anadromous fish and marine species, collectively referred to as “the Services.”

Under the ESA, it is unlawful for anyone to take a listed animal without a permit. “Take” is defined as harassment, harm, pursuit, hunting, shooting, wounding, killing, trapping, capturing, or collecting or attempting to engage in any of these activities. The USFWS and NMFS are Icicle Creek Work Group members and part of their respective roles is to ensure consistency with applicable state and federal laws, including the ESA. This has been established as one of the Guiding Principles of this program evaluation. In addition, any individual projects with the potential to result in take of a species protected under the ESA would undergo consultation with the Services prior to project implementation. For additional information about coordination with the Services specific to the Icicle Creek Strategy, refer to Chapter 5, *Consultation and Coordination*.

1.10.2 Magnuson-Stevens Fishery Conservation and Management Act

Section 305(b)(2) of the Magnuson-Stevens Act (MSA) requires federal agencies to consult with NMFS on activities that may adversely affect essential fish habitat (EFH). EFH is defined in the MSA as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. A federal action agency, or its official designee, must determine whether its actions may adversely affect EFH. If the agency determines that an action may adversely affect EFH, the action agency must prepare an EFH Assessment. If the action would not adversely affect EFH, then the agency should document this determination in its record. Any individual projects with the potential to result in adverse effects on EFH would undergo consultation with NMFS prior to project implementation. For additional information about coordination with NMFS specific to the Icicle Creek Strategy, refer to Chapter 5, *Consultation and Coordination*.

1.10.3 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 U.S.C. 661-667e) was enacted in 1934 and amended in 1958 (Public Law 85-624) and provides for equal consideration of wildlife conservation in coordination with other features of water resource development programs. Consultation with USFWS and WDFW would be required during implementation of water resource development portions of the program (e.g., plans to control or modify any stream or other body of water). This consultation is typically conducted concurrently with other regulatory review or permitting processes under NEPA, ESA, and CWA compliance. Also, WDFW is an Icicle Creek Work Group member and part of its role is to ensure consistency with applicable state and federal laws, including the Fish and Wildlife Coordination Act.

1.10.4 Clean Water Act

The CWA (33 USC 1251 *et seq.*) was enacted in 1972 and is the primary federal law regulating discharges of dredged or fill material and pollutants into waters of the United States. The EPA has established water quality standards for the discharges of dredged or fill material and pollutants under the regulatory provisions of the CWA, as summarized below. The CWA is jointly implemented by the EPA and the U.S. Army Corps of Engineers (USACE).

1.10.4.1 Section 401, Water Quality Certification

Section 401 of the CWA requires that any project with the potential to result in discharge to waters of the United States obtain a water quality certification permit. In the State of Washington, individual projects with the potential to result in discharge to waters of the United States would require a water quality certification permit from Ecology.

1.10.4.2 Section 402, National Pollutant Discharge Elimination System

Section 402 of the CWA requires permission for any construction activities resulting in disturbance to 1 acre of land or greater or for any point source discharges from a municipal, industrial, or commercial facility into a surface water of the United States. Permissions must be obtained through the NPDES permit and be consistent with water quality standards set forth by the CWA. NPDES permits are also administered by Ecology in the State of Washington.

1.10.4.3 Section 404 Permit Program

Section 404 of the CWA establishes a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. An individual permit is required for potentially significant impacts, whereas a general permit, issued on a nationwide, regional, or state basis, may be suitable for discharges that have only minimal adverse effects. Individual projects with the potential to result in the placement of dredged or fill material into waters of the United States, including wetlands, would require a permit from USACE.

1.10.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of their actions on cultural resources, including archaeological resources, historic properties, and traditional cultural properties. Federal agencies must undergo a process of consultation with the State Historic Preservation Office and potentially affected federally recognized tribes to ensure the potential for impacts on these resources are appropriately minimized. Individual projects led by a federal agency or requiring a federal permit or approval will undergo Section 106 evaluation. Within the State of Washington, the State Historic Preservation Office is the Washington State Department of Archeological and Historic Preservation (DAHP). Section 106 could apply to any of the projects that receive federal funding or a federal permit, or take place on federal land.

1.10.6 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (25 USC 3001-3013) provides a process for federal agencies and museums receiving federal funding to return certain Native American cultural items to lineal descendants, establishes a process for the protection of the inadvertent discovery of Native American cultural items on federal and tribal lands, and provides penalties for noncompliance and illegal trafficking. Individual projects involving federal agency permits or approvals would be required to comply with this law.

1.10.7 National Archaeological Resources Protection Act

The National Archaeological Resources Protection Act (16 USC Chapter 1B) governs the excavation of archaeological sites on federal and Native American lands and the removal and disposition of archaeological collections from those sites. Individual projects occurring on federal lands would be required to comply with this law.

1.10.8 Executive Order 13007: Indian Sacred Sites

Executive Order 13007 requires federal agencies to promote access to and protection of American Indian sacred sites. Sacred sites can only be identified if tribes or an appropriately authoritative representative of a Native American religion has informed the agency of the existence of a site.

1.10.9 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.

1.10.10 Executive Order 11990: Protection of Wetlands

Executive Order 11990 requires federal agencies to ensure their actions minimize the destruction, loss, or degradation of wetlands and preserves or enhances the beneficial values of wetlands. Any wetland losses associated with individual projects would be addressed through evaluation and permitting consistent with the Clean Water Act.

1.10.11 Executive Order 12898: Environmental Justice

Executive Order 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their actions on minorities and low-income populations. The effects of individual projects involving federal permits or approvals will result in further evaluation of the potential for disproportionate impacts on these populations.

1.10.12 Wilderness Act

The Wilderness Act of 1964 created the National Wilderness Preservation System and establishes regulations for the management and use of wilderness areas on federal lands.

The Wilderness Act prohibits permanent roads or commercial enterprises, except where they provide for recreation or other purposes of the Act, and generally prohibits the use of motorized equipment; however, certain nonconforming uses are permitted as described within the act, including access to non-federal inholdings and for the maintenance and reconstruction of existing water infrastructure, such as dams.

1.10.13 U.S. Forest Service Special Use Permit

The USFS special-use authorization is a legal document, such as a permit, lease, or easement that allows occupancy, use, rights, or privileges on USFS land. The Alpine Lakes Wilderness Area is jointly administered by the USFS Okanogan-Wenatchee and the Mt. Baker-Snoqualmie National Forest management.

Upper and Lower Snow Lakes and Nada Lake are owned and operated by USFWS. IPID owns easements that encompass Klonaqua, Square, Colchuck, and Eightmile Lakes. All of these lakes are located in the Alpine Lakes Wilderness Area. IPID and the USFWS have existing water rights, easements, and access agreements with the USFS that allow the lakes to be used for storage and release of water. These agreements include the right to conduct maintenance activities within the Alpine Lakes Wilderness Area. Depending on ownership and easement authority at the various lakes, additional special use permits may be required.

1.10.14 Governor’s Executive Order 05-05

Any state-funded capital construction projects or land acquisition projects for the purpose of capital construction require Governor’s Executive Order 05-05 (GEO 05-05) review. This order requires all state agencies to integrate DAHP, the Governor’s Office of Indian Affairs, and concerned tribes into the capital improvement project planning process to protect the public interest in historic and cultural sites. Consultation with DAHP is typically conducted by the responsible federal agency; however, this directive ensures coordination for capital improvement projects regardless of federal involvement. GEO 05-05 could apply if any of the projects receive state capital improvement funds.

1.10.15 Washington State Archaeological Protection

Washington State law (Revised Code of Washington 27.53.060) requires a permit from DAHP prior to the disturbance of any known archaeological sites and provides for criminal penalties for activities conducted without having obtained a written permit prior to beginning such activities. Individual projects with the potential to disturb known archeological sites would be required to comply with this law.

1.10.16 Hydraulic Project Approval

The WDFW administers the Hydraulic Project Approval (HPA) program under the State Hydraulic Code (Washington Administrative Code 220 – 110), 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 will require an HPA.

1.10.17 Washington State Department of Natural Resources Aquatic Use Authorization

An Aquatic Use Authorization is required from Washington State Department of Natural Resources (WDNR) for 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. Individual projects requiring an aquatic use authorization will undergo review by WDNR.

1.10.18 Joint Aquatic Resources Permit Application

To streamline the environmental permitting process, multiple regulatory agencies have combined their processes into one application called the Joint Aquatic Resources Permit Application (JARPA). Relative to the Icicle Creek Strategy, the JARPA can be used to obtain local, state, and federal approvals for compliance with the Shoreline Master Program, Ecology’s 401 Water Quality Certification, HPA, the WDNR Aquatic Use Authorization, and the USACE’s Section 404 review for individual projects requiring these permits and approvals.

1.10.19 Reservoir Storage Permit

A Reservoir Storage Permit issued by the State of Washington is required for any impoundment that is either 10 feet or more in depth or can retain 10 or more acre-feet of water regardless of whether the impounded water is on-channel or off-channel. Reservoir Storage permits are regulated under RCW 90.03.370, and authority to issue Reservoir Storage Permits resides with Ecology. The permitting process is similar to water rights permit application processing in that there is no statutory timeline for a decision by Ecology; permits are processed in order of priority date. Expedited permitting (e.g., cost reimbursement) is an avenue for those seeking accelerated permit processing. Reservoir Storage Permits are often confused with Dam Safety Permits, which are required for construction of dams capable of storing 10 acre-feet of water above natural grade (WAC 173-175-020), and many storage projects require both permits. Similarly, Reservoir Storage Permits are not used in place of water rights permits (permit for beneficial use of water). Separate permit authorization is required for diversion / withdrawal and use of source water.

1.10.20 Dam Construction Permit

A Dam Construction Permit is issued by the State of Washington and is required for any impoundment that stores 10 acre-feet of water or more (WAC 173-175-020). The state can exempt some dams that meet this threshold provided they are less than 6 feet tall. Impounded volumes are measured based upon the maximum potential storage volume that could be released in the event of dam failure, and in many instances this volume is dictated by the crest of the dam (rather than spillway) relative to natural grade. Dam Construction Permits are issued by the Dam Safety Office (DSO) of Ecology. The permitting process involves evaluation of dam purpose, operational class, dam size, downstream hazard classification, federal regulatory nexus, and other factors. Once constructed, dams must be operated and maintained in accordance with DSO requirements and are subject to periodic inspection by the state (WAC 173-175-200).

1.10.21 Water Right Permit

A Water Right Permit (water right) is issued by the State of Washington and is required in order to use waters of the State. A water right is a legal authorization to use a predefined non-wasteful quantity of public water for a designated purpose that must qualify as a beneficial use (e.g., irrigation, domestic, fire flow, fish propagation, etc.). Water rights authorizations may be either a claim, permit, or certificate; however, permits and certificates are the only forms of new authorizations issued. Uses of water below a set quantity or for certain uses may be exempt from permitting. Once a permit is issued, the permittee has a prescribed time window to put their authorized quantity to beneficial use. The quantity put to beneficial use represents the “perfected” quantity that may be certificated. Once certificated, some portions of water rights authorization may be changed, which may be advantageous; however, authorized quantities may also be forfeited (relinquished) because of unexcused periods of non-use. Water rights applications are reviewed and approved in order of priority date—meaning they are processed sequentially based on the date the application is accepted by Ecology. Options for expedited application processing are available. In order for Ecology to issue a Water Right Permit, the proposal must meet a four-part test including: 1) water is available (both legally and physically), 2) the permit is for beneficial use, 3) will not impair other rights, and 4) not contrary to the public interest.

1.10.22 County Shorelines Management Act Permit (Shoreline Substantial Development or Conditional Use Permit)

Compliance with the Shoreline Management Act (Chapter 90.58 RCW) is required for development in proximity to water bodies of a certain size. In Chelan County, these water bodies 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. Unless exempted from permitting under RCW 90.58.030(3), there are three typical shoreline permitting pathways that involve both local jurisdiction (Chelan County) and Ecology. These are the Substantial Development Permit, Shoreline Conditional Use Permit, and Variance. The Shoreline Substantial Development Permit is issued by Chelan County and is required for any activities that constitute substantial development as defined in the adopted Shoreline Management Program. Substantial Development Permit decisions made by Chelan County are not reviewed by Ecology but are filed by the State. Conditional Use Permits and Shoreline Variances are issued by Chelan County but are also review and approved by Ecology. Conditional Use Permits are issued in circumstances where a particular shoreline use is not preferred or outright allowed but may be permitted based on circumstances. In contrast, Variances are provided in cases when particular use is allowed but an alternative numerical development standard, such as maximum building height, minimum setback, etc., is allowed.

1.10.23 Critical Areas Review

Critical areas review is required by the Growth Management Act that establishes standards for use and development of lands based on the existence of critical areas such as critical aquifer recharge areas, fish and wildlife habitat conservation areas, frequently flooded areas, geologically hazardous areas, and wetlands. Zoning designations that affect critical areas are provided in Chapters 11 and 13 of the Chelan County Code.

1.10.24 Building, Fill, and Grading Permit*s*

Any site improvement (development), including grading and structural improvements, require a County building permit per Chelan County Code Chapter 14.

1.10.25 Water System Plan Update

Water system planning is required under WAC 246-290-100 for any new group, defined as a community water system or one that provides service to 1,000 or more connections or meets other requirements. An update to water system planning documents is required if a system proposes to make infrastructure changes that change the number of connections, expands the service area identified in previous planning documents, or expands the geographic area not previously approved. Water system plans and water system plan updates are reviewed and approved by Washington State Department of Health.

1.10.26 Instream Flow Rule Amendment

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 water body is located.

1.10.27 Construction Stormwater General Permit and Stormwater Pollution Prevention Plan

Coverage under a Construction Stormwater General Permit is required for construction activities that meet certain thresholds. Typically, the threshold for permit coverage includes clearing, grubbing, and excavating activities that disturb 1 or more acres and discharges to waters of the State. Currently, the State of Washington has a Construction Stormwater General Permit through the NPDES that covers all areas of Washington State with the exception of federal operations and Indian Country. This permit was issued on November 18, 2015 and expires on December 31, 2020. Construction site operators with sites subject to minimum thresholds may apply for coverage under the state permit by submitting a Notice of Intent (NOI) to Ecology a minimum of 60 days prior to anticipated discharge. Public notice is also required. Once coverage is obtained, operators must develop a Stormwater Pollution Prevention Control Plan (SWPPP), implement Stormwater Best Management Practices (BMPs), and perform sampling at discharge monitoring locations. Coverage under the permit requires that monthly Discharge Monitoring Reports (DMR) be submitted to Ecology with the exception that high turbidity discharge events be reported within 24 hours.

1.11 Documents Adopted under SEPA

An extensive body of work has been completed to better understand water management issues in the Icicle Subbasin and to explore the feasibility of potential solutions to benefit water users and fish. Pursuant to provisions of the SEPA Rules (WAC 197-11-630), Ecology and Chelan County are adopting the following documents as part of this PEIS to meet a portion of Ecology's responsibilities under SEPA:

- Anchor Environmental, L.L.C., 2007, Preliminary Draft, Needs and Alternatives Analysis, Icicle Creek Sub-Basin Storage Study
- Anchor QEA, 2011, Water Storage Report, Wenatchee River Basin
- Anchor QEA, 2012, IPID Pump Exchange Project Appraisal Study
- Anchor QEA, 2015, Icicle and Peshastin Irrigation Districts Pump Exchange, Summary of Potential Operations and Maintenance Funding Strategies.
- Anchor QEA, 2015, Icicle- Peshastin Irrigation District (IPID) Pump Exchange (Dryden Alternative) Summary of Additional Analyses.
- Anchor QEA, 2015, LNFH Tribal Fishery Analysis, 2015 (draft)
- Anchor QEA, 2017, Cascade Orchards Irrigation Company – Conceptual Design Update
- Anchor QEA, 2017, IPID Conservation Plan – Full Piping Improvement Option, 2017, Anchor QEA
- Anchor QEA/Aspect Consulting, 2015, Eightmile Lake Restoration and Expansion Appraisal Study,
- Aspect Consulting, 2014, Conservation Plan Survey
- Aspect Consulting, 2014, Upper Klonaqua Lake Conceptual Review
- Aspect Consulting/Anchor QEA, 2015, Alpine Lakes Optimization and Automation Appraisal Study, 2015, LNFH Effluent Pump Back Preliminary Assessment.
- Chelan County Natural Resources Department & Anchor Environmental, LLC, 2007, Peshastin Subbasin, Needs and Alternatives Study
- EcoAssets and Associates, 2013, Icicle Creek Boulder Field Fish Passage Assessment,
- Golder Associates, 2005, WRIA 45 Summary of Groundwater/Surface Water Interaction and Groundwater Resource Reference
- Icicle Creek Target Flow Report for Leavenworth National Fish Hatchery, 2004, Montgomery Water Group
- LNFH, 2009, Proposed Flow Management Operations for 2009-2014

- Montgomery Water Group, 2004, Water Management Plan for Leavenworth National Fish Hatchery
- Montgomery Water Group, 2006, Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed
- Montgomery Water Group, Pacific Groundwater Group, and EES, 2003, Wenatchee River Basin, Watershed Assessment
- Nelson, Mark, Andy Johnsen, and R.D. Nelle, 2009, Seasonal Movements of Adult Fluvial Bull Trout and Redd Surveys in Icicle Creek
- Northwest Power and Conservation Council, 2004, Wenatchee Subbasin Plan
- Ringel, B.K., 2006, Progress Report, Icicle Creek Water Temperatures, November 1, 2005 - October 31, 2006.
- Sutton, Ron and Chelsie Morris, 2005, Technical Memorandum, Instream Flow Assessment of Icicle Creek, Washington
- The Watershed Company, 2005, Lower Icicle Creek Reach Level Assessment
- Trout Unlimited/Forsgren Associates, 2014, IPID Instream Flow Improvement Options Analysis, 2014,
- USBOR, 2010, Groundwater Conditions at LNFH
- USBOR, 2017, DRAFT Snow Lake Water Release Control Valve Replacement Environmental Assessment
- USBR, 2012, Leavenworth National Fish Hatchery Final Value Analysis
- USBR, 2014, LNFH Groundwater Model Update Technical Memorandum
- USBR, 2014, LNFH Icicle Creek Rapid Geomorphic Assessment
- USDA, 2014, Climate Change Vulnerability and Adaptation in the North Cascades Region
- USFWS, 2006, Biological Assessment for Operations and Maintenance of Leavenworth National Fish Hatchery
- USFWS, 2010, LNFH Low Flow Contingency Plan
- USFWS, 2012 Leavenworth National Fish Hatchery, National Pollutant Discharge Elimination System Discharge Monitoring Reports
- USFWS, 2013, Icicle Creek Fish Passage Evaluation for LNFH
- USFWS, 2013, Icicle Creek Instream Flow and Fish Habitat Analysis for LNFH
- USFWS, 2015, Biological Assessment of Operation and Maintenance of Leavenworth National Fish Hatchery

- USFWS, 2017, Biological Assessment of Operation and Maintenance of Leavenworth National Fish Hatchery
- USFWS, 2017, Leavenworth Fisheries Complex Implementation Plan, 2017
- Varela and Associates, 2011, City of Leavenworth, Water System Plan
- Washington State Department of Ecology & Anchor QEA, LLC, 2010, Draft Feasibility Study, Campbell Creek Reservoir
- Waterfall Engineering et. al., 2016, Icicle Creek Boulder Field Fish Passage Design,
- WDFW, 2017, Alpine Lake Flow Augmentation Pilot Study 2017, Icicle Creek Tributary Monitoring Report
- Wenatchee Watershed Planning Unit, 2006, Wenatchee Watershed Management Plan
- Wenatchee Watershed Planning Unit, 2008, Wenatchee Watershed Planning, Phase IV—Detailed Implementation Plan

CHAPTER 2.0 ALTERNATIVES

2.1 Description of Programmatic Proposal

This chapter describes the proposed alternatives developed by the IWG to meet the objectives set forth in the Icicle Creek Guiding Principles that were discussed in detail in Chapter 1, Sections 1.1 and 1.2. Each of the five alternatives described in this document were intended to fully meet the Guiding Principles, using a different combination of projects with individualized costs, benefits, and impacts.

2.1.1 Icicle Strategy Overview

As discussed in Section 1.1, the IWG is made up of a diverse set of stakeholders representing local, state, and federal agencies; tribes; irrigation and agricultural interests; and environmental organizations. The IWG developed a set of Guiding Principles that are the objectives for integrated water resource management in the Icicle Creek Subbasin. Figure 2-1 provides the Guiding Principles as well as metrics for each, which were discussed in greater detail in Chapter 1. This table is used to help compare how well the five Alternatives and the No-action Alternative evaluated in this PEIS meet or partially meet the Guiding Principles.

A key principle endorsed in the IWG Operating Procedures is that all projects in an Alternative move forward together as a group to ensure that the shared vision of improved water management in Icicle Creek was achieved, as opposed to a fragmented and partial solution that could lead to further conflict. If a particular project that is part of an Alternative becomes unfeasible, then the IWG agreed to reconvene and select a substitute project to address the Guiding Principle that suffered the shortfall. Projects can be phased, which will be necessary given funding and permitting constraints. However, the IWG would continue to support later phases of project development even as early project construction begins to show progress in meeting the Guiding Principles.

Figure 2-1. Guiding Principles with Metrics[1]

Icicle Workgroup Guiding Principles and Metrics

This summary describes the IWG Guiding Principles and how they are quantified for the development of an integrated project list. Full qualitative descriptions of the guiding principles are included in the IWG Operating Procedures. Metrics for guiding principles are subject to feasibility, funding, and permitting.

Guiding Principle	Metric	
Improve Instream Flows	Icicle Creek Historic Channel: • 60 cfs minimum flows (drought years) • 100 cfs minimum flows (non-drought years), short-term goal • 250 cfs minimum flows (non-drought years), long-term goal • 2,600 cfs maximum flow to preserve habitat function	Flow improvement needed (in projects) to meet total minimum flows: 40 cfs[1]
Improve sustainability of LNFH	• Meet *U.S. v. Oregon* and other agreements specifying fish production requirements • 57 cfs supply protected long-term (at least 20 cfs conservation goal) • Diverse source availability (temperature, pathogen-free) to maximize fish health • Structures minimize unintended fish passage impediments	
Protect Tribal and Non-Tribal harvest	• Catch per unit of effort (CPUE) improved • Maintain multi-species harvest opportunities • Tribal Impacts Assessment and Adaptive Management Plan being implemented, addressing attraction flows, sediment transport, fish migration/straying, site access and amenities	
Improve Domestic Supply	• 1,750 acre-feet of reliable year-round supply (2.5 cfs average, 5 cfs peak)	
Improve Agricultural Reliability	• Automate / Optimize Alpine Lakes Reservoirs for improved reliability (plus instream flow benefit) • Restore/repair Eightmile Lake Reservoir up to 2,500 acre-feet (900 ac-ft additional instream flow/domestic benefit) • Current interruptible agricultural users have firm supply in average water years / agriculture water bank (2 to 4 cfs)	
Enhance Icicle Creek Habitat	• Improve passage in Icicle Creek including to Upper Icicle Creek • Make investments in physical habitat improvement with consideration for high flow habitat and low flow refuge, minimize fish passage impediments, and improve limiting factor spawning/rearing • Offset project-related terrestrial impacts with land acquisition/easements	
Comply with State and Federal Law, and Wilderness Acts	• Identify and engage regulators in the process • Environmental review completed (project check) • All projects appropriately permittable (project check) • All diversions (LNFH, IPID, COIC) appropriately screened (project check)	

[1]Based on a review of historic stream gage records, the existing average low flow in historic channel in non-drought years is 65 cfs (16 of the most recent 20 years) and average drought low flows is 20 cfs (2001, 2003, 2005, 2015). To meet Guiding Principle flow targets, approximately 40 cfs in project flow benefit is needed.

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[1] Reference: http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/current-project/Guiding%20Principle%20Metrics%2002-04-2016.pdf

2.2 Development and Analysis of Alternatives

The alternatives analyzed in this document are the result of ongoing studies and discussions with state and federal regulators on how to best manage water within the Icicle Creek Subbasin. Additionally, discussions with private stakeholders through IWG meetings, outreach meetings, and SEPA scoping helped shape these alternatives. This section explains how the projects and alternatives were selected for inclusion in this PEIS.

The IWG has been working since December 2012 to develop the Guiding Principles and the projects intended to address them. One of the first exercises conducted by the IWG was to assemble a master project list based on conceptual ideas by IWG members, projects identified in the Wenatchee Watershed Plan, projects in various funding program queues, and projects in active appraisal or feasibility studies. In the first few months of the IWG (e.g., early 2013), over 60 potential projects had been identified that could assist in meeting the Guiding Principles. Early versions of these master project lists are available on Chelan County's website.

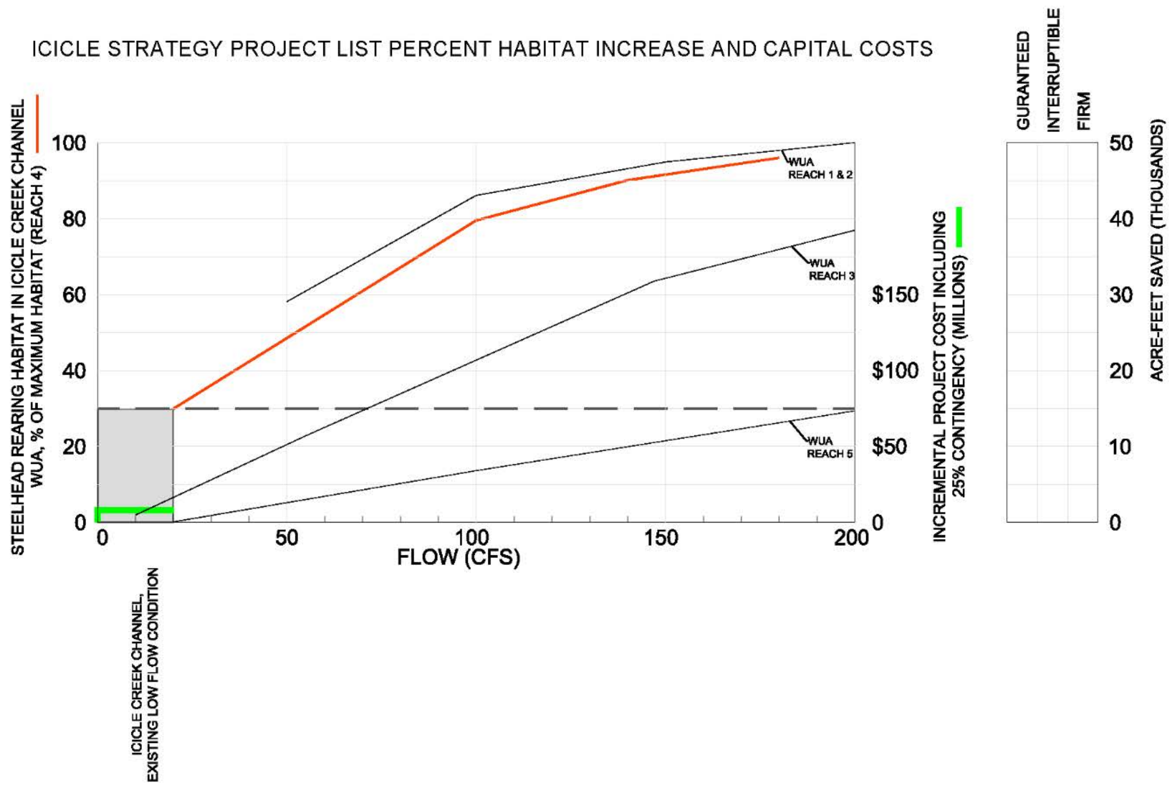
Following identification of potential projects, and concurrent with the IWG's efforts to put numeric standards to the qualitative Guiding Principles established in December 2012, the IWG developed a screening evaluation for projects. The method of evaluation included considering project benefit, water right pedigree,[2] and project costs. Then the IWG went through several iterative exercises where projects were aggregated to meet the Guiding Principles and provide a range of options based on the above listed factors (project benefit, water right pedigree, and project cost).

Figure 2-2 thru 2-5 illustrate this process. The projects are not listed in any specific order, and some project variations listed in these figures are not included in any of the Alternatives evaluated in the PEIS. These figures are for illustrative purposes to show how projects were evaluated and grouped into packages.

[2] Water Right pedigree refers to when water from a particular project will be available. **Guaranteed** water consists of water that will always be available based on permanently placing the water into the state TWRP. **Firm** water refers to water that will be on long-term donation or lease to the state Trust Water Right Program. For these projects, firm water is generally federally owned water and the water is not being permanently transferred to the TWRP because of laws prohibiting a permanent transfer. **Interruptible** water, in this scenario consists of water that may not be available every year for instream flows. This includes water made available for instream flows from the Alpine Lakes Reservoirs Optimization, Modernization, and Automation, because in low water years, when the district needs a larger portion of their water, the water will not be placed in the TWRP.

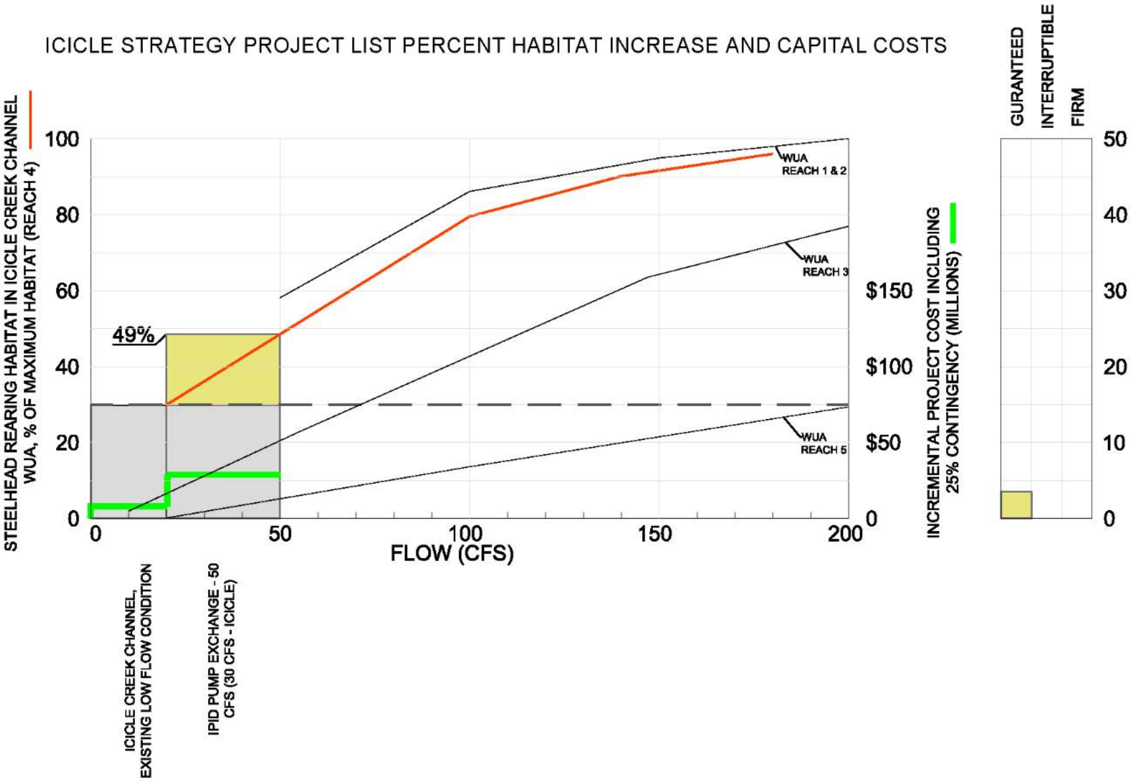
In Figure 2-2, the red line represents the WUA flow-habitat relationship for the historical channel (see Figure 2-34) and the gray bar represents an average low flow condition of 20 cfs in that reach. The note in the bottom left of the figure presumed a number of projects would also be included that did not provide flow benefit, but would address other Guiding Principles (e.g., screening, tribal fishery protection).

Figure 2-2. Minimum Flow (less the 20 cfs) and Instream Flow Goals (100 cfs) Overlaid by WUA for Spawning Steelhead in Icicle Creek Historical Channel



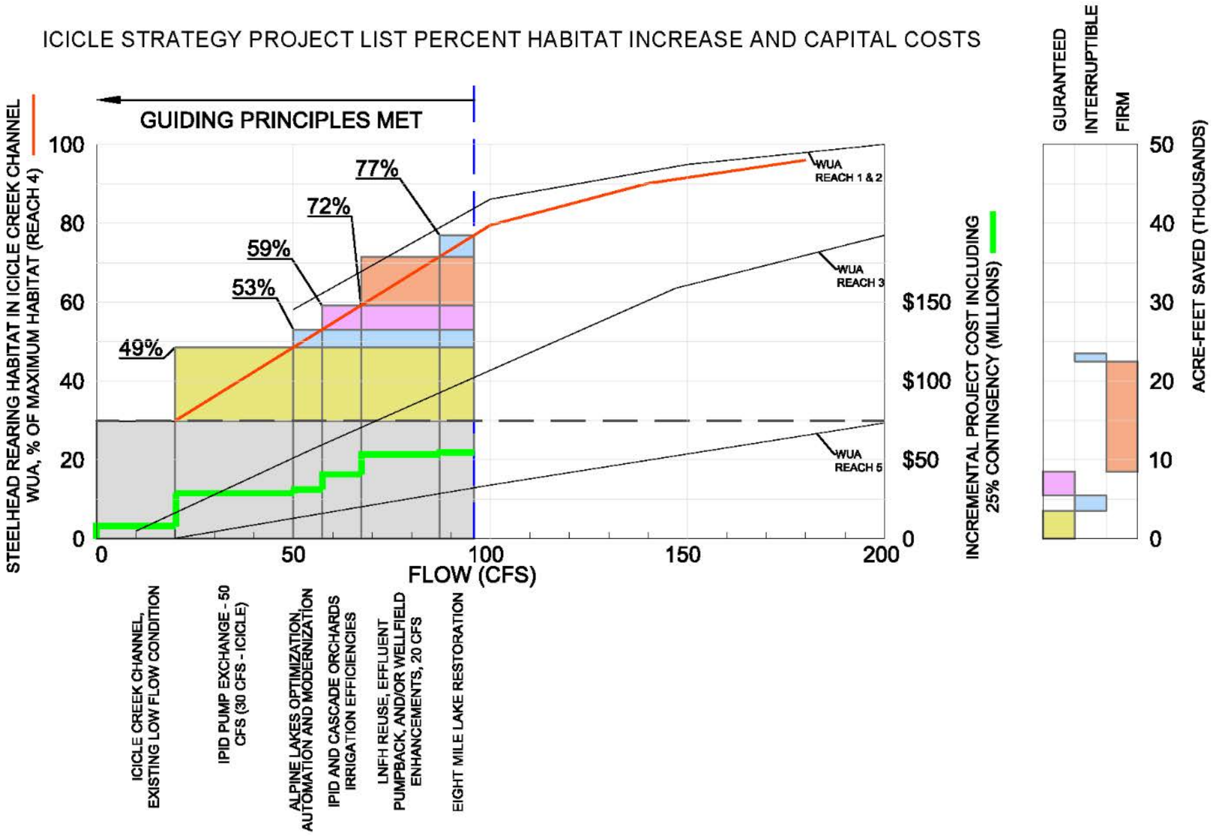
In Figure 2-3, the first project in this example was added, which was a potential pump exchange on the Wenatchee River that would provide up to 30 cfs benefit in Icicle Creek. Habitat improvement is tracked (49 percent improvement), cost is tracked (in the green line against the secondary Y-axis), and the pedigree of the water (guaranteed) appears in the stacked bar chart on the far right.

Figure 2-3. Comparison of Project Benefits and Costs to Flow and WUA, Step 1



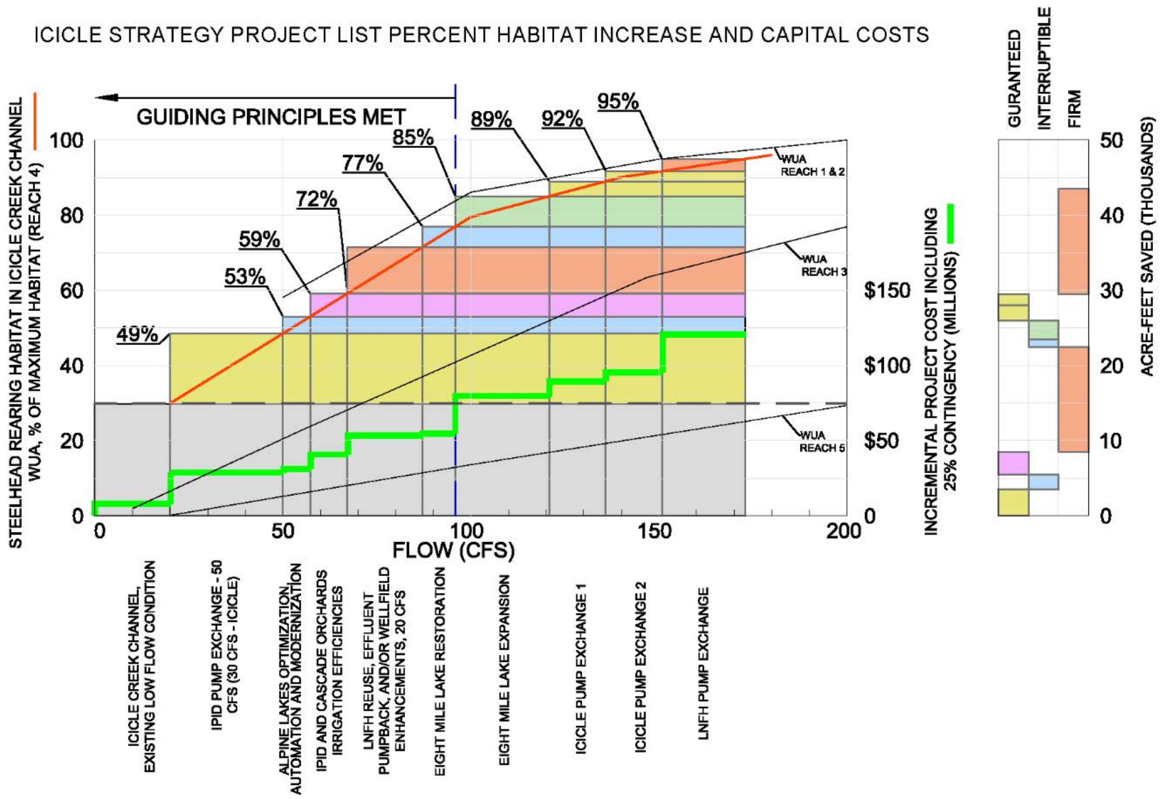
In Figure 2-4, a grouping of projects that would potentially meet the Guiding Principles (dashed vertical blue line) was created. Many combinations of such projects were considered. In each case, there is increasing habitat benefit, cost increases, and the pedigree of the water provided is matched to each project.

Figure 2-4. Comparison of Project Benefits and Costs to Flow and WUA, Step 2



In Figure 2-5, and in keeping with the long-term goal of 250 cfs, the IWG considered other projects that could be added beyond the short-term goal to further improve Icicle Creek. This also was evaluated because some projects to the left of the dashed vertical Guiding Principle line may become infeasible, which would necessitate consideration of other replacement projects.

Figure 2-5. Comparison of Project Benefits and Costs to Flow and WUA, Step 3



After several months of considering different project packages (or combinations of projects), ultimately the IWG assembled what would become known as the “Base Package,” or Alternative 1 in this PEIS, and endorsed it for comment and consideration in environmental review. The IWG’s endorsement of Alternative 1 was for the purpose of giving the public a specific set of projects to consider, with an openness for considering other project opportunities that could also meet all of the Guiding Principles.

2.2.1 Identification of Alternatives through SEPA Scoping

The IWG advanced their Base Package (Alternative 1) forward for programmatic environmental review by Ecology and Chelan County, who are acting as co-lead agencies. Prior to developing the PEIS, the IWG conducted outreach and scoping to inform the PEIS extent and scope, and to solicit ideas for additional variations to Alternative 1 that would result in reasonable alternatives to meet the Guiding Principles.

SEPA scoping feedback and comments received during a public meeting held by the co-lead agencies (Chelan County and Ecology) and the IWG helped to shape the alternatives analyzed in this PEIS. Chelan County and Ecology began preparations for SEPA scoping for the Icicle Strategy in January 2016. They prepared an expanded Environmental Checklist, issued a Determination of Significance (DS), and launched Programmatic SEPA Scoping in February 2016. A checklist is sometimes not prepared when a DS is issued, but the co-leads decided a detailed environmental checklist would help the public and agencies understand the scope of the proposal and direct them to resources gathered by the co-leads to help inform the potential benefits and impacts of implementation of the Icicle Strategy.

The IWG held an early outreach meeting to gain other stakeholder perspectives in February 2015 at the Good Shephard Center in Seattle. Their presentation focused on the proposed improvements to instream flows and water supply, and habitat improvements such as groundwater augmentation, new/modified storage, water markets, and fish passage/screening, as well as development of specific projects such as the Alpine Lakes Optimization and Automation and the Eightmile Lake Storage Restoration.

On April 20, 2016, the IWG held a public open house at the Leavenworth Fire Hall in Leavenworth, Washington to encourage public participation in the SEPA process. The IWG presented information on their Guiding Principles and the alternatives they evaluated to create the Base Package of projects to meet them. Members of the public submitted comments based on the presentation. The SEPA Comment Period for public input ended on May 11, 2016; however, one late comment was accepted. Copies of the comments can be accessed at the Chelan County website.[3]

The co-lead agencies met and reviewed comments received during SEPA scoping. They reviewed each comment and prepared a comment responsiveness summary. This exercise helped shape the scope of investigations in the PEIS. It also helped inform the co-leads on alternative selection. The co-leads met with the IWG to review four additional alternatives, in addition to the no-action and base package alternatives, that would be considered in the PEIS and received its concurrence. For example, the IWG received several comments regarding projects focused on conservation, some requested having no action in the wilderness area, and others requested increasing storage options in the Icicle Creek Subbasin. To be responsive to these diverse comments and to ensure the best suite of projects was selected, the co-leads developed Alternatives 2, 3, and 4 that are composed of a mix of projects that had been reviewed or studied by the IWG since the inception of the work group.

[3] http://www.co.chelan.wa.us/natural-resources/pages/icicle-strategy-sepa-comments

Alternative 5 was developed during the drafting of the EIS based on stakeholder discussion and further study of conservation opportunities in the IPID through their irrigation comprehensive plan. Additionally, with further study and funding opportunities for some projects, the No-action Alternative was modified to include several projects common to other alternatives. However, these projects' focus and benefits would not be the same if action on the Icicle Strategy does not occur.

All alternatives can meet the objectives of the Guiding Principles, but with different emphases, costs, benefits, and impacts.

A 60-day public comment will be reopened following the release of this draft PEIS. These comments will be considered when finalizing the PEIS.

2.3 Summary of Alternatives

The Icicle Strategy seeks to improve water resources management in the Icicle Creek Subbasin and achieve the specific metrics outlined in the Guiding Principles. This PEIS evaluates four alternatives that meet the Guiding Principles, along with a No-action Alternative. These alternatives are introduced here and discussed in further detail in Section 2.4. The following Section 2.5 provides a detailed narrative of each project included in the suite of projects used to create the alternatives.

Each action alternative is composed of a variety of several projects developed to help meet the IWG's Guiding Principles. In summary, the five alternatives include:

- **No-action Alternative:** The No-action Alternative is presented to show the impacts of not implementing the Icicle Strategy. Under the No-action Alterative, some projects may be developed on separate and different pathways by proponents other than the IWG, although it is unlikely all would be implemented. Funding for projects would be delayed or less competitive without an integrated solution, resulting in slower implementation of projects that do succeed without IWG support. Project beneficiaries may be different and not focused on meeting guiding principles. Projects that may be implemented, on their own independent timelines, could improve streamflow by approximately 32 cfs and 18,094 acre-feet.
- **Alternative 1 (Base Package):** The IWG has identified the first alternative as the Base Package, consisting of 12 elements that work in concert to achieve all of the Guiding Principles. The package is a mix of projects, including automating and optimizing reservoir releases at seven Alpine Lakes; efforts to make hatchery, irrigation, and domestic use more efficient; enhancement of habitat, fish passage, and fish screening; and protection of tribal and non-tribal fisheries. The suite of projects proposed under Alternative 1 (listed in Table 2-1) is estimated to cost $81.7 million, which includes a 25 percent contingency. These projects are

anticipated to provide 89 cfs and 31,958 acre-feet of total water benefit (instream and out-of-stream), of which 88 cfs and 28,458 acre-feet instream flow benefit. This estimate of instream flow benefit includes reach benefit for out-of-stream uses that would occur downstream.

- **Alternative 2:** This alternative builds on the foundation of Alternative 1, but replaces the Alpine Lakes Optimization project with the IPID Dryden Pump Exchange project. Alternative 2 is estimated to cost $91 million, which includes a 25 percent contingency. This alternative would provide 84 cfs and 27,978 acre-feet of total water benefit (instream and out-of-stream), of which 83 cfs and 24,478 acre-feet of instream flow benefit. This estimate of instream flow benefit includes reach benefit for out-of-stream uses that would occur downstream.
- **Alternative 3:** This alternative also builds on the foundation of Alternative 1, but focuses on project selection outside the Alpine Lakes Wilderness Area through greater reliance on conservation and pump exchange projects. Because supply and demand cannot be matched well without storage, it also includes a legislative change for instream flow impacts that would occur when conserved water is not able to fully meet demand in-time and in-place. This is a requirement given recent Supreme Court clarity in the *Foster/Yelm* case. Alternative 3 is estimated to cost $89 million, which includes a 25 percent contingency. This alternative would provide 71 cfs and 24,378 acre-feet of total water benefit (instream and out-of-stream), of which 70 cfs and 23,578 of instream flow benefit. This estimate of instream flow benefit includes reach benefit for out-of-stream uses that would occur downstream.
- **Alternative 4:** This alternative provides a greater emphasis on development of water supplies, with enhancements to Eightmile Lake and storage improvements at the Upper Klonaqua and Snow Lakes. This alternative was selected to evaluate the value of greater flexibility in shaping water availability to meet future changes in both supply and demand. Alternative 4 would cost the most and provide the most water. The estimated cost, which includes a 25 percent contingency, is $96 million. This alternative would provide 132 cfs and 35,385 acre-feet of total water benefit, of which 131 cfs and 34,585 acre-feet of instream flow benefit. This estimate of instream flow benefit includes reach benefit for out-of-stream uses that would occur downstream.
- **Alternative** 5: This alternative builds on the foundation of Alternative 1, but provides a greater emphasis on out-of-basin water supplies. Under Alternative 5, the IPID Irrigation Efficiencies element would be replaced with the IPID Full Piping and Pump Exchange. Under the IPID Full Piping and Pump Exchange, the IPID diversion would be completely removed from Icicle Creek, and it would be replaced with three pump stations on the Wenatchee River. The estimated cost, which includes a 25 percent contingency, is $174.4 million. This alternative would provide 196 cfs and 58,958 acre-feet of total water benefit, and 195 cfs and 55,458 acre-feet of instream flow benefit to Icicle Creek. This estimate of instream flow benefit includes reach benefit for out-of-stream uses that would occur downstream.

This PEIS evaluates each alternative for probable significant adverse impacts, potential costs and benefits, mitigation measures, and probable required permit approvals. The alternatives are discussed in further detail in Section 2.4.

Most of these alternatives use several of the same projects to meet the Guiding Principles because scoping did not reveal reasonable alternatives to meet them. For example, there was consensus on Guiding Principles such as screening, hatchery conservation improvements, and protection of tribal and non-tribal fisheries. Therefore, these are included in each of the five Alternatives. Table 2-1 provides a list of all projects by alternative and notes common projects. Sections 2.4 through 2.8 provide a detailed discussion of each alternative.

2.3.1 No-action Narrative Description

The No-action Alternative represents what might happen if no integrated, comprehensive strategy for managing water resources in Icicle Creek is adopted and implemented by the IWG to meet the Guiding Principles established by the IWG. Under the No-action Alternative, some projects may still be developed, but projects would be developed on separate timelines and for different purposes than those outlined in the Guiding Principles. Projects would likely be developed independently by members of the IWG or by proponents other than the IWG. Funding for projects would likely be delayed and projects may be less competitive for funding without an integrated strategy. Projects could be delayed or not implemented at all because of the lack of consensus-building at the local level. The No-action Alternative would fail to meet the instream flow Guiding Principle.

It is difficult to predict which of the projects might be constructed, delayed, or not implemented. However, based on the level of study and potential funding available for the various projects at the time of this PEIS, the following projects[4] are likely to implemented in some form under the No-action Alternative.

- **Alpine Lakes Optimization, Modernization, and Automation** modernizes and automates the outlet works and gate infrastructure at seven lakes. Under the Icicle Strategy, this project would be implemented for instream flow benefit. However, if the Icicle Strategy does not advance, it is probable that at some point IPID would implement this project to improve their operations as part of routine reservoir maintenance that all infrastructure owners consider. However, if IPID pursues modernization and automation of the gates on its own, releases for the purposes of benefiting instream flow would not be guaranteed and would more likely be optimized for agricultural use.

[4] Refer to Section 2.5 for full descriptions of projects.

Table 2-1
Alternatives Being Considered

Projects	Proposed Alternatives					
	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Conservation						
IPID Irrigation Efficiencies	○	●	●	●	●	
COIC Irrigation Efficiencies (Piping)	●	●	●	●	●	●
Domestic Conservation Efficiencies	○	●	●	●	●	●
LNFH Conservation and Water Quality Improvements	●	●	●	●	●	●
Pump Exchange						
IPID Dryden Pump Exchange	○	○	●	●		
Full IPID Pump Station						●
COIC Irrigation Efficiencies (Pump Exchange)	●	●	●	●	●	●
Modification/Restoration of Existing Storage						
Alpine Lakes Reservoir Optimization, Modernization and Automation	○	●			●	●
Eightmile Lake Storage Restoration	○	●	●	○	●	●
New Storage						
Eightmile Lake Storage Enhancement					●	
Upper Klonaqua Lake Storage Enhancement					●	
Upper and Lower Snow Lakes Storage Enhancement					●	
Habitat/Fisheries Improvements						
Tribal Fishery Protection	○	●	●	●	●	●
Habitat Protection and Enhancement	○	●	●	●	●	●
Fish Passage	●	●	●	●	●	●
Fish Screening	●	●	●	●	●	●
Legislative/Administrative Tools						
Water Markets		●	●	●	●	●
Instream Flow Rule Amendment	○	●	●	●	●	●
OCPI legislative fix from instream flow impacts				●		

○ *Represents projects that might proceed if funding becomes available. However, under the No-action Alternative, project beneficiaries may be different and project timelines are unknown.*

● *Represents projects that are likely to occur as described, but could be replaced by another project that fulfills the same guiding principles if a design, funding, or permitting fatal flaw is identified.*

- **IPID Irrigation Efficiencies** would likely continue to be explored and implemented if funding were available because IPID has continually worked to improve efficiency within the District. However, funding may be more limited if not included as part of an integrated water resource management strategy, which could limit the scope and magnitude of efficiency projects. Additionally, all water saved through irrigation efficiency upgrades would likely assist IPID in meeting agricultural reliability purposes only, rather than bolstering instream flows, unless funding is used for a specific project that requires a trust water right transfer or some other commitment to instream flows.

- **COIC Irrigation Efficiencies and Pump Exchange** funding opportunities will likely exist for this project if the Icicle Strategy is not implemented. The COIC project is already proceeding with design and environmental permitting based on the strength of consensus built by the IWG over the last 5 years. Funding for the project is primarily based on the potential benefit the project offers to Icicle Creek. The project would shift the point of diversion for COIC from Icicle Creek to a location near the confluence of Icicle Creek and the Wenatchee River. The project would also improve efficiency. The project would benefit Icicle Creek and assist in providing more reliable service to COIC.

- **Domestic Conservation** would likely continue to be explored and implemented if funding were available because the City of Leavenworth has already invested in conservation in the past and is required to pursue water use efficiency measures as part of conservation planning required by Municipal Water Law. The County also has addressed continuing rural conservation options by teaming with local water purveyors on how to incentivize or promote this idea. However, funding may be more limited if not included as part of an integrated water resource management plan, which could limit the magnitude of conservation projects. Regardless, water saved under the No-action Alternative would benefit the domestic uses in a similar manner as although potentially to a lesser degree than would occur for the other alternatives.

- **Eightmile Lake Storage Restoration** will occur because IPID has a long-term responsibility to maintain its infrastructure to provide reliable water service to its irrigation customers, while protecting public safety of those downstream of their dams. While the Eightmile Lake Dam is in need of repair, the District has prioritized other capital improvements over this project in recent years, including conservation and other dam maintenance, in part to allow for this project to be evaluated in more detail by the IWG. However, the need to make improvements has become more urgent because the outlet is collapsing and losing capacity. In addition, a fire in 2017 burned to the shoreline of the lake, likely changing the hydrology of inflow to the lake and raising concerns about the condition and safety of the dam. IPID declared an emergency on March 13, 2018, as a result of the 2017 fire and is actively coordinating with local, state, and federal agencies on this project. If not implemented or funded as part of an integrated strategy, IPID would not be obligated to release any of this water for instream flow or domestic benefit as envisioned under multiple Alternatives considered in this PEIS. Instead that water would be retained for agricultural reliability and drought resiliency.

- **Habitat Protection and Enhancement** may occur at a reduced level. Prior to the IWG, Chelan County has worked on habitat improvements in lower Icicle Creek. This would likely continue, although funding may be more limited if not included as part of an integrated water resource management plan project and the extent of the habitat protection and enhancement could be lower.

- **Instream Flow Rule Amendment** may be sought if other required projects are completed (e.g., LNFH improvements and habitat enhancement), as envisioned under the original rule language in WAC 173-545-090. However, this may occur over a longer timeline.

- **LNFH Conservation and Water Quality Improvements** focuses on projects to reduce surface water use and improve access to groundwater. Projects required in the Biological Opinion would continue without the Icicle Strategy. These include consideration of water reuse, groundwater augmentation, and a pump back that would allow for changing operations at Structure 2 and the division of water between the historic and hatchery channels.

- **Fish Screen Compliance** upgrades will likely continue if the Icicle Strategy is not implemented. These upgrades are required by law, and grant funding has already been expended on the design of screening improvements for the City of Leavenworth and IPID diversions. Screening for COIC is included in the COIC Irrigation Efficiencies project, while screening for LNFH is required under the BiOp and will be the subject of NEPA environmental review. However, implementation may occur on a slower timeline based on funding and would not necessarily occur in a way that would benefit other projects included in the Icicle Strategy, such as Habitat Protection and Enhancement.

- **IPID Dryden Pump Exchange** may be implemented under the No-action Alternative. However, the project would likely be rescaled and focused, at least initially, on reducing diversions from Peshastin Creek and improving the reliability of water supply to the Peshastin Irrigation District (PID) Main Canal, which could result in no benefit or less benefit in Icicle Creek.

2.3.2 Alternative 1 (Base Package) Narrative Description

Alternative 1, also referred to as the Base Package, meets all the objectives defined in the IWG's Guiding Principles. These projects have been agreed to and moved forward by the IWG for review in this PEIS. While IWG members have reserved a final recommendation on Alternative 1 until resolution of the PEIS and consultation with the co-leads in 2018, this alternative represented the best recommendation available after 4 years of study by IWG members.

Alternative 1 includes the following projects[5]:

- **Alpine Lakes Reservoirs Optimization, Modernization, and Automation** modernizes and automates the outlet works and gate infrastructure at seven lakes. The intent is to improve management and releases of stored water at seven lakes in the Icicle Creek Subbasin based on changing conditions to meet the Subbasin's needs. It increases streamflow for fish and improves reliability and operation of stored water for agricultural use and the LNFH. (GP1; GP5)[6]
- **IPID Irrigation Efficiencies** explores options to improve irrigation delivery and on-farm efficiencies. Projects may include canal piping or lining and on-farm efficiency upgrades, which would improve drought resiliency and reliability to district users. This project also benefits fish by increasing streamflow. (GP1; GP5)
- **COIC Irrigation Efficiencies and Pump Exchange** proposes to change COIC's point of diversion from its existing location at RM 4.5 on Icicle Creek to a location on the right bank of the Wenatchee River near its confluence with Icicle Creek or on the left bank of Icicle Creek near its confluence with the Wenatchee River and implement other water saving measures, such as piping the delivery system. The augmented streamflow has the potential to improve reliability of water supply for agriculture, benefit fish passage and habitat, and maintain treaty and non-treaty harvests. (GP1; GP5)
- **Domestic Conservation Efficiencies** focuses on conservation projects in the City of Leavenworth and Chelan County and implements municipal and rural water efficiency projects such as leak detection and repair, meter installation, and water use conservation to improve domestic supply. (GP4)
- **Eightmile Lake Storage Restoration** rebuilds the Eightmile Lake dam to restore usable storage to the historical and permitted high water storage elevation. This would increase streamflow for fish and meet the domestic water needs of the City of Leavenworth and surrounding rural areas in Chelan County and improves the reliability and drought resiliency for agricultural users. (GP1; GP4; GP5)

[5] Taken from Icicle Strategy SEPA Checklist: http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA/Icicle%20Strategy%20SEPAChecklist%20Signed.pdf
[6] GP = Guiding Principal. See explanation in Table 2-2.

- **Tribal and Non-Tribal Fisheries** ensures that projects and actions taken do not have negative effects on tribal fishery activity in the Icicle Creek Subbasin. It monitors fishery effectiveness and implements actions for improvement, while protecting Tribal Treaty and federally protected harvest rights and non-tribal harvest at all times. (GP2)
- **Habitat Protection and Enhancement** identifies and implements stream restoration and protection projects such as riparian plantings, engineered log jams, and conservation easements to improve stream habitat and ecosystem health. (GP6)
- **Instream Flow Rule Amendment** modifies the instream flow rule's interim domestic reservation of 0.1 cfs to a final level of 0.5 cfs. This helps meet domestic water needs through 2050. As described in Chapter 173-545 WAC, the rule amendment requires instream flow and habitat restoration. This will improve domestic supply in the Icicle Creek subbasin. (GP4)
- **LNFH Conservation and Water Quality Improvements** focuses on projects to reduce surface water use and improve access to groundwater. These projects may include onsite reuse, an effluent pump back, and wellfield enhancements for year-round benefits. It would also increase streamflow for fish and improve access to reliable water for the hatchery's operations. These projects also improve water quality in Icicle Creek. (GP1; GP2)
- **Fish Passage** improves passage by assessing and removing barriers, so fish have better access to healthy habitats. This could include improved operation at Structure 2 and modification of channel morphology at the Boulder Field. Improved passage will increase the amount of habitat fish can access within the subbasin. (GP6)
- **Fish Screening** upgrades fish screens on diversions to meet current standards. This will bring the major diverters on Icicle Creek into compliance with Washington State and NMFS screening requirements and bring LNFH into compliance with the screening requirements set in the Biological Opinion (NMFS, 2015). These projects reduce fish mortality, which ultimately improves fish passage. (GP6; GP7)
- **Water Markets** creates an Icicle Water Market and seeds it with an initial 1,000 acre-feet of water for agriculture use in the Icicle Creek Subbasin and Wenatchee River Basins during shortages. (GP4)

Additional projects may be pursued outside of the Icicle Strategy if Alternative 1 is selected as the preferred alternative, such as the IPID Dryden Pump Exchange. However, project beneficiaries may be different and project timelines are unknown.

Table 2-2 shows how the Base Package of projects included in Alternative 1 addresses the IWG's Guiding Principles. This suite of projects is expected to cost $82M, provides 89 cfs and 31,958 acre-feet of total water benefit (88 cfs and 28,458 acre-feet of instream benefit).

Table 2-2
How Alternative 1 (Base Package) Meets Guiding Principles

Guiding Principle Number	Guiding Principles	How the Base Package Meets the Guiding Principles
GP1	Improve Instream Flow	Meets goals of 100 cfs in average years and 60 cfs in drought years. Anticipated flow improvement is 88 cfs, in addition to base flows.
GP2	Improve Sustainability of LNFH	Meets goal of source redundancy and improved fish rearing and capacity, allowing LNFH to meet fish production goals. Also, improves water quality, and passage in Icicle Creek.
GP3	Protect Tribal and Non-Tribal Harvest	Meets goal of instream flow improvement balanced with preservation of fishery with adaptive management strategy in place, and potential amenity and access increases.
GP4	Improve Domestic Supply	Meets peak 2050 domestic demand
GP5	Improve Agricultural Reliability	Meets goal of 1,000 acre-feet for agricultural interruptible water rights.
GP6	Enhance Icicle Creek Habitat (includes fish passage and fish screens)	Meets goal of additional habitat improvement.
GP7	Comply with State and Federal Laws and Wilderness Acts	Meets goal by requiring project checks on all permits and an environmental review.

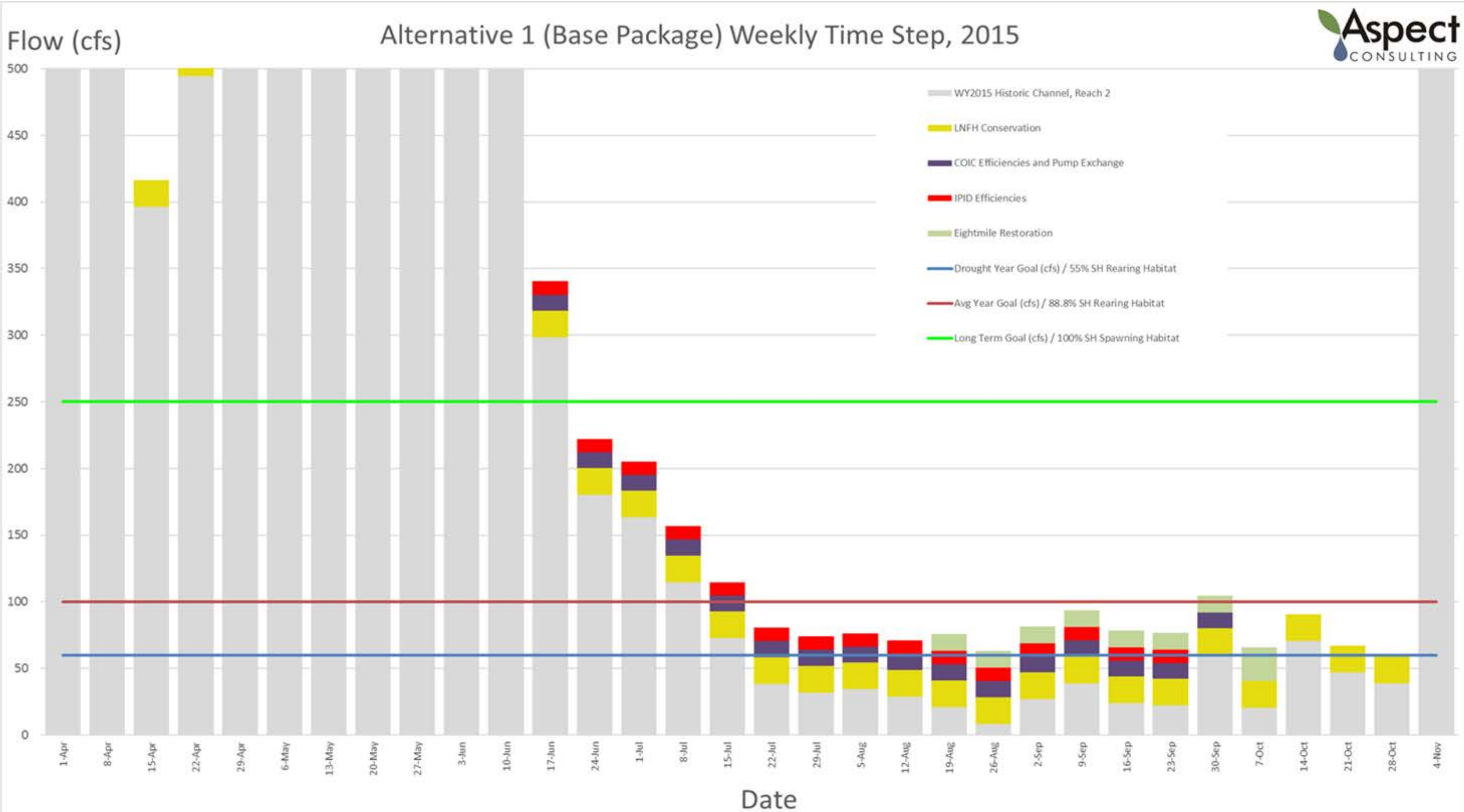
Because Icicle Creek experiences low flows most acutely in the late summer/early fall (see Section 3.3), it is insufficient to consider the instream flow Guiding Principle met if the annual quantities meet "average" drought or non-drought year conditions. Rather, it is appropriate to consider performance of the Alternatives on a weekly time-step and to consider both actual flows in an indicator drought and non-drought year, as well as how average conditions fair. To that end, 2015 was selected as a representative drought year and 2014 as a representative non-drought year.

Natural weekly flows in the historic channel were shown along with additional water supply made available from projects in each Alternative to compare to the Guiding Principles. Some projects provide a constant or fixed weekly flow benefit in proportion to their savings (e.g. conservation), while others are adaptive (e.g. storage). Where adaptation was possible, greater flow benefit is achieved by targeting releases to late summer/early fall. Both Alpine Lakes Reservoirs Optimization, Modernization, and Automation and Eightmile Lake Storage Restoration can be managed adaptively, and releases would be managed based on annual flow conditions.

For comparison purposes, Alternative 1 also evaluated how projects compared to average drought conditions (80% exceedance) and non-drought conditions (50% exceedance). However, the effect of this methodology under-predicts weekly low flows in both scenarios because the low flow week does not occur in the same week each year. Therefore, this evaluation was only shown for Alternative 1, while all alternatives used the indicator year method.

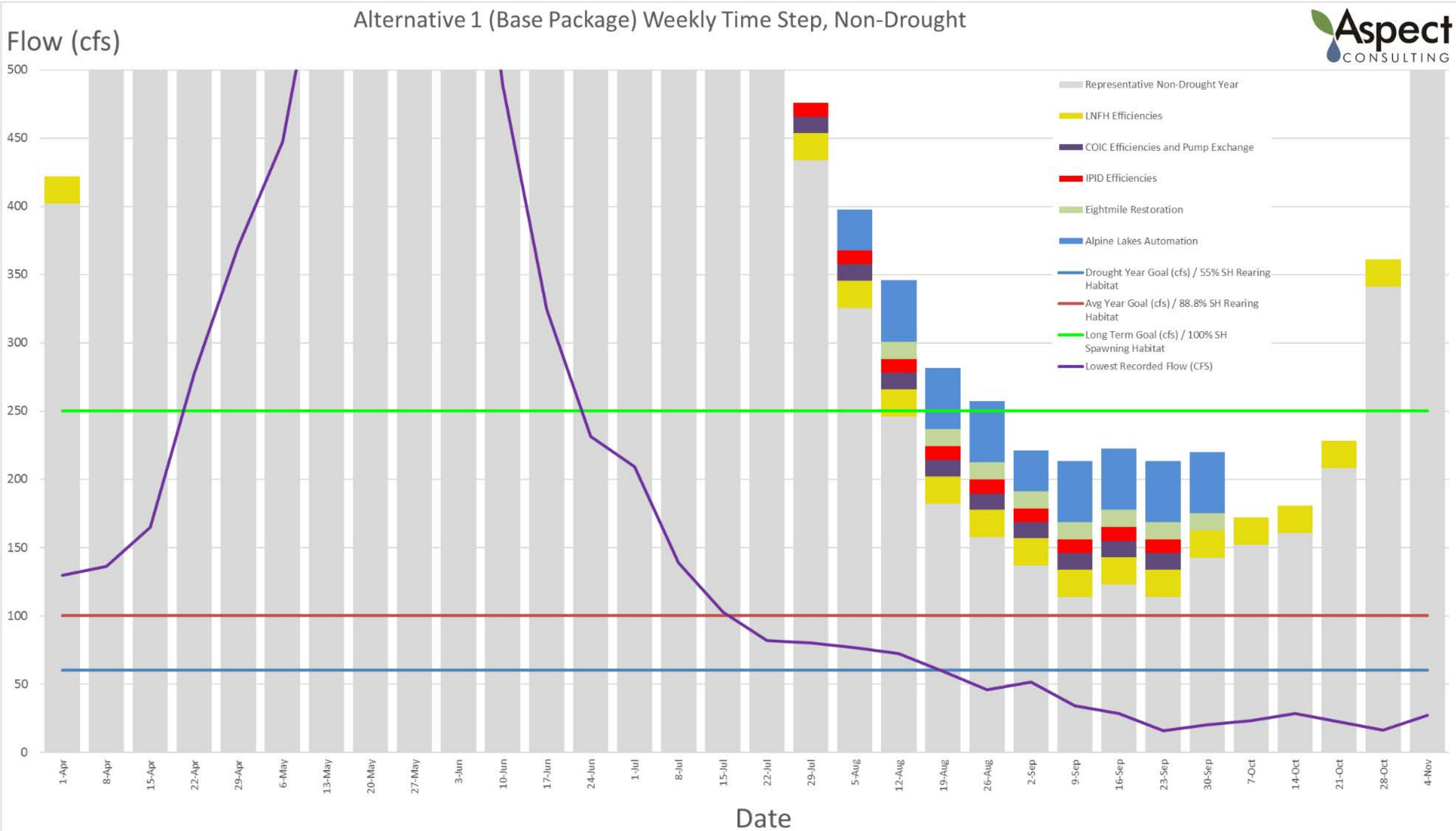
As shown in Table 2-2, the suite of projects proposed under Alternative 1 meets streamflow restoration goals established in the Guiding Principles. Figures 2-6, 2-7, 2-8, and 2-9 illustrate streamflow benefits in drought and non-drought years, as well as real time flows in 2015 and 2016 water years with the Alternative 1 projects added. Under all these scenarios, the 100 cfs short-term flow restoration goal is met.

Figure 2-6. Alternative 1 (Base Package) Weekly Time Step, 2015 (Drought Year)[7]



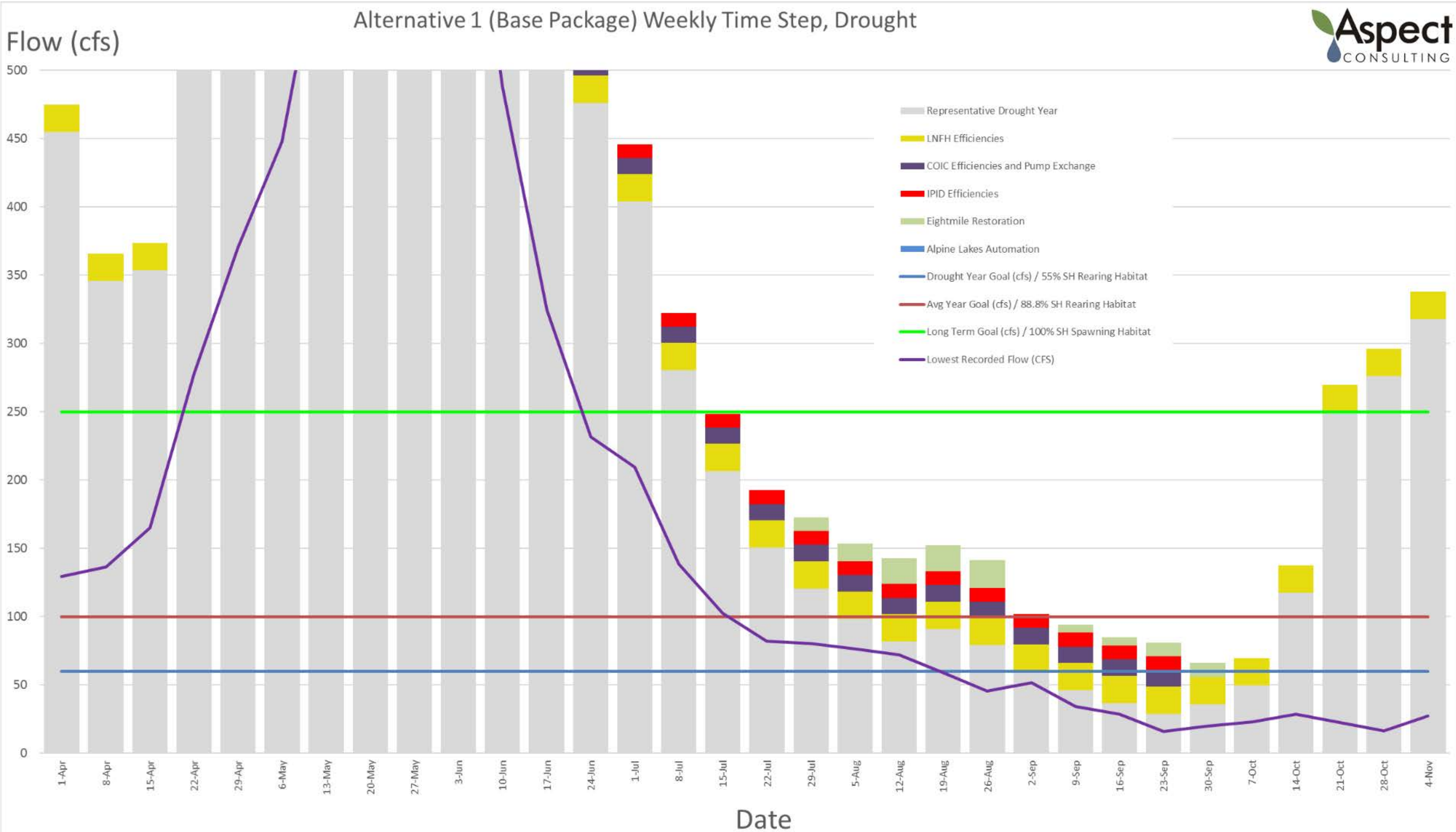
[7] Represent 2015 flows in Icicle Creek with estimated flow benefit achieved from Alternative 1 implementation

Figure 2-7. Alternative 1 (Base Package) Weekly Time Step, 2014 (Non-Drought Year)[8]



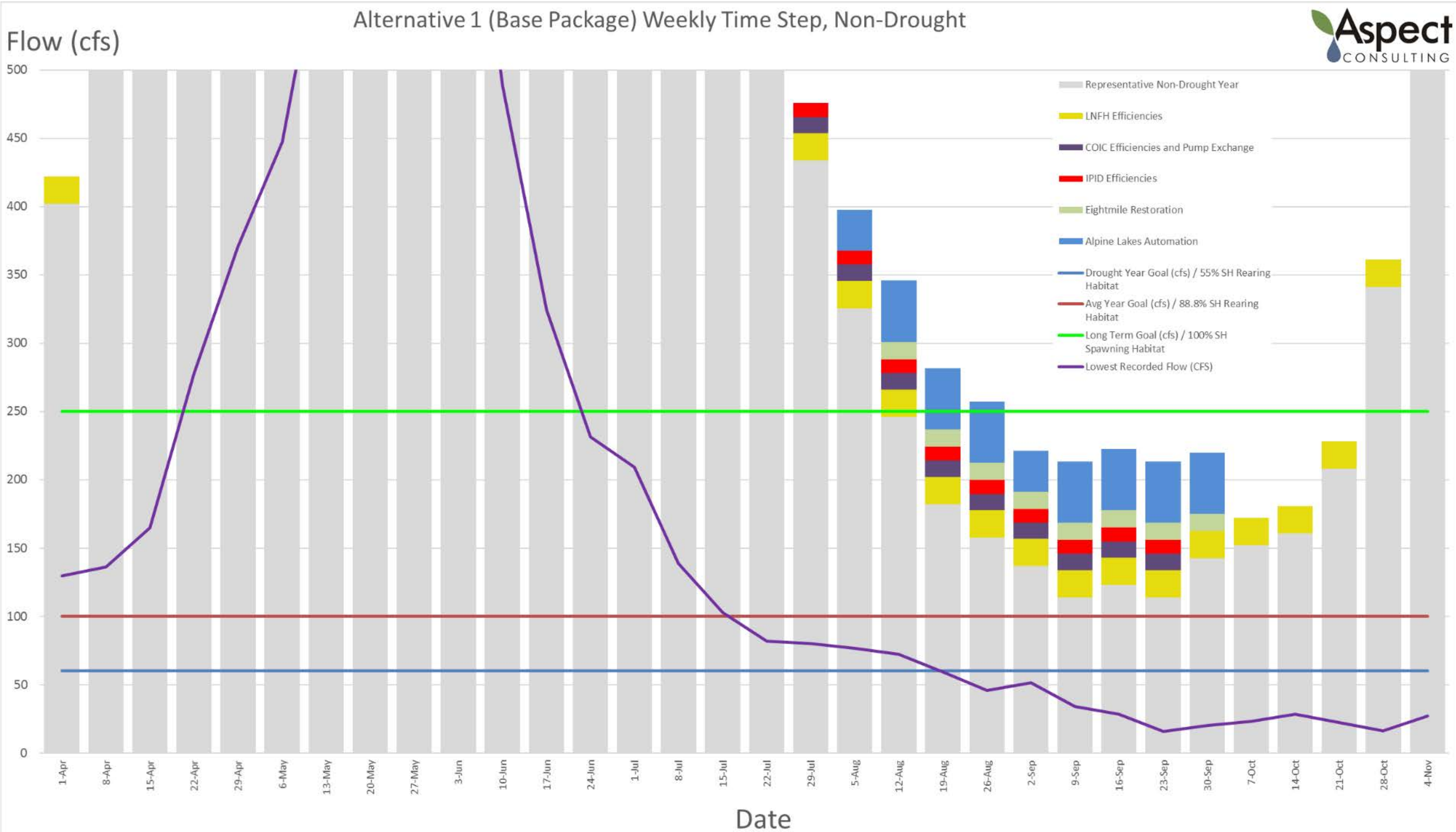
[8] Represent 2014 (46% exceedance) flows in Icicle Creek with estimated flow benefit achieved from Alternative 1 implementation.

Figure 2-8. Alternative 1 (Base Package) Weekly Time Step, Drought/Low Water Year Scenario[9]



[9] Represents 80-percent dry year flows in Icicle Creek with estimated flow benefit achieved from Alternative 1 implementation

Figure 2-9. Alternative 1 (Base Package) Weekly Time Step, Non-Drought Scenario [10]



[10] Represent average flows in Icicle Creek during "non-drought" years (50% exceedance) with estimated flow benefit achieved from Alternative 1 implementation

2.3.3 Alternative 2 Narrative Description

The IWG developed Alternative 2 in response to SEPA scoping comments that requested examination of pump station options and omission of the Alpine Lakes Optimization, Modernization, and Automation project. This alternative includes most of the projects from the Base Package (Alternative 1)—with the exception of the Alpine Lakes Optimization, Modernization, and Automation—and adds the IPID Dryden Pump Exchange project.

Alternative 2 includes the following projects:

- **IPID Dryden Pump Exchange** would install a pump station on the right bank of the Wenatchee River near Dryden and a delivery pipeline that would extend through private orchards and driveways to the IPID canals. Water pumped from the Wenatchee River would allow for a corresponding reduction in diversions from Icicle and Peshastin Creeks, which would improve streamflow. The augmented streamflow has the potential to improve reliability of water supply for agriculture, benefit fish passage and habitat, and maintain treaty and non-treaty harvests. (GP1; GP5)
- IPID Irrigation Efficiencies (GP1; GP5)
- COIC Irrigation Efficiencies and Pump Exchange (GP1; GP5)
- Domestic Conservation Efficiencies (GP4)
- Eightmile Lake Storage Restoration (GP1; GP4; GP5)
- Tribal Fisheries Protection (GP3)
- Habitat Protection and Enhancement (GP7)
- Instream Flow Rule Amendment (GP4)
- Leavenworth National Fish Hatchery Conservation and Water Quality Improvements (GP2)
- Fish Passage (GP6)
- Fish Screening (GP6; GP7)
- Water Markets (GP5)

Additional projects may be pursued outside of the Icicle Strategy if Alternative 2 is selected as the preferred alternative, such as the IPID Dryden Pump Exchange. However, project beneficiaries may be different and project timelines are unknown.

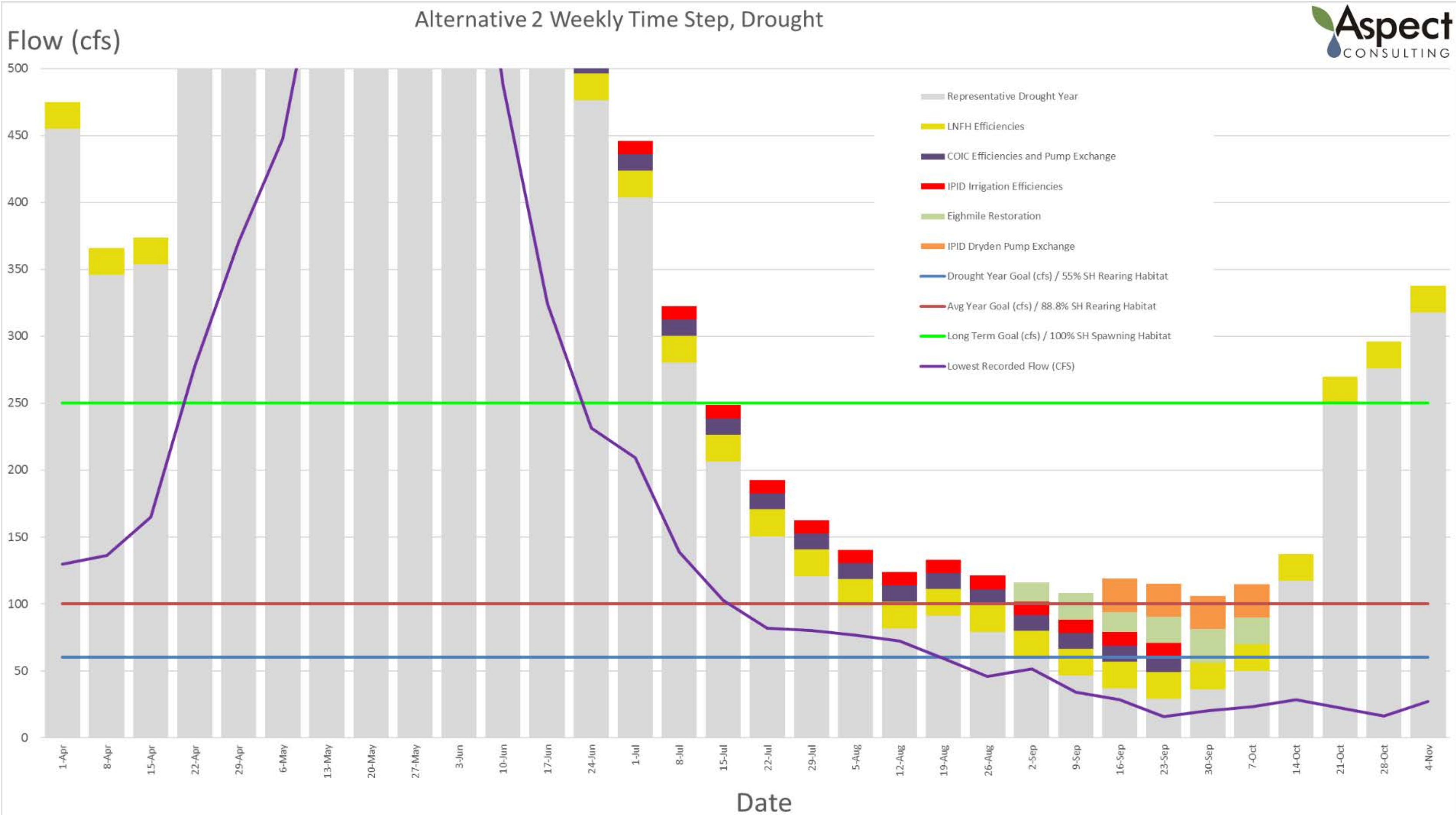
Table 2-3 shows how Alternative 2 addresses the IWG's Guiding Principles. This suite of projects is expected to cost $91M, provides 84 cfs and 27,978 acre-feet of total water benefit (instream and out-of-stream).

Table 2-3
How Alternative 2 Meets Guiding Principles

Guiding Principle Number	Guiding Principles	How Alternative 2 Meets the Guiding Principles
GP1	Improve Instream Flow	Meets goals of 100 cfs in average years and 60 cfs in drought years. Anticipated flow improvement is 83 cfs, in addition to base flow.
GP2	Improve Sustainability of LNFH	Meets goal of source redundancy and improved fish rearing and capacity, allowing LNFH to meet fish production goals. Also, improves water quality, and passage in Icicle Creek.
GP3	Protect Tribal and Non-Tribal Harvest	Meets goal of instream flow improvement balanced with preservation of fishery with adaptive management strategy in place, and potential amenity and access increases.
GP4	Improve Domestic Supply	Meets peak 2050 domestic demand
GP5	Improve Agricultural Reliability	Meets goal of 1,000 acre-feet for agricultural interruptible water rights.
GP6	Enhance Icicle Creek Habitat (includes fish passage and fish screens)	Meets goal of additional habitat improvement with adaptive management.
GP7	Comply with State and Federal Laws and Wilderness Acts	Meets goal by requiring project checks on all permits and an environmental review.

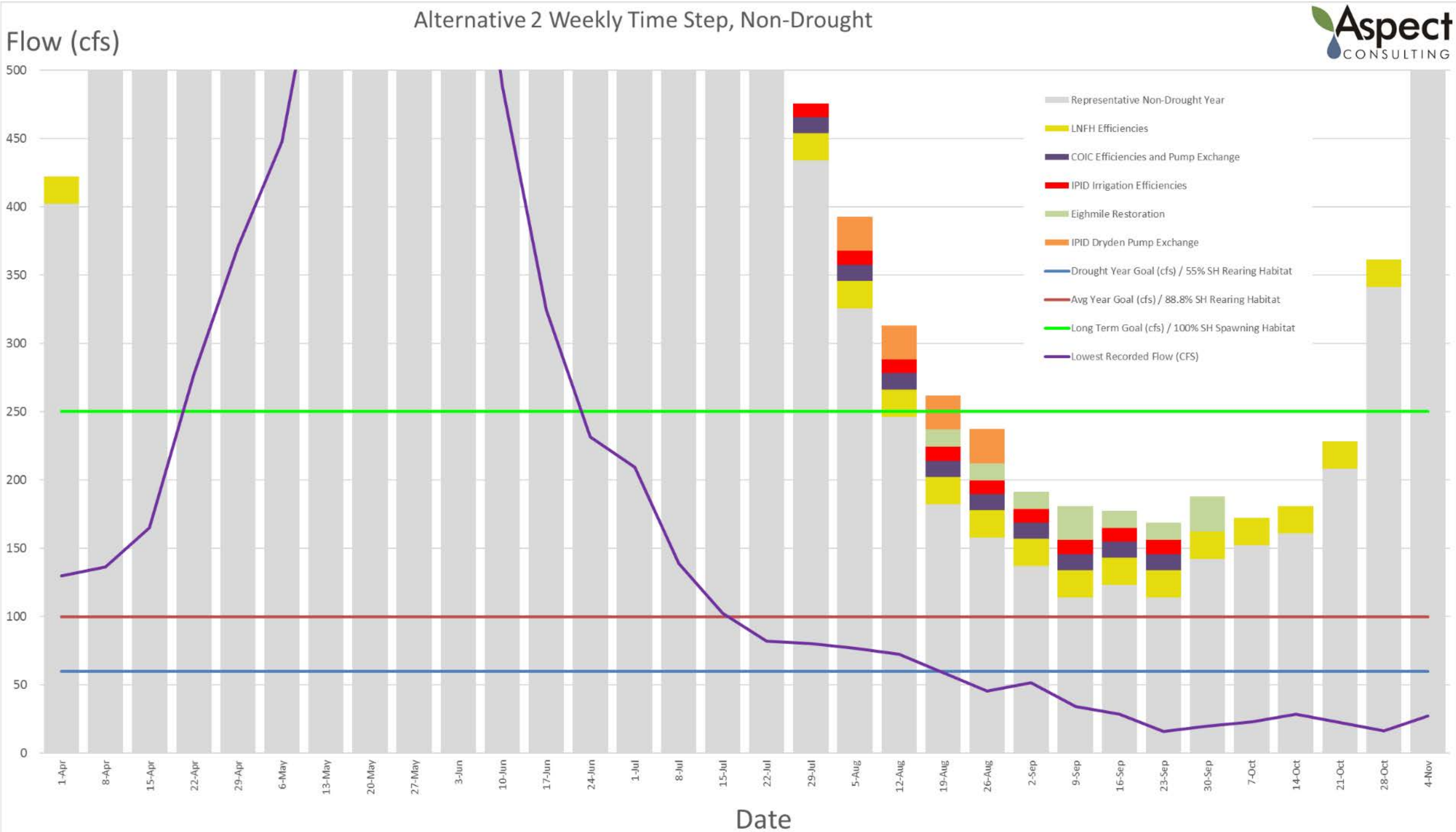
As shown in Table 2-3, the suite of projects proposed under Alternative 2 meets streamflow restoration goals established in the Guiding Principles. Figures 2-10 and 2-11 illustrate streamflow benefits in drought (2015) and non-drought (2014) years for Alternative 2. These figures show that the short-term instream flow goal of 100 cfs would be met under both scenarios.

Figure 2-10. Alternative 2 Weekly Time Step, Drought/Low Water Year Scenario[11]



[11] Represents 80-percent dry year flows in Icicle Creek with estimated flow benefit achieved from Alternative 1 implementation

Figure 2-11. Alternative 2 Weekly Time Step, Non-Drought Scenario [12]



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[12] Represent average flows in Icicle Creek during "non-drought" years (50% exceedance) with estimated flow benefit achieved from Alternative 1 implementation

2.3.4 Alternative 3 Narrative Description

Alternative 3 is a response to SEPA scoping comments that expressed a desire for an alternative that excluded projects within the Alpine Lakes Wilderness Area. Alternative 3 includes most of the projects from the Base Package presented in Alternative 1, with the exception of the Alpine Lakes Optimization, Modernization, and Automation and the Eightmile Lake Storage Restoration. It calls for a legislative change to waive impacts to instream flows when conservation and pump-exchange-based supplies cannot perfectly meet demand required to provide domestic reliability. For example, conservation supplies are available from April to October in this Alternative, but the Guiding Principle for domestic reliability requires year-round supplies. Because instream flows are at times not met from November to March, this would impair instream flows if legislative approval was not provided. Ecology no longer has the authority to waive these kinds of impacts through an Overriding Consideration of the Public Interest (OCPI) determination under RCW 90.54.020 given clarity from the Supreme Court in cases like *Swinomish* and *Foster/Yelm*.

Alternative 3 includes the following projects:

- IPID Dryden Pump Exchange (GP1; GP5)
- IPID Irrigation Efficiencies (GP1; GP5)
- COIC Irrigation Efficiencies and Pump Exchange (GP1; GP5)
- Domestic Conservation Efficiencies (GP4)
- Tribal Fisheries Protection (GP3)
- Habitat Protection and Enhancement (GP6)
- Instream Flow Rule Amendment (GP4)
- Leavenworth National Fish Hatchery Conservation and Water Quality Improvements (GP2)
- Fish Passage (GP6)
- Fish Screening (GP6; GP7)
- Water Markets (GP5)
- Legislative Change for Instream Flow Impacts. Under this project, the IWG would seek a legislative change that would allow impairment to the Instream Flow Rule when increased flow from conservation do not line up temporally with demand. (GP4)

Additional projects may be pursued outside of the Icicle Strategy if Alternative 3 is selected as the preferred alternative, such as the Eightmile Lake Storage Restoration Project. However, project beneficiaries may be different and project timelines are unknown.

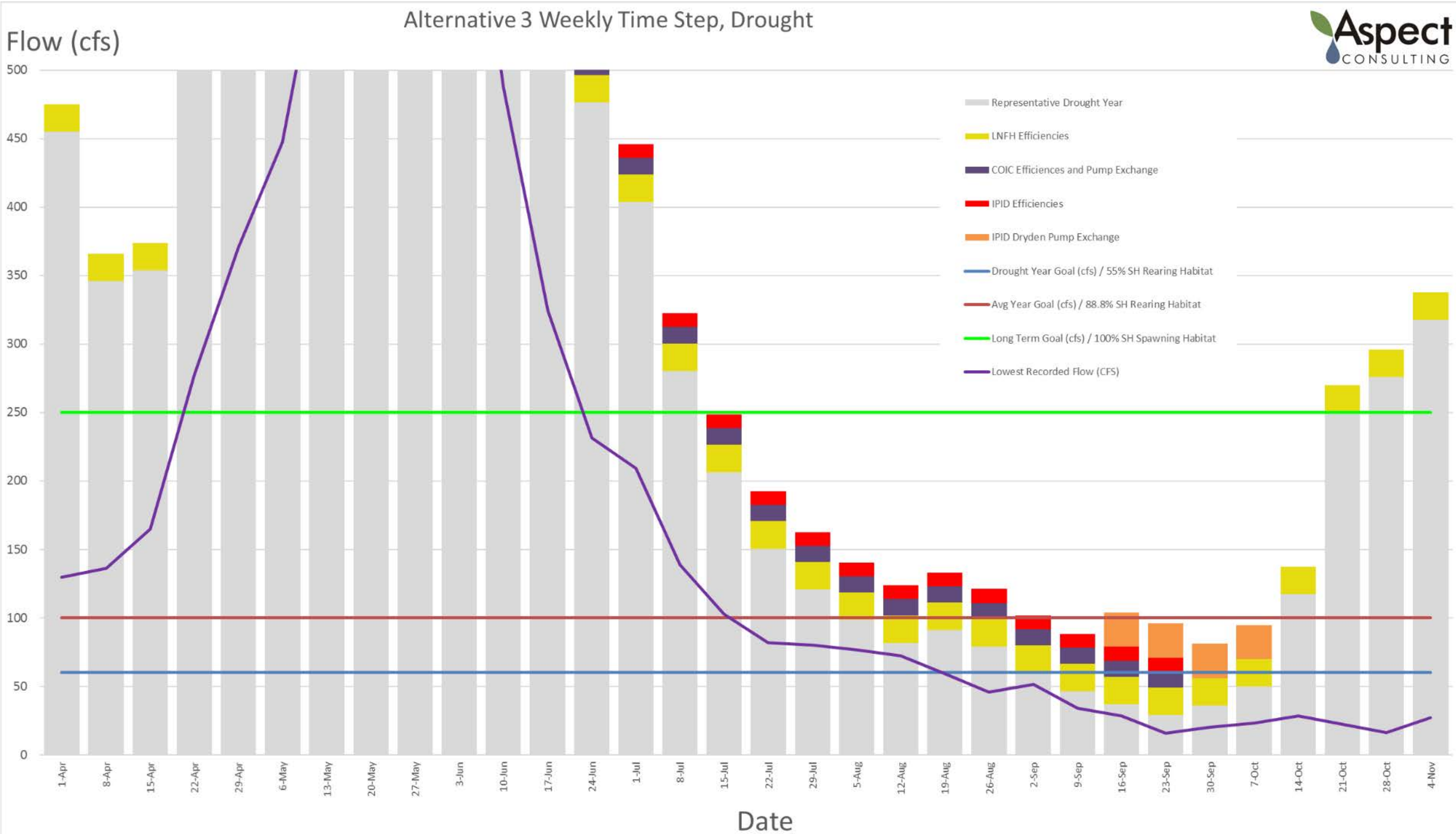
Table 2-4 shows how Alternative 3 addresses the IWG's Guiding Principles.

Table 2-4
How Alternative 3 Meets Guiding Principles

Guiding Principle Number	Guiding Principles	How Alternative 3 Meets the Guiding Principles
GP1	Improve Instream Flow	Meets goals of 100 cfs in average years and 60 cfs in drought years. Anticipated flow improvement is 70 cfs in addition to base flow.
GP2	Improve Sustainability of LNFH	Meets goal of source redundancy and improved fish rearing and capacity, allowing LNFH to meet fish production goals. Also, improves water quality, and passage in Icicle Creek.
GP3	Protect Tribal and Non-Tribal Harvest	Meets goal of instream flow improvement balanced with preservation of fishery with adaptive management strategy in place, and potential amenity and access increases.
GP4	Improve Domestic Supply	Meets domestic needs through legislation.
GP5	Improve Agricultural Reliability	Meets goal of 1,000 acre-feet for agricultural interruptible water rights.
GP6	Enhance Icicle Creek Habitat (includes fish passage and fish screens)	Meets goal of additional habitat improvement with adaptive management.
GP7	Comply with State and Federal Laws and Wilderness Acts	Meets goal by requiring project checks on all permits and an environmental review.

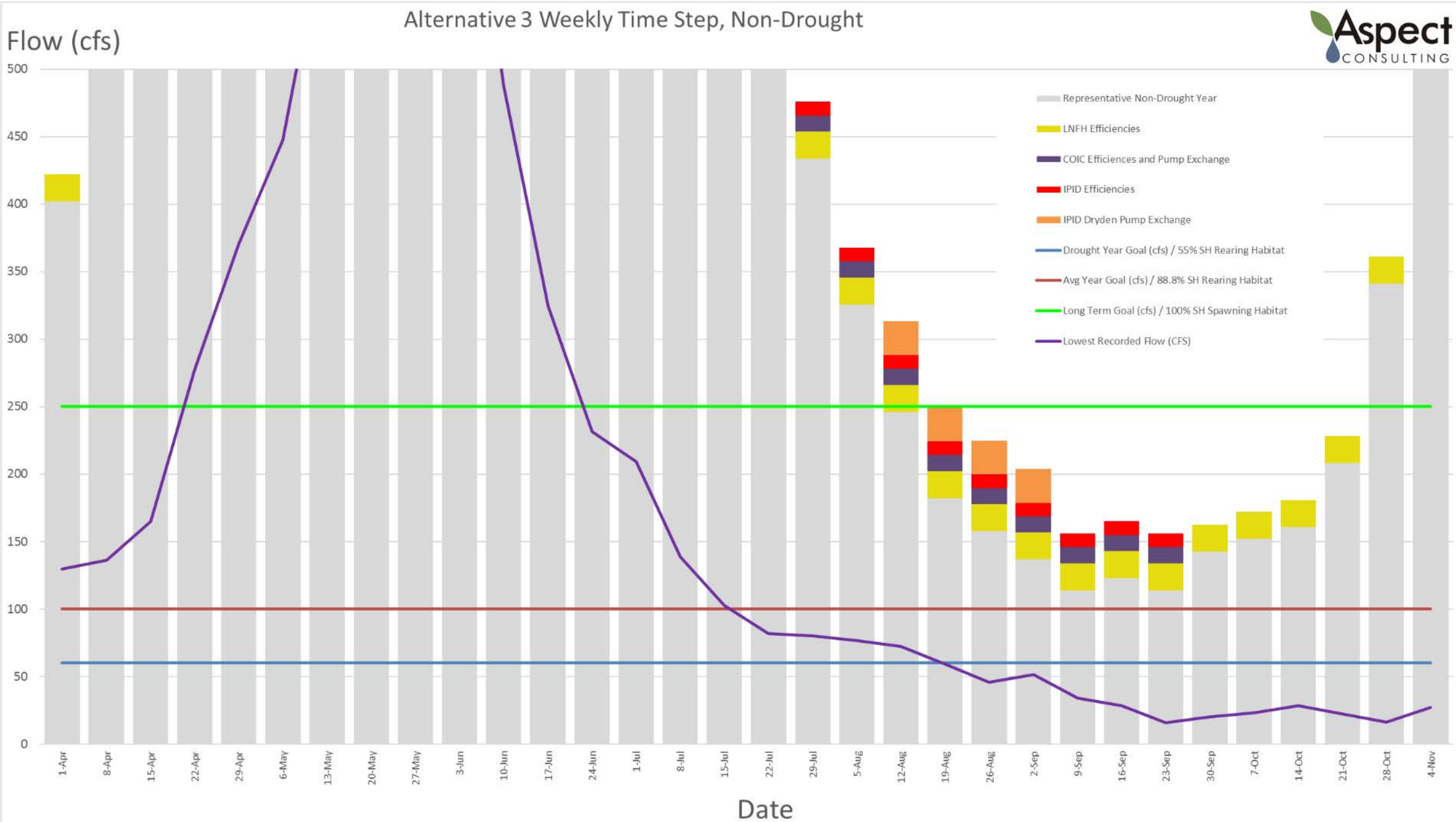
As shown in Table 2-4, the suite of projects proposed under Alternative 3 meets streamflow restoration goals established in the Guiding Principles. Figures 2-12 and 2-13 illustrate streamflow benefits in drought and non-drought years for Alternative 3. These figures show the Guiding Principle of 100cfs would be met in drought and non-drought years.

Figure 2-12. Alternative 3 Weekly Time Step, Drought/Low Water Year Scenario[13]



[13] Represents 80-percent dry year flows in Icicle Creek with estimated flow benefit achieved from Alternative 1 implementation

Figure 2-13. IWG Alternative 3 Weekly Time Step, Non-Drought Scenario [14]



[14] Represent average flows in Icicle Creek during "non-drought" years (50% exceedance) with estimated flow benefit achieved from Alternative 1 implementation

2.3.5 Alternative 4 Narrative Description

Alternative 4 was created as a response to SEPA scoping comments that requested increased storage in the Icicle Creek Subbasin as an adaptive measure to climate change uncertainty and to better react to changes in future demand. This alternative has all the same projects as the Base Package presented in Alternative 1, but calls for increasing storage at Eightmile Lake to above the historical high water mark and enhancing storage and release at Upper Klonaqua and Upper Snow Lakes. Conservation was not reduced over that identified in Alternative 1 because it was necessary to meet other Guiding Principles (e.g., LNFH hatchery reliability, agricultural reliability).

- Alpine Lakes Reservoirs Optimization, Modernization, and Automation (GP 1; GP5)
- **Eightmile Lake Storage Enhancement** differs from the Eightmile Lake Storage Restoration project included in the Base Package in Alternatives 1 and 2. It calls for increasing the useable storage to approximately 3,500 acre-feet by rebuilding the dam to raise the high-water storage elevation and increasing the available draw down. (GP1; GP4; GP5)
- **Upper Klonaqua Lake Storage Enhancement** takes advantage of potential storage in Upper Klonaqua Lake by installing infrastructure to draw down the lake. Options for draw down include tunneling, pumping, and siphon. Bathymetry suggests up to 2,448.2 acre-feet of water could be available for release. (GP1; GP4)
- **Upper and Lower Snow Lakes Storage Enhancement** would raise the dam on Upper Snow Lake to increase storage capacity by 1,079 acre-feet. (GP1; GP4)
- IPID Irrigation Efficiencies (GP1; GP5)
- COIC Irrigation Efficiencies and Pump Exchange (GP1; GP5)
- Domestic Conservation Efficiencies (GP4)
- Tribal Fisheries Protection (GP3)
- Habitat Protection and Enhancement (GP6)
- Instream Flow Rule Amendment (GP4)
- Leavenworth National Fish Hatchery Conservation and Water Quality Improvements (GP2)
- Fish Passage (GP6)
- Fish Screening (GP6; GP7)
- Water Markets (GP5)

Additional projects may be pursued outside of the Icicle Strategy if Alternative 4 is selected as the preferred alternative. However, project beneficiaries may be different and project timelines are unknown.

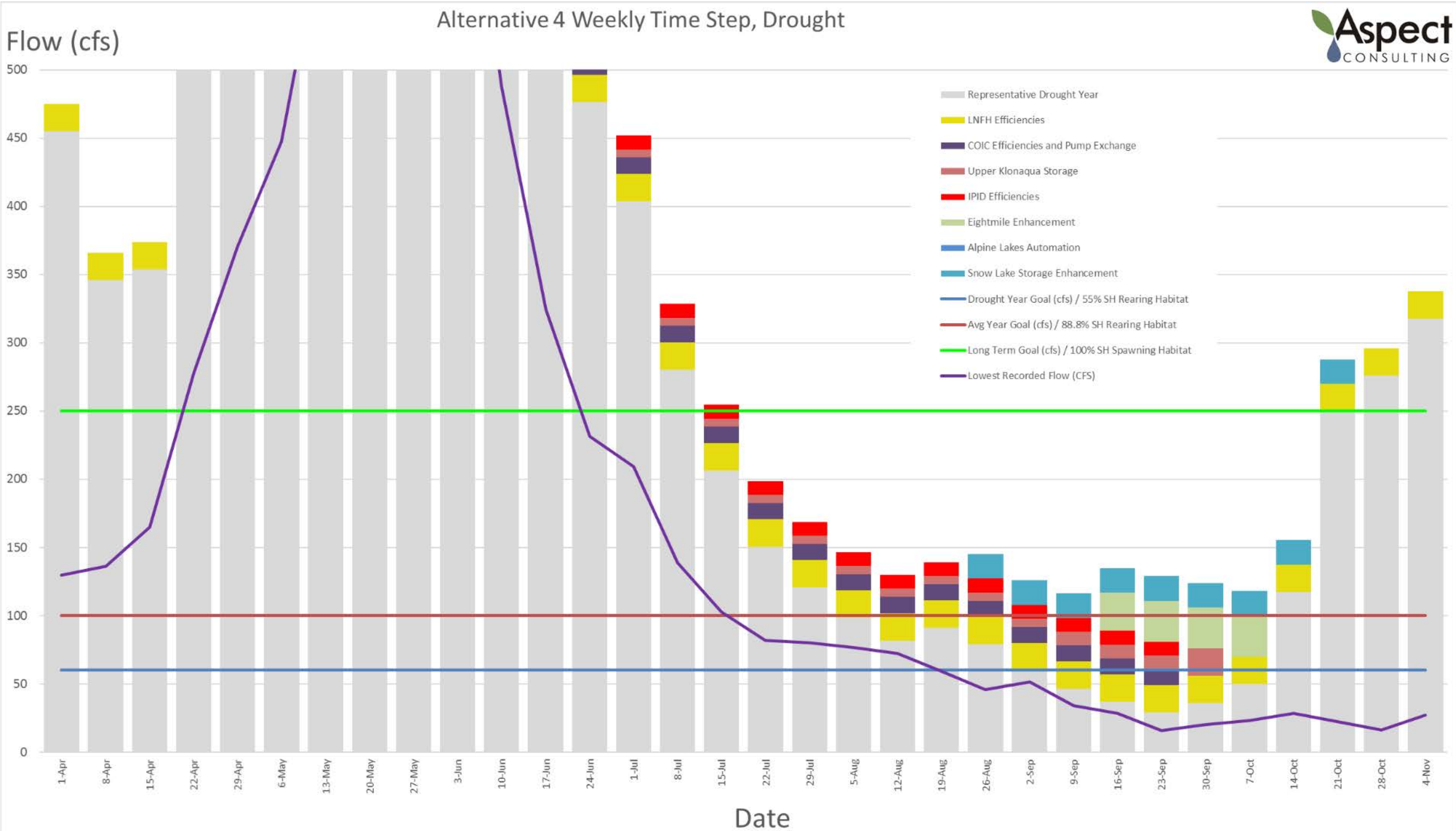
Table 2-5 shows how Alternative 4 addresses the IWG's Guiding Principles.

Table 2-5
How Alternative 4 Meets Guiding Principles

Guiding Principle Number	Guiding Principles	How Alternative 4 Meets the Guiding Principles
GP1	Improve Instream Flow	Meets goals of 100 cfs in average years and 60 cfs in drought years. Anticipated flow improvement is up to 131 cfs.
GP2	Improve Sustainability of LNFH	Meets goal of source redundancy and improved fish rearing and capacity, allowing LNFH to meet fish production goals. Also, improves water quality, and passage in Icicle Creek.
GP3	Protect Tribal and Non-Tribal Harvest	Meets goal of instream flow improvement balanced with preservation of fishery with adaptive management strategy in place, and potential amenity and access increases.
GP4	Improve Domestic Supply	Meets peak 2050 domestic demand
GP5	Improve Agricultural Reliability	Meets goal of 1,000 acre-feet for agricultural interruptible water rights.
GP6	Enhance Icicle Creek Habitat (includes fish passage and fish screens)	Meets goal of additional habitat improvement with adaptive management.
GP7	Comply with State and Federal Laws and Wilderness Acts	Meets goal by requiring project checks on all permits and an environmental review.

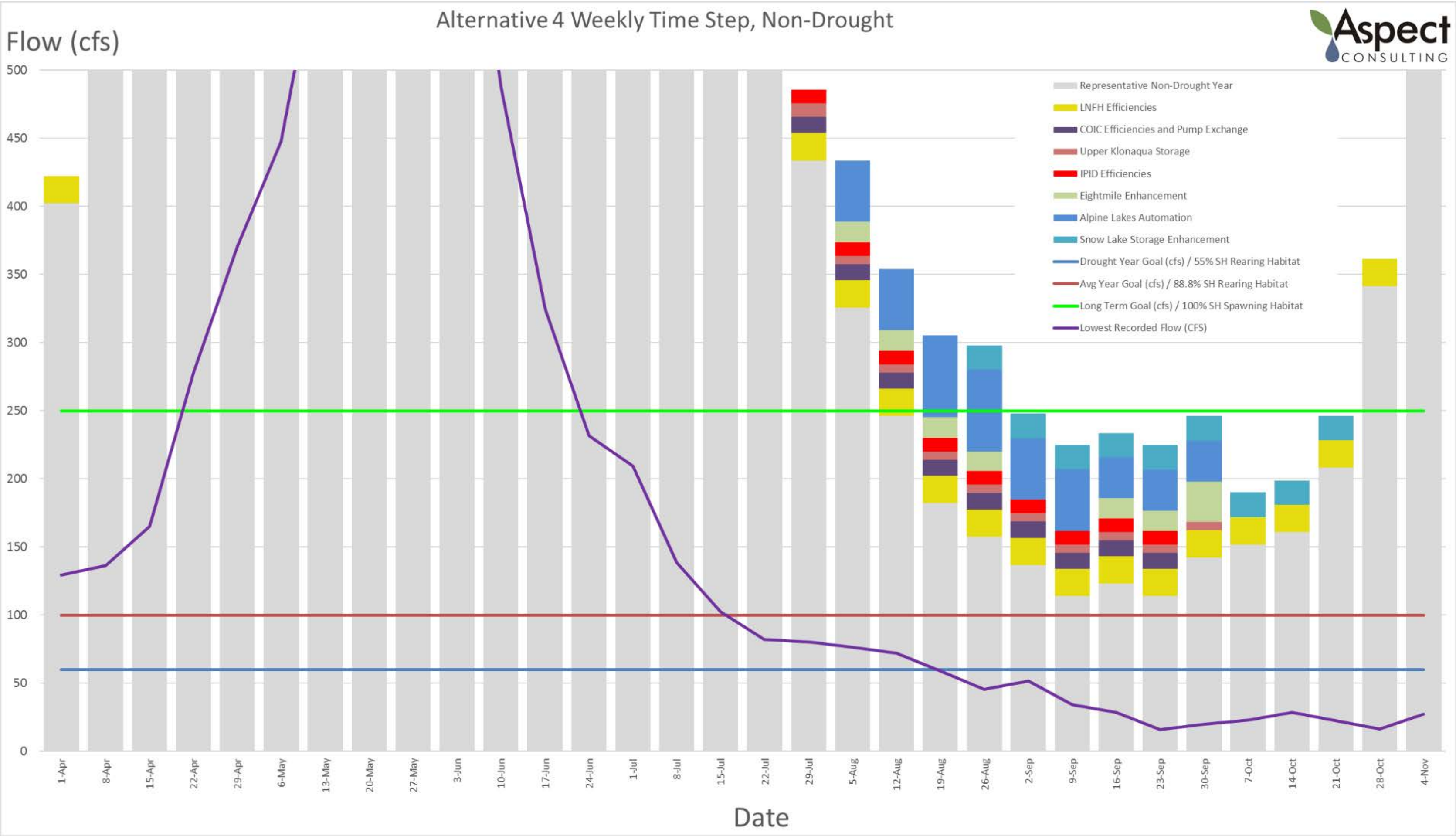
As shown in Table 2-5, the suite of projects proposed under Alternative 4 meets streamflow restoration goals established in the Guiding Principles. Figures 2-14 and 2-15 illustrate streamflow benefits in drought and non-drought years for Alternative 4. These figures show the short-term goal set in the Guiding Principle of 100 cfs would be met in drought and non-drought years.

Figure 2-14. IWG Alternative 4 Weekly Time Step, Drought/Low Water Year Scenario[15]



[15] Represents 80-percent dry year flows in Icicle Creek with estimated flow benefit achieved from Alternative 1 implementation

Figure 2-15. IWG Alternative 4 Weekly Time Step, Non-Drought Scenario [16]



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16 Represent average flows in Icicle Creek during "non-drought" years (50% exceedance) with estimated flow benefit achieved from Alternative 1 implementation

2.3.6 Alternative 5 Narrative Description

The IWG developed Alternative 5 in response to continued stakeholder input that suggested completely removing IPID's diversion from Icicle Creek to the Wenatchee River. As part of its irrigation comprehensive plan update, IPID completed a very cursory review of a project that would replace the IID and PID canal systems with a pressurized pipe delivery system supplied by pump stations on the Wenatchee River at three locations, referred to herein as the IPID Full Piping and Pump Exchange project. Alternative 5 includes the same projects as Alternative 1, except the IPID Irrigation Efficiencies project is replaced by the IPID Full Piping and Pump Exchange project. This alternative would not eliminate the need for operation and management of storage within the Alpine Lakes Wilderness. IPID would need to continue to store and release water from reservoirs within the Alpine Lakes Wilderness to ensure water was available in the Wenatchee River for their use because instream flows are insufficient on both Icicle Creek and the Wenatchee River in the summer to meet IPID out-of-stream uses without storage. Alternative 5 would provide up to 195 cfs of instream flow benefit in Icicle Creek in both drought and non-drought years.

Alternative 5 includes the following projects:

- **IPID Full Piping and Pump Exchange** would fully replace the IPID canal systems with a pressurized pipe delivery system. Three intake and pump station facilities would be constructed on the Wenatchee River to supply the new system. The existing surface water diversion facilities on Icicle Creek and Peshastin Creek would be removed. This project would increase stream flow in Icicle Creek by up to 117 cfs, improve reliability of water supply for agriculture, benefit fish passage and habitat, and maintain treaty and non-treaty harvests. (GP1; GP5)
- Alpine Lakes Optimization, Modernization, and Automation (GP1; GP5)
- COIC Irrigation Efficiencies and Pump Exchange (GP1; GP5)
- Domestic Conservation (GP4)
- Eightmile Lake Storage Restoration (GP1; GP4; GP5)
- Tribal Fishery Preservation and Management (GP2)
- Habitat Protection and Enhancement (GP6)
- Instream Flow Rule Amendment (GP4)
- Leavenworth National Fish Hatchery Conservation and Water Quality Improvements (GP1; GP2)
- Fish Passage (GP6)
- Fish Screen Compliance (GP6; GP7)
- Water Markets (GP4)

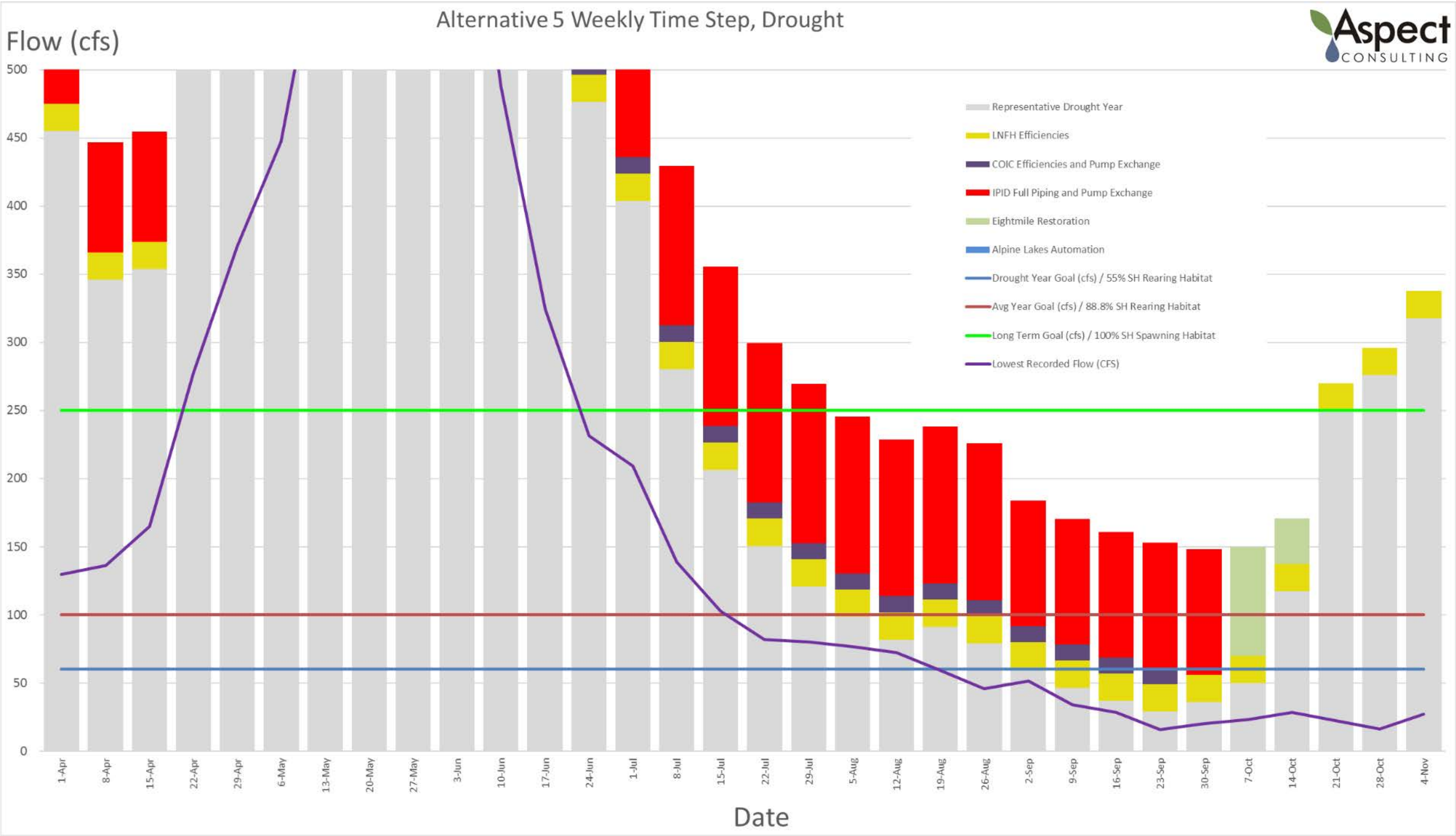
Table 2-6 shows how Alternative 5 addresses the IWG's Guiding Principles.

Table 2-6
How Alternative 5 Meets Guiding Principles

Guiding Principle Number	Guiding Principles	How Alternative 5 Meets the Guiding Principles
GP1	Improve Instream Flow	Meets goals of 100 cfs in average years and 60 cfs in drought years. Anticipated flow improvement is 195 cfs.
GP2	Improve Sustainability of LNFH	Meets goal of source redundancy and improved fish rearing and capacity, allowing LNFH to meet fish production goals. Also, improves water quality, and passage in Icicle Creek.
GP3	Protect Tribal and Non-Tribal Harvest	Meets goal of instream flow improvement balanced with preservation of fishery with adaptive management strategy in place, and potential amenity and access increases.
GP4	Improve Domestic Supply	Meets peak 2050 domestic demand
GP5	Improve Agricultural Reliability	Meets goal of 1,000 ac-ft for agricultural interruptible water rights.
GP6	Enhance Icicle Creek Habitat (includes fish passage and fish screens)	Meets goal of additional habitat improvement with adaptive management.
GP7	Comply with State and Federal Laws and Wilderness Acts	Meets goal by requiring project checks on all permits and an environmental review.

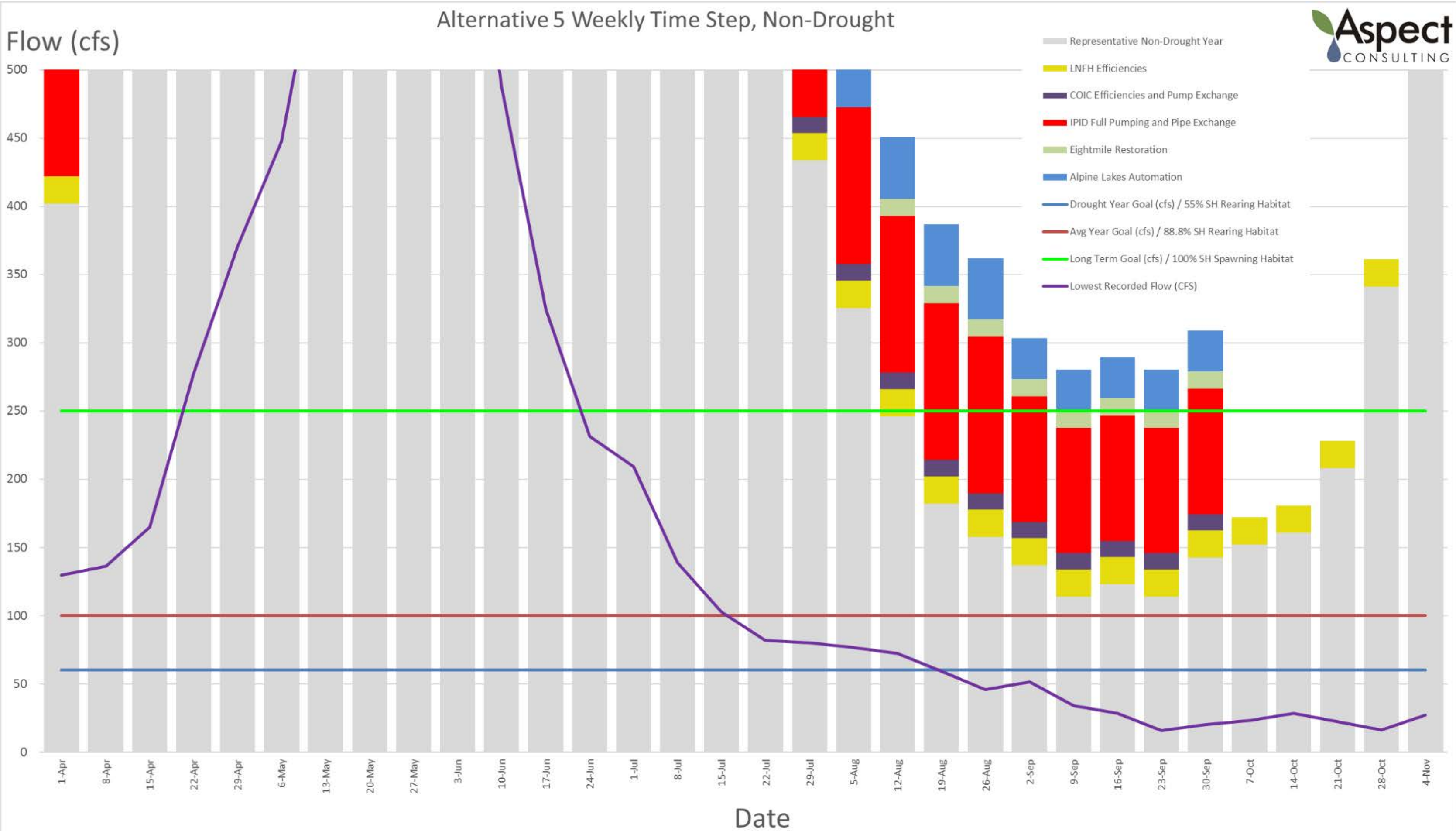
As shown in Table 2-6, the suite of projects proposed under Alternative 5 meets streamflow restoration goals established in the Guiding Principles. The main benefit Alternative 5 adds is much higher streamflow benefit than provided in the other alternatives, albeit at a much higher cost, which is discussed in more detail in Section 2.9. Figures 2-16 and 2-17 illustrate streamflow benefits in drought and non-drought years for Alternative 5. These figures show that the short-term instream flow goal of 100 cfs would be met under both scenarios.

Figure 2-16. IWG Alternative 5 Weekly Time Step, Drought/Low Water Year Scenario[17]



[17] Represents 80-percent dry year flows in Icicle Creek with estimated flow benefit achieved from Alternative 1 implementation

Figure 2-17. IWG Alternative 5 Weekly Time Step, Non-Drought Scenario [18]



[18] Represent average flows in Icicle Creek during “non-drought” years (50% exceedance) with estimated flow benefit achieved from Alternative 1 implementation

2.3.7 Previous Studies for Developing the Alternatives

Since the creation of the IWG, several studies have been conducted and used to develop the projects identified in the Base Package and other alternatives, along with those no longer under consideration.

The IWG conducted focused evaluations on key elements of the Guiding Principles. Past studies that contributed to the creation of the projects that compose the Alternatives are provided in Section 1.11 of this document.

2.4 No Action Alternative

The No-action Alternative represents the likely results expected if an integrated approach to water resource management does not continue in the Icicle Creek Subbasin. Under the No-action Alternative, projects could be developed independent of the other projects identified as part of one or more of the alternatives evaluated by this EIS. However, there would be no coordinated, integrated effort to better manage and improve water resources in the Icicle Creek Subbasin.

The IWG's collaboration with local and state agencies addresses some of the ongoing issues affecting water flow and quality in the Icicle Creek watershed. Without the participation of the IWG and a coordinated effort to implement projects developed as part of the Icicle Strategy, these partnerships would be weakened, and any enhancements developed by the efforts of a single entity may not be as effective as if they were implemented and managed with multiple projects in an adaptive and coordinated manner with stakeholder input. The No-action Alternative has the potential to further complicate the following issues or leave them unresolved.

Instream Flows Goal Will Not Be Met: Under the No-action Alternative, the instream flow goals of 100 cfs during non-drought years, and 60 cfs during drought years would not be met and there would be no coordinated effort to achieve these goals. While some projects that provide instream flow benefit would likely continue toward implementation, most of the projects would not be developed with instream flow benefit as a primary goal. Projects would likely focus on other beneficial purposes, like water supply reliability, or may be marketed to out-of-stream or out of basin uses. The maximum anticipated instream flow increase under the No-action Alternative is estimated to be 31.9 cfs, based primarily on the assumption that LNFH and COIC projects would move forward and provide instream flow improvements.

Resumption of Leavenworth v. Ecology: The City of Leavenworth filed a declaratory judgement action in Chelan County Superior Court seeking a determination of the maximum annual quantity of surface water diversion from Icicle Creek. The City of

Leavenworth claims their surface water certificate states their diversion should be 1,085 acre-feet per year. Ecology maintains that the City of Leavenworth agreed to a limit of 275 acre-feet per year based on a prior settlement. The Court ruled partially in favor of Ecology in 2012, and the City of Leavenworth appealed. This case is currently on hold while the City of Leavenworth and Ecology try to resolve this issue through the IWG. The IWG's Guiding Principles address the City of Leavenworth and surrounding area's domestic supply concerns and calls for 2,300 to 4,100 acre-feet of reliable year-round supply. Under the No-action Alternative, projects designed to improve domestic supply, mainly Eightmile Lake Storage Restoration or Legislative Changes to OCPI, would likely not be implemented or would be implemented without providing benefit for domestic supply. Without the projects that would increase domestic water supply, the City's diversion amount will remain in contention.19

Losing benefit from IPID participation: IWG member IPID manages water storage and releases from Klonaqua, Square, Colchuck, and Eightmile Lakes, and has shared storage in the Snow Lake system (Upper and Lower Snow Lake, and Nada Lake). Several of the projects proposed in the Alternatives include optimization and storage restoration or enhancement efforts on these lakes to increase instream flow benefits for the entire watershed. If these projects are implemented independent of the Icicle Strategy, there is not a guarantee that IPID would manage lake releases for instream flow enhancement. Additionally, the IWG will not have the opportunity to influence the design or aesthetics of any future updates or improvements that IPID may make to its dams and outlet facilities at these Alpine Lakes.

LNFH loses State partnership: The LNFH is actively collaborating with Ecology and WDFW as part of the Icicle Strategy to assess hatchery operations and look for ways to improve and enhance the infrastructure to make it more sustainable, increase instream flow, improve water quality, and benefit fish health and habitat. Synergy will be lost in this process if the collaboration ends and projects are not addressed under the Icicle Strategy. Implementing the Guiding Principles as part of this strategy also has the potential to resolve issues around water quality and quantity that have been the cause of past and ongoing litigation for the LNFH. Although the litigants of past and ongoing court cases involving the LNFH are not active participants in the IWG, improved hatchery operations, improved instream flow in the historical channel, screen compliance, and improved habitat are all litigation issues that would likely persist to a greater extent (or on a slower pathway to compliance) under the No-action Alternative. However, even if the benefits of the IWG partnership are lost, LNFH is still responsible for implementing projects agreed to in the Biological Opinion, which is described in Section 1.5.2, and improvements at LNFH are still expected to occur under the No-action Alternative.

[19] http://www.ecy.wa.gov/programs/wr/cwp/images/pdf/LeavenworthvEcology.pdf

Restricted long-term growth in the City of Leavenworth and Icicle Subbasin: One of the IWG's priorities is to meet current and future domestic water supplies for the City of Leavenworth and surrounding basin through 2050. Without a sustainable plan for addressing growth in the City of Leavenworth and rural Chelan County, there is no guarantee that the water supply will keep up with demand as the population rises. Past water planning efforts were focused on near-term growth. Without an integrated strategy, projects aimed at increasing domestic supplies would likely not be implemented or would be implanted to a lesser extent, and water resource planning needed to address long-term growth would be less coordinated and not as effective at meeting future water supply needs.

Reduced or delayed improvement to agricultural reliability: Several of the projects proposed by the IWG have an added benefit of improving agricultural reliability. If the Icicle Strategy does not move forward, it is unlikely the Water Markets Project would be implemented. The 56 interruptible water users in the basin would continue to face hardship when low streamflows prevent them from irrigating. IPID and COIC may see improvements to their water supply and delivery system reliability if improvements to those systems are implemented independent of a coordinated Icicle Strategy, but it is anticipated that these improvements would proceed at a slower pace.

Possible fish screening process delays: The Icicle Strategy includes upgrading fish screens at major surface water diversions along Icicle Creek to comply with current fish passage requirements. The City of Leavenworth, IPID, and LNFH/COIC have diversions that are in need of screen upgrades. These upgrades would likely need to happen whether any other projects presented in the IWG's alternatives are implemented as a comprehensive Icicle Strategy or not. Under the partnership of the IWG, these entities and others have an established connection to WDFW to assist in screen design, and a means to find funding that would help offset costs associated with new screens. Without the IWG and a coordinated Icicle Strategy, each entity would have to go through the fish screen design and implementation process independently, creating the potential for a more expensive and lengthy implementation process.

This No-action Alternative is presented as a means of comparing the impacts of the Icicle Strategy to those of continuing on without an integrated strategy and the benefits of the IWG partnership.

Short- and long-term effects of the No-action Alternative are presented in Chapter 4.

2.5 Alternative 1 (Base Package)

This section provides a project-by-project summary of the elements of the Base Package with references to previous planning documents and studies where greater detail can be found.

2.5.1 Alpine Lakes Optimization, Modernization and Automation

This project is designed to change operations at existing dams to make water available for instream flow and more reliable for irrigation district users. The project would increase the frequency of lake draw down, but minimum reservoir water levels would remain the same. In non-drought years, this project would provide 30 cfs and 5,465 acre-feet for instream flow benefit. The following section describes the project background and implementation in greater detail.

IPID and USFWS operate seven alpine lakes in the Icicle Creek Subbasin to augment water supply for irrigation and fish propagation. IPID operates Klonaqua, Square, Eightmile, and Colchuck Lakes, and the USFWS manages Upper and Lower Snow Lakes and Nada Lake. The reservoirs are all enhanced natural lakes with small dams and other control infrastructure at their outlets. These dams and associated infrastructure, such as control gates or valves and low-level outlet pipes or tunnels, were installed in the 1920's though 1940's, allowing IPID and the USFWS to capture and store additional runoff during the winter and spring for release during the late summer low-flow period. Flows released from Square, Klonaqua, Eightmile, and Colchuck Lakes allow IPID to maintain irrigation diversions during the late summer low-flow period on Icicle Creek. Flows released from the Snow Lakes and Nada Lake supply water to LNFH and allow the USFWS to meet instream flow obligations. Nada Lake and Upper and Lower Snow Lakes are operated primarily for water supply to LNFH and to maintain instream flows. IPID also has storage rights in Upper and Lower Snow Lakes for irrigation. Storage and release of water from the Alpine Lakes are authorized by state-issued water rights. Table 2-7 provides a summary of the water rights for IPID and USFWS.

Table 2-7
IPID and USFWS/USBR Storage and Diversion Rights, Icicle Creek Subbasin

Water Source	Certificate Number	Certificate Holder	Priority Date	Cert Qi (cfs)	Cert Qa (afy)	Adj Qi (cfs)	Adj Qa (afy)
Icicle & Snow Creek	S4-35002JC	IID	1910 (Class 2)	1.7525	---	83.33	---
Icicle & Snow Creek	S4-*35002ABBJ	IID/PID	1910 (Class 2)	81.577	---	83.33	---
Icicle Creek	1082	PID	1919 (Class 5)	34.38	---	34.38	---
Icicle Creek	1824	USBR	1942	42	---	---	2,500
Klonaqua Lake	1227	IID	1926 (Class 5)	25	---	25	2,500
Eightmile Lake	1228	IID	1926 (Class 5)	25	---	50	2,500
Colchuck Lake	1229	IID	1926	50	---	NA	NA
Square Lake	5527	IID	1926	10	2,000	NA	NA
Snow Lake	1591	IID	1926	25	---	NA	NA
Snow Lake	1592	IID	1926	---	1,000	NA	NA
Snow Lake	1825	USBR	1942	---	16,000	NA	NA

Notes:
Cert – quantities documented on the certificate
Adj – additional information contained in the adjudication record
Qi – instantaneous quantity
Qa – annual quantity
cfs – cubic feet per second
afy – acre feet per year
IID – Icicle Irrigation District
PID – Peshastin irrigation District
USBR – United States Bureau of Reclamation
--- none listed
NA – not applicable, these rights were not subject to the 1927 adjudication
[1] Right confirmed for 83.33 cfs through adjudication. The right was subsequently split and a change to place of use was completed for 1.7525 cfs
[2] Documented total storage constructed at Snow Lake is 12,000 acre-feet, shared by USFWS and IPID. Under a separate agreement, IPID is entitled to 750 acre-feet of the Snow Lake storage

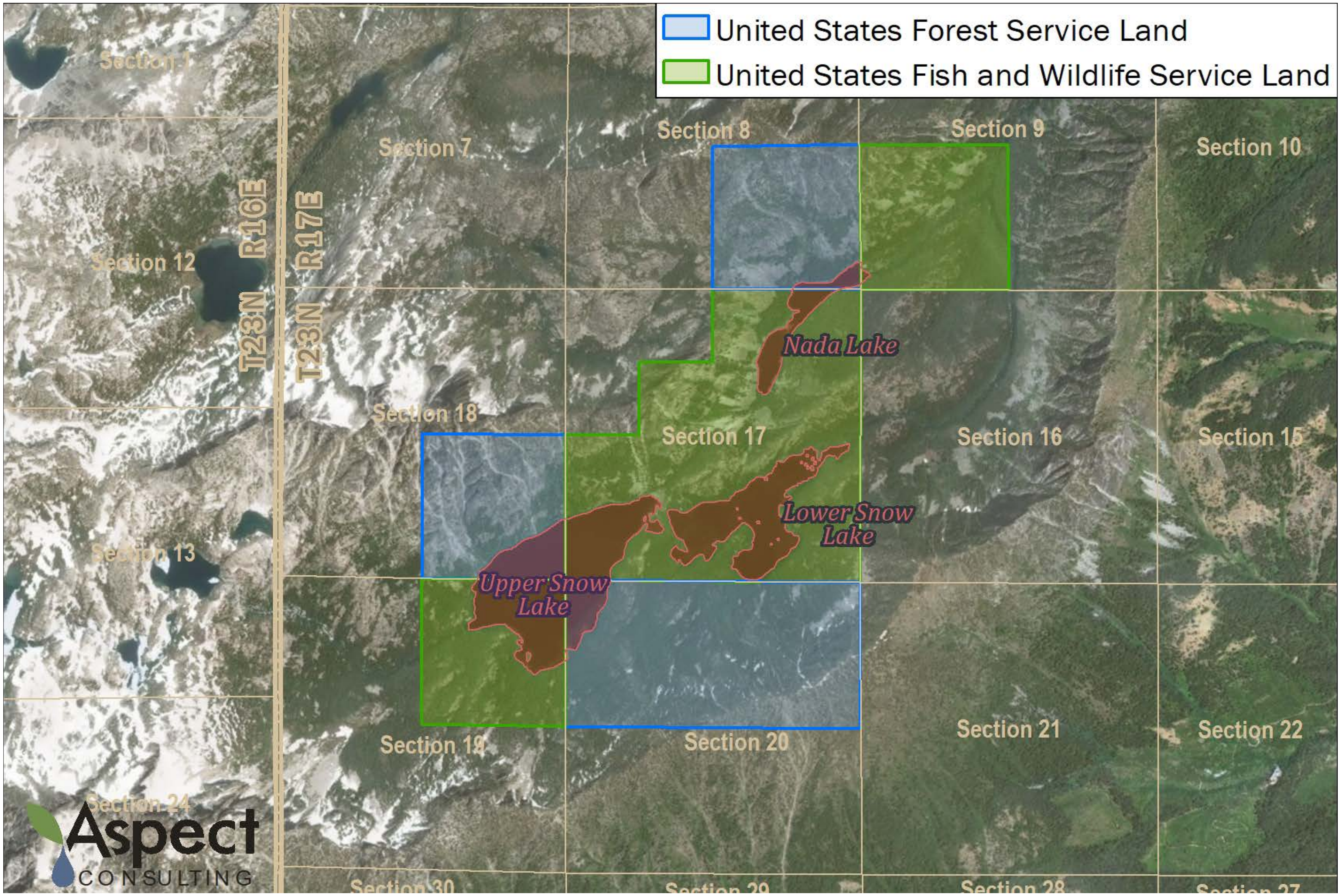
These storage water rights and dams were developed many decades prior to the establishment of the Alpine Lakes Wilderness Area in 1974. IPID held deed to lands associated with Eightmile, Colchuck, and Klonaqua Lakes. The USFS identified these lands for acquisition shortly after the establishment of the wilderness area. IPID and USFS entered into a land exchange agreement in 1986, which culminated with transferring the properties to USFS in 1990. As part of that exchange, IPID received the following easement, which pertains to Eightmile, Klonaqua and Colchuck Lakes:

> "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."

Additionally, the USFS issued agriculture irrigation and livestock watering easements for Square Lake and those portions of Colchuck Lake that were not covered by the easement described above. These easements grant IPID the right to operate and maintain their water facilities with consultation and concurrence from the USFS. Before the issuance of these easements, Square Lake was operated under a special use permit, after it was determined Square Lake was not under the jurisdiction of Washington State DNR because of navigability criteria.

The USFWS maintains ownership of the lakes they operate (Upper Snow, Lower Snow, and Nada Lakes). In 1939, USBR acquired portions of Section 17 and 19, Township 23 North, Range 17 East W.M., adjacent to Snow and Nada Lakes. In 1930, IPID acquired an easement from the State of Washington to overflow the bed and shores of Snow Lake. That easement was transferred to USBR in 1941, and then to USFWS in 1949. Ownership of these properties were never transferred to the USFS. However, the USFS owns lands adjacent to the shoreline of Upper and Lower Snow Lakes located in Section 18 and 20 of Township 23 N, Range 17 East W.M. Figure 2-18 shows USFWS lands in green and USFS lands in blue.

Figure 2-18. Ownership of Lands Adjacent to Upper and Lower Snow Lakes and Nada Lake



Source: Provided by USFWS

The Alpine Lakes Optimization, Modernization, and Automation project would improve instream flows and provide reliable irrigation water supply by automating releases and allowing for more frequent, optimized releases from the lakes than historical operations. Water released from the Alpine Lakes would enhance instream flows in tributaries to Icicle Creek, Icicle Creek itself, and the Wenatchee River to the confluence with the Columbia River.

Currently, gates or valves on reservoir outlets are operated manually to release stored water and are accessed by hiking in or by helicopter. Therefore, the gate or valve openings are set infrequently, and reservoir releases are not optimized to meet water demands. For example, all the lakes currently operate by gravity and flow release volumes change as the lake level drops. If IPID requires an additional 10 cfs from a lake in July, they may set the initial release to 15 cfs, and by the time they return to re-adjust it, it may have diminished to 5 cfs. Initially, that extra water is surplus to IPID’s need, and as the lake draws down, IPID’s needs are under-supplied.

In non-drought water years, one lake is typically drawn down by IPID on a rotational basis for maintenance purposes, with each lake being drawn down approximately once every three to five years. Maintenance activities include clearing debris (e.g., logs, rocks) from inlet and outlet pipes, burning encroaching brush, exercising and inspecting valves and gates, repairing dam surfaces from erosion or spalling, and other activities. In drought years, all lakes are drawn down to supplement IPID’s irrigation supply. Depending on the severity of the drought, IPID may augment its supplies from a combination of some or all of the five lakes in which it has water rights.

The current infrastructure can be seen in Figures 2-19 through 2-25. Proposed changes are illustrated in Figure 2-26 and discussed in detail later in this section.

Figure 2-19. Automation Impacts – Eightmile Lake

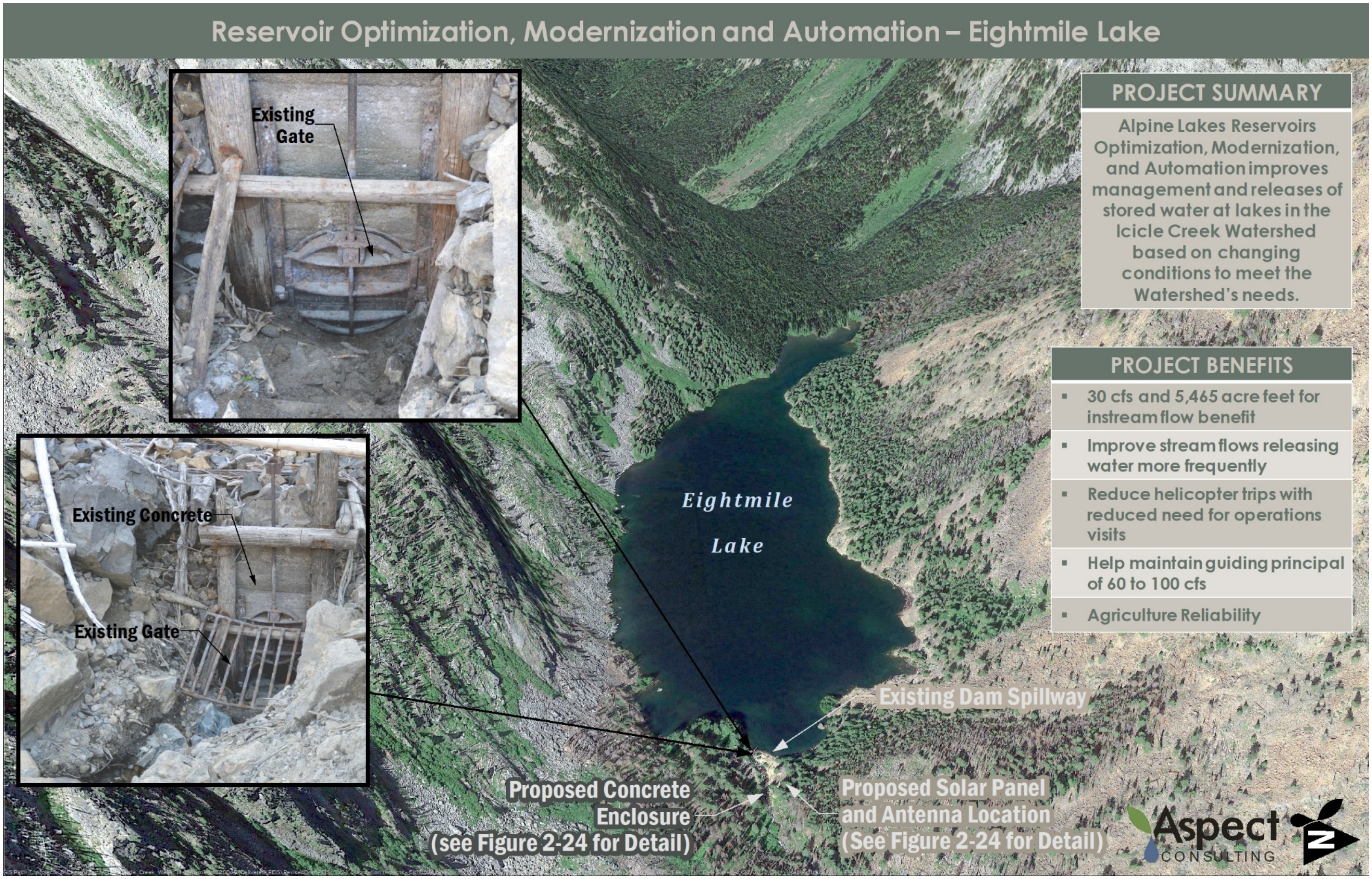


Figure 2-20. Current Alpine Lakes Infrastructure, Eightmile Dam (2015)

Figure 2-21. Automation Impacts – Klonaqua Lake

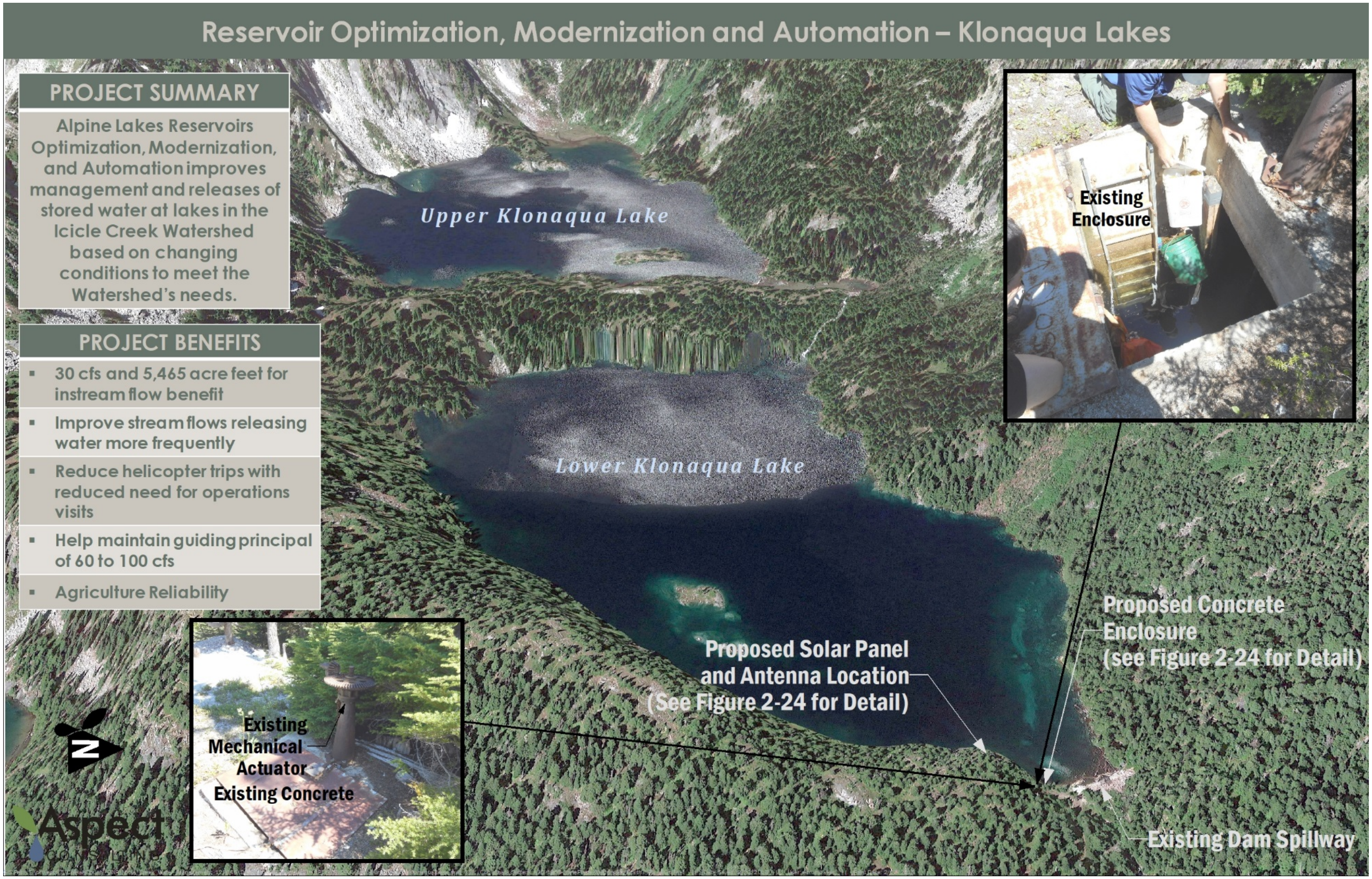


Figure 2-22. Automation Impacts – Colchuck Lake

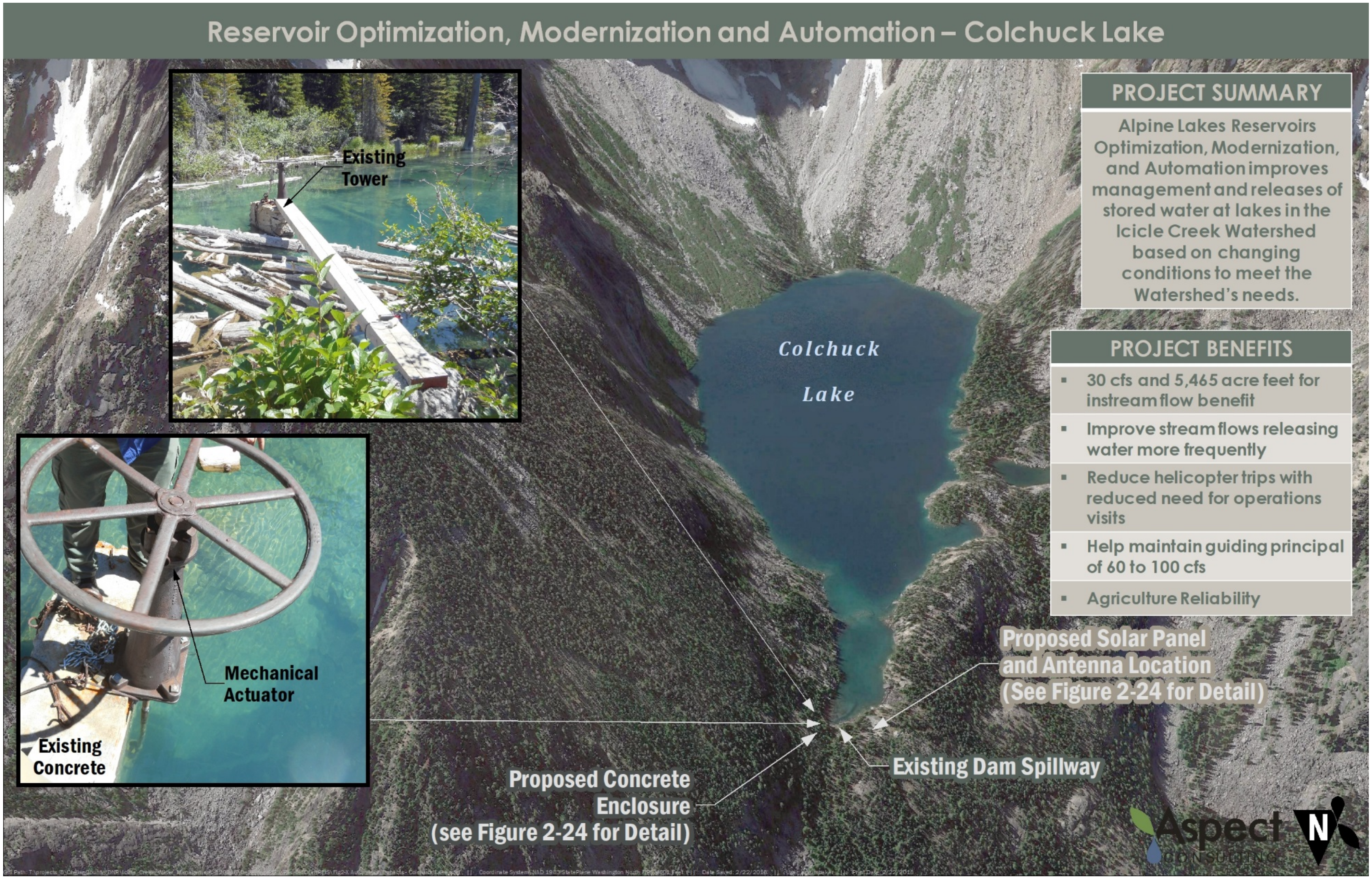


Figure 2-23. Automation Impacts – Square Lake

Figure 2–24. Current Alpine Lakes Infrastructure, Square Lake Dam

Under the proposed project, instead of lakes augmenting water supply on a rotational basis (one per year), all lakes would be drawn down to normal low-pool elevations annually, thus creating additional instream flow benefits. Operational lake levels would not be altered under this project. Flow in Icicle Creek near LNFH would be monitored, and before flows drop below a Guiding Principle target (e.g., 60 cfs or 100 cfs depending on water year), water from the lakes would be released to maintain the target flow.

Existing control gates and valves would be upgraded or replaced to allow for automated control rather than hiking or flying into the lakes to operate them. Basic monitoring equipment would be installed (e.g., lake level monitoring, outlet flow release monitoring). Telemetry systems would also be installed to allow for remote monitoring and operation.[20] Figure 2-24 provides an example of what this telemetry and monitoring equipment might look like based on current operations by LNFH at Nada Dam. Where warranted, the gate or valve at the lake outlet would be replaced. The control gate or valve at each lake would be retrofitted with a motorized actuator that would operate the gate or valve automatically. A solar panel and batteries would be installed to power the actuator. An antennae and other telemetry equipment would also be installed to allow for remote communication and control of the actuator by IPID or USFWS. Some provision to winterize the equipment would also be made. This project would use radio repeaters located on either Wedge Mountain or Icicle Ridge, both of which are outside the Wilderness Area.

[20] Taken from: http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/AlpineLakes_final_reduced.pdf

Figure 2-25. Automation Impacts – Snow Lakes

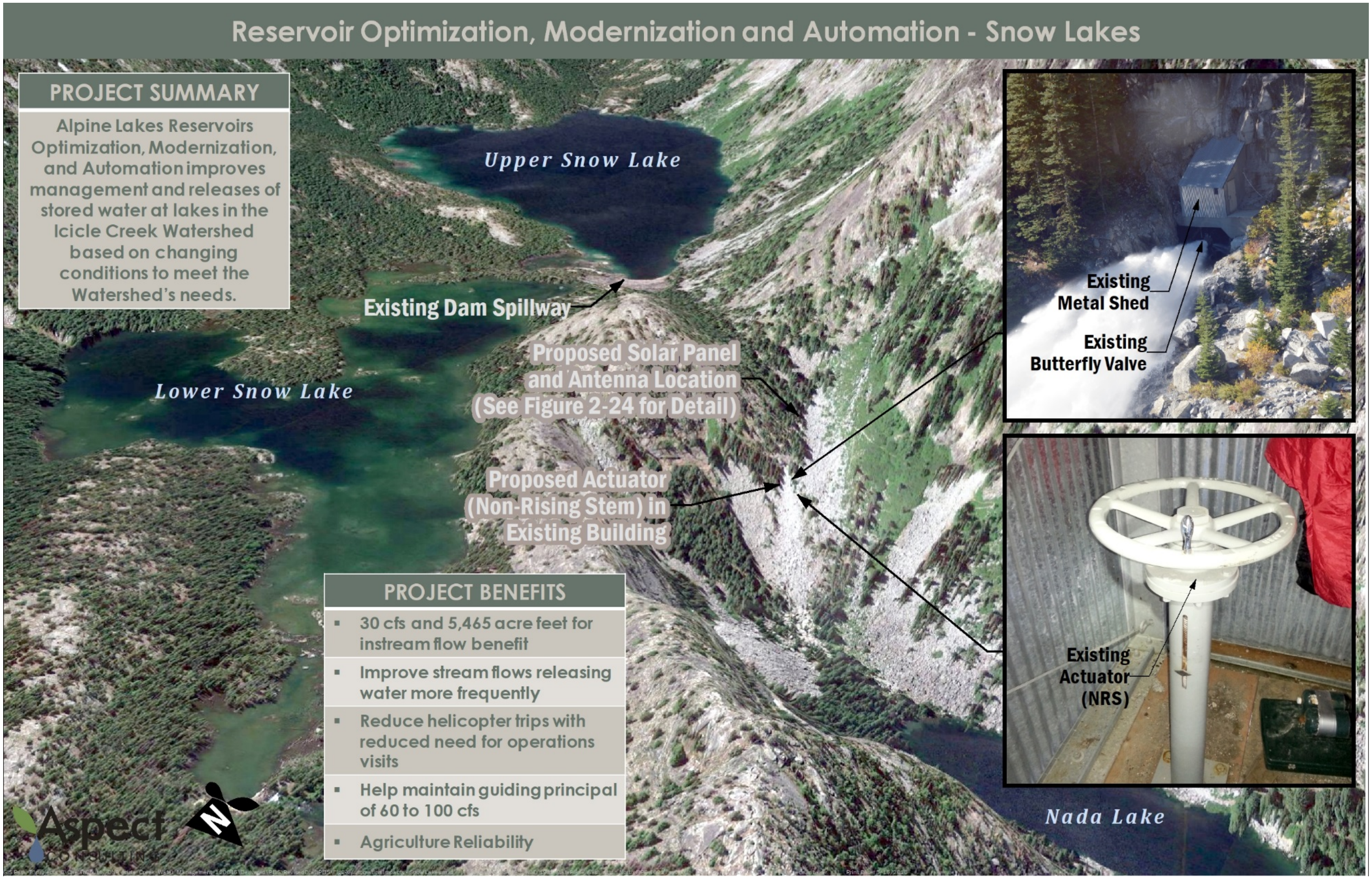
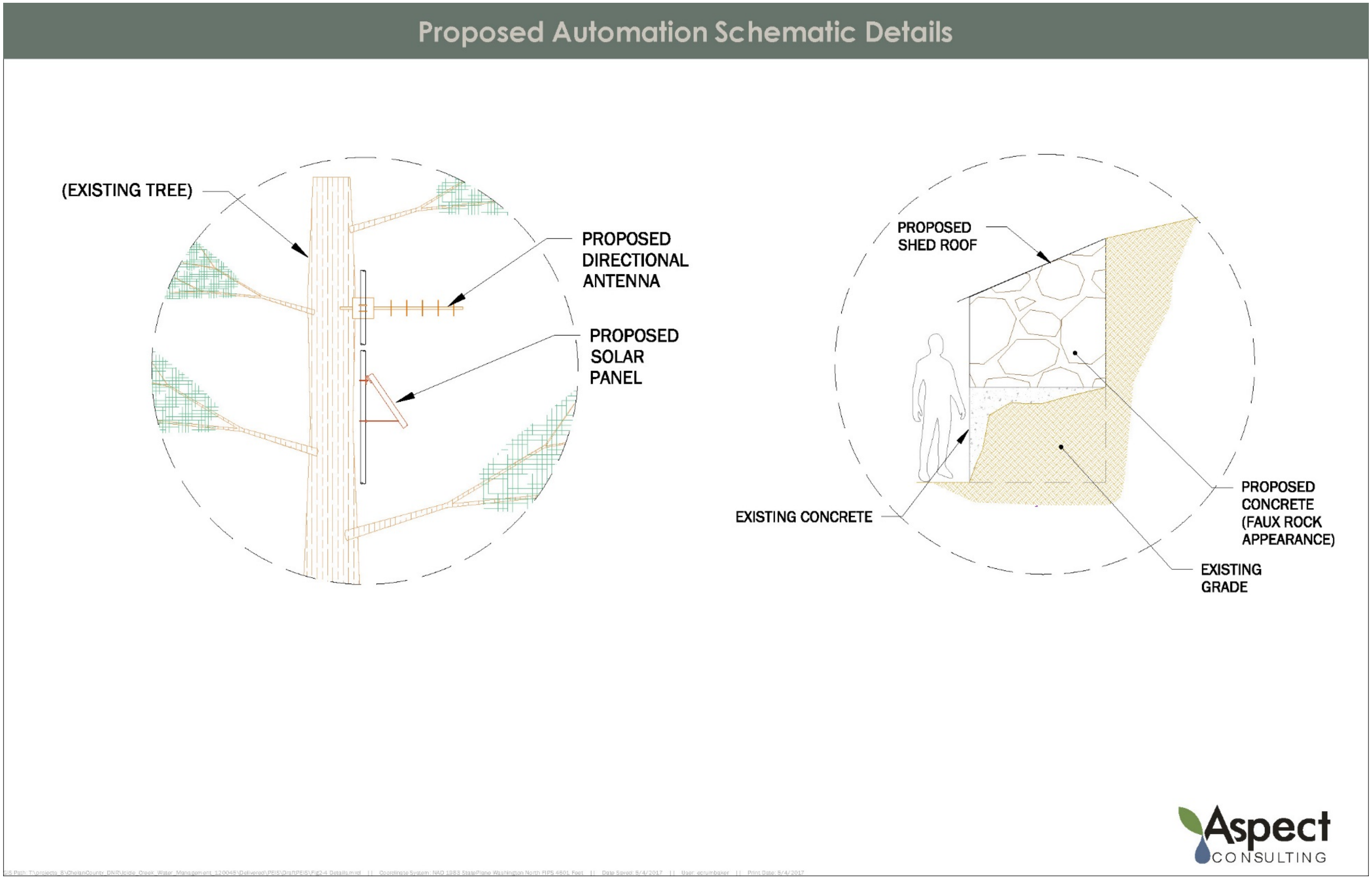


Figure 2-26. Proposed Automation Schematic Details



The IWG previously evaluated whether these releases would adversely affect future IPID supplies under drought and climate change scenarios. IPID was initially concerned that if it released water from all the lakes, and if the following year was a drought year, then its supplies in the next water year would be diminished. Based on the appraisal study, an additional 5,465 acre-feet would be available for release into Icicle Creek for instream flow benefit with 100 percent refill reliability in Colchuck, Eightmile, Klonaqua, and Square Lakes. The usable storage volume would not increase, but the amount released during a typical year would increase (e.g., future normal years would mimic historical IPID drought year operations). The estimated instream flow benefits of 5,465 acre-feet could be managed as 30 cfs over 92 days, or some different combination of rate and time depending on the type of water year and when the fish needed the water. Under this project, Nada and Snow Lakes refill reliability would drop from 97 percent to 93 percent, for a slightly increased risk in future drought years.

The estimated project costs for study and construction are $784,519 (Aspect, 2015), and updated to 2018 dollars using the RS Means Historical Cost Index. The estimated cost per acre-foot is $144.

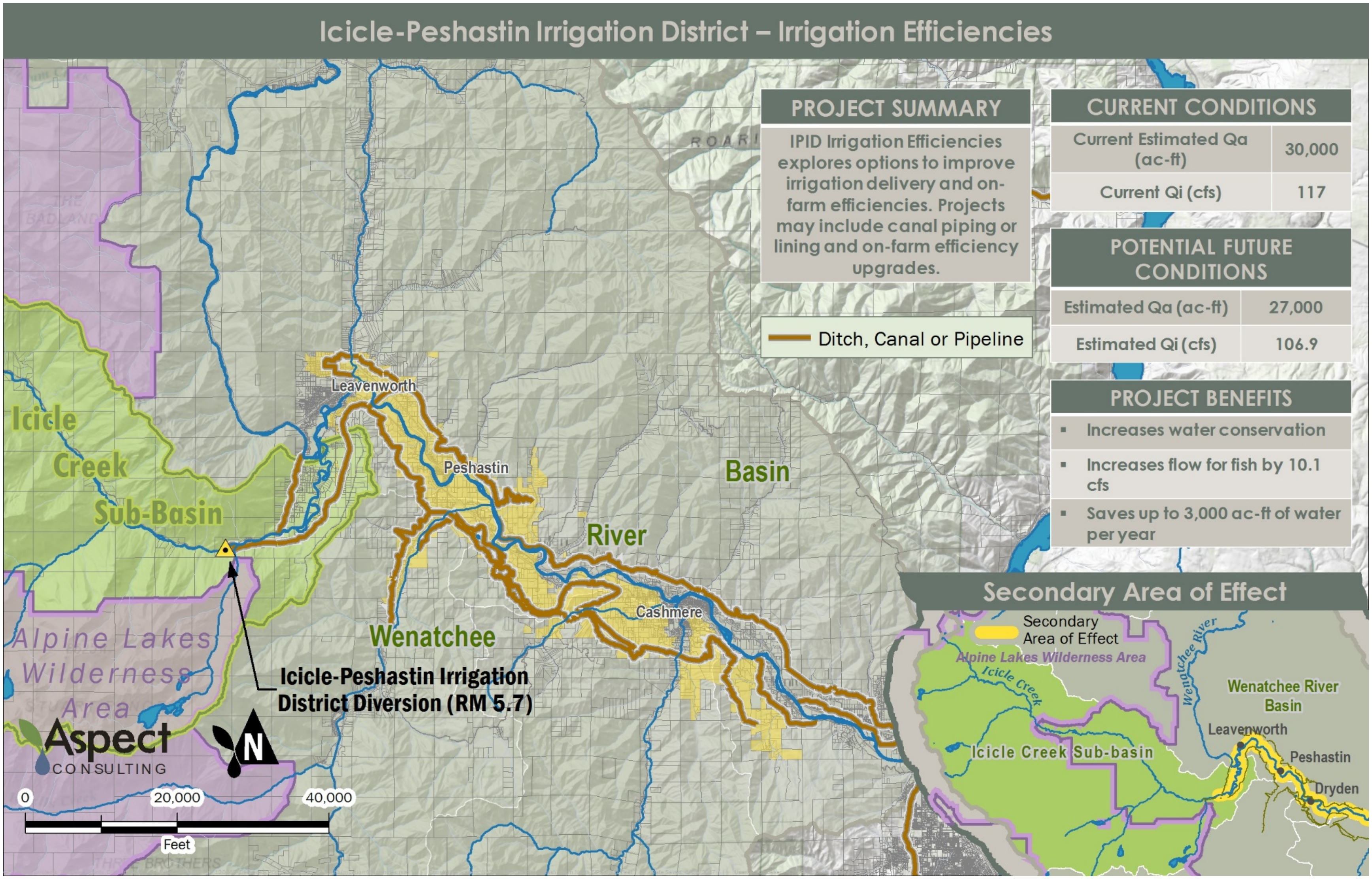
More specific details about this project are available in the *Alpine Lake Optimization and Automation Appraisal* (Automation Appraisal Study) (Aspect, 2015) and the *Icicle Creek Flow Augmentation Pilot Study and Alpine Lakes Automation Feasibility Study* (Flow Augmentation and Automation Feasibility), (Aspect, 2017), and the Alpine Lakes Optimization and Automation Feasibility Study (Appendix C).

2.5.2 IPID Irrigation Efficiencies Project

The IPID Irrigation Efficiencies Project includes traditional irrigation efficiency upgrades, such as canal lining or piping of irrigation ditches. The IWG anticipates that 10 percent water savings or 10.1 cfs (3,000 acre-feet annually) could be achieved from implementing efficiency upgrades that will be identified in the IPID Comprehensive Water Conservation Plan. Comprehensive Water Conservation Plans were prepared for Icicle and Peshastin Irrigation Districts in 1993 (Klohn Leonoff, Inc. 1993). An integrated update to both districts plans, known as the IPID Comprehensive Water Conservation Plan, is currently being prepared and should be complete in September 2017.

IPID provides irrigation to 8,065 acres in the Wenatchee Basin. Of this acreage served, approximately 80 to 90 percent is in orchard, less than 5 percent is rotational crops or hay, and approximately 5 to 10 percent provides outdoor irrigation water for residential land (Aspect, Icicle Conservation Summary, 2014). IPID’s system is a gravity fed canal with points of diversion located on Icicle Creek at RM 5.7 and on Peshastin Creek. A large portion of the canal is lined or piped, although there are several partially lined or unlined sections in the upper reaches of the canal system. IPID’s diversionary water rights from Icicle Creek total approximately 117 cfs. See Figure 2-27 for additional explanation of the IPID irrigation efficiencies.

Figure 2-27. Irrigation Efficiencies



IPID has implemented several efficiency projects in the last 20 years:

Canal to Pipeline Conversion. The project converted 9,900 linear feet of unlined canal into a piped system and was completed in 2011. The piped section includes the end of the Peshastin Irrigation District Canal from Brender Creek to the downstream end near Pioneer Street in Cashmere. The project was partially funded by Ecology's Office of the Columbia River with a total project cost of $2 million. The project has resulted in an estimated savings of 1.2 cfs and 360 acre-feet of water savings from Peshastin Creek.

On-Farm Efficiencies. Presently, on-farm efficiency is nearly maximized throughout IPID. In order to live within the narrow allotment of 6.75 gpm per acre and remain competitive with their crops, the majority of water users have converted to micro-spray or drip systems that result in extremely high water use efficiencies. Per Ecology Guidance Document 1210 (Ecology, 2011), application efficiencies for micro-spray and drip systems average 85 and 88 percent, respectively. Some farmers have implemented soil moisture sensors in attempts to further reduce on-farm water use; however, there are some farmers that have complained this has led to poor crop results and can be difficult to manage.

Canal Lining. IPID has a long history of lining their canals and repairing leaking portions of already lined canals. Presently, only a small portion of their canals remain unlined.

Under this project, IPID's Comprehensive Water Conservation Plan would be updated. The purpose of a Comprehensive Water Conservation Plan is to identify opportunities for conservation, improve the operation of the system, and increase efficiency. The Icicle Irrigation District Comprehensive Water Conservation Plan and the Peshastin Irrigation District Comprehensive Water Conservation Plan are over 20 years old. The updated IPID Comprehensive Water Conservation Plan would identify new opportunities for irrigation efficiency upgrades and infrastructure improvements to reduce water diversions from Icicle Creek.

Conservation projects that might be identified in the IPID Comprehensive Water Conservation Plan and implemented to improve efficiency include additional canal lining or piping and on-farm efficiency upgrades. Based on preliminary estimates, it is anticipated that IPID could achieve up to a 10 percent water savings, which equates to approximately 10 cfs (3,000 acre-feet annually).

IPID is updating their Comprehensive Water Conservation Plan, with the final expected in spring 2018. Cost for conservation improvements are expected to be approximately $7.5 million. The cost of improvements will be further estimated as part of the update to the IPID Comprehensive Water Conservation Plan. The total cost per acre-foot is estimated at $2,543.[21]

[21] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/IPID%20Conservation_final_reduced.pdf

2.5.3 COIC Irrigation Efficiencies and Pump Exchange Project

The COIC Irrigation Efficiencies Project consists of installing a piped and pressurized system, and replacing the current gravity fed point of diversion with a pump station downstream on the Wenatchee River or Icicle Creek near their confluence. The COIC project would restore 11.9 cfs (3,640 acre-feet annually) to lower Icicle Creek.

COIC currently shares a point of diversion with LNFH on Icicle Creek at RM 4.5. It provides water to irrigators in the lower reaches of the Icicle Creek Subbasin, near the confluence of Icicle Creek with the Wenatchee River. Proposed conservation measures in COIC's irrigation system, subject to COIC shareholder approval, would add up to 11.9 cfs and 3,640 acre-feet per year to the lower 4.5 miles of Icicle Creek. Implementation of this project would also allow for a smaller screen at the LNFH diversion. See Figure 2-28 for additional explanation of the COIC irrigation efficiencies.

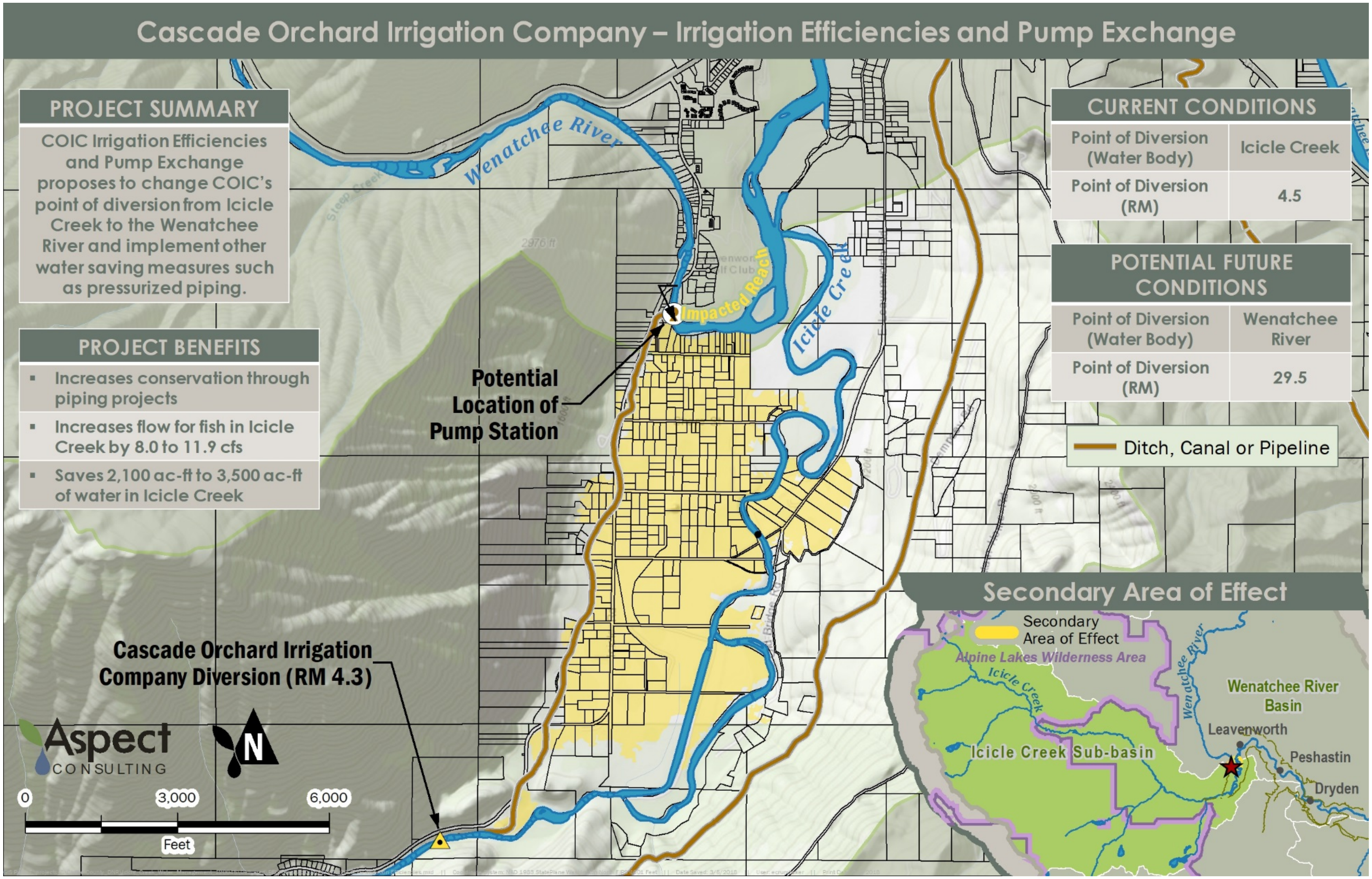
COIC is exploring the option of moving their point of diversion to the right bank of the Wenatchee River just upstream of its confluence with Icicle Creek or to the left bank of Icicle Creek just upstream of its confluence with the Wenatchee River, which would leave more water in the lower 4.5 miles of Icicle Creek. Improvements would also include replacement of the open ditch system with a closed-pipe system to improve efficiency. COIC recently completed an alternatives analysis to explore various conservation project options, including the following:[22]

Option 1: Option 1 would result in construction of a pressurized delivery system supplied by a pump station near the confluence of the Wenatchee River and Icicle Creek. COIC's portion of the diversion facilities shared with LNFH on Icicle Creek would no longer operate. Saved water from the existing diversion to the new diversion would be put into the State's trust water rights program. The alternative would benefit the critical reach of Icicle Creek by moving COIC's diversion and associated water right downstream. If diversions up to the limit allowed by the water right were moved to the new point of diversion, the benefit to flows in Icicle Creek would be as much as 11.9 cfs.

In addition to leaving flow in lower Icicle Creek, the improvements would also increase the efficiency of the COIC system. A range of design capacities, from 4 cfs to 8 cfs, were evaluated for this alternative to cover the range of potential future water needs. It is likely that a pressurized system would need to be sized to deliver a flow rate near the middle of that range. This efficiency measure would reduce the historical diversion quality by 4 to 8 cfs.

[22] Details taken from http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/COIC_final_reduced.pdf

Figure 2-28. COIC Irrigation Efficiencies and Pump Exchange



The Opinion of Probable Costs developed in the *COIC Alternatives Analysis Study* (Anchor QEA, December 2015) indicates that total project costs for a 6 cfs capacity system would be approximately $2.5 to $2.8 million.

Option 2: Option 2 would evaluate COIC's current water use patterns to identify efficiency improvement opportunities, landscaping changes, irrigation timing, or other conservation measures that could create savings and that might make water available for future uses at COIC or be marketed for municipal and/or mitigated uses. This alternative is not intended to be a stand-alone alternative; Option 2 would be considered in addition to Option 1.

Option 2 was calculated by estimating annual consumptive quantities of existing crops and associated irrigation practices from Ecology Guidance Document 1210 (Ecology, 2011) and Policy 1120. Assuming total irrigated area within COIC is close to the 419 acres of potential irrigation shown in the analysis, up to 733 acre-feet of consumptive use is occurring at COIC. Additional research will be required to assess actual consumptive use, type of water application systems used in each parcel, and more refined data on actual transpiration using precise measurements from tensiometers and associated technology.[23]

The COIC shareholders approved the project sponsor to identify locations for a pump station and implement system improvements that are generally consistent with those identified for Option 1. Potential pump station sites have been evaluated and narrowed to three locations, as follows:

- On the right bank of the Wenatchee River approximately 0.8 miles upstream of the confluence with Icicle Creek near the Icicle Road Bridge.
- On the right bank of the Wenatchee River approximately 0.3 miles upstream of the confluence with Icicle Creek.
- On the left bank of Icicle Creek approximately 0.7 miles upstream of the confluence with the Wenatchee River.

COIC is working with project sponsor, Washington Water Trust, to further study the feasibility of these sites and determine the best approach for implementing the proposed efficiency project. In June 2017, a conceptual design report was completed to further analyze the project and evaluate potential options (Anchor, 2017).

[23] Alternative summaries from Anchor QEA, 2016, Alternatives Evaluation Study – Public Release version – Cascade Orchards Irrigation Company, prepared for Cascade Orchards Irrigation Company, December 2015

2.5.4 Domestic Conservation

The Domestic Conservation Project focuses on implementing conservation for domestic users within the City of Leavenworth and rural areas of the Icicle Creek Subbasin. Based on primary estimates, the IWG anticipates savings of 0.5 cfs and 400 acre-feet, all of which would go toward domestic supply. See Figure 2-29 for additional explanation of domestic efficiencies.

City of Leavenworth: The City of Leavenworth provides domestic water for citizens, visitors, and commercial uses from Icicle Creek and City wells. The City of Leavenworth currently provides water to 2,981 units, with the average Equivalent Residential Use at 304 gallons per day. Over the past 20 years, the City of Leavenworth has reduced water use while increasing the number of connections it serves. To accomplish this water savings, Leavenworth has spent $3.6 million dollars on capital improvements and implemented several voluntary conservation programs. Combined, these efforts have yielded 56 million gallons in water savings (171.86 acre-feet).

Future conservation projects identified by the IWG include leak detection and repair or replacement of leaky water mains, replacing residential meters, evaluating a conservation-oriented rate structure, expand conservation education and xeriscape programs, and rebates for efficient residential fixtures. Additionally, City of Leavenworth is exploring opportunities for reclaimed water.

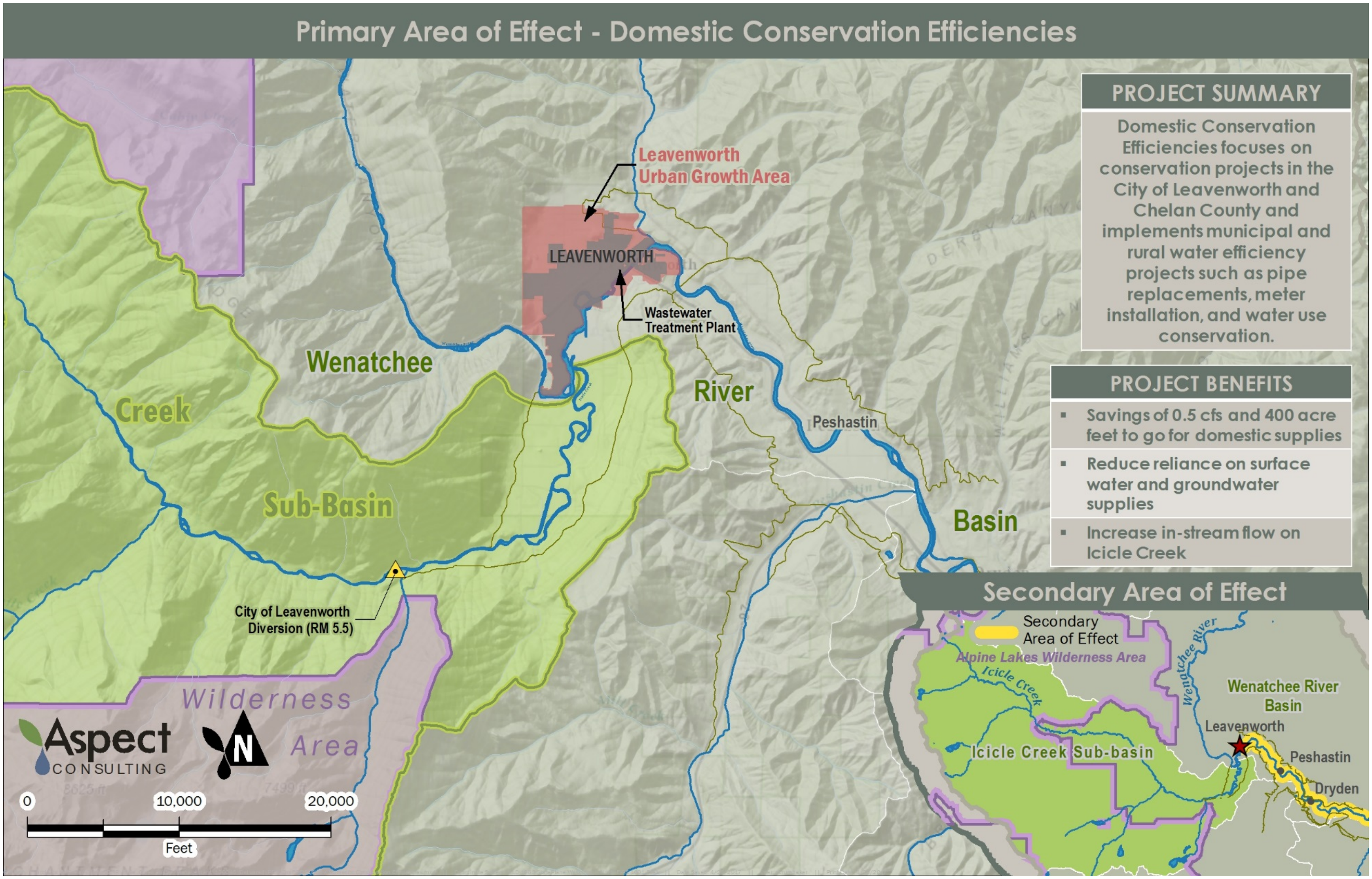
Rural Water Users: Other residents of the Icicle Creek Subbasin outside the City of Leavenworth rely on domestic wells to supply their water. Under a rural water conservation program, Chelan County would implement conservation education, xeriscaping programs, and rebates for permanent conservation efforts (e.g., lawn buy-back programs or efficient residential fixture retrofits).

The estimated cost of the city and rural project is $1 million for pipe replacement and rural conservation, which would save 400 acre-feet of water. Additionally, there would be approximately $1 million for new meters and conservation-oriented rate structures. This is anticipated to produce additional savings; however, behavior change based on price of water is difficult to predict, so those water savings are not included in this prediction. The estimated cost per acre-foot for domestic conservation is $2,500. [24]

This municipal and domestic project's efforts would increase water conservation and help supply water for the population projections in the area through 2050 and meets Guiding Principles to improve domestic supply.

[24] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/ConservationEfficiencies_final.pdf

Figure 2-29. Domestic Conservation Efficiencies



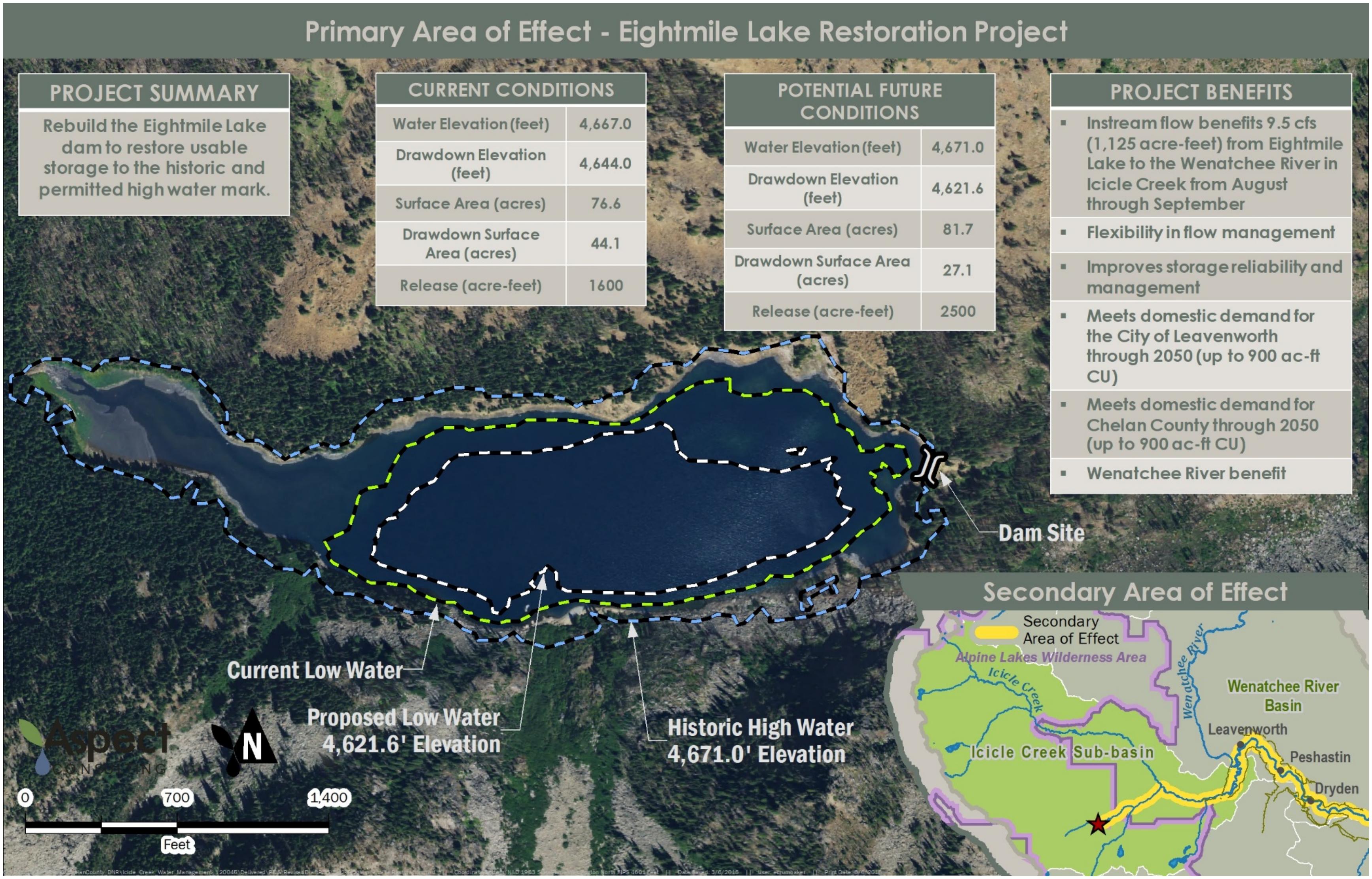
2.5.5 Eightmile Lake Storage Restoration

Eightmile Lake is one of four Alpine Lakes managed by IPID. A small dam, gate, and low-level outlet pipeline constructed in the 1920s at the lake outlet allow for controlled releases. IPID releases water from Eightmile Lake and the other managed Alpine Lakes in the late summer low-flow period to provide additional flows in Icicle Creek for irrigation.

The small dam structure consists of a rock masonry and concrete structure abutting an earth and rock embankment. Erosion of the embankment portion of the dam has reduced the controlled release volumes from Eightmile Lake to less than 1,400 acre-feet, although in some years approximately 1600 acre-feet is released if Eightmile Lake releases are prioritized ahead of the other lakes due to continued leaks from the reservoir. IPID has water rights that allow for storage of 2,500 acre-feet annually. Other existing operation challenges include damage to and deterioration of the outlet gate, which has made operation of the gate very challenging, and collapse of a portion of the low-level outlet pipeline, which has significantly reduced capacity of the pipeline in recent years. The reduction in the capacity of the low-level outlet pipeline is an urgent concern for IPID, because a loss of release capacity at Eightmile Lake could impair IPID’s ability to meet late summer irrigation demands.

The Eightmile Lake Storage Restoration Project (Figure 2-30) would replace the dam, low-level outlet pipeline, and controls. The new rebuilt/restored dam would restore the amount of water impounded and the new low-level outlet would allow for additional draw down below current levels. Cumulatively, this new infrastructure these would restore the usable storage capacity of the lake to the volume that was available historically and allowed by IPID’s water right (2,500 acre-feet). The project would also allow for automation and optimization of releases from the lake. This would provide 12.6 cfs and 900 acre-feet (out of the 2,500 acre-feet stored) of additional volume for controlled release. Project beneficiaries are instream flow and domestic, and releases could be managed year-round based on flow and weather conditions. Because releases will be utilized to mitigate consumptive domestic use when the instream flow rule is not met, the quantity made available for domestic use will be stretched to 3,600 acre-feet when accounting for natural flow availability.

Figure 2-30. Eightmile Lake Restoration



The Eightmile Lake Storage Restoration Project includes the following construction activities:

- Rebuild and restore the dam at Eightmile Lake with a spillway/high water surface elevation that matches the historical spillway/high water surface elevation (approximately 4,671 feet)
- Extend the new low-level outlet pipeline into the lake to facilitate operational draw down for access of the full volume allowed by IPID's water right of 2,500 acre-feet.[25] The low level-outlet pipe would operate as a siphon as the lake draws down and would allow for a maximum draw down to an elevation of just under 4,621 feet.

More specific detail on this project is provided in the *Eightmile Lake Restoration Feasibility Study* provided in Appendix B of this document.

The estimated project cost for this option is $1.6 million, or $1,422 per acre-foot.

Shortly before the release of this draft EIS, IPID declared a state of emergency on March 13, 2018, due to potential failure of the Eightmile Dam. Concern's regarding potential failure were raised by the Ecology's Dam Safety Office and the USFS following the Jack Creek fire during the summer of 2017. The Jack Creek fire intensely burned a vast area of the Eightmile watershed. Because of the intensity of the fire, hydrophobic soils have developed within the watershed, which may lead to a significant increase in runoff. This could lead to increased erosion on the earth portion of the dam, which could undermine the structure. A dam failure could contribute an addition 15,000 cfs to Icicle Creek during a natural high flow event (approximately 10,000 cfs). This would result in flooding and pose a potential risk to the approximately 200 people who reside downstream near the Icicle Island area.

Because of the timing of IPID's emergency declaration, the draft PIES does not contemplate this action's impacts on the proposed alternatives. This may be evaluated further in the final PEIS. However, it is expected that the emergency declaration may be the subject of environmental review for the emergency actions that and will not include mandatory releases of water for instream flow as contemplated in these Guiding Principles.

2.5.6 Tribal Fishery Preservation and Enhancement

Yakama Nation and the Confederated Tribes of the Colville Reservation exercise federally protected fishing rights on Icicle Creek. From early May through mid-July of each year, Yakama and Colville tribal members fish near the LNFH at several locations, including the plunge pool at the base of the spillway to the hatchery channel. The purpose

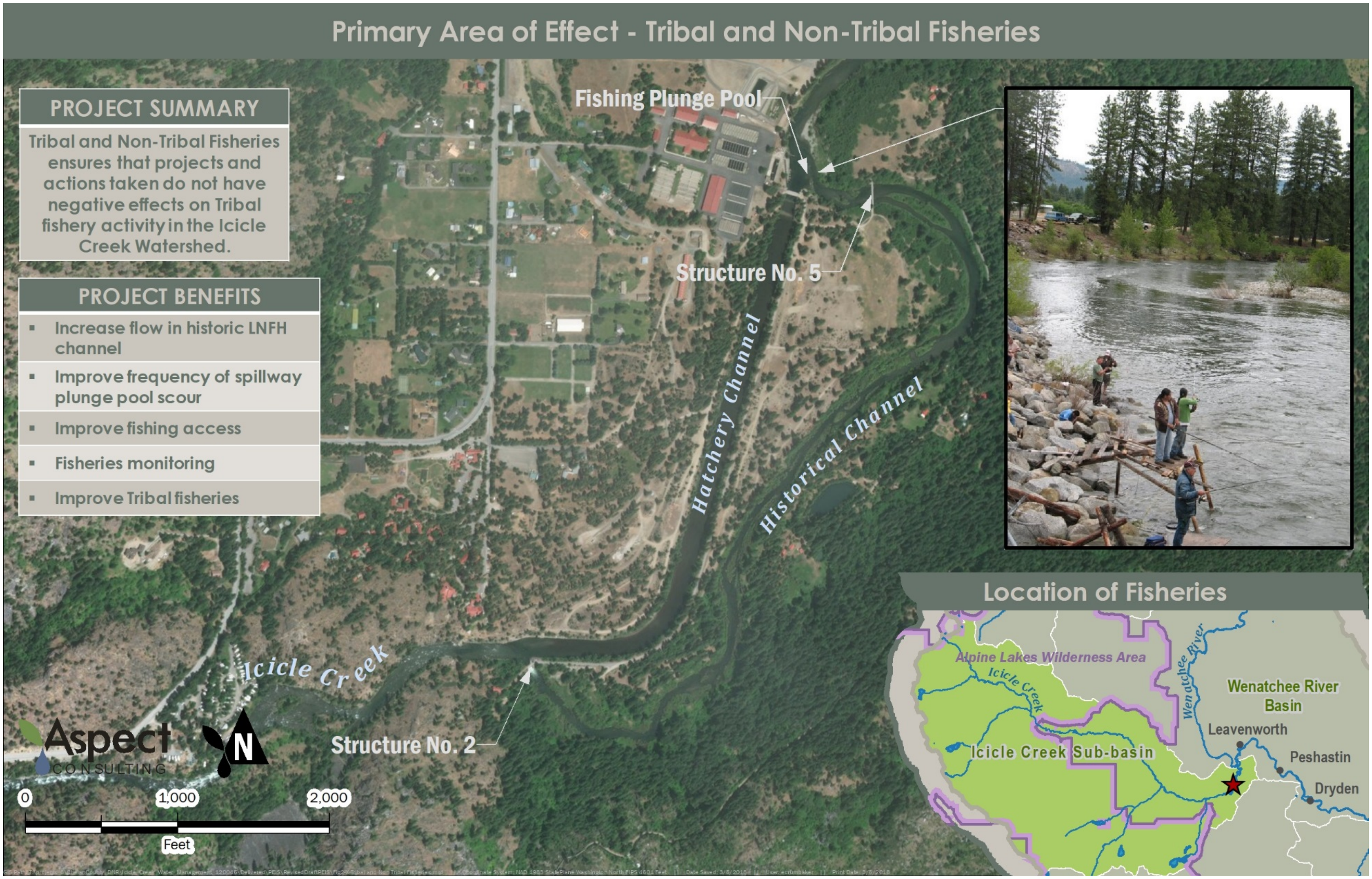
[25] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/EIGHTMILE_final_reduced.pdf

of this project is to ensure that other projects implemented as part of the Icicle Strategy do not have negative effects on the tribal fisheries and protect federally protected tribal treaty harvest rights and non-tribal fishing. See Figure 2-31 for additional explanation of Tribal fishery protection and enhancement.

To accomplish this, the IWG commissioned a report analyzing the impacts of increasing flow in the historical channel and reducing flow in the Hatchery Channel (Anchor QEA, 2015). This report found that:

- When the radial gates at Structure 2 are fully opened, water backs up into the Hatchery Channel when the flow in Icicle Creek is approximately 300 cfs.
- When the radial gates at Structure 2 are fully opened, water does not spill over the Hatchery Channel Spillway until the flow in Icicle Creek is approximately 990 cfs.
- If the LNFH closed one of the gates at Structure 2, the flows at which water would back up into the Hatchery Channel and begin to spill over the Hatchery Channel spillway would be roughly half of what would be required with both gates fully opened. Keeping one of the gates closed allows the Hatchery Channel to remain full for several more weeks during a typical year. Since this study, independently controlled radial gates were installed.
- The LNFH uses Structure 5 to control water levels and restrict upstream migration of fish in the historical channel during the May 15 to July 17 harvest period when the fish count above this structure is greater than 50 Chinook. However, in recent years fish counts above Structure have not exceeded 50 fish. This operation is discussed in greater detail in Section 3.7.
- Scour in the pool downstream of the spillway is primarily initiated during peak flow events, such as those that would occur during a flood with a return period of 2 years or more. Scour would occur at flows as low as the 2-year flow and the scour pools downstream of the Hatchery Channel would be maintained.
- The restrictions on gate operation at Structure 2 are primarily intended to limit flows to the Hatchery Channel during low-flow periods. It is the current understanding that the gates at Structure 2 have typically remained open during peak flows when the Hatchery Channel fills and overflows with the gates fully opened. Consequently, the peak flows and corresponding conditions that cause scour at the bottom of the Hatchery Channel spillway are not likely to be impacted by the current restrictions.
- Bedload sediment in Icicle Creek (based on a subsurface gravel bar sample having a D50 of 11.5 mm) will be transported at the 10-year event downstream of the spillway. The coarser surface gravel bar sediment sample (D50 of 63.3 mm) will be transported when flows reach approximately a 100-year event.

Figure 2-31. Tribal and Non Tribal Fisheries



- Because the restrictions on gate operation at Structure 2 are primarily intended to limit flows to the Hatchery Channel during low-flow periods and sediment transport primarily occurs during peak flow events, sediment transport downstream of the spillway will not likely to be impacted by the current restrictions.
- The integrated list of projects being evaluated by the IWG are intended to maintain a minimum flow during non-drought years in Icicle Creek of at least 100 cfs. Increasing the flow to 100 cfs in Icicle Creek during the late summer low-flow period should not affect scour and sediment transport through the pool downstream of the Hatchery Channel spillway because scour and sediment transport are initiated by peak flows that occur earlier in the year.
- Turbulence and air entrainment are caused by the strength of the hydraulic jump that occurs when flow exits the spillway. It appears that flow rates in excess of 500 cfs in the spillway provide the largest water surface fluctuations and air entrainment, and are the conditions noted by LNFH staff where air bubbles and turbulence provide some cover for salmon.

Figures 2-32 and 2-33 provide examples of cover provided by turbulence and air entrainment at the plunge pool during two different flow scenarios, 700 cfs and 1,700 cfs. These photos illustrate how turbulence increases, providing improved cover from predators for fish, as flow increases.

Figure 2-32. 700 cfs at Plunge Pool

Figure 2-33. 1,700 cfs at Plunge Pool

If flows in the Hatchery Channel are too low to generate turbulence and air entrainment, LNFH may wish to evaluate other methods for inducing turbulence or air entrainment. Potential methods may include the following:

- Diverting flows around or through the spillway with a pipe or pipes that could discharge into the pool downstream at a high enough elevation to cause air entrainment from the falling water
- Creating a bubble curtain with a mechanical device
- Discharging effluent or pump back water at the head of the spillway or into an elevated pipe to increase turbulence and air entrainment
- Using sprinklers or spray jets to cause turbulence at the head of the scour pool

These kinds of improvements will be further evaluated during the next phase of study, which would include development of an adaptive management plan. The plan would provide further study on data gaps and potential improvements identified in the Tribal Fisheries Analysis report, and would develop alternatives for attraction and retention of fish in tribal fishing areas during the harvest periods that is coordinated with changing operations at LNFH and increased flow. Fishery effectiveness monitoring would also be a key component of the project, as well as access and amenity improvements. It may also be possible to improve fishing access, the fishing experience, or CPUE through further study. Continued monitoring of the scour pool through additional periodic bathymetry monitoring could also help clarify potential impacts of increased instream flow.

This project fulfills the IWG's Guiding Principle to protect tribal treaty and federally protected harvest rights at all times by maintaining or improving the tribal fisheries on Icicle Creek.

The estimated cost for this project is $500,000.[26]

[26] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA 20Open 20House/Handouts/TribalFisheries_final_reduced.pdf

2.5.7 Habitat Protection and Enhancement

The IWG is planning habitat improvement projects throughout Icicle Creek. This element is intended to improve ecological function within the Icicle Creek Subbasin, and provide mitigation for project impacts in each Alternative (including short-term construction impacts) identified during project level review. Figure 2-34 provides detail of potential habitat protection and enhancement actions within the subbasin. IWG worked with USFWS, WDFW and Chelan County to assess geomorphic, hydrologic, and hydraulic conditions at sites along the creek and identified potential improvements for each. These include:

Lower Reach: Potential projects include side channel enhancement and floodplain connection.

Near LNFH Structure 5: Potential projects include engineered log jams, riparian plantings, and using rock or large woody debris to reinforce the existing island, develop a thalweg, and reduce overall channel width.

Historical Channel: Potential projects include thinning out trees and then placing whole trees with root wads into the channel.

Near LNFH Structure 2 (head gate dam): Potential projects include placing large rock structures downstream of the dam to induce and/or maintain existing scour holes.

Past projects within the area include acquisitions and conservation easements, planting projects undertaken with private landowners, and reconnecting an historical channel as a side channel habitat.

More recently, Chelan County commissioned a report to provide the scientific basis for identification and development of stream restoration and protection actions for Icicle Creek from RM 0.0 to RM 4.3 (NSD, 2017). This study examined channel incision, sediment supply and transport, the current role of wood, and habitat for juvenile and adult salmonids. This study resulted in recommendations for habitat improvements, including protection of floodplain habitat, reconnecting the floodplain with off-channel habitat, removing lateral constraints on the channel, increasing instream wood loading, and restoring riparian habitat. Table 2-8 provides a list of recommended restoration and protections actions from this report.

Figure 2-34. Habitat Protection and Enhancement

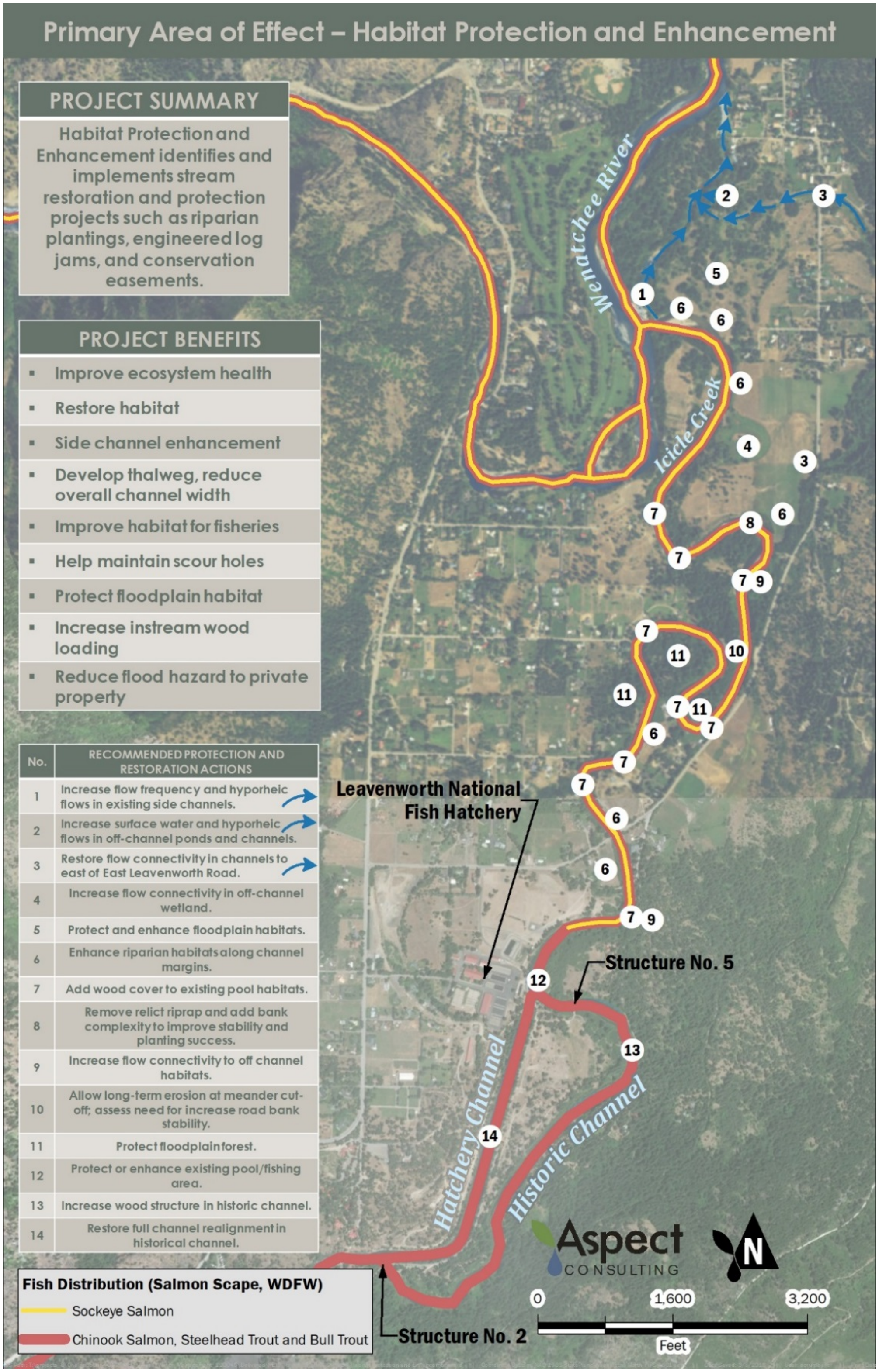


Table 2-8
Recommended Restoration and Protections Actions by Biological Benefit

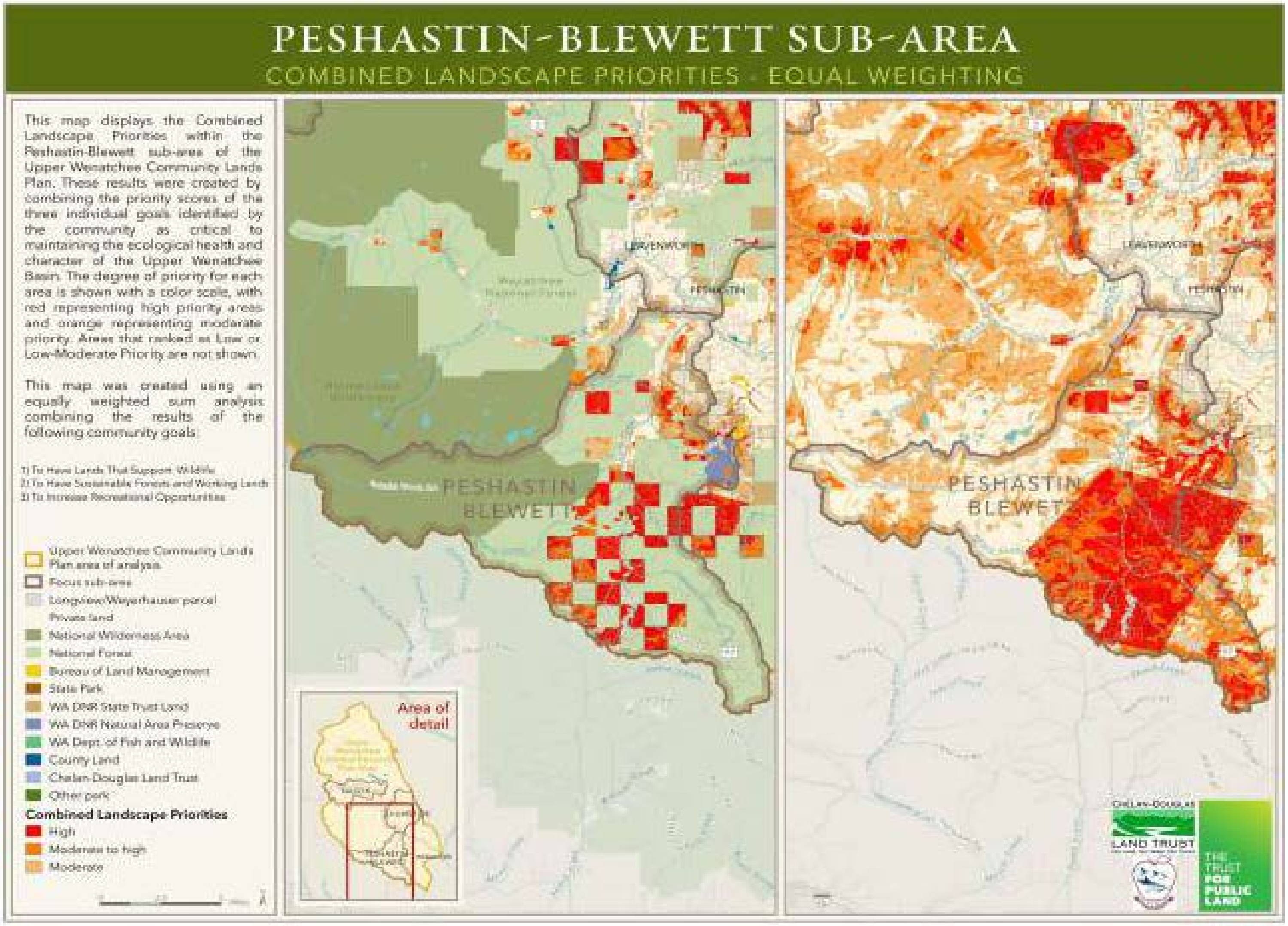
Biological Benefit	Location	Action	Feasibility	Prioritization & Sequencing Rationale
High	RM 0.0 – 1.0	Floodplain protection; Establish a stream corridor; Land acquisition	High	Provides long-term benefits associated with preventing human disturbance to floodplain habitats over a combined 150 acres of active floodplain; allows for increasing floodplain flooding and channel migration without risk to human structures and property; increases ability to implement instream actions adjacent to the properties with less risk to private property.
Medium	RM 1.3 – 2.0	Floodplain protection; Establish a stream corridor; Remove bank armoring; Acquisition	Moderate	Provides long-term benefits associated with preventing human disturbance to a combined 22 acres of floodplain habitats; allows for increasing floodplain flooding and channel migration without risk to human structures and property; increases ability to implement instream actions adjacent to the properties with less risk to private property.
High	RM 0.0/ Confluence	Reconnect Floodplain and off-channel habitat; Large woody material placement	Moderate	Provides immediate benefits addressing key off-channel habitat needs within 2,800 linear feet of existing channel. Can be implemented in conjunction with adjacent protection and riparian actions, such as installing Large woody material.
High	RM 3.0 – 4.3/LNFH Channel	Reconnect floodplain and off-channel habitat; Large woody material placement	Moderate	Install large wood structure within the historical channel. Wood installation will provide immediate improvements for cover, complexity, and pool formation. This action is appropriate given potential actions to increase flow and/or for full channel realignment.
Medium	RM 0.0 – 3.0	Large woody material placement	Moderate	Provides immediate instream habitat and floodplain benefits. Implement in association with riparian restoration efforts and with efforts to reduce channel confinement.

Biological Benefit	Location	Action	Feasibility	Prioritization & Sequencing Rationale
High	RM 1.1	Reconnect floodplain and off-channel habitat; Large woody material placement	Moderate	Small off-channel area (3 acres) with existing pond and channel features. Restoration can be paired with in-channel wood loading to improve site hydraulics and increase cover.
Medium	RM 1.0	Large woody material placement; Riparian restoration; Remove bank armoring	Moderate	Repair of degraded meander can be completed in conjunction with Protection actions. Install large wood structure, remove relict bank protection, and establish floodplain riparian community.
High	RM 3.0 – 4.3 LNFH	Reconnect floodplain and off-channel habitat; Flow improvement	Low	Actions to improve flow into the historical channel include modifications to Structure 2 and/or full channel reconnection. This will require direct coordination with LNFH operations, tribal fishery interests, and adjacent private landowners. This is likely a long-term and low feasibility action with high benefits.
Medium	RM 0.4	Reconnect floodplain and off-channel habitat	Moderate	Off-channel area (8.5 acres) will required either floodplain excavation or in-channel wood placement to improve inundation regime. Restoration can be paired with Protection and Riparian Restoration actions.
Medium	RM 0.1 – 0.3	Riparian restoration	High	Actions can be paired with Lower Icicle Protection actions. Action should be implemented with instream large woody material (LWM) loading to protect plantings and with irrigation to improve planting performance.
Medium	RM 2.1 – 2.6	Riparian restoration	High	Actions will require willing private landowners. Action should be implemented with instream LWM loading and irrigation to improve planting performance.

Biological Benefit	Location	Action	Feasibility	Prioritization & Sequencing Rationale
Medium	RM 2.7	Reconnect floodplain and off-channel habitat; Large woody material placement	Moderate	Small off-channel area (3 acres) will required either floodplain excavation or in-channel wood placement to improve inundation regime. No existing pond or off-channel features.
Low	RM 0.0 – 1.0	Reconnect floodplain and off-channel habitat; Install culverts within East Leavenworth Road	Low	Requires additional analysis of effects to adjacent landowners; likely difficult to greatly increase inundation regime because of elevated floodplain even with new culverts in East Leavenworth Road. Need to combine with Protection Act

The IWG plans to coordinate land acquisition projects with the Upper Wenatchee Community Land Plan (UWCLP) to protect land within the Icicle Creek Subbasin. The UWCLP is a community driven plan to conserve forest lands throughout the Upper Wenatchee Basin. Throughout the UWCLP study area, the Lands Plan identified 99,657 acres as high priority land for conservation, with 45,164 acres of that being high priority wildlife land, 11,786 acres of high priority recreation land, and 20,160 acres of high priority working lands. For the habitat protection projects, lands would be selected that are adjacent to the Icicle Creek Subbasin, which could expand habitat connectivity or access for wildlife. Additionally, this action could increase recreational access to the Icicle Creek Subbasin. Figure 2-35 provides a view of priority landscapes identified in the Icicle Creek area. This is a combined, equal-weighted priority map that includes various landscape priorities, include wildlife habitat, recreational opportunities, and sustainable forest and working landscapes.

Figure 2-35. Combined Landscape Priorities for the Icicle Creek Area



Source: Upper Wenatchee Community Lands Plan, September 2016

This project meets and advances the objectives set out in the Guiding Principles to enhance the Icicle Creek habitat by improving instream habitat and ecosystem health, and conserve land in the upper reaches of the Icicle Creek Subbasin.

Approximately $2.5 million would be budgeted for instream habitat and land acquisition projects.[27] Specific decisions on habitat protection and enhancement projects will be made after selection of the preferred alternative, so that projects can be tailored to mitigation needs for the selected alternative.

2.5.8 Instream Flow Rule Amendment

Amending the Wenatchee Instream Flow Rule Chapter 173-545 WAC would provide an additional 0.4 cfs and 400 acre-feet for domestic supply.

The Wenatchee Instream Flow Rule, which establishes an instream flow water right and sets reserves for the Wenatchee River and each of its major tributaries, including Icicle Creek, was established based on the recommendations of the Wenatchee Watershed Planning Unit and public input received during the rule-making process. Within the Wenatchee Instream Flow Rule a reservation of water was established for future domestic use in the Icicle Creek Subbasin. Currently, the reserve is set at 0.1 cfs, but to supply projected demand this reserve needs to be increased. The Wenatchee Instream Flow Rule provides for a reserve increase of up to 0.5 cfs in the Icicle Creek Subbasin so long as it is within the limitation of the 4.0 cfs reserve for the Wenatchee Basin (WAC 173-545-090(d)(iv)). To increase the Icicle Creek Subbasin reserve, instream flow and habitat improvement projects must be implemented in Icicle Creek.

This project is being coordinated with instream flow and habitat projects, and is intended to amend the reserve to meet demand projected through 2050. To increase the Icicle reserve a formal rule amendment must occur.

An amendment to the instream flow rule fulfills the Guiding Principle to improve domestic supply by making water available to meet demand projections through 2050. The estimated cost for this project is $50,000. [28]

[27] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/Habitat_final.pdf
[28] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/InstreamFlowRule_final.pdf

2.5.9 Leavenworth National Fish Hatchery Conservation and Water Quality Improvements Project

The LNFH Conservation and Water Quality Improvements Projects will provide 20 cfs and 14,454 acre-feet year-round in Reach 4 for instream flows.

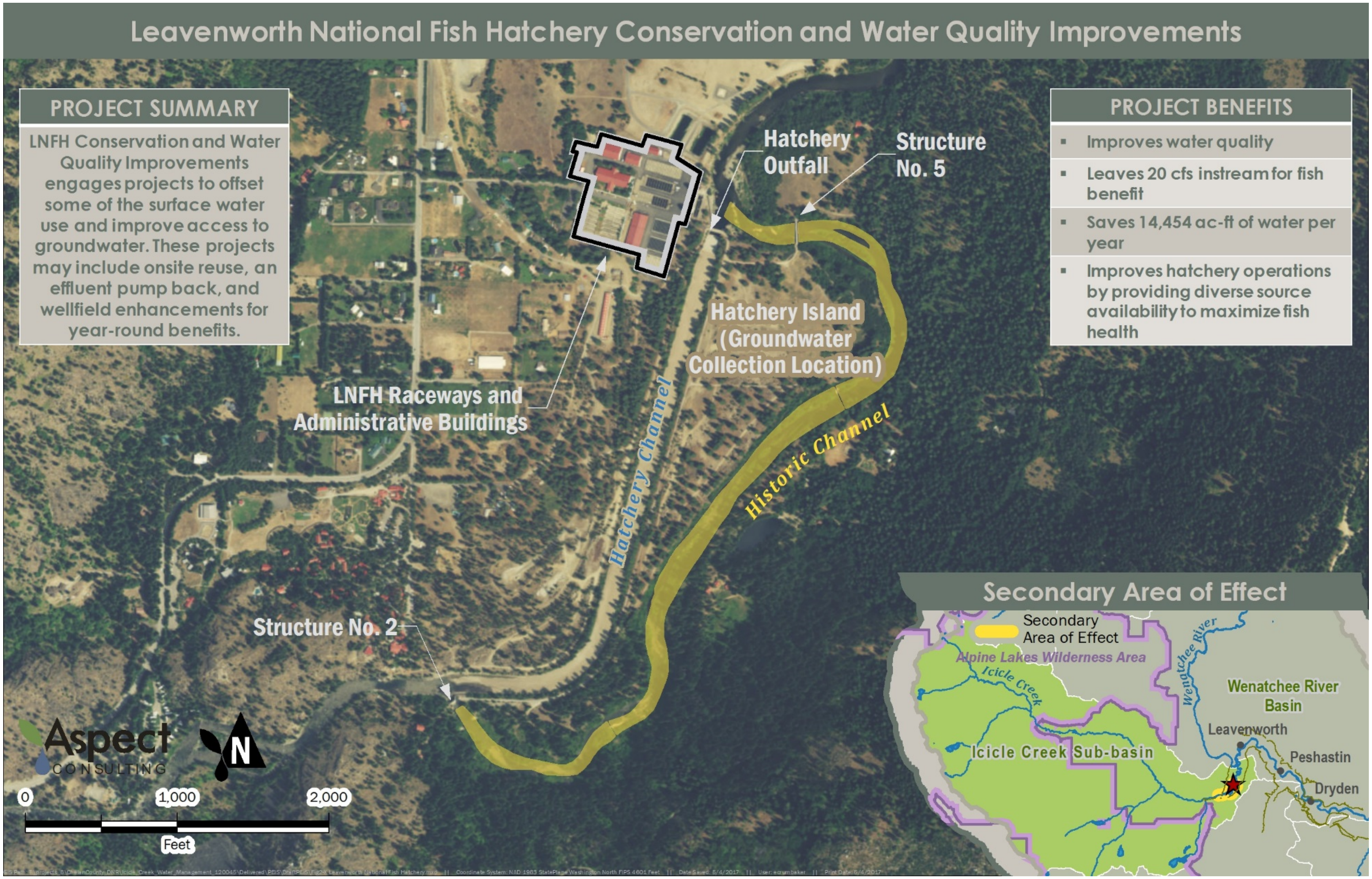
The LNFH relies on both a surface water diversion from Icicle Creek at RM 4.5 (42 cfs) and groundwater wells located near the hatchery canal (14.9 cfs) to produce the water necessary for their fish production year-round. The hatchery also relies on 16,000 acre-feet of storage to supplement surface water diversion during low-flow periods (July through early October). To maintain groundwater supplies in LNFH's shallow wells, flows from Icicle Creek are diverted to the Hatchery Channel for groundwater recharge. These flows are controlled by LNFH Structure 2.

The Leavenworth Fisheries Complex Planning Report (McMillen Jacobs, 2016) investigated a range of alternatives for improving operations and meeting fish production targets at three hatcheries, including the LNFH. It included an evaluation of the LNFH site, assessing land issues, water quality and quantity, biological risks and benefits, and policy and socioeconomic considerations. From this assessment, the study identified alternatives for cost-effective, viable improvements to the existing fish production facilities that develop the water supply to fully utilize and preserve existing water rights, modernize or replace aging/obsolete infrastructure, and develop fish culture technologies to increase fish health, efficiency of fish production energy, and water use. See Figure 2-36 for additional explanation on LNFH improvements.

The report's recommended plan for LNFH identifies high-priority projects over the next 10 years, with $2.5 to $5 million per year expenditures. The high-priority projects include:

- Modify or replace existing surface water intake screen that incorporate NOAA-compliant screens.
- Implement short-term phosphorous management measures.
- Repair or replace failing surface water transmission pipes.
- Construct a new surface water filtration and disinfection facility to treat a portion of incoming surface water supply. Installation of a water chiller is scheduled for spring of 2017.
- Replace outdated spawning facilities.
- Provide back-up power to Wells No. 1, 2, 3, and 7 to ensure continuous supply for the critical incubation and rearing.
- Construct new rearing vessels with roof covers.
- Install an effluent pump-back system to pump water into the Hatchery Channel and recharge the wellfield. The results would be a reduction of water currently diverted from Icicle Creek for that purpose.

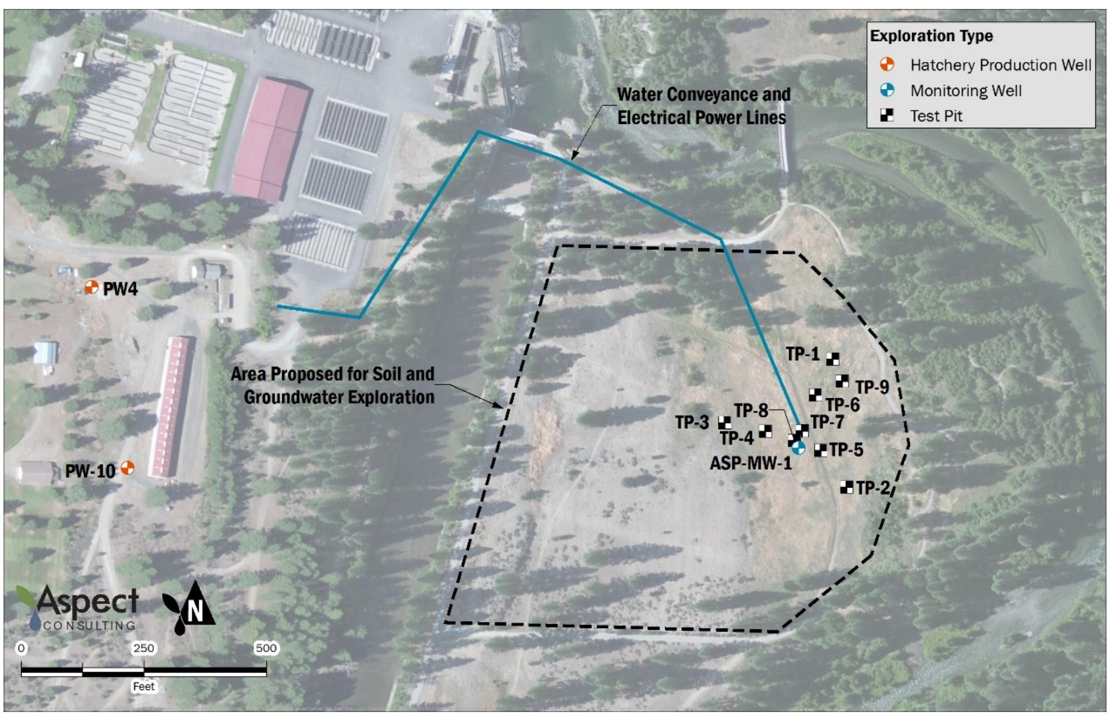
Figure 2-36. Leavenworth National Fish Hatchery



The IWG has investigated several improvements identified in *The Leavenworth Fisheries Complex Planning Report* (LNFH Planning Report) (USFWS, 2016), including upgrading screens and intake piping at the LNFH point of diversion (more information provided in the screening section below), groundwater augmentation, effluent pump back, and circular reuse tanks to achieve water conservation and quality goals established in the Guiding Principles.

To better understand groundwater augmentation options, geophysical investigation of the LNFH property and an adjacent Chelan County-owned parcel was completed in 2014 and 2015 as an initial step to identify areas for potential groundwater supply development (Aspect, 2015). These investigations found good conditions for groundwater collectors, such as shallow depth to groundwater, saturated coarse gravel and cobbles, and nearby surface water to recharge and maintain water levels. Additionally, a pump test of a drilled well on Hatchery Island indicated the well could provide sustainable yields. Developing groundwater sources could reduce surface water diversions and support a sustainable LNFH by providing cool, pathogen-free water for fish propagation. The groundwater supply development goal identified in the Leavenworth Fisheries Complex Planning Report is 8 cfs of additional capacity, with project development costs estimated at $3 million, with implementation occurring over the next 10 years (McMillen Jacobs, 2016). Figure 2-37 provides an overview of the geophysical investigation conducted.

Figure 2-37. Groundwater Investigation Site Plan



Source: Leavenworth National Fish Hatchery Groundwater Investigation Memo. Aspect Consulting, 2015.

In 2015, historical low flows in Icicle Creek led LNFH to run an emergency effluent pump back pilot program. Effluent pump back involves effluent water from the hatchery back into the Hatchery Channel to recharge the shallow groundwater wells that provide water to the hatchery. Under prior operating conditions, the gates at Structure 2 were lowered to divert water from Icicle Creek into the Hatchery Channel. The water in the Hatchery Channel recharges shallow groundwater wells that are a critical part of the LNFH groundwater supply. When the Hatchery Channel is not wetted, the shallow groundwater wells run dry.

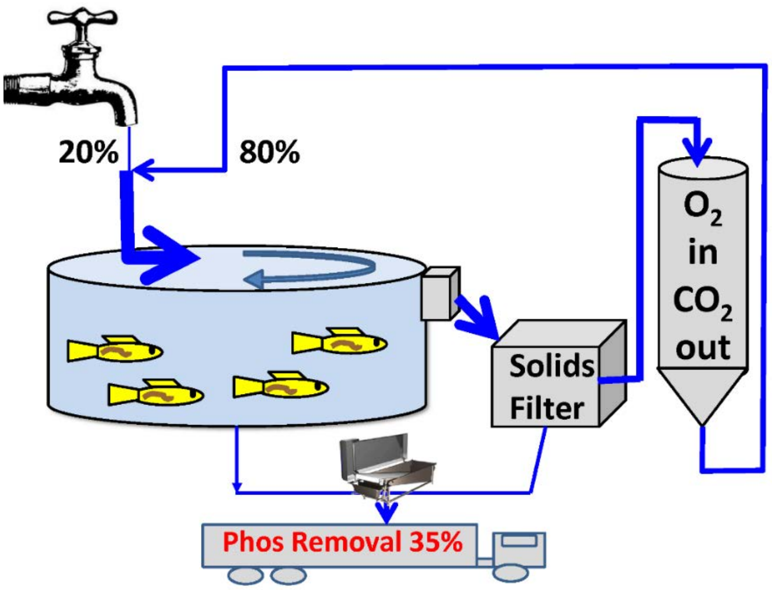
Due to low flows and high water temperatures in 2015, LNFH implemented an emergency pilot of a pump back operation that uses the clean, run-through water to keep the Hatchery Channel wetted. Under the 2015 pilot program, temporary pumps were installed at the bottom of the fish ladder, adjacent to the spillway, where effluent water is discharged to Icicle Creek and pumped into the Hatchery Channel. The results of the pilot program found that the pump back increased groundwater levels in the adjacent aquifer, prevented Reach 4 from being a "losing reach," and decreased total phosphorous discharge at the outfall (Anchor QEA, 2016; McMillen Jacobs, 2016). If effluent pump back were implemented on a permanent basis, project costs are estimated at between $839,000 and $998,000 (Anchor QEA, 2016). The *Leavenworth Fisheries Complex Planning Report* calls for implementation to occur between 2017 and 2018 (McMillen Jacobs, 2016). Figure 2-38. is a photo from the pilot program. The photo on the left is the temporary piping from the fish ladder to the Hatchery Channel. The photo on the right is of the Hatchery Channel from near the top of the fish ladder.

Figure 2-38. Effluent Pump Back Pilot Program

2.5.9.1 Circular Tanks

Circular tanks offer several advantages over the current LNFH raceways. This includes improved water quality and controllable swimming velocities that may increase fish fitness and survival. Additionally, circular tanks reuse water, significantly reducing water demand. The estimated cost of installing new circular tanks at LNFH is $4.5 to $6.4 million depending on the alternative selected, with implementation scheduled between 2019-2023 (McMillen Jacobs, 2016). LNFH completed a circular tank/water reuse feasibility study in Spring of 2017. Figure 2-39 illustrates how circular tanks operate.

Figure 2-39. Circular Tanks for Fish Rearing



These improvements meet the IWG's Guiding Principles to improve instream flow, support a sustainable LNFH, and enhance Icicle Creek habitat and fish passage. It has instream flow benefits of up to 20 cfs in Icicle Creek and provides a reliable water supply for hatchery operations.

The hatchery is prepared an implementation plan to meet requirements set in the 2015 Biological Opinion and implement improvements identified in the planning report (NMFS, 2015; UWFWS, 2017). Some of these projects are not part of the improvement projects put forward by the IWG, and are not considered in this report.

Cumulatively, IWG sponsored projects are estimated to cost $20 million dollars, or $1,383 per acre-foot. [29]

[29] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/LNFH_final.pdf

2.5.10 Fish Passage

The IWG has identified the need for fish passage improvements at LNFH and in Upper Icicle Creek. They have proposed several potential projects that would improve upstream fish passage at these locations.

The historical channel suffers from passage issues during low-flow conditions because of channel morphology. When flows drop below 200 cfs, passage is limited for fluvial bull trout. When flows drop below 120 cfs, passage is limited for mid-size fish, such as steelhead. When flows drop below 30 to 40 cfs, passage is limited for juvenile salmonids.

The IWG seeks to improve passage in the historical channel (Reach 4) by increasing streamflow. With the long-term goal of increasing minimum streamflow in the historical channel to 250 cfs, passage through this reach would be provided for these species at various life stages. Habitat improvement, described above, is also designed to improve passage by improving channel conditions throughout this reach and lower reaches. See Figure 2-40 for additional explanation of fish passage improvements.

Structure 5 at LNFH is also a structural fish barrier. However, this barrier is by design and is an operational requirement for LNFH to collect broodstock. Additionally, the operation of Structure 5 enhances the tribal fishery. During broodstock collection, pickets are placed in Structure 5 to prevent large fish from migrating upstream, but allows small and juvenile fish passage. Structure 5 is operated for broodstock collection from mid-May through June. In addition to the intentional barrier provided by Structure 5, Icicle Creek's channel is wide at this point, so low flows can lead to shallow conditions that pose a passage barrier. Channel changes or restricting flow with Structure 5 could help increase stream depth during low-flow events, improving passage.

LNFH Structure 2 is a headgate located at RM 3.8 designed to control flow into the Hatchery Channel. Because of the design of this structure, the velocity of water moving through the structure can prevent upstream migration. When both gates are open, this structure does not provide passage for juvenile salmonids; limits passage for rainbow trout, bull trout, and lamprey when flow is above 64 cfs; and limits steelhead and salmon passage when flow is above 512 cfs. Independently operated radial gates have been installed on Structure 2, which improves passage issues. The IWG proposes to improve Structure 2 (or replace with a passive structure) to allow for improved fish passage while retaining the ability to split flows between the hatchery canal and the historical channel in a way that maintains the existing tribal fishery conditions at the plunge pool, improves ecosystem health of the historical channel, and meets the LNFH's operational needs. Figure 2-41 shows Structure 2.

Figure 2-40. Fish Passage and Fish Screening

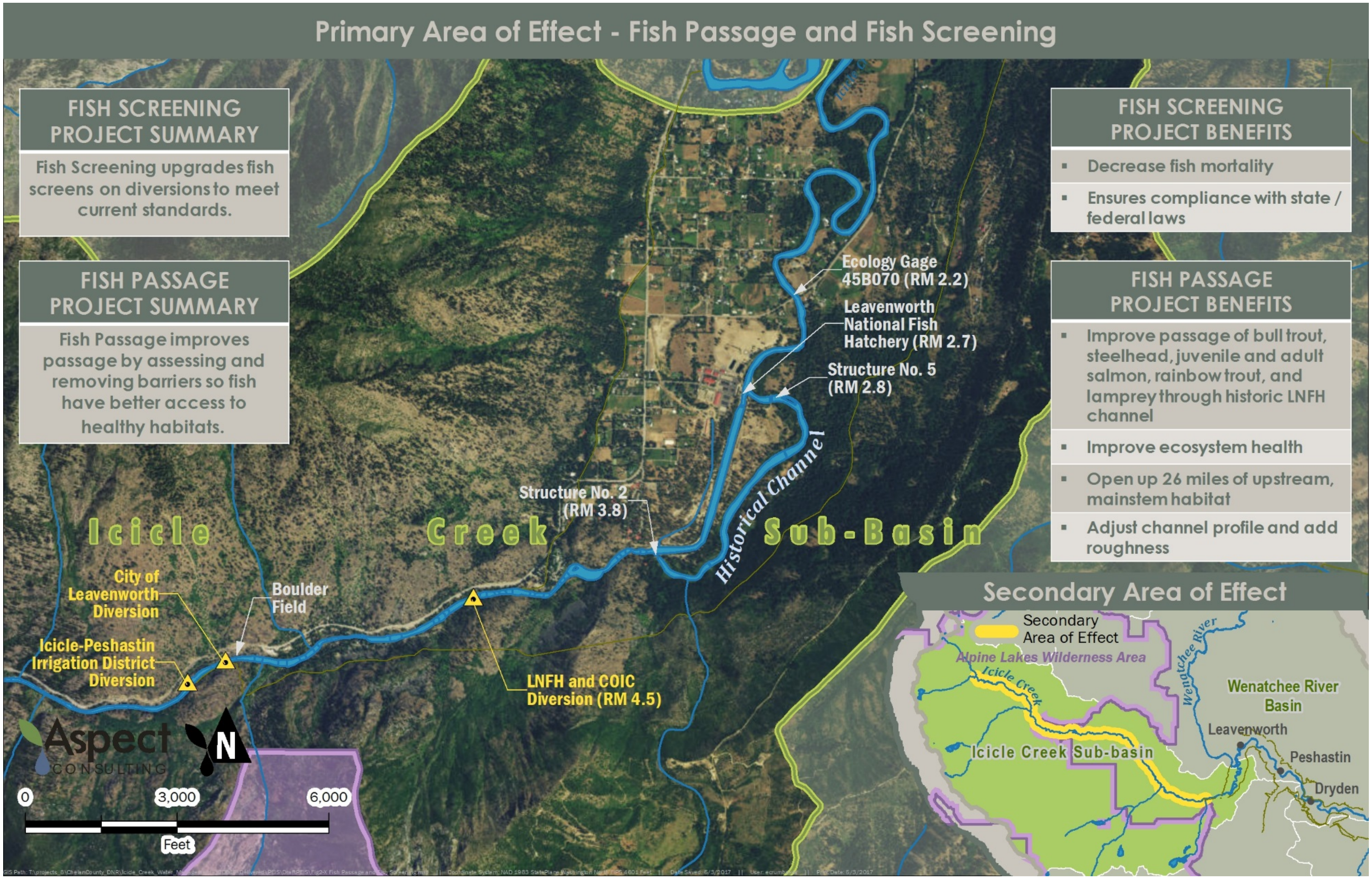


Figure 2-41. Structure 2

Source: The Leavenworth Fisheries Complex Planning Report (McMillen Jacobs, 2016).

In addition to operational and infrastructure changes the LNFH, modifications to the boulder field located at RM 5.6 would provide passage and access to approximately 26 miles of upstream, mainstem habitat. The boulder field has been identified as having anthropogenic origin (EcoAssets, 2013). Primary passage concerns include gaps between boulders being filled by smaller sized substrate and woody debris that blocks passage and affects surface and subsurface flow and velocity (EcoAssets, 2013). A passage assessment at the boulder field has been completed and passage improvement locations identified. Passage improvements at the boulder field can be broken into two categories—middle boulder field and upper boulder field. Options considered for the middle boulder field passage include a channel profile adjustment, installing a roughened channel, installing vertical slot fishways, or installing a low-flow pool and weir fishway. Options considered for upper boulder field passage include a pool and chute fishway and constructed riffle. Costs for the various passage measures range from $260,000 to $1 million (EcoAssets, 2013). The preferred alternatives recommended in the EcoAssets study were the channel profile adjustment for the middle reach and a pool and chute fishway in the upper reach, with estimated costs of $770,000 and $258,000, respectively. Figure 2-42 provides an example of a pool and chute fishway.

Figure 2-42. Example of pool and chute fishway

Source: Icicle Creek Boulder Field Fish Passage Assessment (EcoAssets, 2013).

Trout Unlimited, a IWG member leading the boulder field passage project, is currently working on design options. NEPA will be required for this project, and will likely result in an Environmental Assessment with the Army Corps of Engineers (USACE) acting as lead agency. Chelan County Community Development will act as SEPA lead agency. Those environmental review documents are expected to evaluate potential impacts on the tribal fishery that could result from increased passage attraction above LNFH. Currently, many fish that migrate upstream of Structure 2 return downstream to the scour pool for harvest because of unsuitable upstream habitat.

Improving fish passage meets the Guiding Principles of enhancing Icicle Creek habitat and passage, and supporting a sustainable LNFH.

The estimated costs of implementing these projects is approximately $6 million.[30]

[30] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/PassageImprove_final.pdf

2.5.11 Fish Screen Compliance

There are three large diversions on Icicle Creek with screens that do not meet current requirements. The IWG is recommending upgrades to these screens to comply with current NMFS and state standards. These screening projects will help decrease fish mortality in Icicle Creek.

The LNFH and COIC have a shared diversion located at RM 5.4. The Biological Opinion for LNFH requires this diversion's screen be upgraded to meet current fish passage requirements. LNFH and COIC are considering various operational changes that would reduce screen sizing, and LNFH is exploring water reuse options. COIC is considering moving their point of diversion to a location near the confluence of the Icicle Creek and the Wenatchee River and implementing other efficiency upgrades. The COIC completed an Alternatives Analysis in March 2015 (Anchor QEA, WWT, 2015) to evaluate potential changes to their supply. New diversion facilities for COIC would be designed with screens meeting current NMFS standards. If COIC moves forward with improvements that change the location of their diversion, COIC would no longer share a diversion with LNFH and LNFH would then size and design diversion improvements to meet only meet the needs of LNFH.

Depending on screen size and other intake structure improvements made to the LNFH diversion, cost estimates range from approximately $5.2 to $12.4 million. The implementation schedule for this project depends on environmental review and implementation of water efficiency upgrades. However, the 2015 Biological Opinion required screening within 8 years of the Biological Opinion date (MNFS, 2015).

In addition to upgrading the screens, the Icicle Strategy includes improvements the intake structure at LNFH. As part of this project, dilapidated sections of intake piping would be replaced. This will improve operations at LNFH and help facilitate the screen upgrade. USFWS is pursuing additional intake structure upgrades, descriptions of which are available in the *Leavenworth Fisheries Complex Planning Report* and the anticipated Leavenworth Fisheries Complex Implantation Plan. Figure 2-43 is a photo of the current screening facilities for LNFH and COIC.

Figure 2-43. LNFH/COIC Fixed Plate Screen (left) and COIC Bypass Screen (right)

The City of Leavenworth and IPID points of diversion are both located at RM 5.7, across Icicle Creek from one another. IPID owns and operates a small diversion structure that spans the creek at that location. The IPID diversion facilities are on the right bank (looking downstream) and include a diversion channel, operational spillways, a flow measurement flume, paddle wheel-driven rotating drum fish screens, and a bypass spillway. The facilities do not meet current NMFS standards and have potential to result in stranding or injury to fish.

The City of Leavenworth operates a diversion on the left bank (looking downstream) just upstream of the IPID diversion structure. City of Leavenworth facilities consist of a reinforced concrete diversion structure with a vertical, fixed plate screen. These facilities also have potential to cause injury and mortality to fish associated with stranding or entrainment in existing diversion facilities.

These projects are associated with the boulder field fish passage projects. Currently, only limited opportunistic passage occurs through the boulder field. The proposed fish passage improvements would enhance passage for anadromous and resident migratory species, including ESA-listed steelhead and bull trout. The IWG has identified the need to bring the IPID and City of Leavenworth screening facilities into compliance with current NMFS standards prior to improving passage through the boulder field. Screening upgrades have been identified as a potential early action item for the IWG, but would have to be coordinated with boulder field passage projects. Both the City of Leavenworth and IPID have been working with WDFW on securing funding for screen design. The current project estimate for screening these two diversions is approximately $5 million. However, improved estimates are expected later this year.

This project decreases fish mortality and brings major diversions up to current screening standards. In keeping with the Guiding Principles, it supports a sustainable LNFH and ensures compliance with state and federal laws.

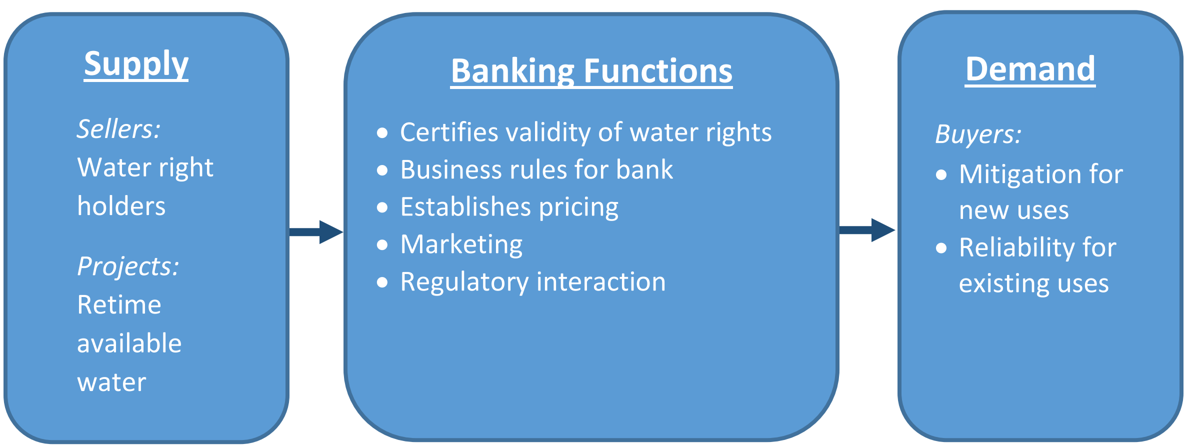
The screening improvements cost estimate range from $10.4 to $17.6 million, with additional costs for upgrading the intake structure.[31]

2.5.12 Water Markets

There are 56 agricultural water users in the Icicle and Wenatchee Basins that are curtailed in water-short years. Under this project, the IWG would create a voluntary Icicle Water Market to improve agricultural reliability for these water users, providing 3.4 cfs and 1,000 acre-feet to irrigators with interruptible water rights in the Icicle and Wenatchee basins.

Water markets allow people and farms who face water use restrictions to purchase mitigation credits to allow water use. Water banks and markets are part of the critical portfolio of tools needed to help address the complexities of water management—including drought risk, surface water-groundwater interactions, and legal and regulatory disputes and restrictions over water markets—thereby allowing scarce water resources to be allocated more efficiently. Figure 2-44 provides an overview of the water banking process.

Figure 2-44. Water Banking Process Overview



The overall goal of a water market is to facilitate water transfers using market forces. These goals include:

- Making water supplies available when and where needed during times of drought;
- Improving streamflows and preserving instream values during fish critical periods;
- Reducing water transaction costs, time, and risk to purchaser;
- Facilitate fair and efficient reallocation of water from one beneficial use to another;

[31] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/ScreenImprovements_final_reduced.pdf

- Providing water supplies to offset impacts related to future development and the issues of new water rights;
- Facilitating water agreements that protect upstream community values while retaining flexibility to meet critical downstream water needs in times of scarcity

In Washington, water markets are generally established through purchasing a water right and placing the water right into the Trust Water Rights Program (TWRP), where it can offset impacts of new users. After a water right is placed in the TWRP for mitigation and instream flow enhancement, a Trust Water Right Agreement (TWRA) is developed that specifies where and how new uses can be mitigated by the trust water right. Once the TWRA is developed, mitigation credits can be issued for new water users as specified by the TWRA.

Rather than providing mitigation for new uses, the Icicle Water Market would allow water to be moved to existing interruptible agricultural farms during water-short years. The Water Market would be seeded through a purchase of 1,000 acre-feet of senior irrigation water rights. These senior water rights would be enrolled in the TWRP, and Ecology would enter into a TWRA with the bank manager, likely Chelan County, to establish where, when, how, and what quantity of the trust water right could be used as mitigation. This would also include the development of a suitability map. Once the TWRA is established, Chelan County would develop its own business rules about price and restrictions. These business rules would be based on interviews with the 56 potential program participants regarding interest in the program and price points.

The estimated project cost is $3 million, or $3,000 per acre-foot.[32]

2.5.13 Costs and Benefits for Alternative 1 (Base Package)

The purpose of this section is to describe the costs and benefits of the projects that make up the Base Package in Alternative 1. This is not a cost-benefit analysis, but rather a summary of the predicted costs and benefits of Alternate 1. Cumulatively, these projects meet all of the Guiding Principles.

Alternative 1 has a total project benefit of 89 cfs and 31,958 acre-feet of total water (instream and out-of-stream water). The estimated cost is $63.3 million, $79.2 million when including a 25 percent contingency. With the contingency, the price per acre foot is estimated at $2,477 per acre-foot. The average cost per acre-foot of water developed by the Office of Columbia River is approximately $500/acre-foot. Table 2-9 provides a breakdown of each project by describing the benefits and costs associated with each. These costs are subject to change as projects progress through feasibility and design, and a more complete picture of costs are developed.

[32] http://www.co.chelan.wa.us/files/natural-resources/documents/Planning/icicle_work_group/SEPA%20Open%20House/Handouts/WaterMarkets.pdf

Table 2-9
Summary of Alternative 1 Costs and Benefits

Project	Total Water Developed		Project Cost ($ M)	Cost/ (ac-ft)	Instream Flows (cfs)	LNFH	Fish Harvest	DM Supply	Ag Reliability	Habitat	Comply with Laws
	cfs	Ac-ft									
Alpine Lakes Optimization & Automation	30	5,464	0.78	144	30				x		x
IPID Irrigation Efficiencies	10	3,000	7.50	2,500	10				x		x
COIC Irrigation Efficiencies & Pump Exchange	12	3,640	2.80	769	12				x		x
Domestic Conservation	0.5	400	1.00	2,500	-			x			x
Eightmile Lake Storage Restoration	13	3,600	1.60	444	13			x	x		x
Tribal & Non-tribal Fishery Preservation and Enhancement	-	-	0.50	-	-		x				x
Habitat Protection & Enhancement	-	-	2.50	-	-					x	x
Instream Flow Rule Amendment	0.4	400	0.05	125	-			x			x
LNFH Conservation & Water Quality Improvements	20	14,454	20.00	1,384	20	x					x
Fish Passage	-	-	6.00	-	-					x	x
Fish Screen Compliance	-	-	17.60	-	-					x	x
Water Markets	3	1,000	3.00	3,000	3				x		x
Totals	**89**	**31,958**	**63.3**	**1,982**	**88**	**x**	**x**	**x**	**x**	**x**	**x**
Contingency			**79.2**	**2,477**							

2.5.14 Timeline

The proposed timeline to implement the Base Package of projects that compose Alternative 1 is below.

- Spring 2016 – Programmatic SEPA Scoping
- Summer 2016-Summer 2018 – Programmatic EIS Development
- Summer 2018 – Draft PEIS
- Fall 2018 – Final PEIS, Preferred Alternative Selection
- Fall 2018-Spring 2019 – Project Level Environmental Review Scoping and NEPA Integration (Depending on Alternative Selected), Applicable design or feasibility studies on projects
- Summer 2019-Summer 2020 – Project Level Environmental Review (if applicable)
- Spring 2019-Fall 2028 – Project Construction/Implementation

There will be 60-day public comment periods following release of the draft and final PEIS. If it is determined that project-level SEPA scoping is necessary, there will also be opportunities for public comment during the scoping and following release of the draft and final project EIS.

2.6 Alternative 2

Alternative 2 was developed in response to SEPA scoping comments and includes a mix of projects that meet the Guiding Principles. It includes many of the projects included in Alternative 1—with the exception of the Alpine Lakes Optimization, Modernization, and Automation project—and adds the IPID Dryden Pump Exchange project. The projects included in Alternative 2 are described below.

2.6.1 IPID Dryden Pump Exchange

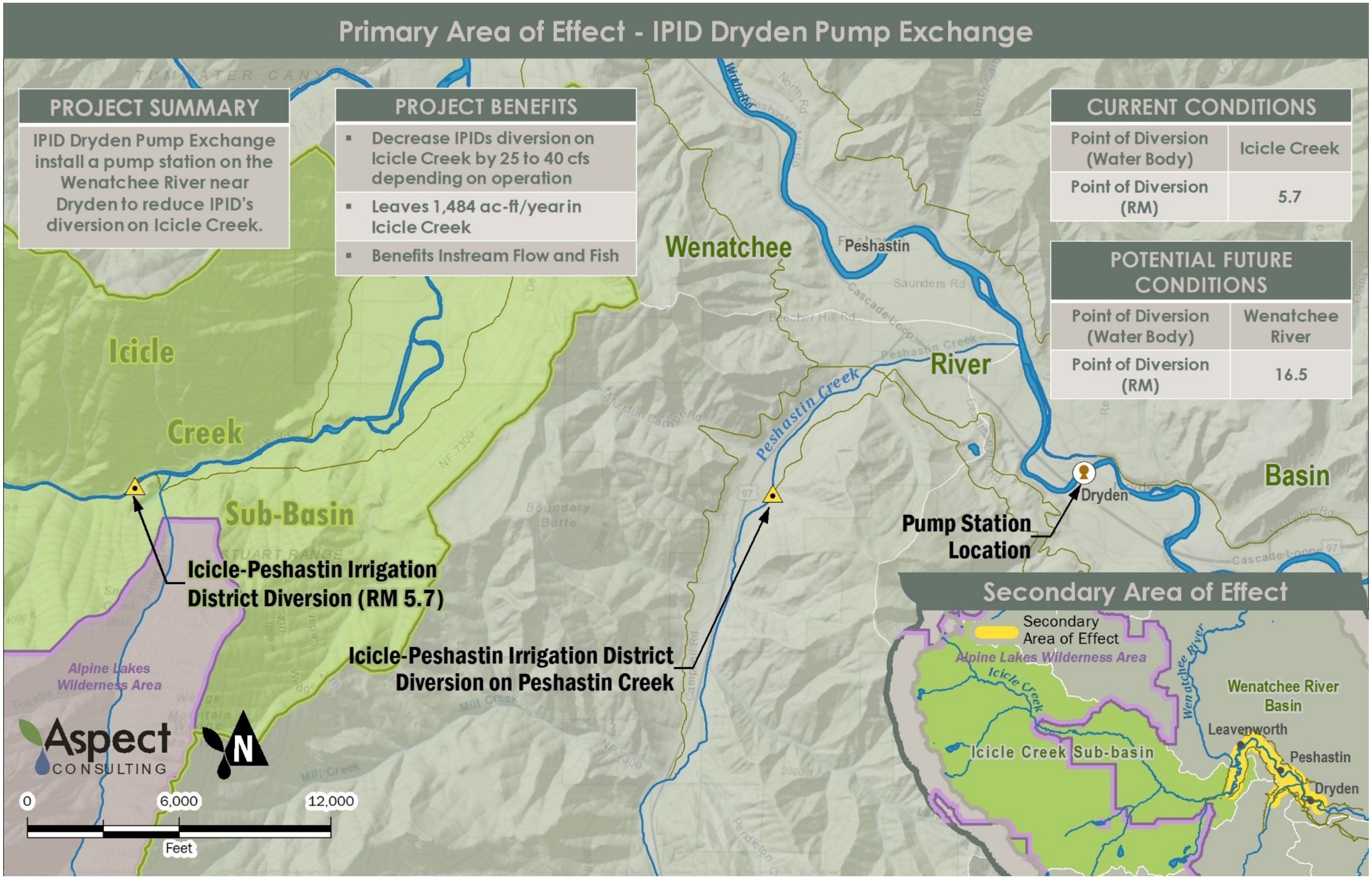
The IPID Dryden Pump Exchange project would supply a portion of IPID water from the Wenatchee River as opposed to Icicle and Peshastin Creeks. This project would provide an average water savings of 25 cfs and 1,484 acre-feet.

In December 2012, Anchor QEA submitted an *Appraisal Study of the Peshastin Irrigation District Pump Exchange* (Anchor QEA, 2012) project to Ecology and Chelan County Natural Resources. The Pump Exchange project sought to find ways to increase flow in Peshastin Creek downstream of the IPID diversion on Peshastin Creek to improve late summer fish passage, spawning, and rearing conditions in lower Peshastin Creek. The Appraisal Study evaluated five pump exchange options that would divert water through a pump station on the right bank (looking downstream) of the Wenatchee River near Dryden, Washington.

An options comparison was presented to IPID and a preferred option was selected that would include a pump station on the right bank of the Wenatchee River near the Highway 2 bridge, immediately west of Dryden and a delivery pipeline that would extend through private orchards and driveways to the PID and IID canals. Based on the review of project options with IPID, this location was selected as the preferred project because of more favorable hydraulic conditions at the proposed diversion location, a lower projected project cost, and the potential for improving the reliability of the IPID system by providing an alternate source of supply downstream, of the most vulnerable part of the system.

Additional alternatives for pump exchange projects were evaluated by Trout Unlimited, with the assistance of Forsgren Associates, in 2014, as part of the *Icicle Irrigation District Instream Flow Improvement Options Analysis Study* (Forsgren Associates 2014). These included options for pumping directly to the Icicle Irrigation District Canal from the Wenatchee River. A memorandum titled, Icicle and Peshastin Irrigation Districts Pump Exchange Summary of Additional Analysis (Anchor QEA 2015) compared the various alternatives that had been considered by IPID and provided a detailed description of the preferred alternative identified by IPID. The other alternatives considered by IPID were not moved forward in this PEIS, as described in Section 2.10. See Figure 2-45 for additional explanation of the IPID Dryden pump exchange.

Figure 2-45. IPID Dryden Pump Exchange



The current concept for the proposed pump exchange, as identified in the 2015 memorandum, would include the following:

- A pump station located on the right bank of the Wenatchee River, just southwest (upstream) of U.S. Highway 2, approximately 7,250 feet downstream of the confluence of Peshastin Creek with the Wenatchee River (approximately RM 16.5)
- Four vertical turbine pumps, each designed to deliver approximately 12.5 cfs at a total dynamic head (TDH) of 246 feet (500 horsepower each)
- A 1,240-foot, 42-inch-diameter delivery pipeline that would extend south and east through an existing orchard, and then south and west up a steep hillside to the PID Canal
- A delivery structure at the PID Canal approximately 19,560 feet downstream of the diversion at Peshastin Creek
- Replacement of approximately 2,350 feet of the existing PID Canal downstream of the delivery structure with a 48-inch-diameter gravity pipeline to increase the conveyance capacity of the canal to at least 50 cfs
- Construction of a 15.5-acre-foot re-regulation pond with a high water surface elevation of 1,144 feet at a bend in the PID Canal approximately a 1/2 mile east of the proposed delivery structure
- Construction of a pump station on the east bank of the re-regulation pond to deliver flows to the IID Division 3A Canal
- Two vertical turbine pumps, each designed to deliver approximately 12.5 cfs at a TDH of 195 feet (400 horsepower each)
- A 1,300-foot, 30-inch-diameter delivery pipeline that would extend south and east through an existing orchard and up an existing access road to the IID Division 3A Canal
- A delivery structure at the IID Division 3A Canal approximately 200 feet downstream of the siphon outlet

The intent of the IPID Dryden Pump Exchange Project is to meet multiple goals of the IWG’s Guiding Principles. This project has the potential to:

- Augment streamflow in Icicle Creek below the IID diversion at RM 5.7 by as much as 40 cfs during the late summer, with the average flow increase in Icicle Creek of 25 cfs. The project also has the potential to augment streamflow in Peshastin Creek below the IPID diversion at RM 2.4.
- Improve the reliability of water supply for agriculture.
- Benefit fish passage and habitat and treaty and non-treaty harvest.

The total estimated project implementation cost, including the items listed above, is $8.5 million, including a 30 percent contingency to account for project elements that are not understood or have not been well defined at this early stage in the planning process. Long-term costs for operations and life cycle replacement of project elements were also estimated. IPID has indicated that for the project to move forward, long-term operating and life-cycle replacement costs would need to be paid for through grant funding as part of the overall cost of the project because the only beneficiary is instream flows. The present value of the long-term operating and replacement costs were estimated at approximately $5.7 million to $8.8 million, depending on the duration of pumping (estimated from 15 days to 90 days). The resulting total project, including implementation cost and present value of long-term operating and replacement costs, would range from approximately $14.2 million to $17.3 million. O&M costs and the lack of a permanent funding are issues for this project. IPID is continuing to work with Chelan County to develop the pump exchange project concept and has secured funding for a preliminary design evaluation of a portion of the project that would initially target delivering flows to the Peshastin Irrigation District Canal through a pump station on the Wenatchee River near Dryden.

2.6.2 IPID Irrigation Efficiencies

The IPID irrigation efficiencies for this alternative are the same as is described in Section 2.5.2.

2.6.3 COIC Irrigation Efficiencies and Pump Exchange

The COIC irrigation efficiencies and pump exchange for this alternative are the same as is described in Section 2.5.3.

2.6.4 Domestic Conservation

The domestic conservation alternative is described in Section 2.5.4.

2.6.5 Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration is described in Section 2.5.5.

2.6.6 Tribal Fishery Preservation and Enhancement

The tribal fishery preservation and enhancement alternative is described in Section 2.5.6.

2.6.7 Habitat Protection and Enhancement

The habitat protection and enhancement alternative is described in Section 2.5.7.

2.6.8 Instream Flow Rule Amendment

The instream flow rule amendment alternative is described in Section 2.5.8.

2.6.9 Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The LNFH conservation and water quality improvements alternative is described in Section 2.5.9.

2.6.10 Fish Passage

The fish passage alternative is described in Section 2.5.10.

2.6.11 Fish Screen Compliance

The fish screen compliance alternative is described in Section 2.5.11.

2.6.12 Water Markets

The water market alternative is described in Section 2.5.12.

2.6.13 Costs and Benefits for Alternative 2

The costs and benefits for Alternative 2 are described in Table 2-10. However, this is not a cost-benefit analysis, but rather a summary of the predicted costs and benefits of Alternate 2. Cumulatively, these projects meet all of the Guiding Principles by improving streamflow, LNFH sustainability, protecting tribal and non-tribal fishers, improving domestic supply and agricultural reliability, and enhancing Icicle Creek habitat.

Alternative 2 has a total project benefit of 84 cfs and 27,978 acre-feet of total water (instream and out-of-stream water). The current cost estimate is approximately $88.8 million, including a 25 percent contingency. This amounts to $3,174 per acre-foot. As noted above, the average cost per acre-foot of water developed by the Office of Columbia River is approximately $500/acre-foot. Table 2-9 provides a breakdown of each project in Alternative 2 and the benefits and costs associated with each. These costs are subject to change as projects progress through feasibility and design, and a more complete picture of costs are developed.

Table 2-10
Summary of Alternative 2 Costs and Benefits

Project	Total Water Developed		Project Cost ($ M)	Cost/ (ac-ft)	Instream Flows (cfs)	LNFH	Fish Harvest	DM Supply	Ag Reliability	Habitat	Comply with Laws
	cfs	Ac-ft									
IPID Dryden Pump Station	25	1,484	8.50	5,728	25				x		x
IPID Irrigation Efficiencies	10	3,000	7.50	2,500	10				x		x
COIC Irrigation Efficiencies & Pump Exchange	12	3,640	2.80	769	12				x		x
Domestic Conservation	0.5	400	1.00	2,500	-			x			x
Eightmile Lake Storage Restoration	13	3,600	1.60	444	13			x	x		x
Tribal and Non-Tribal Fishery Preservation and Enhancement	-	-	0.50	-	-		x				x
Habitat Protection and Enhancement	-	-	2.50	-	-					x	x
Instream Flow Rule Amendment	0.4	400	0.05	125	-			x			x
LNFH Conservation and Water Quality Improvements	20	14,454	20.00	1,384	20	x					x
Fish Passage	-	-	6.00	-	-					x	x
Fish Screen Compliance	-	-	17.60	-	-					x	x
Water Markets	3	1,000	3.00	3,000	3				x		x
Totals	**84**	**27,978**	**71.1**	**1,982**	**83**	**x**	**x**	**x**	**x**	**x**	**x**
Contingency			**88.8**	**3,174**							

2.6.14 Timeline

The proposed timeline to implement the projects that compose Alternative 2 is below.

- Spring 2016 – Programmatic SEPA Scoping
- Summer 2016-Summer 2018 – Programmatic EIS Development
- Summer 2018 – Draft PEIS
- Fall 2018 – Final PEIS, Preferred Alternative Selection
- Fall 2018-Spring 2019 – Project Level Environmental Review Scoping and NEPA Integration (Depending on Alternative Selected), Applicable design or feasibility studies on projects
- Summer 2019-Summer 2020 – Project Level Environmental Review (if applicable)
- Spring 2019Fall 2028 – Project Construction/Implementation

There will be 60-day public comment periods following release of the draft and final PEIS. If it is determined that project-level SEPA scoping is necessary, there will also be opportunities for public comment during the scoping and following release of the draft and final project EIS.

2.7 Alternative 3

Alternative 3 focuses on areas outside of the Alpine Lakes Wilderness area. It includes most of the projects from the Base Package in Alternative 1, with the exception of the Alpine Lakes Optimization, Modernization, and Automation project and the Eightmile Lake Storage Restoration. It also calls for legislative action to allow an OCPI to address domestic use and instream flow impacts.

It should be noted that while Alternative 3 does not include projects within the Alpine Lakes Wilderness area, maintenance and construction activities needed for IPID's management of the lakes will continue but water would not be released to meet the Guiding Principles (mainly instream flow).

The projects in Alternative 3 are described below.

2.7.1 IPID Dryden Pump Exchange

The Peshastin Irrigation District pump exchange alternative is described in Section 2.6.1.

2.7.2 IPID Irrigation Efficiencies

The IPID irrigation efficiencies for this alternative are the same as is described in Section 2.5.2.

2.7.3 COIC Irrigation Efficiencies and Pump Exchange

The COIC irrigation efficiencies and pump exchange for this alternative are the same as is described in Section 2.5.3.

2.7.4 Domestic Conservation

The domestic conservation alternative is described in Section 2.5.4.

2.7.5 Tribal Fishery Preservation and Enhancement

The tribal fishery preservation and enhancement alternative is described in Section 2.5.6.

2.7.6 Habitat Protection and Enhancement

The habitat protection and enhancement alternative is described in Section 2.5.7.

2.7.7 Instream Flow Rule Amendment

The instream flow rule amendment alternative is described in Section 2.5.8.

2.7.8 Leavenworth national Fish Hatchery Conservation and Water Quality Improvements

The LNFH conservation and water quality improvements alternative is described in Section 2.5.9.

2.7.9 Fish Passage

The fish passage alternative is described in Section 2.5.10.

2.7.10 Fish Screen Compliance

The fish-screen compliance alternative is described in Section 2.5.11.

2.7.11 Water Markets

The water market alternative is described in Section 2.5.12.

2.7.12 Legislative Change to OCPI

In order to meet the domestic supply Guiding Principle under Alternative 3, there would need to be a legislative change to waive impacts to instream flows when conservation and pump-exchange-based supplies cannot perfectly meet demand required to provide domestic reliability. For example, conservation supplies are available in April to October in this Alternative, but the Guiding Principle for domestic reliability requires year-round supplies. Because instream flows are at times not met from November to March, this would impair instream flows if legislative approval was not provided. Ecology no longer has the authority to waive these kinds of impacts through an OCPI determination under RCW 90.54.020 given clarity from the Supreme Court in cases like *Swinomish* and *Foster/Yelm*.

A legislative change would include having a bill introduced and passed by the state legislature that would allow for impacts to the instream flow rule when domestic demand and flow improvement projects cannot be timed perfectly.

This would provide enough water for Icicle Creek Subbasin and City of Leavenworth population growth through 2050. The project costs would be approximately $25,000. Additional water for the City of Leavenworth would be pursued on the Wenatchee River to reduce impacts to Icicle Creek.

2.7.13 Costs and Benefits for Alternative 3

The purpose of this section is to describe the costs and benefits of this alternative. However, this is not a cost-benefit analysis, but rather a summary of the predicted costs and benefits of Alternate 3. Cumulatively, these projects meet all of the Guiding Principles by improving streamflow, LNFH sustainability, protecting tribal and non-tribal fishers, improving domestic supply and agricultural reliability, and enhancing Icicle Creek habitat.

Alternative 2 has a total project benefit of 71 cfs and 24,378 acre-feet of total water (instream and out-of-stream water). Currently, costs are estimated at approximately $86.9 million, including a 25 percent contingency. This amounts to $3,563 per acre-foot. As noted above, the average cost per acre-foot of water developed by the Office of Columbia River is approximately $500/acre-foot. Table 2-11 provides a breakdown of each project by describing the benefits and costs associated with each. These costs are subject to change as projects progress through feasibility and design, and a more complete picture of costs are developed.

Table 2-11
Summary of Alternative 3 Costs and Benefits

Project	Total Water Developed		Project Cost ($ M)	Cost/ (ac-ft)	Instream Flows (cfs)	LNFH	Fish Harvest	DM Supply	Ag Reliability	Habitat	Comply with Laws
	cfs	ac-ft									
IPID Pump Exchange	25	1,484	8.50	5,728	25				x		x
IPID Irrigation Efficiencies	10	3,000	7.50	2,500	10				x		x
COIC Irrigation Efficiencies	12	3,640	2.80	769	12				x		x
Domestic Conservation Efficiencies	0.5	400	1.00	2,500	-			x			x
Tribal Fishery Protection	-	-	0.50	-	-		x				x
Habitat Protection and Enhancement	-	-	2.50	-	-					x	x
Instream Flow Rule Amendment	0.4	400	0.05	125	-			x			x
LNFH Conservation and Water Quality Improvements	20	14,454	20.00	1,384	20	x					x
Fish Passage	-	-	6.00	-	-					x	x
Fish Screening	-	-	17.60	-	-					x	x
Water Markets	3	3,000	3.00	3,000	3				x		x
Legislative Change to OCPI	-	-	0.03	-	-			x			x
Totals	**71**	**24,378**	**69.5**	**2,850**	**70**	**x**	**x**	**x**	**x**	**x**	**x**
Contingency			**86.9**	**3,563**							

2.7.14 Timeline

The proposed timeline to implement the projects that compose Alternative 3 is below.

- Spring 2016 – Programmatic SEPA Scoping
- Summer 2016-Summer 2018 – Programmatic EIS Development
- Summer 2018 – Draft PEIS
- Fall 2018 – Final PEIS, Preferred Alternative Selection
- Fall 2018-Spring 2019 – Project Level Environmental Review Scoping and NEPA Integration (Depending on Alternative Selected), Applicable design or feasibility studies on projects

- Summer 2019-Summer 2020 – Project Level Environmental Review (if applicable)
- Spring 2019-Fall 2028 – Project Construction/Implementation

There will be 60-day public comment periods following release of the draft and final PEIS. If it is determined that project-level SEPA scoping is necessary, there will also be opportunities for public comment during the scoping and following release of the draft and final project EIS.

2.8 Alternative 4

Alternative 4 was developed in response to SEPA scoping comments expressing a desire for increased storage in the Icicle Creek Subbasin to improve reliability of water supply and resiliency against climate change. This alternative includes many of the same projects included in the Base Package in Alternative 1. It also includes rebuilding control facilities at Eightmile Lake Reservoir to increase storage beyond its historical capacity, enhancing storage and releases from Upper Klonaqua, and rebuilding control facilities at Upper and Lower Snow Lakes to increase storage available from those lakes. The projects included in Alternative 4 are described below.

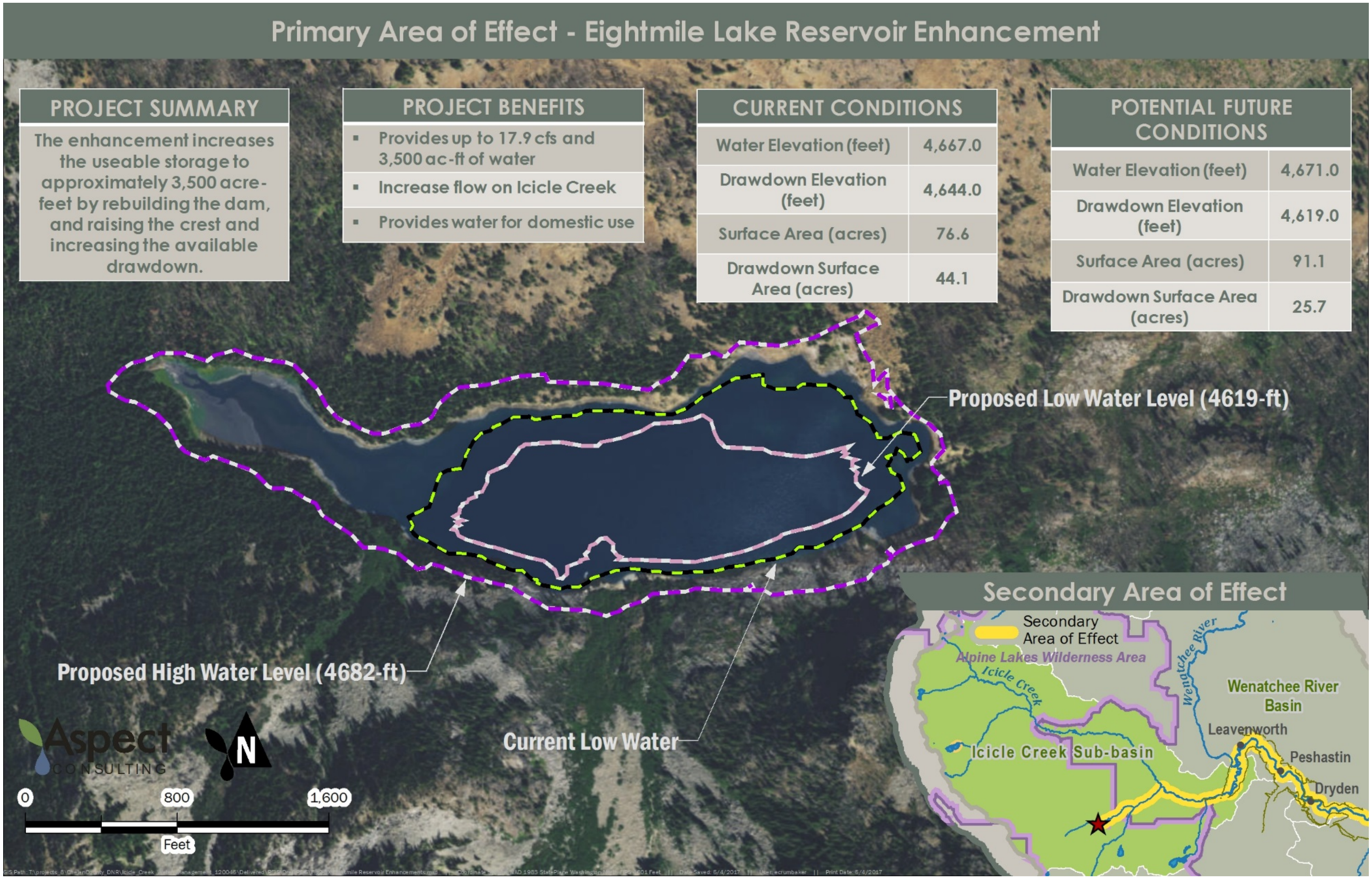
2.8.1 Alpine Lakes Optimization, Modernization and Automation

The Alpine Lakes optimization, modernization and automation alternative is the same as is described in Section 2.5.1.

2.8.2 Eightmile Lake Storage Enhancement

Eightmile Lake Storage Enhancement project proposes to replace the existing dam, low-level outlet pipeline, and controls at Eightmile Lake with facilities that would increase the useable storage capacity to 3,500 acre-feet, which represents a 1,000-acre-foot increase over the volume that can currently be captured and released under IPID's water right. The project would increase the useable storage by increasing the dam height and draw down level. This project would provide up to 17.9 cfs and 1,900 acre-feet of water for instream flow and domestic use. IPID would continuing using up to 1,600 acre-feet of water from Eightmile Lake. See Figure 2-46 for additional information on the Eightmile Lake storage enhancement.

Figure 2-46. Eightmile Reservoir Enhancements



The IWG evaluated four storage scenarios at Eightmile Lake as part of the *Appraisal Study, Eightmile Lake Storage Restoration*. These scenarios included installing a siphon to increase draw down, rebuilding the dam to restore the maximum water surface elevation to its historical level, and rebuilding the dam to increase storage. These project alternatives would provide 2,000 acre-feet, 2,500 acre-feet, and 3,500 acre-feet, respectively, of usable storage. The IWG proposed restoration to 2,500 acre-feet as part of its Base Package of projects, which would include restoration of the dam to allow water to be stored at the historical spillway/high water surface elevation, and extension of the low-level outlet pipe into the lake to facilitate draw down to an elevation of 4,621 feet. This Eightmile Lake Storage Restoration project is included in the Base Package in Alternative 1 and in Alternative 2; it is described in Section 2.5.5.

The Eightmile Lake Enhancement project included in Alternative 4 would increase usable storage to 3,500 acre-feet, and would include the following improvements:

- Rebuild the dam at Eightmile Lake with a spillway/high water surface elevation of 4,682.0 feet, or 11 feet higher than the historical spillway/high water surface elevation (4,671.0 feet).
- Extend the new low-level outlet pipeline into the lake to facilitate operational draw down of the water surface elevation to minimum elevation of 4,619.0 feet.

These improvements would increase the volume available for release and allow for an additional release of 17.9 cfs over a 60-day period.

The maximum inundation area, approximately 91.1 acres, would be larger than the historical maximum inundation area. Most of the newly inundated area would be along the existing, relatively steep shoreline. The water surface area at the new maximum draw down elevation would be approximately 25.7 acres, which is approximately 18.4 acres less than the water surface area at the current minimum water surface elevation.

The Eightmile Lake Enhancement project meets many of the Guiding Principles adopted by the IWG. Instream and out-of-stream flow improvements would benefit ecosystem health and habitat. It also has the potential to benefit operations at the LNFH if the lake was managed to allow for winter low-flow period releases. The enhancements and improvements create over 1,900 acre-feet of new supply for instream flow and municipal use, and automates and optimizes releases to improve reliability for agricultural use and stream flows. Compliance with state and federal laws, including Wilderness Act of 1964 and the Alpine Lakes Area Management Act of 1976, would be required for project permitting and construction.

The cost to implement the Eightmile Lake Enhancement is $3.9 million (Anchor QEA, 2015), as updated using the RS Mean Historical Cost Index. This cost equates to $2,053 per acre-foot of additional storage created. The long-term costs to operate and maintain the new facilities, including regular maintenance, repairs, servicing and inspections, and on-site start-up and shut-down each season, is approximately $18,500 per year.

2.8.3 Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Storage Enhancement project proposes to draw down Upper Klonaqua Lake and would provide up to 20 cfs and 2,448 acre-feet[33] of water for instream flow and domestic benefit.

Upper Klonaqua Lake is located just west of Lower Klonaqua Lake in the Icicle Creek Subbasin of WRIA 45 (Wenatchee Basin) and is used, along with several other area lakes, to augment water supply for the IPID. Both the Upper and Lower Klonaqua Lakes are managed by the IPID, and flows released from both lakes allow the IPID to maintain irrigation diversions and meet instream flow obligations. Access to waters stored in Upper Klonaqua Lake may help to provide more reliable instream flows during critical times of year such as late summer/fall.

Bathymetry and topographic surveys were completed at Upper Klonaqua Lake in September and October 2014 by Gravity Consulting to better understand the volume of water stored in Upper Klonaqua Lake. The survey measured the water surface elevation difference between Upper and Lower Klonaqua Lakes at approximately 115.8 feet. The survey estimated the difference in high water surface elevations between the two lakes at approximately 97 feet.

Releases from Lower Klonaqua Lake are controlled by a gate through a low-level outlet pipeline, which is operated by an actuator at the crest of the existing embankment dam. During the years when Klonaqua Lakes are actively managed, IPID personnel hike more than 10 miles (one way) to the Lower Klonaqua Lake to open the gate in July. IPID personnel return to close the gate in late September or October when the lake is drawn down and the irrigation season is over.

Three conceptual options are under consideration by IPID for allowing access to water stored in Upper Klonaqua Lake that is conveyed to Lower Klonaqua Lake and from there through the existing system to Icicle Creek and IPID uses:

> **Tunneling.** A tunnel option would involve drilling and blasting through the bedrock outcrop between the upper and lower lakes. The tunnel could then be equipped with an automated gate valve to control releases to the lower lake. Based on the bathymetry survey, the preferred location for tunneling would be along the southern portion of the bedrock ridge, where the slope of the lakebed is steep and is not affected by the high bedrock that is apparent in the northeast portion of the lake.
>
> **Siphoning**. Siphoning would involve the use of a pipe for hydraulic conveyance over an intermediate high point by gravity using differential pressure between a

[33] Five release volumes were calculated in the *Bathymetry and Topographic Survey of upper Klonaqua Lake and Conceptual Release Options memorandum* (Aspect, 2014). 2,448 acre-feet represents water possibly made available under the largest draw down scenario of 50 feet.

reservoir surface and an outlet. While it may be possible to implement a siphon to achieve some additional draw down potential, the maximum siphon lift at the high lake elevations would be limited and is likely on the order of 10 to 15 feet. Siphoning would also have inherent operational and maintenance issues associated with initiating and maintaining a siphon. Appropriate infrastructure, including a priming or vacuum pump and generator, would be some of the considerations for a detailed feasibility study and design of a siphoning option.

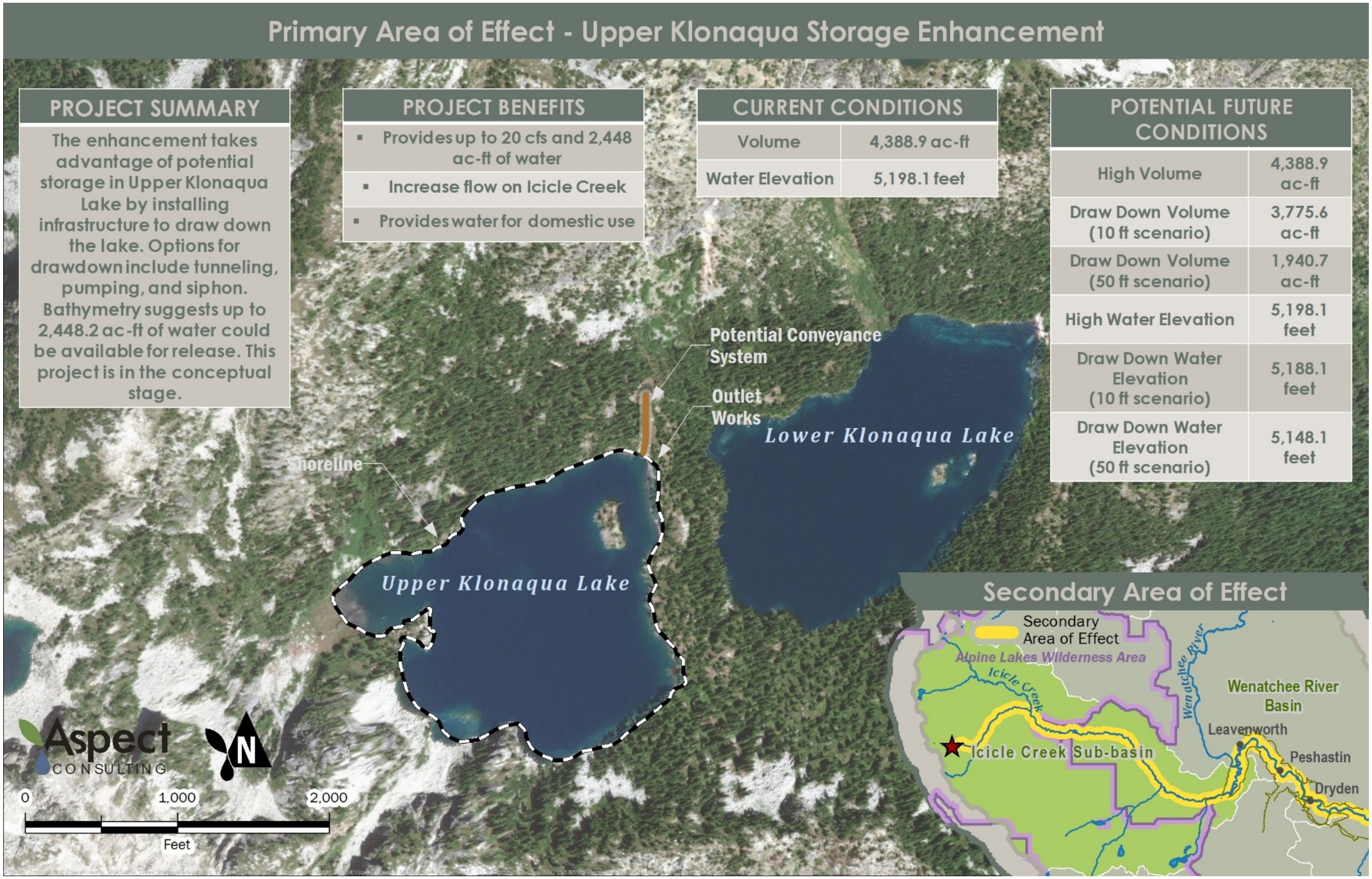
Pumping. Pumping would involve the installation of either a permanent or semi-permanent facility at the lake to lift the water over the land between the two lakes. Submersible pumps or vertical turbine pumps could provide the greatest potential draw down but would require on-site power generation (likely a diesel generator). End-suction, engine driven pumps could also be utilized, but would allow for lesser draw down (similar to siphon limitations) and would provide limited benefit beyond submersible pump or siphoning options. Fuel consumption with a pumping option would be a significant consideration. For example, a 10 cfs pumping system with 50-foot lift capacity may require a 60-kW diesel generator. A generator this size would have a fuel consumption of over 100 gallons of diesel per day. Other fairly significant potential environmental impacts would need to be considered and evaluated with this option, including noise, emissions, spill/leak potential, etc. Physical operation of the pump, including labor, would also need to be considered.

Any of the above options would require detailed feasibility studies, and design and permitting analyses. See Figure 2-47 for additional information on Upper Klonaqua Lake storage enhancement. Release of additional storage from Upper Klonaqua Lake could help meet the Guiding Principles adopted by the IWG, such as additional instream flow augmentation and additional domestic/municipal supply. This project has the potential to increase storage to 2,448 acre-feet, and provide between 5 and 20 cfs of flow benefit. This project is at the conceptual stages and no cost estimates have been developed.

2.8.4 Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement project would increase available storage in the Snow Lakes System, providing up to 18 cfs and 1,079 acre-feet for instream flow and domestic benefit.

Figure 2-47. Upper Klonaqua Storage Enhancement



Upper and Lower Snow Lakes are situated within the Alpine Lakes Wilderness area of the Icicle Creek Subbasin with a combined surface area of approximately 189.3 acres, maximum water surface elevations of 5,420 feet (Upper Snow Lake) and 5,415 feet (Lower Snow Lake), and a tributary basin area of 3,060 acres. The USFWS manages both lakes, and flows released from them supply water to the LNFH (operated by USFWS) and meet instream flow obligations. The combined existing active, useable storage capacity in these lakes is estimated at 12,900 acre-feet, 750 acre-feet of which is released for IPID. Water released from Upper Snow Lake is conveyed through a tunnel to Nada Lake.

The lakes are operated jointly to increase late summer flows in Snow Creek, which is a tributary to Icicle Creek. The increased flows to Icicle Creek help supply the LNFH's operational requirements (approximately 40 cfs between June and October) and supplement flow in Icicle Creek.

The *Water Storage Report, Wenatchee River Basin* (Anchor QEA, Feb. 2011) provided results of a preliminary feasibility analysis of the potential for increasing water storage in the Snow Lakes. Increasing the storage capacity would allow for additional releases during the late summer or during dry years to improve flows in Icicle Creek and the lower Wenatchee River. The additional storage would also improve operations of fish rearing facilities at the LNFH.

The Upper and Lower Snow Lakes Storage Enhancement project would combine some of the recommendations made as part of the feasibility analysis to increase storage available for release from these lakes. The project would also automate releases from the Snow Lakes by making use of additional water storage capacity (within the existing water rights) by improving infrastructure to allow for more water to be captured and released. This would be achieved by implementing additional improvements identified in the *Water Storage Report, Wenatchee River Basin* (Anchor QEA, 2011) to increase storage and automate releases from the Snow Lakes, including:

- **Replace Upper and Lower Snow Lake dams and increase the dam crest elevation by 5 feet at both locations.** The dam structures at Upper and Lower Snow Lakes would be replaced as described in the *Water Storage Report, Wenatchee River Basin* (Anchor QEA, 2011). The new dams would have a crest elevation 5 feet higher than the existing structures.
- **Install a new low-level outlet at Lower Snow Lake that would allow for 3 additional feet of draw down.** The low-level outlet pipe at Lower Snow Lake would be installed 3 feet lower than the existing low-level outlet to increase storage.
- **Replace the low-level outlet pipes and gates at both lakes.** The low-level outlet pipe at both Upper and Lower Snow Lakes would be replaced. A new flap gate would be installed at the inlet to the low-level outlet at Upper Snow Lake to allow water to flow only from Lower Snow Lake to Upper Snow Lake when Upper Snow Lake has been drawn down and is lower than Lower Snow Lake. A new slide gate would be installed on the inlet to the low-level outlet pipe at Lower Snow Lake and

the gate would be automated and connected to telemetry to allow for remote control and optimization of releases.

- Automate the low-level outlet gate at Lower Snow Lake and the existing valve on the penstock that discharges water from Upper Snow Lake to Nada Lake. This includes installation of motorized actuators on release gates and valves, installation of solar panels and battery packs as power supply for motorized actuators, installation of controls and communications equipment at each actuator, and weatherproof enclosures.
- **Install telemetry to allow for remote operation of the automated gate and valve.** This includes using radio telemetry and repeater stations to remotely control water releases.

The preliminary evaluation determined that raising the existing dams or constructing new dams to raise the water levels in Upper and Lower Snow Lakes by 5 feet and drawing down Lower Snow Lake by 3 feet would increase the total storage capacity of the two lakes by approximately 1,079 acre-feet. The additional storage, combined with improvements designed to provide remote control of the outlet valve, would allow for the release of an additional 18 cfs for 30 days or 9 cfs for 60 days to Icicle Creek via Snow Creek to support LNFH operations and increase instream flows in Icicle Creek and the Lower Wenatchee River. See Figure 2-48 for additional information on the Upper Snow Lake storage enhancement.

The overall cost of the project was estimated to be $1.4 million (Anchor QEA, 2011) as update with the RS Means Historical Cost Index, approximately $1,297 per acre-foot of additional storage.

2.8.5 IPID Irrigation Efficiencies

The IPID irrigation efficiencies for this alternative are the same as is described in Section 2.5.2.

2.8.6 COIC Irrigation Efficiencies and Pump Exchange

The COIC irrigation efficiencies and pump exchange for this alternative are the same as is described in Section 2.5.3.

2.8.7 Domestic Conservation

The domestic conservation alternative is described in Section 2.5.4.

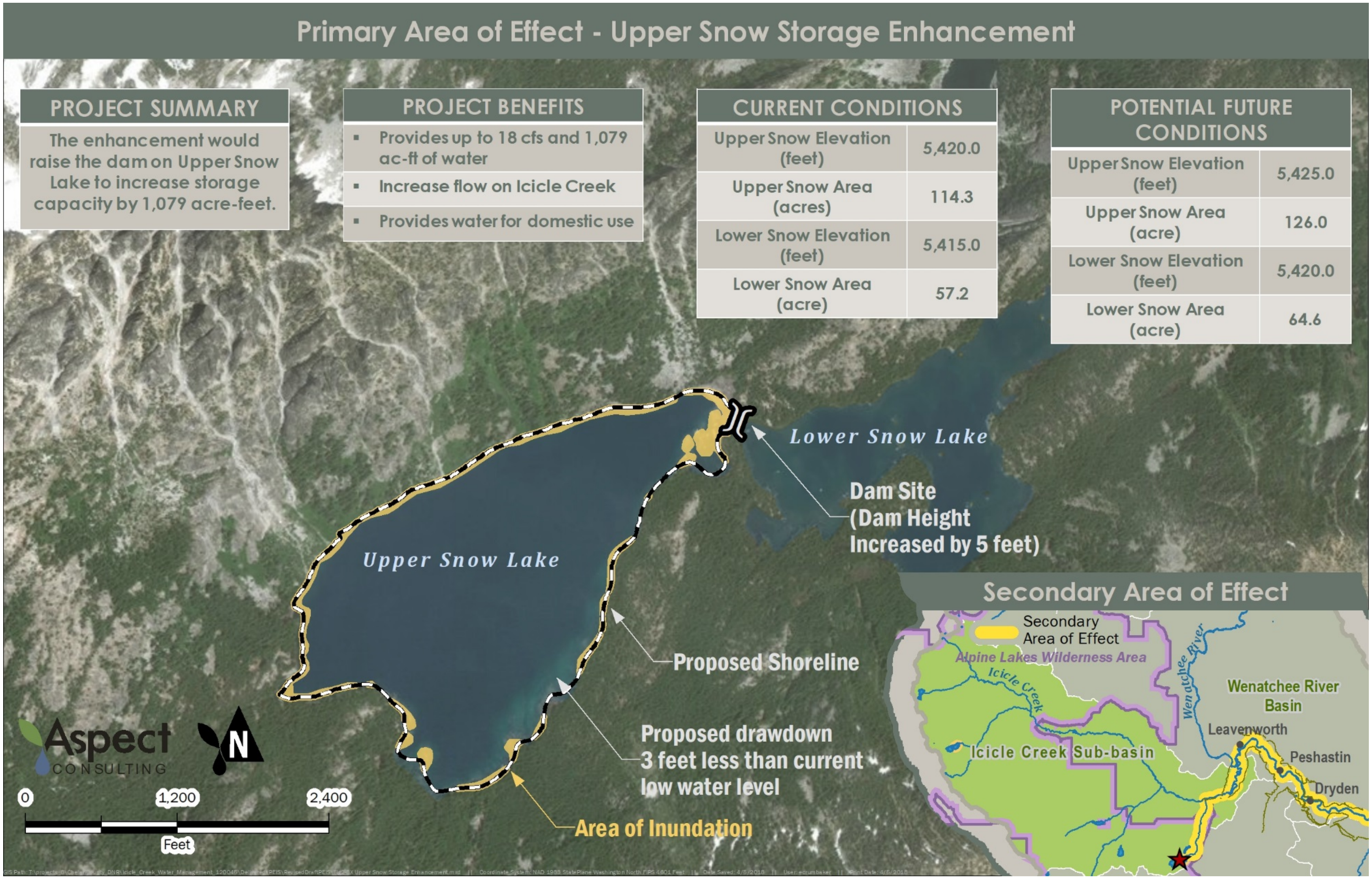
2.8.8 Tribal Fishery Preservation and Enhancement

The tribal fishery preservation and enhancement alternative is described in Section 2.5.6.

2.8.9 Habitat Protection and Enhancement

The habitat protection and enhancement alternative is described in Section 2.5.7.

Figure 2-48. Upper Snow Storage Enhancement



2.8.10 Instream Flow Rule Amendment

The instream flow rule amendment alternative is described in Section 2.5.8.

2.8.11 Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The LNFH conservation and water quality improvements alternative is described in Section 2.5.9.

2.8.12 Fish Passage

The fish passage alternative is described in Section 2.5.10.

2.8.13 Fish Screen Compliance

The fish screen compliance alternative is described in Section 2.5.11.

2.8.14 Water Markets

The water market alternative is described in Section 2.5.12.

2.8.15 Costs and Benefits for Alternative 4

The costs and benefits for Alternative 4 are described in Table 2-12. However, this is not a cost-benefit analysis, but rather a summary of the predicted costs and benefits of Alternate 4. Cumulatively, these projects meet all of the Guiding Principles by improving streamflow, LNFH sustainability, protecting tribal and non-tribal fishers, improving domestic supply and agricultural reliability, and enhancing Icicle Creek habitat.

This alternative would provide an estimated by 132 cfs and 35,385 acre-feet of total water (instream and out-of-stream) and cost approximately $83.8 million (including a 25 percent contingency). The estimated cost per ac-ft is $2,368. However, this cost estimate does not include the potential costs of the Upper Klonaqua Storage Enhancement project because cost estimates have not been produced for this project. The average cost per acre-foot of water developed by the Office of Columbia River is approximately $500/acre-foot. Table 2-12 provides a breakdown of each project in Alternative 4 and the benefits and costs associated with each. These costs are subject to change as projects progress through feasibility and design, and a more complete picture of costs are developed.

Table 2-12
Summary of Alternative 4 Costs and Benefits

Project	Total Water Development		Project Cost ($M)	Cost/ (ac-ft)	Instream Flows (cfs)	LNFH	Fish Harvest	DM Supply	Ag Reliability	Habitat	Comply with Laws
	cfs	ac-ft									
Alpine Lakes Automation	30	5,464	0.78	144	30				x		x
IPID Irrigation Efficiencies	10	3,000	7.50	2,500	10				x		x
COIC Irrigation Efficiencies	12	3,640	2.80	769	12				x		x
Domestic Conservation Efficiencies	0.5	400	1.00	2,500	0			x			x
Eightmile Lake Storage Enhancement	18	3,500	3.90	1,114	18			x	x		x
Snow lake Storage Enhancement	18	1,079	1.40	1,297	18			x	x		x
Upper Klonaqua Lake Storage Enhancement	20	2,448	unknown	-	20			x	x		x
Tribal Fishery Protection	-	-	0.50	-	0		x				x
Habitat Protection and Enhancement	-	-	2.50	-	0					x	x
Instream Flow Rule Amendment	0.4	400	0.05	125	0			x			x
LNFH Conservation and Water Quality Improvements	20	14,454	20.00	1,384	20	x					x
Fish Passage	-		6.00	-	0					x	x
Fish Screening	-		17.60	-	0					x	x
Water Markets	-	1,000	3.00	3,000	3				x		x
Totals	132	35,385	**67.0**	**1,894**	**131**	**x**	**x**	**x**	**x**	**x**	**x**
Contingency			**83.8**	**2,368**							

2.8.16 Timeline

The proposed timeline to implement the projects that compose Alternative 4 is below.

- Spring 2016 – Programmatic SEPA Scoping
- Summer 2016-Summer 2018 – Programmatic EIS Development
- Summer 2018 – Draft PEIS
- Fall 2018 – Final PEIS, Preferred Alternative Selection
- Fall 2018-Spring 2019 – Project Level Environmental Review Scoping and NEPA Integration (Depending on Alternative Selected), Applicable design or feasibility studies on projects
- Summer 2019-Summer 2020 – Project Level Environmental Review (if applicable)
- Spring 2019-Fall 2028 – Project Construction/Implementation

There will be 60-day public comment periods following release of the draft and final PEIS. If it is determined that project-level SEPA scoping is necessary, there will also be opportunities for public comment during the scoping and following release of the draft and final project EIS.

2.9 Alternative 5

Alternative 5 was developed following further study on piping and conservation options for IPID and based on ongoing discussions with stakeholders about the potential for reducing diversions from Icicle Creek. This alternative includes all projects proposed under Alternative 1, except the IPID Dryden Irrigation Efficiencies project would be replaced by the IPID Full Piping and Pump Exchange project. The IPID Full Piping and Pump Exchange project would replace the IPID canal systems with a pressurized pipe delivery system. Three intake and pump station facilities would be constructed on the Wenatchee River to supply the new system. The existing surface water diversion facilities on Icicle Creek and Peshastin Creek would be removed. Even though the diversion would be completely removed from Icicle Creek, IPID would still need to store and release water from their lakes within the Alpine Lakes Wilderness to ensure that water was available in the Wenatchee River for its use. Without releases from the lakes, water supply shortages to IPID would exist in both average and drought years, and these shortages would increase with climate change. The projects included in Alternative 5 are described below.

2.9.1 IPID Full Piping and Pump Exchange Project

The IPID Full Piping and Pump Exchange would eliminate the surface water diversions on Icicle Creek and Peshastin Creek by constructing of three surface water intake and pumping facilities on the Wenatchee River and fully piping and pressurizing the IPID delivery system. System updates proposed for this project are summarized in Table 2-13. The conceptual configuration would place the new piping infrastructure in the existing canal easements, mostly within existing canal alignments. However, other configurations would need to be evaluated to optimize the efficiency and cost of the system. The conceptual configuration described in Table 2-13 is illustrated in Figure 2-49.

Table 2-13
Summary of Improvement Concept Evaluated for IPID Full Piping and Pump Exchange

Characteristic	Pump Station A	Pump Station B	Pump Station C
Existing Infrastructure Replaced	IID Diversion 1, 2, 4, and 5 Canals, Gibbs Ditch	IID Diversion 3A Canal and PID Canal	IID Diversion 3B Canal
Pump Station Location	Wenatchee River, Near Leavenworth Siphon	Wenatchee River, Upstream of Dryden Dam	Wenatchee River, Near Cashmere WWTP
Capacity[1]	52 cfs	57 cfs	24 cfs
Pumping Head	372 feet	257 feet	574 feet
Booster Station	No	Yes	No
Re-regulating Pond Location	No	In bend in PID Main Canal, near Dryden	No
Re-regulating Pond Size	N/A	15.5 acre-feet	N/A
Pipe Sizing	12-inch to 36-inch	8-inch to 48-inch	20-inch to 30-inch

Notes:

1. The capacity was determined by estimating the number of shares served by each system and multiplying by 6.75 gpm per share, which is the maximum amount of IPID delivers to its customers at each customer turnout. A 5-percent allowance was added on to the calculated flow rate to allow for leakage and loss in the distribution system.

BPS: Booster Pump Station
Cfs: Cubic Feet per second
IID: Icicle Irrigation District
PID: Peshastin irrigation District
PS: Pump Station
WSEL: Water Surface Elevation
WWTP: Wastewater Treatment Plant.

Each system shown in Figure 2-49 would consist of a surface water intake and pump station that would deliver water through a network of pressurized delivery pipelines to water users. System B would pump water into a re-regulation pond at the elevation of the existing PID Canal and two booster pump stations would be constructed to lift the water to the elevation of the IID Canal. The current IPID points of diversion on Icicle Creek and Peshastin Creek would be removed.

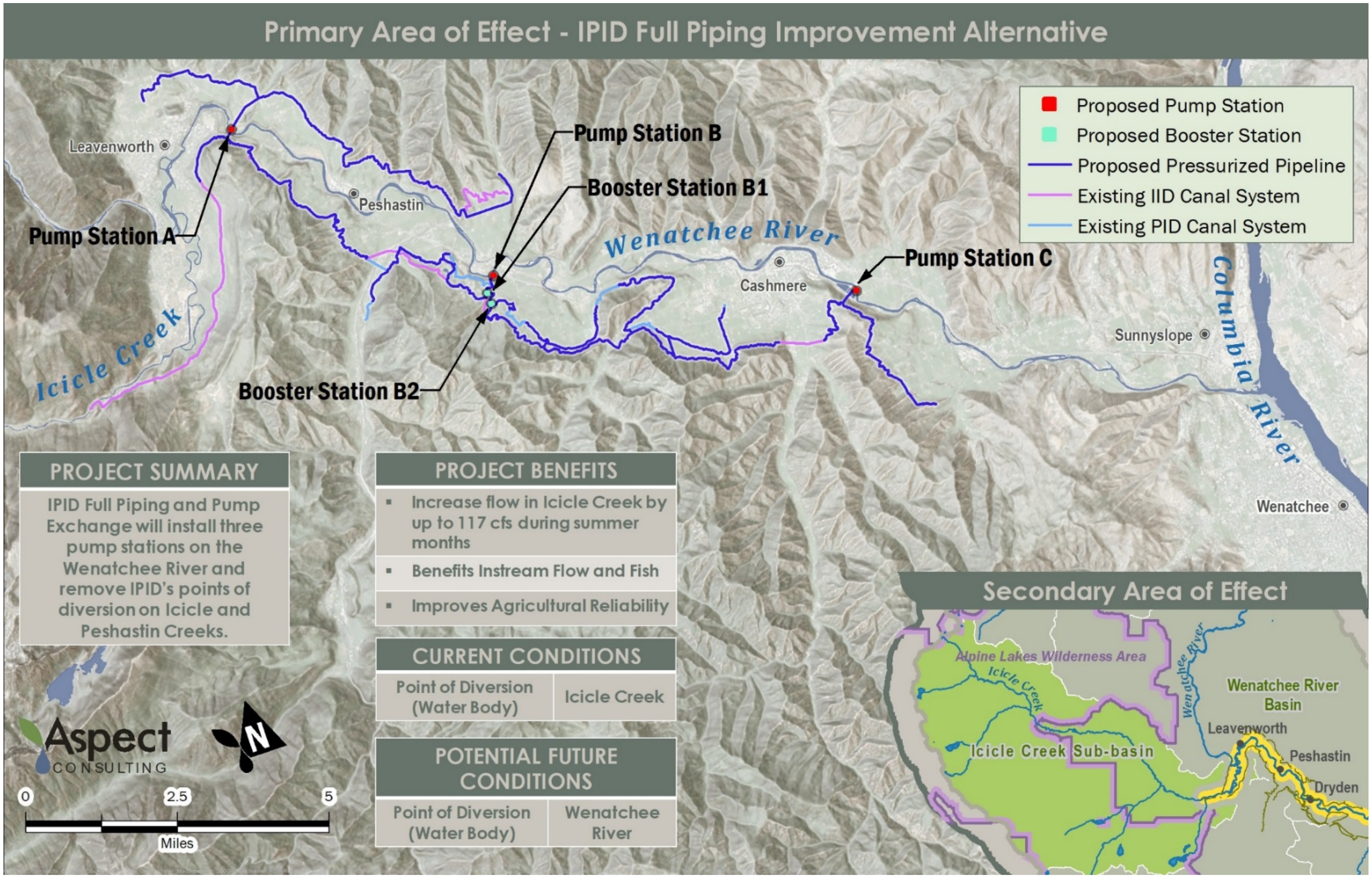
A total of more than 39 miles of pressurized pipeline would be installed to replace the open ditches that IPID currently operates. This would result in a more efficient system, with reduced evaporative loss, seepage, and operational spills.

The project would result in one customer on the IID Diversion 1 Canal to be converted to an individual well system because it would take a long length of dead-end pipe to reach that customer.

A concept-level opinion of probable costs was developed in the *IPID Conservation Plan -Full Piping Improvement Option Memorandum* (Anchor, 2018). This included construction costs and long-term O&M costs. The estimated construction cost, including contingency costs to account for project elements that are not understood or have not been defined at this stage, is between $72.5 million and $83.7 million. Annual O&M, is estimated at between $775,000 and $821,000.

The IPID Full Piping and Pump Exchange estimated water savings is 117 cfs and 30,000 acre-feet.

Figure 2-49. IPID Full Piping and Pump Exchange



2.9.2 Alpine Lakes Optimization, Modernization and Automation

The Alpine Lakes Optimization, Modernization and Automation project is the same as is described in Section 2.5.1.

2.9.3 COIC Irrigation Efficiencies and Pump Exchange

The COIC Irrigation Efficiencies and Pump Exchange for this alternative are the same as is described in Section 2.5.3.

2.9.4 Domestic Conservation

The Domestic Conservation project is described in Section 2.5.4.

2.9.5 Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration project is described in Section 2.5.5.

2.9.6 Tribal Fishery Preservation and Enhancement

The Tribal Fishery Preservation and Enhancement project is described in Section 2.5.6.

2.9.7 Habitat Protection and Enhancement

The Habitat Protection and Enhancement project is described in Section 2.5.7.

2.9.8 Instream Flow Rule Amendment

The Instream Flow Rule Amendment project is described in Section 2.5.8.

2.9.9 Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The LNFH Conservation and Water Quality Improvements project is described in Section 2.5.9.

2.9.10 Fish Passage

The Fish Passage project is described in Section 2.5.10.

2.9.11 Fish Screen Compliance

The Fish Screen Compliance project is described in Section 2.5.11.

2.9.12 Water Markets

The Water Market project is described in Section 2.5.12.

2.9.13 Costs and Benefits for Alternative 5

The costs and benefits for Alternative 5 are described in Table 2-14. However, this is not a cost-benefit analysis, but rather a summary of the predicted costs and benefits of Alternate 5. Cumulatively, these projects meet all of the Guiding Principles by improving streamflow, LNFH sustainability, protecting tribal and non-tribal fishers, improving domestic supply and agricultural reliability, and enhancing Icicle Creek habitat.

Alternative 5 is expected to result in a total of 196 cfs and 55,458 acre-feet of instream and out-of-stream water. The current cost estimate is approximately $174.4 million, including a 25 percent contingency. This amounts to $2,958 per acre-foot. As noted above, the average cost per acre-foot of water developed by the Office of Columbia River is approximately $500/acre-foot. Table 2-14 provides a breakdown of each project in Alternative 5 and the benefits and costs associated with each. These costs are subject to change as projects progress through feasibility and design, and a more complete picture of costs are developed.

2.9.14 Timeline

The proposed timeline to implement the projects that compose Alternative 5 is below.

- Spring 2016 – Programmatic SEPA Scoping
- Summer 2016-Summer 2018 – Programmatic EIS Development
- Summer 2018 – Draft PEIS
- Fall 2018 – Final PEIS, Preferred Alternative Selection
- Fall 2018-Spring 2019 – Project Level Environmental Review Scoping and NEPA Integration (Depending on Alternative Selected), Applicable design or feasibility studies on projects
- Summer 2019-Summer 2020 – Project Level Environmental Review (if applicable)
- Spring 2019-Fall 2028 – Project Construction/Implementation

There will be 60-day public comment periods following release of the draft and final PEIS. If it is determined that project-level SEPA scoping is necessary, there will also be opportunities for public comment during the scoping and following release of the draft and final project EIS.

Table 2-14
Summary of Alternative 5 Costs and Benefits

Project	Total Water Developed		Project Cost ($ M)	Cost/ (ac-ft)	Instream Flows (cfs)	LNFH	Fish Harvest	DM Supply	Ag Reliability	Habitat	Comply with Laws
	cfs	ac-ft									
IPID Full Piping & Pump Exchange	**117**	**30,000**	**83.7**	**2,790**	**117**				x		x
Alpine Lakes Optimization and Automation	30	5,464	0.78	144	30				x		x
COIC Irrigation Efficiencies & Pump Exchange	12	3,640	2.80	769	12				x		x
Domestic Conservation	0.5	400	1.00	2,500	-			x			x
Eightmile Lake Storage Restoration	13	3,600	1.60	444	13			x	x		x
Tribal and Non-Tribal Fishery Preservation and Enhancement	-	-	0.50	-	-		x				x
Habitat Protection and Enhancement	-	-	2.50	-	-					x	x
Instream Flow Rule Amendment	0.4	400	0.05	125	-			x			x
LNFH Conservation and Water Quality Improvements	20	14,454	20.00	1,384	20	x					x
Fish Passage	-	-	6.00	-	-					x	x
Fish Screen Compliance	-	-	17.60	-	-					x	x
Water Markets	3	1,000	3.00	3,000	3				x		x
Totals	196	58,958	139.53	2,367	195	x	x	x	x	x	x
Contingency			174.41	2,958.25							

2.10 Pairing and Phasing

Some projects evaluated in this PEIS have received considerable evaluation to date, while others are at the conceptual or preliminary stages. In some cases, project proponents had already been working on projects that were then integrated into an alternative considered in the PEIS (e.g., pump exchanges, Alpine Lake automation, boulder field passage). In other instances, investments parallel to the PEIS process seemed appropriate because the projects had broad consensus and support (e.g., COIC Irrigation Efficiency and Pump Exchange) and were included in all the alternatives. As the PEIS process concludes, the co-leads and the IWG will meet to determine how best to phase and pair projects to meet Guiding Principles. Several factors likely to play into such decisions include:

- Whether the PEIS is sufficient for environmental review for a project or whether supplemental environmental review is appropriate.
- Whether there is a federal nexus for the project that necessitates NEPA compliance.
- Whether funding is available for the project.
- Whether permits have been applied for.
- Whether there is balance in the projects being moved forward so all Guiding Principles show progress.

2.11 Alternatives Eliminated from Further Study

During development of the Icicle Strategy, the IWG considered numerous options to address water resources management in the Icicle Creek Subbasin. As their work progressed, it became apparent some of the projects under evaluation did not adequately meet or were in direct conflict with the Guiding Principles. There were also options that did not receive consensus-based support from the IWG members, and per the group's Operating Procedures, were not pursued further.

Initially the IPID Full Piping and Pump Exchange was not considered in any of the alternatives in this PEIS because it did not receive consensus-based support based on O&M cost estimates. However, based on stakeholder input and further study, an alternate configuration was developed. This, along with hopes to find funding support of O&M costs, moved the IPID Full Piping and Pump Exchange into further consideration, resulting in the development of Alternative 5.

The following sections describe the projects that have been eliminated from consideration.

2.11.1 Reservoir Removal

During the SEPA scoping, some commenters recommended removing all of the reservoirs within the Icicle Creek Subbasin to restore the area to a more natural state. The IWG did not further consider this proposal in the PEIS for several reasons.

The reservoirs in the Alpine Lake Wilderness Area support LNFH and IPID operations. IPID serves approximately 85 percent of the irrigated land in the Wenatchee Valley from

Cashmere up to the Cascade Range (USFS, 1981). These lands are primarily in commercial orchard production and are the foundation of the local economy. Without the drought year supply provided by these reservoirs, orchard production would likely be significantly impacted. Additionally, this proposal does not align with the Guiding Principles. Removing the reservoirs from the Alpine Lakes Wilderness would reduce streamflow, decrease domestic and agricultural reliability, and would make meeting the Guiding Principles nearly impossible in the future as climate change predictions call for less snowfall and more rainfall in the Icicle Subbasin. Additionally, taking away private property rights would not align with the Guiding Principle that calls for complying with state and federal laws.

2.11.2 Removing Leavenworth National Fish Hatchery

Removing the LNFH was also suggested by commenters during the SEPA scoping period. This option was also not explored further by the IWG as it lacked broader support from area stakeholders and does not align with the Guiding Principles. LNFH was constructed in the 1940s to provide mitigation for the loss of natural fish production as a result of the construction and operation of Grand Coulee Dam. The USFWS and USBOR recently conducted an alternatives analysis to determine the best possible method for meeting fish production targets. This included analyzing whether to relocate or upgrade existing facilities. The analysis concluded that upgrading LNFH rather than removing it was the best alternative based on costs and production. Removing LNFH would not align with the Guiding Principles to protect tribal harvest and improve sustainability at LNFH.

CHAPTER 3.0 AFFECTED ENVIRONMENT

3.1 Introduction

This chapter describes environmental resources within the project area, as defined in Section 1.4.2 of this document. Descriptions of environmental resources are organized by sub-regions:

- The Alpine Lakes sub-region encompasses the mountainous region southwest of Leavenworth. The sub-region includes Square, Klonaqua, Eightmile, Colchuck, and Snow/Nada Lakes and the tributaries that connect these lakes with Icicle Creek;
- The Icicle Creek sub-region consists of the mainstem Icicle Creek floodplain and valley walls from the mouth of Leland Creek near the Icicle Creek headwaters at RM 26 to the confluence with the Wenatchee River; and
- The Wenatchee River Corridor sub-region lies within the Wenatchee River Valley and covers the Wenatchee River and adjacent areas from just upstream of the confluence of Icicle Creek to the confluence with the Columbia River.

Additionally, where applicable, an overview of resources for the entire area is provided in addition to the focused, sub-region descriptions.

3.2 Earth

This section describes Earth elements present in the project area, and conditions affecting proposed alternatives including topography, geology and soils, and geological hazards. Earth elements of the project area are first described in a regional context and followed by a detailed description by sub-region.

3.2.1 Regional Geology

The Icicle project area is located in the central and eastern portions of the Cascade Mountain Range. The Cascades were tectonically uplifted beginning in the late Eocene epoch (approximately 37 million years ago) as a result of the offshore collision of tectonic plates at the Cascadia subduction zone (CSZ). Coincident volcanism emplaced igneous rocks, including intrusives, lava flows, and ash, throughout the Cascades, which continues to modern times. Continued uplift of the region resulted in erosion and deposition of sedimentary rocks. More recent erosion from alpine glaciers and streams shaped the landscape to its current form while depositing unconsolidated sediments in low-lying areas. Figure 3-1 presents a geologic map of the Icicle project area based on mapping published online by Washington Department of Natural Resources (2017).

Figure 3-1. Surficial Geology

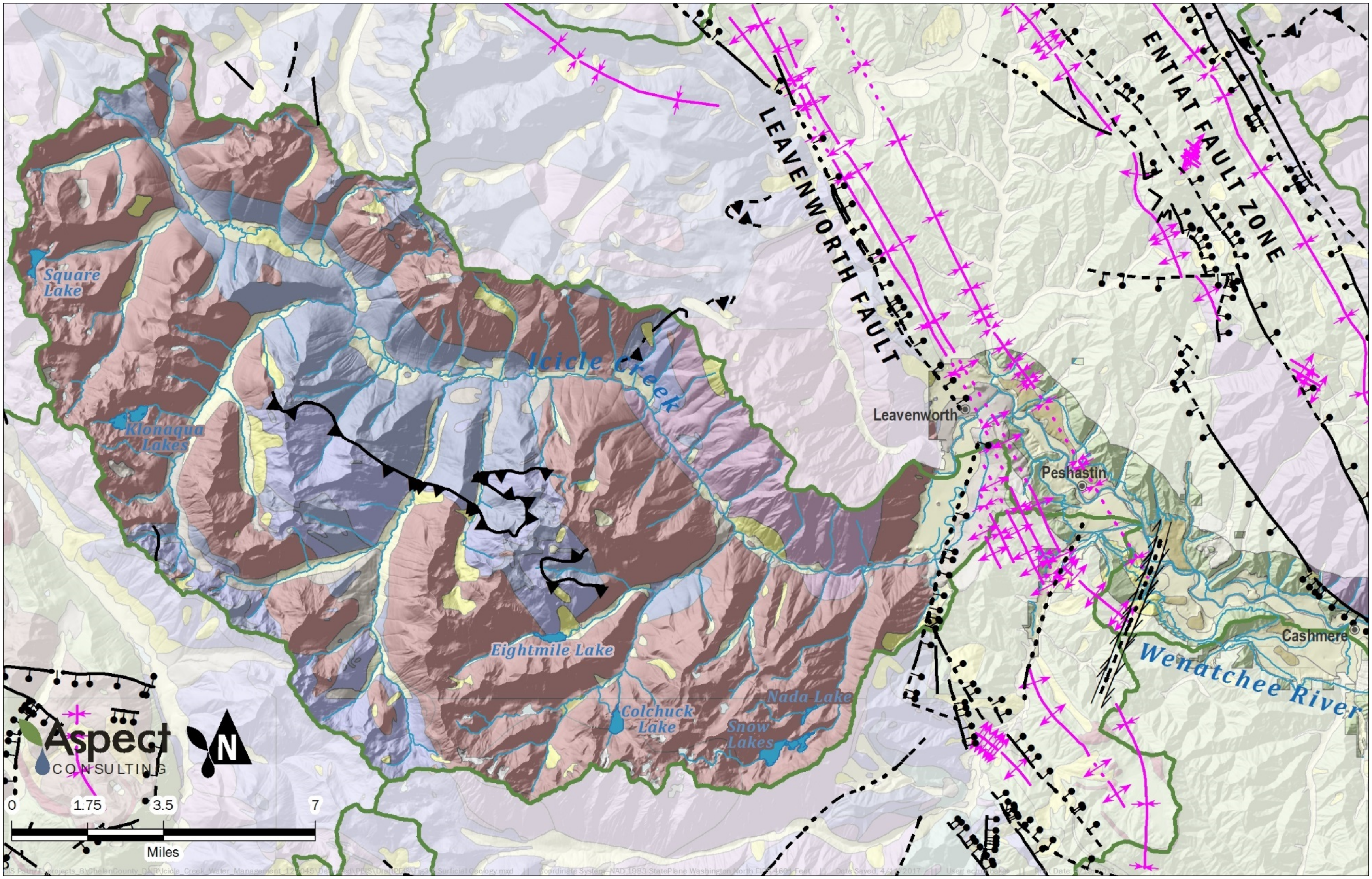


Figure 3-1. Surficial Geology (Legend)

Basin Boundary

Faults (WA DNR)

Dip-Slip Movement

Normal fault - Identity and existence certain, location accurate. Bar and ball on downthrown block

Normal fault - Identity or existence questionable, location approximate. Bar and ball on downthrown block

Normal fault - Identity and existence certain, location inferred. Bar and ball on downthrown block

Normal fault - Identity and existence certain, location concealed. Bar and ball on downthrown block

Thrust fault - Identity and existence certain, location accurate. Sawteeth on upper plate

Thrust fault - Identity and existence certain, location inferred. Sawteeth on upper plate

Thrust fault - Identity and existence certain, location concealed. Sawteeth on upper plate

Strike-Slip Movement

Right-lateral strike-slip fault - Identity and existence certain, location inferred. Arrows show relative motion

Right-lateral strike-slip fault - Identity and existence certain, location concealed. Arrows show relative motion

Movement Unknown

Fault, unknown offset - Identity and existence certain, location accurate

Fault, unknown offset - Identity and existence certain, location inferred

Fault, unknown offset - Identity and existence certain, location concealed

Surficial Geologic Units (WA DNR)

Quaternary Rocks and Deposits

Qp Quaternary bog, marsh, swamp, or lake deposits

Qgl Pleistocene bog, marsh, swamp, or lake deposits

Qa/Qt/Qaf Quaternary alluvium

Qls/Qta Quaternary mass-wasting deposits

Ql Quaternary eolian deposits, loess

Qad Pleistocene alpine glacial drift

Qfg/Qfs Pleistocene outburst flood deposits

Quaternary-Tertiary Rocks

QMs Quaternary-Tertiary sedimentary rocks and deposits

Tertiary Rocks

Ec/Ecg PLMa/Oc Tertiary sedimentary rocks and deposits

Eib/OEian Tertiary intrusive rocks

Mesozoic Rocks

Jhmc/JTRhm Mesozoic heterogeneous metamorphic rocks

Kigb/Kigd/Kiq/Kit Mesozoic intrusive rocks

JTRu/Ju Mesozoic ultramafic rocks

Kid Mesozoic volcanic rocks

Precambrian Rocks

pCgn Precambrian heterogeneous metamorphic rocks

Water

Water

Ice Ice

Folds (WA DNR)

Anticline - Identity and existence certain, location accurate

Anticline - Identity and existence certain, location concealed

Syncline - Identity and existence certain, location accurate

Syncline - Identity and existence certain, location concealed

3.2.1.1 Major Geologic Units

The oldest rocks in the Icicle project area are Mesozoic gneisses of the Mad River terrane that are confined to a small area in the southeast portion (map unit MZgn). The Mesozoic Ingalls Tectonic Complex occupies the southern and western portions of the project area. Geologic units associated with this ophiolite mélange are mapped locally as ultramafic serpentinite and peridotite (MZPZu) and metamorphosed rocks of the Chiwaukum Schist, including biotite schist and amphibolite (MZhm). These rocks were intruded by igneous rocks of the Mesozoic Mount Stuart batholith, which forms the Mount Stuart Range in the central and western portions of the project area. Geologic units associated with the Mount Stuart batholith are mapped as granodiorite, tonalite, and granite (MZi), and diorite (Kid). Subsequent regional uplift resulting in erosion of older rocks produced Tertiary continental sedimentary rocks in fault-bounded low-lying grabens. These rocks occupy the eastern portion of the project area. The predominant geologic unit associated with the Tertiary sedimentary rocks is mapped as sandstone, siltstone, and shale of the Chumstick Formation (Tc). Quaternary unconsolidated sediments mapped throughout the project area consist of alluvium (Qa); glacial drift and glacial deposits (Qad) from alpine glaciers consisting of till, gravelly outwash, lacustrine and bedded silts, and terrace gravels; and mass-wastage deposits (Qls).

3.2.2 Geologic Structures

Major geologic structures in the Icicle project area and vicinity include the north-south striking, strike-slip Evergreen fault (Dragovich et al., 2002) located 6 miles to the west, and the northwest-southeast-striking, high-angle Leavenworth fault zone (Tabor et al., 1982 and 1987) located in the western portion of the subbasin, and the Entiat fault (Tabor et al., 1987) located east of the project area about 3 miles east of Cashmere, Washington.

Internal thrust faults are present within the Ingalls Tectonic Complex, and several subsidiary faults and folds are present associated with the Leavenworth and Entiat fault zones.

The Leavenworth and Entiat faults bound the Wenatchee River Valley, a structural valley located at the western margin of the northwest-trending Chiwaukum structural low (Cheney, 2007), a fault-bounded tectonically subsided region (formerly known as the Chiwaukum graben [Gresens, 1983]).

3.2.3 Soils

Soils are formed slowly over time by the interaction between geology of the parent material, slope, climate, and natural vegetation of the area. Parent material consists of bedrock, alluvium, colluvium, loess, and volcanic ash, and soil is often a mixture of these. Soils in the project area are mapped and classified by the Natural Resources Conservation Service (NRCS) in its Soil Survey publications for mountainous regions, including Alpine Lakes and Icicle Creek sub-regions (NRCS, 2007) and the Wenatchee River Corridor sub-region (NRCS, 1975). Sub-region soil classifications are discussed below.

3.2.4 Regional Geological Hazards

Geological hazards, including seismic, mass wasting (landslides), and erosion, are present in the Icicle project area. The Chelan County Code, Chapter 11.86, Geologically Hazardous Overlay District (GHOD), uses published sources to identify areas having landslide and erosion hazards and also identifies hazards presented by snow avalanche. Where applicable, geological hazards present in the sub-regions are discussed in greater detail.

3.2.4.1 Seismic Hazards

The site is located within a region subject to earthquakes on shallow crustal faults and in the Cascadia subduction zone. Hazards associated with earthquakes include seismic shaking, surficial ground rupture, and liquefaction. Earthquakes can also trigger mass wasting events.

Large earthquakes in Washington and Oregon are associated with the CSZ, which lies approximately 150 miles to the west of the Icicle project area (Department of Natural Resources, 2008). Hazards associated with the CSZ include deep (Benioff zone) earthquakes and subduction zone earthquakes. Deep earthquakes generally originate during rupture of the sinking oceanic plate, have magnitude 7.5 or less, and occur approximately every 10 to 30 years. The subduction zone earthquakes occur because of rupture between the subducting oceanic plate and the overlying continental plate. These earthquakes have magnitude up to 9 and a recurrence interval on the order of 500 years.

A shallow earthquake within the Cascade Mountains occurred in 1872, east of the project area, near Entiat and had an estimated magnitude of 6.8 (Bakun, et al., 2002). Future earthquakes within the Cascades would likely be shallow and could exceed magnitude 7 (Noson and Qamar, 1988).

3.2.4.2 Mass Wasting

Mass wasting events include landslides, earthflows, mudflows, debris flows, slumps, creeps, and rock falls. Areas of existing or potential mass wasting are mapped in Chelan County's GHOD in all three sub-regions based on mapped slope failures and a combination of geologic, slope, and hydrologic conditions.

3.2.4.3 Erosion

Erosion hazards are identified in Chelan County's GHOD based on areas identified as "severe" erosion hazard according to the U.S. Department of Agriculture Soil Conservation Service Chelan County Soil Survey Manual (Natural Resources Conservation Service, 2017). The GHOD identifies the presence of erosion hazards in all three sub-regions of the project area. Erosion hazards increase in areas having steeper slopes.

3.2.5 Alpine Lakes

3.2.5.1 Geology and Physiography

The Alpine Lakes sub-region encompasses the mountainous region southwest of Leavenworth. The sub-region includes Square, Klonaqua, Eightmile, Colchuck, and Snow/Nada Lakes and the tributaries that connect these lakes with Icicle Creek.

Geology is characterized by steep bedrock mountains mapped as granites of the Mount Stuart batholith (MZi) and ultramafic/metamorphic of the Ingalls Tectonic Complex (MZPZu and MZhm). Alpine glaciation incised steep valleys, hanging valleys, and cirques that frequently encompass lake beds and stream channels. Several glaciers are still present. Glaciers and streams deposited thin layers of glacial drift and alluvium over bedrock in low-lying areas. Several large mass wastage deposits (Qls) are mapped.

The resistant granites of the intrusive Mt. Stuart batholith control topography. Elevations range from about 1,400 feet above sea level (asl) at the mouth of Snow Creek to 9,400 feet asl at Mount Stuart (WGS 84 datum). Slopes on glacially incised peaks and valley walls exceed 60 degrees, while the bottoms of valleys and cirques are generally less than 20 degrees.

3.2.5.2 Soils

Soils in the Alpine Lakes sub-region of the Icicle project area are broadly classified by NRCS as soils on mountains at middle elevations and soils in valleys and on mountains at high elevations.

On middle-elevation mountains up to about 3,600 feet asl, soils are shallow (up to 20 inches deep), well-drained, and formed from colluvium and residuum derived from metamorphic and igneous bedrock mixed with volcanic ash and loess. These are gravelly, stony, and boulder sandy loams occurring on slopes from about 5 to 45 degrees.

On mountains ranging from about 3,500 to 8,300 feet asl, soils are very deep (up to 60 inches), well-drained, and formed in volcanic ash and loess mixed with colluvium and residuum derived from metamorphic and igneous rock. On some mountainsides and in high elevation valley bottoms ranging from about 2,600 to 5,500 feet asl, soils are very deep, well-drained, and formed in volcanic ash and pumice over glacial till. High elevation soils are gravelly, stony, and boulder sandy loams occurring on slopes from about 5 to 45 degrees on mountainsides and 2 to 30 degrees in valley bottoms.

3.2.5.3 Geologic Hazards

Potential geological hazards consist of mass wastage including landslides and rock falls, debris flows, erodible soils on steep slopes, and seismic hazards associated with regional and local faults. A landslide is mapped at Eightmile Lake that formed the lake by blocking Eightmile Creek. Avalanches are common because of deep snow pack and steep slopes.

3.2.6 Icicle Creek Corridor

3.2.6.1 Geology and Physiography

The Icicle Creek sub-region consists of the mainstem Icicle Creek floodplain and valley walls from the mouth of Leland Creek near the Icicle Creek headwaters at RM 26 to the confluence with the Wenatchee River.

The geology of this sub-region is characterized by the same bedrock present in the Alpine Lakes sub-region. Alpine glaciation carved the existing Icicle Valley that extended from the headwaters of Icicle Creek to a terminal moraine in Leavenworth. Alluvium (Qa) is mapped in several places where the valley widens; the most significant alluvial deposits occur in the lower portion south of Leavenworth where the valley widens to over 1 mile. Glacial drift (Qad) is mapped on the east valley wall in the lower portion of the drainage. Mass wastage deposits (Qls) are mapped on the north valley wall near the mouth of Mountaineer Creek.

Topography is controlled by resistant bedrock that forms the walls of the Icicle Valley. Elevations range from 1,000 feet asl near the confluence of Icicle Creek with the Wenatchee River in Leavenworth to greater than 5,000 feet on the valley walls. Slopes on the valley wall exceed 60 degrees in places, and slopes on the valley floor are less than 20 degrees.

3.2.6.2 Soils

Soils in the Icicle Creek sub-region of the Icicle project area are the same as for the Alpine Lakes sub-region for the upper reaches of Icicle Creek (Subsection 3.2.5.2, Soils) and same as the Wenatchee River Corridor sub-region (Subsection 3.2.7.2, Soils) for the lower reach of Icicle Creek.

3.2.6.3 Geologic Hazards

Potential geological hazards consist of mass wastage including landslides and rock falls, debris flows at the mouths of tributaries and on steep slopes, flooding, erodible soils on steep slopes, and seismic hazards associated with regional fault zones and the Leavenworth and Entiat fault zones. Avalanches are common because of deep snow pack and steep slopes.

3.2.7 Wenatchee River Corridor

3.2.7.1 Geology and Physiography

The Wenatchee River Corridor sub-region lies within the Wenatchee River Valley between the cities of Leavenworth and Cashmere.

Geology is primarily characterized by bedrock uplands mapped as continental sedimentary rocks of the Chumstick Formation (Tc) that form the valley walls. Bedrock west of Leavenworth is associated with rocks of the Mount Stuart batholith. Bedrock is overlain by quaternary terrace and alluvial deposits in the Wenatchee River valley bottom that originated primarily from up-valley alpine glacial sources (Qad) but with some lacustrine deposits of glacial outburst flood origin (Qf). At Leavenworth, the terminus of alpine glaciation, Qad consists of lacustrine sediments overlain by alluvium and coarse moraine deposits. The mapped width of the quaternary deposits on the valley floor from Leavenworth to Cashmere is about 0.5 to 1 mile. Throughout most of the valley, Quaternary deposits form small ridges and terraces above the Wenatchee River where the river has incised the sediments. Alluvium (Qa) is present in the Wenatchee River floodplain and near the mouths of tributaries. Mass wastage deposits (Qls) are mapped on the west side of the valley, south of the junction of Highways 2 and 97.

The Wenatchee River Corridor lies within the Chiwaukum structural low and is bounded to the northeast by the Entiat fault and to the west by the Leavenworth fault. Elevations range from 750 feet asl at the Wenatchee River at Cashmere to over 3,000 feet asl in the mountains surrounding the valley. Topography on the valley margins is controlled by bedrock with slopes less than 30 degrees except areas where streams have incised and have slopes greater than 40 degrees. Terraces on the valley floor generally have slopes less than 20 degrees.

3.2.7.2 Soils

Soils in the Wenatchee River Corridor and lower Icicle Creek are broadly classified by NRCS in valley bottoms as very deep (up to 60 inches), well-drained, and formed in alluvium. These are sandy loams occurring on slopes from about 5 to 15 degrees. Soils on mountainsides are deep (up to 40 inches), well-drained, and formed in volcanic ash and residuum derived from sandstone and metamorphic bedrock. These are silty loams occurring on slopes from about 15 to 25 degrees.

3.2.7.3 Geologic Hazards

Potential geological hazards include landslides, debris flows from intermittent and perennial drainages that empty to the valley, erodible soils, and seismic hazards associated with regional faults and the Leavenworth and Entiat faults.

3.3 Surface Water Resources

This section summarizes the surface water quantity in the project area. It also discusses the overall water budget for the project area. This review does not represent an extent and validity review and is not intended to determine the validity of quantities of water available surface water rights. Surface water resources are addressed for the following sub-regions, including:

- The Alpine Lakes (Square, Klonaqua, Colchuck, Eightmile, Upper and Lower Snow, and Nada Lakes);
- The Icicle Creek drainage from the Alpine Lakes to the confluence with the Wenatchee River; and
- The Wenatchee River Corridor from just upstream of Icicle Creek to the confluence with the Columbia River.

Information about water rights and water resources infrastructure is provided in Section 3.6, Water Use. Information about surface water quality is presented in Section 3.5.2, Surface Water Quality.

3.3.1 Alpine Lakes

The Alpine Lakes sub-region is at the top of the Icicle Creek Subbasin, and includes Square, Upper and Lower Klonaqua, Eightmile, Colchuck, Upper and Lower Snow, and Nada Lakes. There are also numerous other lakes within this sub-region; however; they do not have dams, are not managed for water supply, and are not anticipated to be impacted by the Icicle Strategy.

Square, Upper and Lower Klonaqua, Eightmile, Colchuck, Upper and Lower Snow, and Nada Lakes drain small catchments high up in the watershed. Outflows from these lakes are managed by either IPID or the USFWS. Cumulatively, these catchments drain 10,596 acres and contribute an estimated minimum of 23,871 acre-feet of water to the Icicle Creek system. Table 3-1 provides a summary of the Annual Water Supply from these lakes.

Table 3-1
Alpine Lakes Annual Water Supply Statistics

Lake	Lake Water Surface Elev. (feet)	Drainage Area (acres)	10% Exceedance Annual Inflow (acre-feet)	50% Exceedance Annual Inflow (acre-feet)	90% Exceedance Annual Inflow (acre-feet)	Estimated Annual Inflow – Minimum (acre-feet)
Square	4,989	1,010	8,158	6,148	4,722	3,701
Lower Klonaqua	5,090	800	5,093	3,808	2,895	2,249
Eightmile	4,671	3,804	18,713	14,141	10,896	8,575
Colchuck	5,570	941	4,883	3,665	2,800	2,182
Upper and Lower Snow	5,420 & 5,415	3,060	12,610	9,478	7,254	5,663
Nada	4,989	981	3,310	2,497	1,920	1,507

Note: Elev. = elevation

Square, Upper and Lower Klonaqua, Eightmile, Colchuck, Upper and Lower Snow, and Nada Lakes all have man-made dams at their outlets and have been managed as reservoirs and used to augment the flow in Icicle Creek since the 1920s. The storage in these lakes is actively managed for irrigation and fish propagation use by IPID and USFWS under storage water rights, as described in Section 3.61.1, Alpine Lakes Storage Rights. Measurement of active storage volumes has been performed through collection of LiDAR and bathymetric survey data. Bathymetry was performed on both Eightmile Lake and Upper Klonaqua Lake (only). LiDAR was collected in October 2016, which included Square Lake, Lower Klonaqua Lake, Colchuck Lake, Eightmile Lake, and Upper and

Lower Snow Lakes. Estimated useable storage volumes associated with the Alpine Lakes is provided in Table 3-2 below.

Table 3-2
Alpine Lakes Storage Volume Estimates

Lake	Maximum Normal Stage (feet)	Minimum Normal Stage (feet)	Operational Range (feet)	Active Storage Volume (acre-feet)
Square	4,985	4,954	31	2,130
Lower Klonaqua	5,094	5,066	28	1,690
Eightmile	4,667	4,644	23	1,370
Colchuck	5,563	5,546	17	1,480
Upper Snow	5,433	5,273	160	12,590
Lower Snow	5,429	5,427	2	140

Source: *Appraisal Study, Alpine Lakes Optimization and Automation* (Aspect, 2014)

Each of these lakes has a small dam structure at the outlet that allows for capture and controlled release of water to increase water supply available for diversion from Icicle Creek by IPID or the USFWS. Generally, the lakes begin filling around the beginning of the water year (October) and fill through the late fall, early winter, and spring, even in dry years. Once each lake is full to the constructed spillway or overflow elevation on the dam at the lake outlet, water flows over the dam or constructed spillway to a natural stream channel or tributary to Icicle Creek. Controlled releases from the lakes commence typically in late 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, typically consisting of a gated or valved tunnel or pipeline that extends under or around the dam at the outlet. IPID or the USFWS opens a gate on the low-level outlet to release water and draw down the lake. The USFWS operates a valve each July or August at the outlet of a tunnel and pipeline to control releases from Upper and Lower Snow Lakes to Nada Lake. IPID typically opens gates at one or two of the lakes they operate (Square, Klonaqua, Eightmile, and Colchuck) in late July or early August. During dry years, they may open gates at all of the lakes.

3.3.2 Icicle Creek Corridor

3.3.2.1 Icicle Creek Tributaries

Major Icicle Creek tributaries downstream of the Alpine Lakes include Leland, French, Eightmile, and Snow Creeks.

Leland Creek conveys surface water runoff from the Square Lake drainage. Prospect Creek drains Square Lake and enters Leland Creek several miles downstream. There are several other tributaries to Leland Creek, which drains a tributary basin of approximately 15 square-miles and confluences with Icicle Creek at RM 28.0. Historical streamflows are not available for Leland Creek, but 2016 flow monitoring work found that Leland Creek had a discharge of approximately 19 cfs in late September. Table 3-3 provides all flow data obtained as part of the 2016 flow monitoring study conducted by WDFW for Leland Creek and its tributaries (Personal Communication with Robert Granger, WDFW, 2016).

Table 3-3
Leland Creek Drainage Flows

Date	Location	Discharge (cfs)	Water Temp (°C)
9/20/16	Leland Creek (upstream of confluence with Prospect Creek)	10.30	7.60
9/20/16	Prospect Creek (upstream of confluence with Leland Creek)	8.92	8.60
9/21/16	Leland Creek (upstream of confluence with Icicle Creek)	19.24	5.90

(Source: Personal Communication, Robert Granger, WDFW, 2016)

French Creek confluences with Icicle Creek approximately 6.0 miles downstream of Leland Creek at RM 22.0. Klonaqua Creek drains Klonaqua Lake and joins French Creek high in the system. French Creek drains a tributary basin area of approximately 25 square miles. Flows in French and Klonaqua Creeks are provided in Table 3-4.

Table 3-4
French Creek Drainage Flows

Date	Location	Discharge (cfs)	Water Temp (°C)
9/19/16	French Creek (upstream of Icicle Creek Trail Foot Bridge)	12.56	8.70
9/19/16	French Creek (midway between Icicle Creek and Klonaqua Creek)	13.53	8.50
9/19/16	French Creek (upstream of confluence with Klonaqua Creek)	6.50	8.10
9/19/16	Klonaqua Creek (upstream of confluence with French Creek)	2.98	8.60

(Source: Personal Communication, Robert Granger, WDFW, 2016)

Eightmile Creek drains a tributary area of 30 square miles and conveys surface water runoff from both Eightmile Lake and Colchuck Lake via Colchuck and Mountaineer Creek. Eightmile confluences with Icicle Creek at approximately RM 9.0. Flow data are not available for Eightmile Creek, but Eightmile Creek is believed to provide a significant discharge to the Icicle Creek system.

Snow Creek conveys surface water flow from Upper Snow, Lower Snow, and Nada Lakes to Icicle Creek. Snow Creek confluences with Icicle Creek at RM 5.2, draining a tributary basin of approximately 10 square miles. Flow data is not available for Snow Creek.

3.3.2.2 Icicle Creek Mainstem

The Icicle Creek Subbasin is the largest subbasin in the Wenatchee River Watershed. Mainstream Icicle Creek is approximately 32 miles long, beginning high in the Alpine Lakes Wilderness at Josephine Lake and discharging into the Wenatchee River at the City of Leavenworth near RM 25.6. Figure 1-1 provides an overview of Icicle Creek's location, gaging stations, and major diversions, which includes IPID's, City of Leavenworth's, and LNFH/COIC's point of diversion.

The shape of the Icicle Creek hydrograph is typical for the area. 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. Stream flow then begins to increase in response to autumn precipitation and remains steady through winter. When snow begins melting in spring, streamflow increases until its summer peak.

Figure 3-2 shows 10 percent, 50 percent, and 90 percent exceedance flows in Icicle Creek at RM 5.8, just upstream of major diversions. Percent exceedance is a way to describe the percentage of time for which an observed stream flow is greater than or equal to a defined stream flow. Low flows have a high exceedance percentage because higher flows are expected most of the time. Conversely, high flows tend to have a lower exceedance percentage. The peak 50 percent exceedance flow at RM 5.8, which represents the peak annual flow during an average year, is approximately 2,000 cfs. The peak flow typically occurs in June. The 50 percent exceedance low flow, which represent the low flow during an average year, occurs in late September and is approximately 120 cfs.

The Icicle Creek mainstem has been divided into five distinct reaches based on characteristics and major infrastructure. These reaches were introduced in Section 1.2.1.1, Adequate Streamflow, and shown on Figure 1-3. A brief description of each reach is provided below.

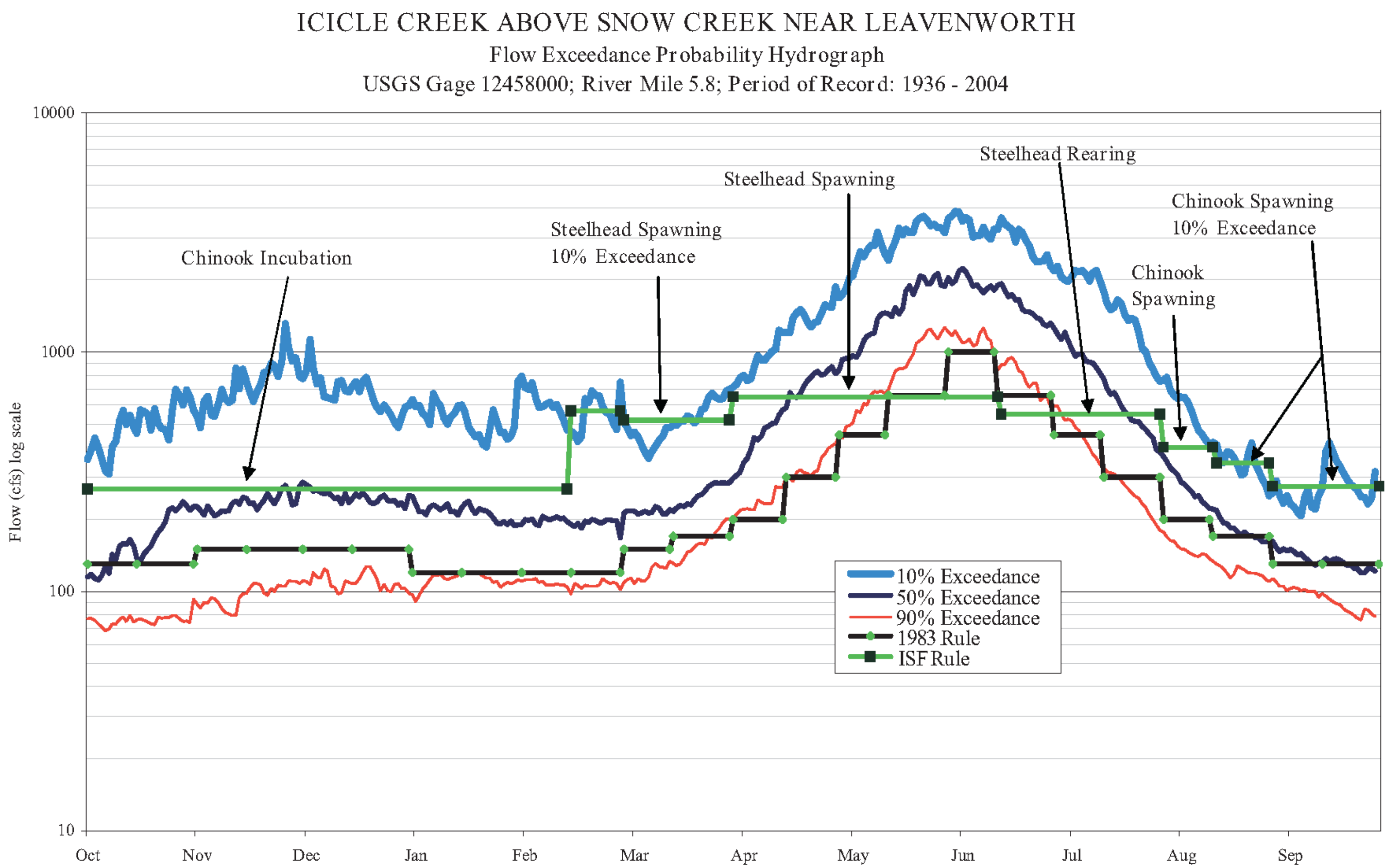
3.3.2.3 Reach 1

Reach 1 of Icicle Creek is located above RM 5.7 and includes Icicle Creek's headwaters. Figures 1-1 and 1-3 provides River Miles and reaches. Reach 1 intercepts major tributaries, including Eightmile Creek, French Creek, and Leland Creek. The Icicle Creek U.S. Geological Survey (USGS) gaging station is also located within this reach at RM 5.8, which is upstream of all the major diversions. Reach 1 ends at the IPID Diversion at RM 5.7. Because Reach 1 benefits from many inputs (tributaries), but few outputs (diversion), this reach tends to have higher flows than those farther downstream.

3.3.2.4 Reach 2

Reach 2 of Icicle Creek begins at RM 5.7 and ends at RM 4.5. Snow Creek flows into Icicle Creek at RM 5.2. Diversions within this reach include IPID's and City of Leavenworth's diversion at RM 5.7. Additionally, diversions occur at the bottom of this reach to LNFH and COIC, who share diversion infrastructure at RM 4.5. The boulder field, which is a major fish passage barrier is also within Reach 2. Flows in Reach 2 are diminished by the IPID diversion during the irrigation season (April through September) and the City of Leavenworth Diversion year-round. IPID has a peak diversion rate of 117 cfs, and City of Leavenworth has the right to divert up to 6.2 cfs. Both of these diversions export water out of the Icicle Creek Subbasin, although IPID has some operational spills in the Icicle Creek Subbasin which return a portion of the diverted water to the system. Table 3-5 provides an estimate of flow in Reach 2 at the boulder field. This is upstream of the City of Leavenworth Diversion.

Figure 3-2. Icicle Creek Stream Flows at RM 5.8



(Source: Wenatchee Watershed Plan, 2006)

Table 3-5
Estimated 2016 Flow at the Boulder Field

Month	Flow at USGS Gauge (cfs)	IPID Diversion (cfs)	Estimated Flow at Boulder Field (cfs)
August	203	100	92
September*	130	95	20
October (1 – 8)**	97	0	97

*IPID stopped diverting on September 30
**Heavy precipitation increased flows beginning October 8th

3.3.2.5 Reach 3

Reach 3 spans the stretch of Icicle Creek from RM 4.5 to 3.9. This reach begins at the LNFH/COIC point of diversion and ends at LNFH's Structure 2. In addition to the above described IPID and City of Leavenworth diversions, flow in Reach 3 is diminished by COIC and LNFH's diversion. LNFH diverts up to 42 cfs year-round, while COIC has the right to divert 11.9 cfs during the irrigation season (late April through September). There are no major tributaries that contribute flow to Icicle Creek in this Reach.

3.3.2.6 Reach 4

Reach 4 of Icicle Creek begins at RM 3.9 and ends at RM 2.7. This reach is defined as the area between LNFH's Structure 2 and the Hatchery Channel spillway. This area is also known as the historical channel and is the location of target flows under the Guiding Principles. Flows in this section of Icicle Creek are diminished by the diversions described for Reaches 1 through 3. Additionally, the operation of Structure 2 decreases flows in this reach. Structure 2 spans the Historical Channel near the entrance to the Hatchery Channel and includes two radial gates that can be lowered to limit flow to the Historical Channel and divert flow to the Hatchery Channel. Based on the size and configuration of the openings in Structure 2, if the gates are fully open, water will still begin to back up into the Hatchery Channel when the flow upstream of Structure 2 reaches approximately 300 cfs. If the gates at Structure 2 are lowered, water can be diverted to the Hatchery Channel at lower flow rates. The Hatchery Channel has an inverse grade, meaning that the invert of the channel slopes up to its Spillway. Water fills the Hatchery Channel until the water surface reaches the spillway crest at the end of the channel. If the gates at Structure 2 are fully open, the water surface in the Hatchery Channel will reach the spillway crest when the flow in Icicle Creek upstream of Structure 2 reaches approximately 990 cfs.

Historically, the gates at Structure 2 were lowered for longer periods to keep the Hatchery Channel hydrated to maintain shallow groundwater supply to the hatchery. Due to restrictions imposed by regulators in an effort to improve fish passage through the Historical Channel, the use of Structure 2 to hydrate the Hatchery Channel has decreased in recent years. However, Structure 2 is still used, when allowed, to fill the Hatchery Channel for shallow aquifer recharge and to maintain turbulent conditions at the plunge pool downstream of the spillway during tribal fishing to attract fish to the pool. In addition, Structure 2 limits the flow that can be passed on the Historical Channel to approximately 2,600 cfs. Flows in excess of 2,600 cfs could potentially damage habitat in the Historical Channel. There are no major inputs to the system in Reach 4.

3.3.2.7 Reach 5

Reach 5 of Icicle Creek is from RM 2.7 to RM 0.0, which spans from the Historical Channel spillway to its confluence with the Wenatchee River. Flows in Reach 5 are impacted by the diversions described for Reaches 1 through 4. Additionally, local private irrigators have individual surface water diversions along this reach; however, these diversions are orders of magnitude smaller than the diversions described in Reaches 1 through 4. There are no tributaries in this reach, but the LNFH outfall puts a significant amount of water, approximately the amount of water LNFH diverts, back into the system at the top of this reach.

3.3.3 Wenatchee River Corridor

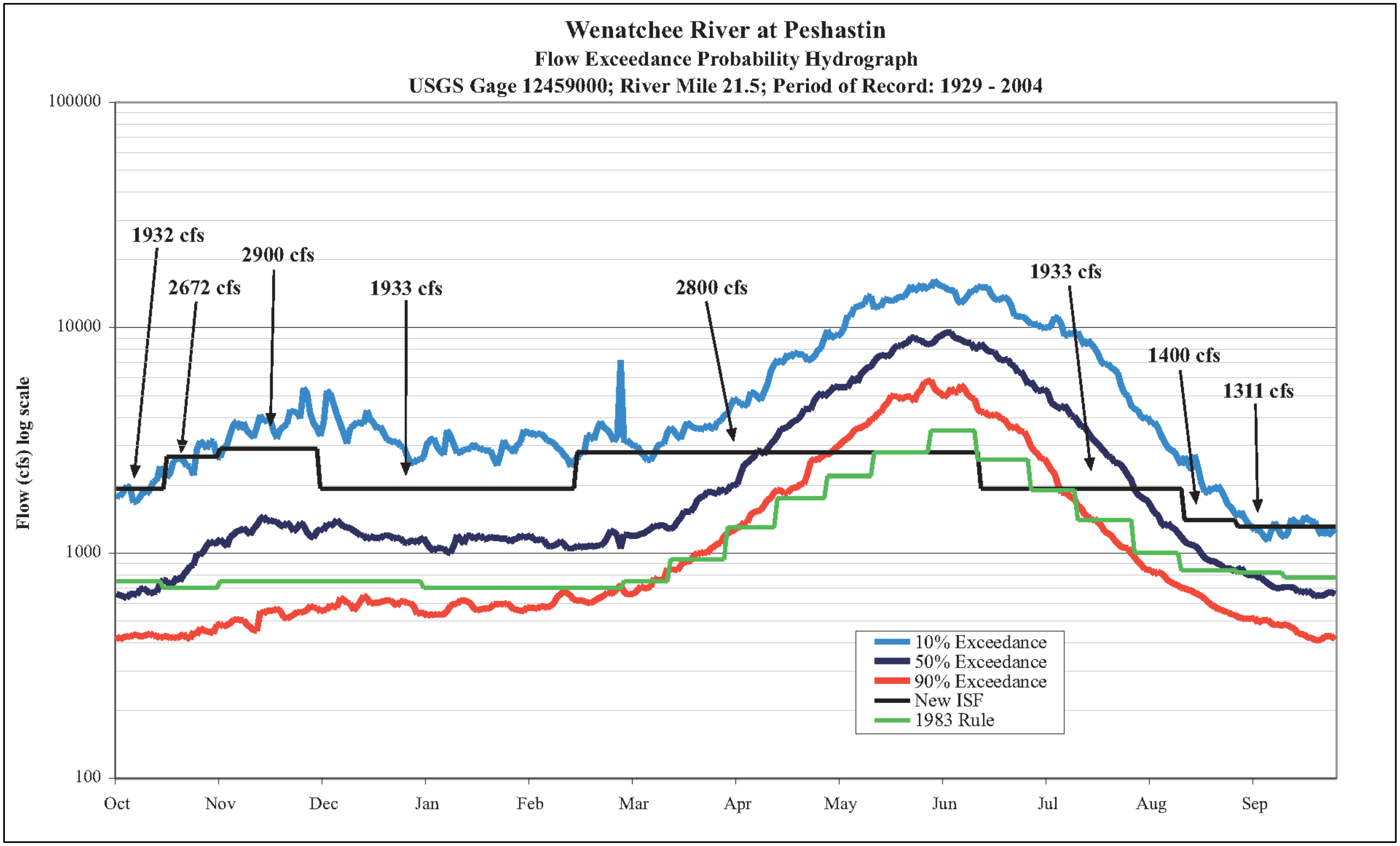
The Wenatchee River flows from the western edge of Chelan County, past Leavenworth, where it is joined by Icicle Creek, to its confluence with the Columbia River in Wenatchee. The Wenatchee River drains the 1,370-square-mile Wenatchee River Watershed, which contains 230 miles of major streams and rivers. Major tributaries to the Wenatchee River include Nason Creek, the Chiwawa River, Chiwaukum Creek, Icicle Creek, Chumstick Creek, Peshastin Creek, and Mission Creek. Icicle Creek contributes 20 percent to the Wenatchee River’s flow (Watershed Planning Unit, 2006).

Figure 3-3 provides flows on the Wenatchee River at USGS gaging station 12459000, located near Dryden, just downstream of the confluence with Peshastin Creek at RM 21.5. This point is downstream of where the Wenatchee River intercepts Icicle Creek. Figure 3-3 shows 10 percent, 50 percent, and 90 percent exceedance flows on the Wenatchee River. In the Wenatchee River, flows peak in June and decline throughout summer. The lowest flows occur in September and October, after which streamflow begins to rise in response to autumn precipitation. Streamflow remains stable through much of the winter, with a steady increase beginning in March and April in response to snowmelt, until stream flow peaks again in June. The 50 percent peak exceedance flow that occurs in June is nearly 10,000 cfs. The 50 percent low flow exceedance, which occurs at the end of September and beginning of October, is approximately 600 cfs.

3.3.3.1 Overall Water Budget

The overall water budget of Icicle Creek surface water resources involves various basin inputs and basin outputs. Basin inputs include direct precipitation that falls as either rain or snow, whereas outputs include surface water diversions (less return flow), surface and subsurface water outflow, evaporation, evapotranspiration, and groundwater recharge.

Figure 3-3. Wenatchee Stream Flow near Peshastin Creek



(Source: Wenatchee Watershed Plan, 2006)

Basin Input

Basin inputs primarily consist of precipitation (both as rain and snow). Typically, snow begins accumulating in the highest elevations of the basin in early fall (September/October) and continues through early spring (March/April). The other type of basin input typically considered in water balance calculations include inter-basin transfers of water (e.g., transfer of water in from an external basin); however, this condition does not exist in the Icicle Creek Subbasin.

The Icicle Creek hydrograph in Figure 3-2 shows the basin inputs as they directly relate to stream flow. The mean annual streamflow at the USGS gage at RM 5.8 is 669 cfs (Wenatchee Assessment, 2003). The mean annual volume is 483,484 acre-feet (Wenatchee Assessment, 2003).

The Wenatchee hydrograph in Figure 3-3 shows the basin inputs as they directly relate to stream flow. The mean annual stream flow at the Wenatchee River gage near Peshastin is 3,099 cfs (Wenatchee Assessment, 2003). The mean annual volume is 2,239,941 acre-feet (Wenatchee Assessment, 2003).

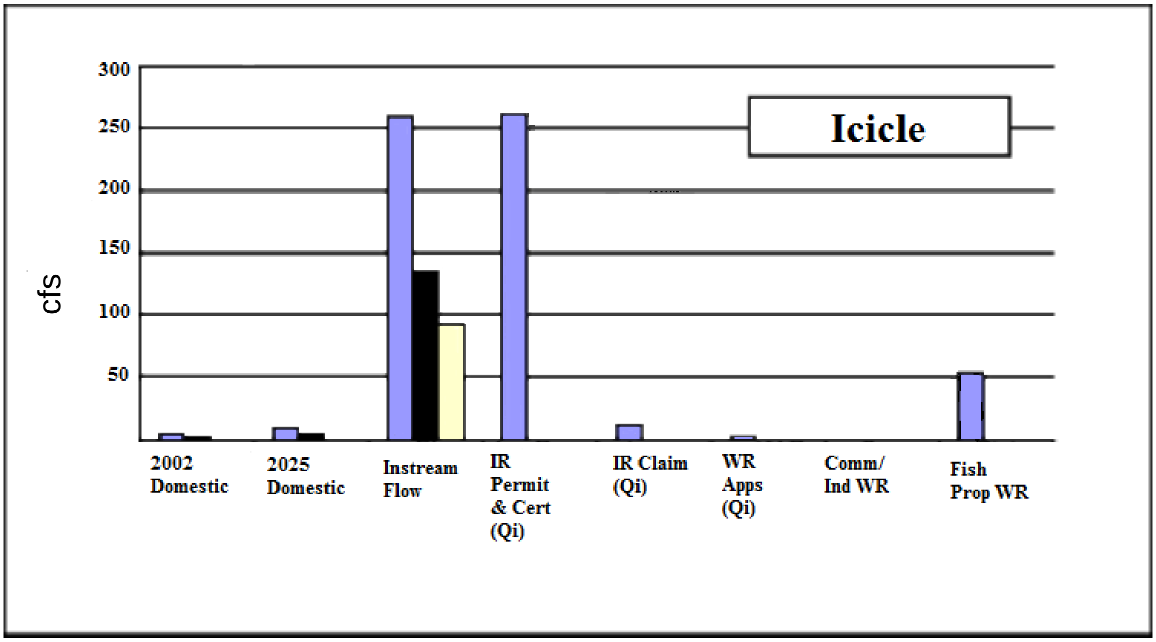
Basin Outputs

Basin outputs consist of evaporation (i.e., from surface water features such as lakes/reservoirs, rivers, and canals), evapotranspiration (e.g., vegetative cover whether naturally occurring or otherwise), surface and shallow subsurface outflow (e.g., Icicle Creek flow), deep recharge (aquifer recharge), out-of-basin transfers (e.g., IPID and COIC diversion), and other consumptive uses such as domestic and municipal supplies from groundwater in continuity with surface water. Basin outputs include:

- IPID Diversion (less return flow) – 117 cfs; 30,000 acre-feet
- COIC Diversion (less return flow) – up to 11.9 cfs; 3,500 acre-feet
- City of Leavenworth Diversion – 6.2 cfs; up to 4,480 acre-feet
- LNFH Diversion (less return flow) – 42 cfs; 30,353 acre-feet
- Evapotranspiration – Unknown
- Rural domestic wells – 1 cfs; 724 acre-feet (Aspect, 2013)
- Other permitted water uses – 9.35 cfs; 1,150 acre-feet

Figure 3-4 provides a summary of the Icicle Water Budget, as prepared by the Watershed Planning Unit in 2006. In Figure 3-4, for Municipal and Domestic demand, the purple bar represents municipal demand and the black bar represents non-municipal domestic demand. For stream flows, the purple bar represents high flows (10 percent exceedance), the black bar represents average flow (50 percent exceedance), and the yellow bar represents low flows (90 percent exceedance). Figure 3-4 indicates that the quantity of water allocated for Icicle Creek exceeds the total water available at 10 percent exceedance flow (high streamflow years). Most of this use is attributed to irrigation water rights. However, this analysis is of all water rights in Ecology's water rights database, which may include water rights that have not been beneficially used in the past and are

Figure 3-4. Icicle Water Budget

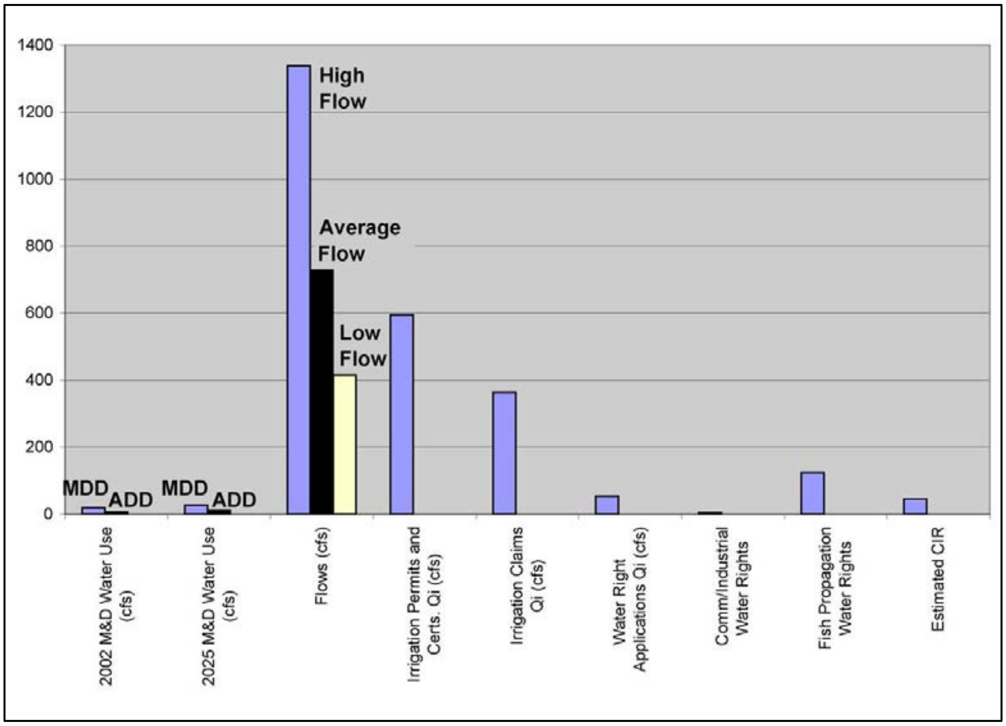


(Source: Wenatchee Watershed Plan, 2006)
Notes: Mun. = municipal; Dom. = domestic; IR. = irrigation; Certs = certificates; Qi = instantaneous quantity; Apps = applications; Comm/Ind = commercial and industrial; W.R. = water right; Prop = propagation

subject to relinquishment. Water rights in Washington State are based on beneficial use, and water rights that are not used are not considered valid and are known as “paper” water rights. Because this analysis did not examine the validity of water rights, actual use in the watershed may be lower.

Figure 3-5 provides a summary of the Wenatchee River Watershed Water Budget, as prepared by the Watershed Planning Unit in 2006. In Figure 3-5, for Municipal and Domestic demand, the purple bar represents municipal demand and the black bar represents non-municipal domestic demand. For Flows, the purple bar represents high flows (10 percent exceedance), the black bar represents average flow (50 percent exceedance), and the yellow bar represents low flows (90 percent exceedance). Figure 3-5 indicates that the quantity of water allocated for the Wenatchee River Watershed is within the high range of available flows but exceeds the 50 percent and 90 percent exceedance flows. As is the case in Icicle Creek, most of this use is attributed to irrigation water rights and claims. However, as discussed above, this analysis did on examine the validity of water rights, and actual use may be lower.

Figure 3-5. Wenatchee River Watershed Water Budget



(Source: Wenatchee Watershed Plan, 2006)

3.4 Groundwater Resources

This section describes the occurrence and movement of groundwater in the Icicle project area. Groundwater quality is discussed in Section 3.5.3, Groundwater Quality. Groundwater resources organized by sub-region:

- The Alpine Lakes (Square, Upper and Lower Klonaqua, Eightmile, Upper and Lower Snow, and Nada Lakes);
- The Icicle Creek drainage from the Alpine Lakes to the confluence with the Wenatchee River; and
- The Wenatchee River Corridor from just upstream of Icicle Creek to the confluence with the Columbia River.

These areas were defined based both on similarity of hydrogeologic conditions within each area, and on where the effect of specific actions (e.g., lake storage restoration, improved irrigation efficiencies, etc.) would be expected to occur. Information and previous studies used to develop this section include:

- Advance Project Plan, Well Rehabilitation, Leavenworth National Fish Hatchery (Robinson & Noble, 1989)

- Initial Watershed Assessment Water Resources Inventory Area (WRIA) 45 Wenatchee River Watershed (Ecology, 1995)
- WRIA 45 Summary of Groundwater/Surface Water Interaction and Groundwater Resource References (Golder, 2005)
- Groundwater Data Summary for the Wenatchee River Watershed Total Maximum Daily Load Study (Ecology, 2007)
- Groundwater Conditions at the Leavenworth National Fish Hatchery, Leavenworth, Washington (USBR, 2010)
- Leavenworth National Fish Hatchery Groundwater Model Update Technical Memorandum (USBR, 2014)
- Leavenworth national Fish Hatchery Water Source Assessment (Aspect, 2014).
- Alternatives Evaluation Study – Public release Version Cascade Orchards Irrigation Company (Anchor QEA, 2015)
- Leavenworth National Fish Hatchery Geophysical Survey Results and Recommendations (Aspect 2015)
- Leavenworth National Fish Hatchery Groundwater Supply Investigation (Aspect 2015)
- Leavenworth National Fish Hatchery Infiltration Gallery Conceptual Alignment (Aspect 2015)

The remainder of this Section provides an overview of hydrogeologic conditions in the project area, groundwater occurrence and flow within the locations described above, and groundwater uses.

3.4.1 Hydrogeologic Setting

This description of the hydrogeologic setting in the Icicle project area builds on the geologic conditions described in Section 3.2, Earth. As discussed previously, bedrock geology in the project area is dominated by crystalline metamorphic and igneous intrusive rock, with the surficial occurrence of sedimentary sandstone, siltstone, and shale rocks in the project area limited to the slopes east and southeast of the City of Leavenworth. Unconsolidated glacial and alluvial deposits overlie the bedrock adjacent to the Alpine Lakes, along the Icicle Creek drainage and its tributaries, and along the Wenatchee River to the Columbia River. These unconsolidated deposits are laterally discontinuous along the Alpine Lakes and in the Icicle Creek drainage above LNFH, where the bedrock-bound valleys are narrow. Adjacent to and below LNFH the Icicle Creek drainage broadens as it approaches the Wenatchee River. Through this area and downstream to the Columbia River the unconsolidated deposits increase in thickness and become laterally continuous.

Groundwater is ultimately derived from precipitation and snowmelt infiltrating through surficial soils and rock, recharging the groundwater system. Groundwater flow is expected to generally follow topography, flowing from higher elevations to lower elevations, sub-parallel to the flows of Icicle Creek and the Wenatchee River. There is expected to be a high degree of hydraulic continuity between the unconsolidated deposits and surface waters where the two are in contact, with groundwater discharging to or being recharged by surface water depending on location and time of year.

Movement and occurrence of groundwater is controlled primarily by the physical characteristics of the geologic units. In general, wells completed in the bedrock have low reported production capacity, with yields on the order of 1 gallon per minute (gpm), although some wells completed in weathered bedrock reportedly produce yields on the order of 15 gpm (Ecology, 1995). The coarse-grained unconsolidated deposits (e.g., sands and gravels), especially at and below LNFH, are the main source of groundwater in the area. Wells completed in coarse-grained deposits reportedly yield from 5 gpm to more than 100 gpm. Finer-grained unconsolidated deposits (silt, clay, and glacial till) generally do not yield significant quantities of water and may act as barriers to flow, where present.

3.4.2 Groundwater Occurrence and Movement

The following subsections provide a more detailed description of the occurrence and movement of groundwater in the four different areas, with the Icicle Creek sub-region being divided at LNFH.

3.4.2.1 Alpine Lakes

Surficial geology within the Alpine Lakes sub-region of the project area is dominated by igneous intrusive and metamorphic bedrock, with limited unconsolidated deposits mapped only around the shoreline of Eightmile Lake. Detailed water budget data for the lakes are not available but 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.

The limited amount of precipitation and runoff that recharges the bedrock and alluvial groundwater systems is expected to flow toward and discharge to the lakes or migrate down-valley before discharging to the Icicle Creek drainage. This flow pattern is affected by lake stage. When the lakes are at high stage (e.g., during spring runoff or as the result of storage operations) these flows may reverse, with surface water recharging groundwater. Although a minor part of the overall water budget, groundwater likely supports late season water levels in the lakes and downstream flows by discharging to surface water when the lakes at lower stages (e.g., during the summer or fall or as the result of releases from storage operations).

3.4.2.2 Icicle Creek Corridor

Tributaries and Icicle Creek Reach 1 and 2

Surficial geology along the Icicle Creek drainage from the Alpine Lakes to LNFH is dominated by igneous intrusive and metamorphic bedrock, with discontinuous unconsolidated alluvial and glacial deposits mapped along the creek and its tributaries. The creek valley in this section is relatively narrow with steep walls. Similar to the Alpine Lakes, given the prevalence of low-permeability bedrock and the steep terrain, hydrology in the Icicle Creek drainage is expected to be dominated by precipitation and snowmelt runoff, with only limited groundwater recharge or discharge.

Groundwater occurring in the bedrock and discontinuous alluvial systems is expected to discharge to Icicle Creek and its tributaries. This relationship may be temporarily reversed during periods of high surface water stage and flow, with surface water recharging groundwater. Although groundwater is a minor part of the annual water budget for Icicle Creek and its tributaries above LNFH, groundwater discharge to surface water likely helps support late season flows in the creek.

Icicle Creek Reach 3, 4, and 5

Icicle Creek transitions from a narrow, bedrock-dominated valley to a broader valley with more extensive unconsolidated glacial and alluvial deposits immediately upstream of LNFH at approximately RM 4. This change in geologic conditions has a significant effect on the occurrence and movement of groundwater, with groundwater contained in unconsolidated deposits playing a significant role in the overall water budget.

The upstream edge of this area also coincides with the location of a surface water diversion on Icicle Creek shared by LNFH and COIC. LNFH conveys surface water in a pipeline from the diversion to the hatchery facilities. COIC conveys water in an unlined canal located along the west edge of the alluvial valley, serving lands between the canal and Icicle Creek downstream to the Wenatchee River. Another diversion, operated by IPID, is located further upstream. The IPID canal is largely lined and extends along the east side of the valley and down the Wenatchee River valley, serving lands near the mouth of Icicle Creek and along the Wenatchee River. LNFH also operates the Hatchery Channel, a human-made channel constructed between the LNFH facility and Icicle Creek. The Hatchery Channel is periodically hydrated with water diverted from Icicle Creek to improve recharge to the unconsolidated deposits and support water levels and yields from LNFH's nearby water supply wells.

Surficial geology along the valley floor is mapped as alluvial deposits. Intrusive and metamorphic bedrock is mapped along the steep slopes of the west edge of the valley, and glacial deposits mantle the slopes on the east side of the valley. Depth to bedrock underlying the valley floor is on the order of 150 to 250 feet, depending on location. The alluvial deposits include coarse-grained sand, gravel, and cobbles that readily transmit water, and finer-grained silts and clays that restrict groundwater flow. The coarser-grained deposits form a shallow, unconfined aquifer and a deeper, semi-confined aquifer separated by a discontinuous layer of finer-grained deposits. LNFH operates water supply wells completed in both the shallow and deeper unconsolidated aquifers, with recent combined well yields on the order of 4,000 gpm (USBR, 2010).

Sources of groundwater in this area include direct infiltration of precipitation and snowmelt, recharge from surface water of Icicle Creek and the Hatchery Channel when hydrated, and seasonal leakage from the COIC and IPID irrigation canals. Previous studies (USBR, 2010; USBR, 2014) indicate a high degree of hydraulic continuity between the unconsolidated aquifers and surface waters of Icicle Creek and the Hatchery Channel. Active management of Icicle Creek, Hatchery Channel, and pumping of LNFH's groundwater supply wells all affect groundwater flow and occurrence in this area. Absent these factors, groundwater flow is expected to be generally down valley, with a component of flow toward Icicle Creek. During periods of high stage in Icicle Creek (e.g., spring runoff) or when the Hatchery Channel is hydrated, groundwater is expected to be recharged from surface water. During periods of lower stage, or when LNFH is operating their supply wells, Icicle Creek generally loses water, recharging the aquifers.

Some seasonal groundwater recharge also likely occurs as a result of leakage from the irrigation canals. A seepage loss study of the unlined COIC canal identified relatively minor losses from the canal of about 5 percent of total flows, or about 0.3 cfs during the period evaluated. Although a seepage loss study has not recently been completed for the IPID canal, the IPID canal is mostly lined through this area, so losses are expected to be less than those for the unlined COIC canal.

3.4.2.3 Wenatchee River Corridor

Surficial geology in the project area downstream from Icicle Creek is predominantly unconsolidated alluvium along the Wenatchee River Valley floor, with sedimentary bedrock forming the valley walls. Depth to bedrock underlying the valley floor is on the order of 100 to 200 feet, depending on location. The alluvial deposits include coarse-grained sand, gravel, and cobbles that readily transmit water, and finer-grained silts and clays that restrict groundwater flow.

Groundwater occurs primarily in the unconsolidated alluvial deposits, with bedrock representing a minor component of the water budget. Wells completed in the bedrock have low reported production capacities, with yields on the order of 1 gpm, although some wells completed in weathered bedrock reportedly produce yields on the order of 15 gpm (Ecology, 1995). Wells completed in the alluvium report yields ranging from about 5 gpm to more than 100 gpm, depending in part on the characteristics of the unconsolidated materials (e.g., grain size, saturated thickness).

Sources of groundwater in this area include direct infiltration of precipitation and snowmelt, recharge from surface water of the Wenatchee River, and infiltration of irrigation and domestic (septic) return flows. Based on the generally coarse-grained nature and relatively thick sequence of unconsolidated deposits adjacent to the Wenatchee River, a high degree of hydraulic continuity is expected between the river and groundwater. This assumption is supported by an Ecology-led study of groundwater-surface water interaction and nutrient loading in the Wenatchee River Watershed (Ecology, 2007) that identified gaining and losing reaches along the entire length of the river, with some areas showing a seasonal transition from gaining to losing conditions.

3.4.3 Groundwater Uses

Groundwater uses in the project area include municipal supply for the Cities of Leavenworth and Cashmere, municipal and multiple domestic supply to smaller water systems, supply to the LNFH for fish propagation, and water right permit-exempt domestic uses. No groundwater uses were identified in the Alpine Lakes area. Groundwater uses within the Icicle Creek drainage above LNFH are limited to about 50 to 60 apparent permit-exempt wells located mostly along Icicle Creek Road, identified based on review of Ecology's well log database. Most of these wells appear to be completed in bedrock rather than unconsolidated deposits.

Groundwater uses in the area from the LNFH to the Wenatchee River include LNFH's permitted withdrawals and apparent permit-exempt domestic uses. LNFH holds water rights that authorize groundwater withdrawals of 6,700 gpm on an instantaneous basis, up to 7,677 acre-feet/year. The number of permit-exempt uses in this area is uncertain, but approximately 300 water well logs from this area were identified in Ecology's well log database.

Groundwater uses downstream from Icicle Creek to the Columbia River include municipal supply for the Cities of Leavenworth and Cashmere, municipal and multiple domestic supply to smaller water systems, and water right permit-exempt domestic uses. Based on information in their 2011 Water System Plan, the City of Leavenworth holds two groundwater rights that authorize withdrawal of 3,000 gpm (6.68 cfs), up to 2,000 acre-feet/year. The Water System Plan states annual quantities authorized for withdrawal under these groundwater rights are non-additive to the City of Leavenworth's surface water rights to Icicle Creek; further, 2,000 gpm (4.46 cfs) of the instantaneous withdrawals authorized under these rights is interruptible and subject to curtailment when flows in Icicle Creek or the Wenatchee River fall below minimum rates. As discussed in Section 1.8 of this document, the City of Leavenworth's water rights are currently under appeal and attributes may change based on the outcome of this litigation.

A water right summary provided by the City of Cashmere indicates they hold four groundwater rights that authorize withdrawal of 1,400 gpm (3.12 cfs), up to 1,227 acre-feet/year. Like the City of Leavenworth, these rights include a combination of additive and non-additive quantities to other water rights. These groundwater rights are not subject to interruption based on instream flows, but several of the City of Cashmere's surface water rights are subject to instream flows. Note that this summary of groundwater rights held by the Cities of Leavenworth and Cashmere was based on review of information provided by the two cities and gathered from Ecology water right files; this review does not represent an extent and validity review and is not intended to determine the validity of quantities of water available under these groundwater rights.

3.5 Water Quality

This section describes water quality of surface and groundwater in the Icicle project area that could be affected by the Program Alternatives. Section 3.3, Surface Water Resources, and Section 3.4, Groundwater Resources, describe these resources in greater detail. The project area includes the Alpine Lakes area within the Icicle Creek Basin, Icicle Creek down to its confluence with the Wenatchee River, the mainstem Wenatchee River from just upstream of Icicle Creek down to its confluence with the Columbia River, and underlying shallow and deep aquifers.

3.5.1 Regulatory Setting

The federal CWA, passed in 1972, aims to restore and maintain the chemical, physical, and biological integrity of the nation's waters. As part of this goal, the CWA sets forth the basic structure for regulating pollutant discharges to surface waterways (e.g., lakes, rivers, ponds, streams, and wetlands) and groundwater (e.g., shallow and deeper aquifers) from both point and non-point sources. The CWA includes provisions for the development of water quality standards, institutes a water quality assessment process to identify impaired waters that do not meet the water quality standards, and establishes the NPDES permitting program to regulate point sources that discharge pollutants to waters of the United States.

The CWA is administered by the U.S. Environmental Protection Agency (EPA) in coordination with state governments. Water quality standards are developed by individual states with oversight from the EPA. Water quality standards identify the potential designated or beneficial uses of surface water bodies within the state (e.g., aquatic life, recreation, and water supply), set water quality criteria (numeric pollutant concentrations and narrative requirements) to provide protection of those designated uses, and include antidegradation policies to protect high quality waters and specify how water quality criteria are to be implemented. The water quality standards for aquatic life and public use of Washington's surface waters are developed and administered by Ecology (Chapter 173-201A WAC; Ecology, 2012a). Where appropriate, these standards are supplemented by the EPA's *Quality Criteria for Water 1986* (EPA, 1986) and its associated amendments. Human health-based water quality criteria used by Ecology are contained in the National Toxics Rule (40 CFR Part 131).

Sections 303(d) and 305(b) of the CWA require states to identify surface waters that do not meet water quality standards and to report the water quality condition of these waters to EPA biennially in the form of a Water Quality Assessment and Integrated Report. This report is used to identify impaired waters that may require the preparation of a water cleanup plan, such as a TMDL allocation or other water quality improvement project. A TMDL describes the type, amount, and sources of water pollution in a particular waterbody, provides an analysis of how much the pollution needs to be reduced or eliminated to meet water quality standards, and establishes targets and strategies to control the pollution in that waterbody (Ecology, 2016a).

Ecology's current Water Quality Assessment and Integrated 305(b) report and 303(d) list were approved by EPA on July 22, 2016. The Water Quality Assessment classifies assessed surface waters into the following water quality categories:

- Category 1 – Meets tested standards for clean waters
- Category 2 – Waters of concern
- Category 3 – Insufficient data
- Category 4 – Polluted waters that do not require a TMDL and have pollution problems that are being solved in one of the three following ways:
    - Category 4a – Has an approved TMDL in place

  - Category 4b – Has a pollution control program in place
  - Category 4c – Is impaired by a non-pollutant, such as low water flow or dams
- Category 5 – Polluted waters that require a TMDL or other water quality improvement project

Category 5 waters are placed on the Section 303(d) list of waters whose beneficial uses have been impaired by pollution. Once a water is placed on the Section 303(d) list, Ecology must then work to develop a TMDL or other water quality improvement project to address the identified impairments.

If there is also a discharge that impacts groundwater, then the requirements of a state waste discharge permit must also be incorporated into the NPDES permit per Chapter 173-200 WAC. Where appropriate, these standards are supplemented by the EPA's *Groundwater Rule* (EPA, 2006)[1], which provides for the protection of public groundwater systems.

3.5.2 Surface Water Quality

As described in Section 3.3, Surface Water Resources, surface waters within the Icicle project area include select Alpine Lakes and their receiving streams that flow to Icicle Creek, Icicle Creek from its headwaters to its confluence with the Wenatchee River, and the Wenatchee River from just upstream of Icicle Creek to the Columbia River. The Wenatchee River and Icicle Creek have been listed on multiple versions of Washington's CWA 303(d) list for temperature, dissolved oxygen, pH, and fecal coliform bacteria (Table 3-6). Other water quality issues include surface water contamination with polychlorinated biphenyls (PCBs), dichloro-diphenyl-trichloroethane (DDT) and its breakdown products (e.g., dichloro-diphenyl-dichloroethane [4,4'-DDD] and dichloro-diphenyl-ethane [4,4'-DDE]), and various other organic pesticides.

[1] Ground Water Rule (GWR) 71 FR 65574, November 8, 2006, Vol. 71, No. 216 Correction 71 FR 67427, November 21, 2006, Vol. 71, No. 224

Table 3-6
Clean Water Act Section 303(d) (Category 5) Listings for Project Waterbodies in the Primary and Secondary Project Development Areas

Waterbody	Water Quality Parameters					
	1996	1998	2004	2008	2012	Current[2]
Icicle Creek	Temperature, Dissolved Oxygen, pH, Instream Flow	Temperature, Dissolved Oxygen, pH, Instream Flow	Temperature, Dissolved Oxygen, pH	Dissolved Oxygen, pH	None	4,4'-DDE, PCB
Wenatchee River	Temperature, Dissolved Oxygen, pH, Instream Flow	Temperature, Dissolved Oxygen, pH, Instream Flow	Temperature, Dissolved Oxygen, pH, 4,4'-DDT, 4,4'-DDD, 4,4'-DDE, Alpha BHC, PCB	Dissolved Oxygen, pH, 4,4'-DDE, PCB	4,4'-DDE, PCB	4,4'-DDE, PCB, Endosulfan

Source: Ecology 2016b

Impaired water quality can adversely affect the designated or beneficial uses of a waterbody, including decreased aesthetic or recreational opportunities, lowered habitat function, and adverse impacts on wildlife and humans. Most of these water quality impairments in the Wenatchee River Watershed occur in the lower portions of the watershed and are largely a result of the much higher degree of urban and agricultural development in the Wenatchee River Corridor.

Within the Wenatchee River Watershed, temperature impairment of water quality has been historically recorded in the lower portion of the watershed within both Icicle Creek and the Wenatchee River (Table 3-6). Water quality degradation related to temperature is caused by a variety of both natural and human-induced processes that contribute to increases in water temperature in streams and other waterbodies. Because warmer water holds less dissolved oxygen than cooler water, increased water temperatures can affect the types of organisms able to live in a waterbody, as well as impairing other designated uses such as recreation and water supply. Increased stream temperatures can result from increases in suspended sediments, removal of riparian vegetation, and decreased instream flows from surface water diversions and groundwater withdrawals.

In addition to increased water temperature, high levels of nutrients, primarily nitrogen and phosphorus, can also result in lowered dissolved oxygen levels. If large amounts of nutrients are available, aquatic plant growth can become excessive and the eventual decomposition of these plants can deplete the water of dissolved oxygen. In the Wenatchee River Watershed, phosphorus is the primary nutrient of concern and enters the river system from a variety of both point and non-point sources. Point sources include wastewater treatment plants and fish hatcheries, and non-point sources include septic

[2] The Washington Department of Ecology's current Water Quality Assessment was submitted to the U.S. Environmental Protection Agency (EPA) in September 2015; it was approved by EPA on July 22, 2016.

systems, agricultural runoff, and abandoned or closed landfills (Ecology, 2009). Such sources are most commonly found in the downstream portion of the project area.

Excessive plant growth from heavy nutrient loading can also cause large, relatively sudden, swings in the pH of the water (Ecology, 2009), which can affect the availability of nutrients and metals and adversely affect aquatic species. High pH (i.e., alkaline) levels are typically encountered in parts of the lower Wenatchee River Watershed and affect aquatic organisms, including all life stages of anadromous fish, by impairing their salt and water balancing process and increasing the toxicity of some contaminants (Ecology, 2009).

Fecal coliform refers to potential disease-causing pathogens (e.g., bacteria and viruses) associated with human and animal waste, which can enter the water body through multiple sources. Water quality degradation from fecal coliform primarily affects water use designations, such as water supply, stock watering, aquatic life support, wildlife habitat, and recreation.

PCBs are organic chlorine compounds that were manufactured in the United States between 1929 and 1979 (Hobbs and Friese, 2016). Common sources of PCB contamination include older electrical equipment (e.g., transformers and capacitors), paints, inks, and sealants. Historically, PCBs have been released into the environment mainly through volatilization into the atmosphere and spills into waterways and onto land. PCBs are known to be carcinogenic and to have adverse effects on the immune, endocrine, nervous, and reproductive systems of humans. In the Wenatchee River Watershed, PCB levels have exceeded water quality standards in portions of the Wenatchee River since 2004 and more recently in the lower-most portion of Icicle Creek in 2015 (Table 3-6).

DDT is a water-resistant chlorinated insecticide that was heavily used to control orchard pests in the Wenatchee River Watershed between the mid-1940s and 1972, when its use was banned by the EPA (Ecology, 2007b). Within the Wenatchee River Watershed, the concentration of DDT and its derivatives have exceeded water quality standards in the lower portion of Icicle Creek and portions of the Wenatchee River more recently (Table 3-6).

To date, Ecology has developed several water quality improvement projects to address impairments that affect project surface waters (Table 3-7). These include TMDLs for temperature (Ecology, 2007b), and dissolved oxygen and pH (Ecology, 2009).

Table 3-7
Water Quality Improvement Projects Affecting Project Surface Waters and Associated Tributaries

Water Quality Improvement Project Name	Pollutant(s)	Applicable Surface Waters	Status
Wenatchee River Watershed Temperature Total Maximum Daily Load	Temperature	• Chiwaukum Creek • Icicle Creek • Little Wenatchee River • Mission Creek • Nason Creek • Peshastin Creek • Brender Creek • Chumstick Creek • Wenatchee River	EPA approved August 2007
Wenatchee River Watershed Dissolved Oxygen and pH Total Maximum Daily Load	Dissolved Oxygen, pH	Wenatchee River Watershed	EPA approved August 2009

Source: Ecology 2016c.

Current water quality is discussed for each of the major project waters in the following sections.

3.5.2.1 Alpine Lakes

As noted in Section 3.3, Surface Water Resources, surface waters within the Icicle Creek Basin originate from high lakes located in the Central Cascades of Washington. This portion of the Icicle project area includes eight lakes: Square Lake, Upper Klonaqua Lake, Lower Klonaqua Lake, Eightmile Lake, Colchuck Lake, Nada Lake, Upper Snow Lake, and Lower Snow Lake, and their receiving streams. These lakes support a variety of designated uses as listed in WAC 173-201A-600, including aquatic life uses, the highest quality recreational use type, and all water supply and miscellaneous uses defined under WAC 173-201A-200 (Table 3-8).

Information on the historic and current water quality of the project lakes is limited, and no water quality studies are listed on the interactive Washington State Lakes Environmental Data website (Ecology, 2016d). Historic lake reconnaissance studies conducted for the USGS in the mid- to late-1970s (Dion et al., 1976; Denthier et al., 1979) provide some basic water quality information for a limited number of lakes. A 1976 study conducted by Dion and others included six of the eight lakes being considered in this EIS (Upper Klonaqua Lake, Lower Klonaqua Lake, Eightmile Lake, Colchuck Lake, Upper Snow Lake, and Lower Snow Lake). That study found the water quality of those lakes to be quite high, with all six lakes having high levels of dissolved oxygen throughout the entire water column and very low nutrient (nitrogen and phosphorus) and bacteria (fecal coliform) levels. Denthier et al. (1979) classified the water quality of these lakes as being excellent, as indicated by high water clarity and low concentrations of dissolved solids. All of the lakes in the Icicle project area were being managed for water storage at the time these studies were conducted.

Table 3-8
Designated Use Listings for Project Waters in the Primary and Secondary Project Development Areas

	Aquatic Life Uses						Recreation Uses			Water Supply Uses				Miscellaneous Uses				
Waterbody	**Char Spawning/Rearing**	**Core Summer Habitat**	**Spawning/Rearing**	**Rearing/Migration Only**	**Redband Trout**	**Warm Water Species**	**Extraordinary Primary Contact**	**Primary Contact**	**Secondary Contact**	**Domestic Water**	**Industrial Water**	**Agricultural Water**	**Stock Water**	**Wildlife Habitat**	**Harvesting**	**Commerce/Navigation**	**Boating**	**Aesthetics**
Alpine Lakes and Receiving Streams (Square Lake, Klonaqua Lake, Eightmile Lake, Colchuck Lake, Nada Lake, Upper Snow Lake, and Lower Snow Lake)		X	X	X			X			X	X	X	X	X	X	X	X	X
Icicle Creek (including tributaries) from mouth to National Forest boundary		X						X		X	X	X	X	X	X	X	X	X
Icicle Creek (including tributaries) from National Forest boundary to confluence with Jack Creek		X					X			X	X	X	X	X	X	X	X	X
Icicle Creek above and including Jack Creek (including all tributaries)	X						X			X	X	X	X	X	X	X	X	X
Wenatchee River mainstem between mouth and Peshastin Creek			X	X				X		X	X	X	X	X	X	X	X	X
Wenatchee River mainstem between Peshastin Creek and the Wenatchee National Forest boundary		X						X		X	X	X	X	X	X	X	X	X

The high water quality of the lakes has been primarily attributed to two factors: 1) limited use by humans due their remoteness, relative inaccessibility, and regulatory protections; and 2) the abundant annual precipitation that allows large volumes of water to flow through them every year, diluting and flushing out any accumulated pollutants (Gilliom et al., 1980). In their 1980 study for USGS, Gilliom et al. analyzed the susceptibility of 60 lakes (including all eight of the project lakes) to water quality degradation by recreational use and determined that all of the project lakes had a low susceptibility to long-term, whole-lake degradation from recreation activities. Although the effect of water management activities on water quality was not specifically addressed in that study, such activities were occurring at the time of the study and would have influenced the water quality observations that were made.

Potential sources of water quality degradation that could affect the lakes are largely limited to recreational uses (e.g., camping and hiking) and ongoing water retention and storage activities by the IPID and USFWS. The major types of pollutants that could enter these lakes from recreational activities include nutrients (nitrogen and phosphorus), pathogens (bacterial, protozoa, and viruses), and sediment. For water retention and storage activities, potential pollutants would primarily be limited to sediment.

None of the lakes or their immediate receiving waters are listed as impaired under Section 303(d) of the CWA. Snow Creek, which receives flow from Nada Lake and Lower Snow Lake, is listed as a water of concern (Category 2) for temperature, pH, and dissolved oxygen in Ecology's current Water Quality Assessment (Ecology, 2016b). Waters listed under Category 2 may have pollution levels that are not quite high enough to violate the water quality standards or there may not have been enough violations to categorize it as impaired according to Ecology's listing policy (Ecology, 2016e). The location of these listings occurs in the vicinity of Snow Creek's confluence with Icicle Creek, which is located downstream of the diversion shared by IPID and the City of Leavenworth and upstream of the diversion shared by the LNFH and COIC. There are no permitted NPDES outfalls on any of the lakes or their immediate receiving waters.

3.5.2.2 Icicle Creek Corridor

Designated uses for Icicle Creek are specified in WAC 173-201A-602 and summarized in Table 3-8. Designated uses include aquatic life support, medium to high quality recreational uses, and all water supply and miscellaneous uses defined under WAC 173-201A-200. Potential sources of water quality degradation that affect Icicle Creek include flow diversion, stormwater runoff from adjacent roads and developed areas, point-source discharges from water treatment plants and other facilities, non-point pollutants from septic systems, and recreational uses. Water quality parameters affected by pollutants from these sources include temperature, dissolved oxygen, pH, turbidity, nutrients, fecal coliform bacteria, and concentrations of various pollutants including heavy metals and organic compounds.

The Leavenworth Water Treatment Plan is an NPDES-permitted facility on Icicle Creek (Ecology, 2016f). That facility is permitted to discharge both process wastewater and non-routine and unanticipated wastewater to Icicle Creek through an outfall located approximately 0.4 mile downstream from the Snow Creek confluence under an NPDES

General Permit for Water Treatment Plants (Ecology NPDES Permit No. WAG645001). The LNFH also has an NPDES permit to discharge wastewater from the hatchery into Icicle Creek (NPDES Permit No. WA0001902). The hatcheries outfall is located at RM 2.7.

Annual temperature monitoring in Icicle Creek has been conducted by the USFWS since 2005 in locations upstream, adjacent to, and downstream of the LNFH (Hall and Kelly-Ringel, 2011; Hall and Henry, 2012; Hall, 2013a, 2013b; Fraser, 2015a, 2015b). Throughout this period, monitoring has indicated that the cumulative effect of two LNFH operations—supplementation with Snow Creek water and the mixing of hatchery return water with well water—reduces in-water temperatures in Icicle Creek during the summer months.

Ecology's current Water Quality Assessment (Ecology, 2016b) records three Category 5 water quality impairment listings for Icicle Creek under Section 303(d) of the CWA (Table 3-6). Two of these are for PCBs and occur in sections of stream channel both upstream and downstream of the East Leavenworth Road Bridge. The other Category 5 listing is for 4,4'-DDE and occurs in a section of the stream upstream from the East Leavenworth Road Bridge. All of these detections were found in the tissue of fish collected from these stream reaches.

During a recent Ecology source assessment study for PCBs and DDT in the Wenatchee River Watershed (Hobbs and Friese, 2016), researchers found that the greater bioaccumulation of PCBs in the Wenatchee River Watershed food web is occurring downstream from Cashmere, approximately 10 RM downstream from the Icicle Creek listing locations. These data appear to suggest that the fish collected from the Icicle Creek reaches were migrating fish that had been feeding in downstream areas. As such, the researchers suggest that the Icicle Creek 303(d) listings for PCBs may be inappropriate.

In addition to its Category 5 listings, Icicle Creek also has several Category 4a listings (approved TMDL in place) for temperature, dissolved oxygen, and pH on Ecology's current Water Quality Assessment (Ecology, 2016b). One Category 4c listing (impairment by a non-pollutant) is also included for instream flow.

The Category 4a temperature listings in Icicle Creek occur between Boggy Creek and Jack Creek, between Doctor Creek and Ida Creek, downstream of Fourth of July Creek, upstream of Bridge Creek, downstream of Eightmile Creek, both upstream and downstream of Snow Creek, downstream of the East Leavenworth Road Bridge, and upstream of the Icicle Creek confluence with the Wenatchee River. The lower portion of Jack Creek is also listed as a Category 4a water for temperature. These listings are being addressed by the Wenatchee River Watershed Temperature TMDL, which was approved by the EPA in August 2007 (Ecology, 2007b).

Category 4a listings for dissolved oxygen and pH occur downstream of the East Leavenworth Road Bridge and upstream of Icicle Creek's confluence with the Wenatchee River (Ecology, 2016b). The Icicle Creek LNFH diversion channel is also listed as a Category 4A water for dissolved oxygen. These impairments are addressed under the

Wenatchee River Watershed Dissolved Oxygen and pH TMDL, which was approved by the EPA in August 2009 (Ecology, 2009) and its associated addendum (Ecology, 2012b).

A portion of Icicle Creek is also Category 4c listed for instream flow impairment. Multiple flow studies performed during the 1990s determined that measured flows in this section of the channel did not meet the instream flows set by the Instream Resources Protection Program – Wenatchee River Watershed, WRIA 45 (Chapter 173-545 WAC) nearly 45 percent of the time or for 66 days on average from August to October (Ecology, 2016g). These conditions are attributed to upstream consumptive uses of water, including streamflow diversions for irrigation, municipal water supply for the City of Leavenworth, and process water supply for the LNFH.

Ecology's current Water Quality Assessment also lists multiple Category 2 (waters of concern) listings for Icicle Creek. Two Category 2 listing for temperature occur in locations both immediately upstream of and within the LNFH diversion channel. Seven Category 2 listings for dissolved oxygen occur in locations between Boggy Creek and Jack Creek, between Bob Creek and Doctor Creek, upstream from its confluence with Bridge Creek, both upstream and within the LNFH diversion channel, and upstream of the East Leavenworth Road Bridge. Jack Creek is also listed as a Category 2 water for temperature. As with the Category 4a listings, areas of low dissolved oxygen are being addressed under the August 2009 Wenatchee River Watershed Dissolved Oxygen and pH TMDL (Ecology, 2009) and its associated addendum (Ecology, 2012b).

3.5.2.3 Wenatchee River Corridor

Designated uses for the Wenatchee River are specified in WAC 173-201A-600 and WAC 173-201A-602 and summarized in Table 3-8. Designated uses include aquatic life support, medium to high quality recreational uses, and all water supply and miscellaneous uses defined under WAC 173-201A-200. Lands within the Wenatchee River Corridor are much more heavily developed than lands located in the higher elevations of the Icicle project area and include several urban areas (Cities of Leavenworth, Peshastin, Dryden, Cashmere, Monitor, Sunnyslope, and Wenatchee) and considerable agricultural lands. As such, potential sources of water quality degradation are more numerous and include flow diversion; point-source discharges from publicly owned treatment works (POTW), municipal stormwater systems, industrial facilities, fish hatchery effluent discharges, and irrigation returns; and non-point pollutants from septic systems, urban runoff, and agricultural runoff. Water quality parameters that are affected by pollutants from these sources include temperature, dissolved oxygen, pH, turbidity, nutrients, fecal coliform bacteria, and concentrations of various pollutants including heavy metals and organic compounds.

Multiple NPDES-permitted facilities discharge to the Wenatchee River. Permitted outfalls include those for the Leavenworth, Peshastin, Dryden, and Cashmere POTWs; multiple fruit packing plants; a Chelan County Public Utility District fish acclimation facility in Dryden; multiple industrial and construction stormwater outfalls; a sand and gravel operation; and multiple irrigation districts for irrigation system weed control.

Ecology's current Water Quality Assessment (Ecology, 2016b) records multiple Category 5 water quality impairment listings for the Wenatchee River, including five for PCBs, five for 4,4'-DDE, and one for endosulfan, an organochlorine pesticide (Table 3-6).

Category 5 listings for PCBs and 4,4'-DDE occur downstream from the Icicle Creek confluence, upstream and downstream of the U.S. Route 2 Bridge in the City of Leavenworth, between the City of Leavenworth and the City of Peshastin, and downstream of the City of Cashmere (Ecology, 2016b). All listings are based on the presence of these pollutants in fish tissue at concentrations that exceed water quality criteria. During a recent source assessment study for PCBs and DDT in the Wenatchee River Watershed (Hobbs and Friese, 2016), Ecology identified multiple potential sources of these pollutants and investigated these potential sources by studying the concentrations in water, biofilms (algae and microbial biomass), and invertebrates in the mainstem of the Wenatchee River. The initial survey showed that the sources of both contaminants are confined to the lower portion of the river (below the City of Leavenworth). The study further identified two distinct PCB source locations—one near the City of Cashmere and the second near the City of Wenatchee. Ecology concluded that both of these sources are likely unknown contaminated sites. For DDT, the study determined that the greatest inputs of DDT into the Wenatchee River are occurring during high-flow and predominantly from the Chumstick Creek and Mission Creek Basins. Irrigation returns were not found to be a large source of DDT to the Wenatchee River. The study also identified an unknown source of DDT between the USGS Peshastin gaging station and Old Monitor Road Bridge just downstream of the City of Cashmere.

The Category 5 listing for endosulfan occurs in Brender Creek, a tributary that enters the Wenatchee River at City of Cashmere, which is also listed as a Category 5 water for chlorpyrifos, a crystalline organophosphate pesticide (Ecology, 2016b). Another Category 5 listing for endosulfan occurs downstream of the City of Cashmere.

In addition to the Category 5 listings, the Wenatchee River and some of its tributaries also have several Category 4a listings for temperature, dissolved oxygen, pH, and bacteria on Ecology's current Water Quality Assessment (Ecology, 2016b). These listings occur at multiple locations throughout the length of the river. These water quality issues are being addressed through the Wenatchee River Watershed TMDLs for temperature (Ecology, 2007b), dissolved oxygen and pH (Ecology, 2009), and fecal coliform bacteria (Ecology, 2007a).

Two Category 4c listings are included for the Wenatchee River in Ecology's current Water Quality Assessment (Ecology, 2016b). River sections identified in these listings occur in the upper portion of the river (between Lake Wenatchee and the City of Leavenworth) and one between the Cities of Leavenworth and Peshastin. These flow deficiencies are attributed to consumptive water uses, particularly irrigation withdrawals.

The current Water Quality Assessment includes multiple Category 2 listings for the Wenatchee River for pH, temperature, dissolved oxygen, and 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD) (Ecology, 2016b). Most of the Category 2 listings for pH, temperature, and dissolved oxygen occur upstream from the City of Leavenworth. The

Category 2 TCDD listings occur in the segment of the river adjacent to the City of Leavenworth, between the Cities of Leavenworth and Peshastin, and downstream of the City of Cashmere.

3.5.3 Groundwater Quality

Groundwater resources in the Icicle project area consist of bedrock and discontinuous alluvial systems and are ultimately derived from rain or snowmelt (Ecology, 1995)[3]. There are two major aquifers in the Wenatchee River watershed: a lower bedrock aquifer and an overlying unconsolidated alluvial and outwash aquifer. The shallower alluvial and outwash aquifer is the main source of groundwater in the area, and in many places has a direct connection with surface waters. Although a minor part of the overall water budget in the Alpine Lakes and upper Icicle Creek portion of the Icicle project area, groundwater likely supports late season water levels in the lakes and downstream tributaries, including Icicle Creek, by discharging to surface waters when levels are lower (e.g., during the summer or fall, or as a result of lake releases from storage operations).

The quality and quantity of the alluvial and outwash aquifer is highly variable depending upon the local geology, the quality of the surface water, and the anthropogenic impacts, such as agriculture. Groundwater quality within the Upper Wenatchee River Watershed is considered to be excellent but deteriorates slightly in the Icicle Creek and Leavenworth areas, and more so moving further downstream (Ecology, 2007)[4]. Elevated nutrient content in the Peshastin and Cashmere areas may be contributing to low dissolved oxygen values in the Wenatchee River.

3.6 Water Use

Water use within the Icicle project area includes a variety of uses, including municipal, rural domestic, fish propagation, instream flows, and irrigation. This section discusses water use and is based primarily on existing state records and operational records of water users, as well as previous reports and studies on water management in the Icicle Creek Subbasin. This review does not represent an extent and validity review and is not intended to determine the validity of quantities of water available under these water rights.

3.6.1 Water Rights

3.6.1.1 Alpine Lakes Water Rights

This section provides a summary of storage water rights for the Alpine Lakes held by IPID and USFWS. This summary is based on information gathered from Ecology's water rights and Dam Safety Office files; WDNR; the USFS and the United States Bureau of

[3] https://fortress.wa.gov/ecy/publications/documents/95160.pdf
[4] https://fortress.wa.gov/ecy/publications/documents/0503018.pdf

Land Management; water right adjudication files from Chelan County Superior Court; and the Chelan County Auditor. Information about land ownership and easements authorizing water impoundment is available in Section 3.17, Wilderness Area.

Attributes of the storage water rights in the project area are provided in Table 3-9. These attributes include storage rights for Colchuck, Eightmile, Klonaqua, Square, Nada, Upper Snow, and Lower Snow Lakes. The rights on Colchuck, Eightmile, and Upper and Lower Klonaqua Lake were subject to the 1927 Icicle Creek water rights adjudication filed in Chelan County Superior Court. The storage rights for Square Lake, Nada Lake, and Upper and Lower Snow Lakes were established after the adjudication began and were not subject to the adjudication. In total, 10,500 acre-feet of storage rights were certificated by IPID, with an additional 16,000 acre-feet of storage certificated by USBR, which are now utilized by the USFWS.

Table 3-9
Attributes of Alpine Lake Storage Rights

Rights Summary Water Source	Certificate Number	Owner Listed on Certificate	Priority Date		Certificated Qi (cfs)	Certificated Qa (afy)	Adjudicated Qi (cfs)	Adjudicated Qa (afy)
Upper and Lower Klonaqua Lake	1227	IID	1926 (Class 5)		25	---	25	2,500
Eightmile Lake	1228	IID	1926 (Class 5)		25	---	25	2,500
Colchuck Lake	1229	IID	1926 (Class 5)		50	---	50	2,500
Square Lake	5527	IID	1926		10	2,000	NA	NA
Snow Lake	1591	IID	1929		25	---	NA	NA
Snow Lake	1592	IID	1929		---	1,000	NA	NA
Snow Lake	1825	USBR	1942		---	16,000	NA	NA

[1] Right confirmed for 83.33 cfs through adjudication. The right was subsequently split and a change to place of use was completed for 1.7525 cfs.
[2] Documented total storage constructed at Snow Lake is 12,000 acre-feet, shared by USFWS and IPID. Under a separate agreement, IPID is entitled to 750 acre-feet of the Snow Lake storage.

Notes: Qi = instantaneous quantity; Qa = annual quantity; cfs = cubic feet per second; afy = acre-feet per year; IID = Icicle Irrigation District; PID = Peshastin Irrigation District; USBR = United States Bureau of Reclamation; --- = not listed; NA = not applicable, these rights were not subject to the adjudication. Qi for the storage rights are a limit on the rate of diversion for storage purposes. Release rates are limited by RCW 90.03.030, which states, "Any person may convey any water which he or she may have a right to use along any of the natural streams or lakes of this state, but not so as to raise the water thereof above ordinary high water mark, without making just compensation to persons injured thereby". IID and PID have entered into a joint operating agreement that specifies PID has 40-percent interested in IID storage rights and Icicle Creek/Snow Creek diversionary rights.

Klonaqua, Eightmile, and Colchuck Lakes Storage Rights

In 1926, IID filed applications with the State of Washington Office of Supervisor of Hydraulics (an Ecology predecessor agency) requesting to divert water from Klonaqua, Eightmile, and Colchuck Lakes for seasonal irrigation. Petitions were also filed with the Washington State Department of Public Lands (a DNR predecessor) to procure the shore and overflow rights to the three lakes. The Office of Supervisor of Hydraulics issued permits to develop the lake sources and the Department of Public Lands issued an order granting "the right to overflow and perpetually inundate said lands."

In 1927, water rights to Icicle Creek and its tributaries were adjudicated in Chelan County Superior Court. The 1929 Final Court Decree affirmed IID's water right permits for the lakes in the amounts of 25 cfs, 2,500 acre-feet per year at Eightmile Lake and Klonaqua Lake, and 50 cfs, 2,500 acre-feet per year at Colchuck Lake. The decree noted that the water rights represented by the permits are "inchoate but may be perfected by compliance with provisions under which the permits were issued; that these rights for storage of water under said permits do not affect the water rights of any other claimant herein reported."

These rights were subsequently certificated by the Office of Supervisor of Hydraulics for 25 cfs (50 cfs at Colchuck Lake) for the purpose of irrigation of 7,000 acres; no annual quantities were specified on the certificates. The Proof of Appropriation (PA) filed to support certificating the storage right to Colchuck Lake indicates that, because of conditions at the site, the reservoir was not raised to the full height planned, that 1,200 acre-feet per year of water was used, and that "utilization of full storage rights necessitate a pumping unit during extreme low flow on Icicle water sheds."

Square Lake Storage Right

An application requesting to divert water from Square Lake for the purpose of irrigation was filed with the State of Washington Office of Supervisor of Hydraulics in 1926. A second application, under the same application number, was filed in 1939 to construct a reservoir and store water at Square Lake. A PA was filed in 1953, asserting completion of construction of the reservoir and distribution system in 1952 and use of up to 40 cfs for "supplementing water supply for total area embraced in Icicle and Peshastin Irrigation Districts… as adjudicated in the Icicle Water right adjudication proceedings." A single certificate was issued for 10 cfs, 2,000 acre-feet per year for irrigation of lands lying within the IPID.

Snow and Nada Lakes Storage Rights

In 1929, IID filed separate applications to appropriate water from Snow Creek and to store water in Snow Lakes. Construction of the storage project was completed in 1940 when USBR drove a tunnel between Nada Lake and Upper and Lower Snow Lakes to provide water for what is now the LNFH. In 1941, IID received two certificates authorizing 25 cfs, 1,000 acre-feet per year for irrigation of 7,000 acres lying within the lands of the IPID. In 1942, Reclamation received a water right certificate for Upper and Lower Snow Lakes in the amount of 16,000 acre-feet per year to supplement the water supply for the hatchery and holding ponds.

Information filed in support of IID's water right included a private agreement between IPID and USBR. This agreement established that USBR would build the control works and provide storage at Upper and Lower Snow Lakes and in return IPID would reduce its rights to Upper and Lower Snow Lakes from 1,000 to 750 acre-feet per year and would not call on storage from Upper and Lower Snow Lakes until water stored in IPID's other reservoirs have begun to be used. File information also indicates that only approximately 12,000 rather than 16,000 acre-feet of storage was constructed by USBR. Based on this, it appears that the current combined storage rights for Upper and Lower Snow and Nada

Lakes are approximately 12,000 acre-feet, of which IPID is entitled to 750 acre-feet per year.

In addition to the storage rights discussed above, there may be reserved rights held by the USFS for waters in the Alpine Lakes Wilderness Area that have not been quantified but could be implied under the federal reserved water right doctrine. However, these water rights would have a priority date of July 12, 1976 (the date the Alpine Area Management Act was passed) or later for lands incorporated into the wilderness area after the management act. Also, the purpose of use of these water rights would be limited to the purpose of wilderness establishment, as described in the Alpine Lakes Area Management Act.

3.6.1.2 Icicle Creek Diversion Rights

Department of Ecology records indicate there are 19 diversionary water rights on Icicle Creek and its tributaries. Cumulatively, these water rights authorize the diversion of 187.36 cfs (Table 3-10.).

Of the 19 water rights listed in Table 3-10, four are major diversions on Icicle Creek that account for 95 percent of the water diverted. These major diverters are IPID, LNFH, COIC, and City of Leavenworth, and these entities are involved in many of the projects proposed under the Icicle Strategy. The following subsections provide more detail on the diversionary water rights held by these four entities.

IPID Diversionary Water Rights

IPID holds diversionary rights to Snow and Icicle Creeks totaling 117.71 cfs (two issued to IID one issued to PID). These water rights were subject to the 1927 Icicle Creek water rights adjudication and have 1910 and 1919 priority dates. The IPID diversion is located at RM 5.7 on Icicle Creek and consists of gravity flow headworks. The water is then conveyed through canals out of basin and into the Wenatchee Valley where it is applied to commercial and residential lands. IPID manages the storage rights discussed above to ensure adequate flow at their point of diversion to satisfy their diversionary rights. An annual quantity is listed on only one of IPID’s three water rights. The one water right with an annual quantity authorizes the use of 25,000 acre-feet per year. IPID irrigates 7,000 acres with these water rights. Based on flow measurements at their diversion point, IPID generally diverts the entire quantity authorized under their Icicle Creek water rights.

Table 3-10
Icicle Creek Surface Water Rights

Water Right No.	Person or Organization	Priority Date	Purpose of Use	Qi (cfs)	Qa (afy)	Source Name
S4-*35007JWRIS	Simons, R E	01/01/1901	IR	0.17	50.00	Icicle Creek
S4-*35008JWRIS	Brisky, O	01/01/1901	IR	1.00	300.00	Icicle Creek
S4-*35009JWRIS	Fromm, S J	01/01/1901	IR	0.08	25.00	Icicle Creek

S4-*35010JWRIS	Fromm, S J	01/01/1901	IR	1.00	300.00	Icicle Creek
S4-*35001JWRIS	Cascade Orchards Inc	01/01/1905	IR	11.90	2,065.00	Icicle Creek
S4-CV1P170	Cascade Orchards Inc	01/01/1905	IR	0.20	--	Icicle Creek
S4-*35002ABBJWRIS	Icicle Irrigation District	04/01/1910	IR	81.58	25,000.00	Icicle Creek
S4-CV1P224	Icicle Irrigation District	04/01/1910	IR	1.75	--	Icicle Creek
S4-*35003ABBJWRIS	Snow Creek Water Users Inc	10/14/1910	IR	4.00	450.00	Snow Creek
S4-*35004JWRIS	City of Leavenworth	01/01/1912	MU	1.52	--	Icicle Creek
S4-*00329CWRIS	Peshastin Irrigation District	10/27/1919	IR	34.38	--	Icicle Creek
S4-CV1P18	Snow Creek Water Company	01/03/1922	IR	--	--	Snow Creek
S4-*05300CWRIS	USFS Wenatchee	11/06/1940	DM	0.05	--	Chatter Creek
CS4-01824C@2	USFWS Leavenworth Fisheries Complex	03/26/1942	FS	42.00	27,482.00	Icicle Creek
S4-*16124CWRIS	City of Leavenworth	06/20/1960	MU	1.50	--	Icicle Creek
S4-24376CWRIS	Falzon, D	08/03/1976	IR	0.05	10.00	Icicle Creek
S4-26394	Schmidt, W E	09/27/1979	DS, PW	3.00	1.00	Bridge Creek
S4-28122	City of Leavenworth	01/28/1983	MU	3.18	636.00	Icicle Creek

Source: Ecology, Water Resources Explorer, https://fortress.wa.gov/ecy/waterresources/map/WaterResourcesExplorer.aspx

Notes: Qi = Instantaneous Quantity; cfs = cubic feet per second; Qa = Annual Quantity; afy = acre-feet per year; FS = Fish Propagation; IR = Irrigation; MU = Municipal; DS = Single Domestic; PW = Power Generation; DM = Multiple Domestic

USFWS Diversionary Water Rights

USFWS holds diversionary rights to Icicle Creek that authorize the diversion of 42.00 cfs at RM 4.5. The water right authorizes the use of 27,482 acre-feet per year for fish propagation at LNFH. LNFH has an intermediate force-release performance goal of 1.2 million fish under U.S. v. Oregon, with that goal ultimately increasing to 1.625 million fish. This water right was changed in 2011 via a Chelan County Water Conservancy Board Decision to add a point of diversion at RM 2.8 in the hatchery spillway pool. This additional point of diversion is to be used on a contingency basis should the original point of diversion at RM 4.5 fail to provide sufficient water. The water use is considered non-consumptive and returns to Icicle Creek just below LNFH at approximately RM 2.6. This water right was not subject to the Icicle Creek adjudication, having a 1942 priority date. While diversionary records are not currently available, the change Report of Examination (ROE) and operations indicate the water right is likely in good standing.

COIC Diversionary Water Rights

COIC shares a point of diversion on Icicle Creek with LNFH at RM 4.5. Their water rights provide for the diversion of 11.9 cfs for irrigation of 600 acres. COIC has a 1905 priority date, as confirmed in the Icicle Creek water rights adjudication, and serves lands just south of the City of Leavenworth. In 1940, COIC applied to change a portion of their water right to provide water to LNFH, which was granted by Ecology in the form of Certificate of Change S4-CV1P170. According to the COIC Alternatives Analysis published in 2015, COIC uses approximately 2,000 acre-feet per year, with a peak diversion rate of about 8.0 cfs. LFNH uses the remaining 3.9 cfs authorized under the COIC water right in exchange for maintenance of the diversion infrastructure (WWT, 2015).

City of Leavenworth Diversionary Water Rights

City of Leavenworth has rights to divert 6.2 cfs from Icicle Creek. Their point of diversion is located at RM 5.7, across Icicle Creek from IPID's diversion. The priority dates of City of Leavenworth's water rights ranges from 1912 to 1983, with one of their water rights being adjudicated. The purpose of use for the water rights is municipal, which encompasses uses such as domestic, commercial, and irrigation. The City of Leavenworth has an estimated water service area population of 2,419 people.

The City of Leavenworth also has one pending water right application and several rejected water right applications for water from Icicle Creek for municipal use. As discussed in Section 1.7, Litigation Related to Water Management in the Icicle Creek Watershed, City of Leavenworth appealed Ecology permitting decisions regarding the quantity of their water rights. That litigation is currently on hold pending the outcome of comprehensive water resource planning.

In addition to the Icicle Creek diversion, the City of Leavenworth has groundwater rights, with points of diversion near RM 27.2 of the Wenatchee River. This location is approximately 0.6 mile upstream of the confluence of Icicle Creek and the Wenatchee River. These wells are drilled to approximately 94 and 106 feet deep and have state water rights authorizing the withdrawal of 1,190 acre-feet per year. The City maintains both sources for redundancy purposes, with the Icicle diversion being operational without power. Based on conversations with the City Manager, the City of Leavenworth may be amenable to exercising water made available through the Icicle Strategy from their Wenatchee River well field rather than their Icicle Creek diversion.

Much of the water diverted from Icicle Creek under the above described water rights is used for water service. The three water purveyors, City of Leavenworth, IPID, and COIC, provide water to approximately 3,250 parcels, although some parcels might be counted twice because of dual service (i.e., indoor water provided by City of Leavenworth and outdoor water provided by an irrigation district). Table 3-11 illustrates how many parcels are served by IPID, COIC, and City of Leavenworth. Additionally, this table shows parcels served by size class. As would be expected, the bulk of parcels served by the City of Leavenworth are smaller, less than half an acre in size, while the irrigation districts tend to serve larger parcels that are at least half an acre in size or more. It should be noted that some of the larger parcels served by the City may also have IPID or COIC service for outdoor irrigation.

Table 3-11
Number of Parcels Served by Entity per Parcel Size Class

Parcel Size	Parcels Served per Entity		
	City	COIC	IPID
0.00-0.10	108	0	0
0.11-0.25	552	0	128
0.26-0.50	270	12	234
0.51-1.00	150	65	361
1.01-2.00	122	118	353
2.01-3.50	36	19	135
>3.50	41	41	508
Total	1,279	255	1,719

3.6.1.3 Wenatchee River Watershed Instream Resources Protection Program

Ecology is required by state law to retain adequate amounts of water in streams to protect and preserve instream resources and uses, such as fish, wildlife, recreation, aesthetics, water quality, and navigation. Ecology does this through the implementation of instream flow rules. Per Chapter 90.22 RCW, Ecology can establish minimum flows or levels on streams and lakes by regulation. This statute sets forth the process for adopting instream flow rules. Instream flow rules are water rights, and consequently, have a priority date consistent with the date they are enacted.

Instream flow rules for The Wenatchee River Watershed are set forth under Chapter 173-545 WAC. The rule was originally adopted in 1983. All water rights in the Wenatchee River Watershed with a later priority date are junior to the instream flow rule and are subject to interruption when instream flows are below the targets prescribed in the rule. The rule was amended December 11, 2007, based on local watershed planning. The control point in Icicle Creek for measuring minimum instream flows is the Ecology gage 45B070 located downstream of LNFH. Figure 3-6 provides a graph of Icicle Creek minimum instream flows as set in WAC 137-545-060(1) compared to the 2015-year flows measured for Icicle Creek at Ecology gage 45070, and Figure 3-6 compares 2016 flows with the flows prescribed in WAC 137-545-060(1). Note, 2015 was a state-declared drought year, while 2016 was not. Minimum instream flows were not met either of these years and are generally not met in throughout the year in “average” years.

The Wenatchee Instream Flow Rule also established a reserve to the Icicle Creek Subbasin (WAC 173-545-090). This reservation was created with an OCPI determination and was affirmed through 2016 legislation after the Swinomish v. Ecology Washington Supreme Court Decision, which limited the use of OCPI determinations for creating reserves to instream flow rules. The reserve allows for the use of 0.1 cfs of water, with an additional 0.4 cfs to be considered after completion of flow restoration efforts targeting habitat on Icicle Creek between RM 5.7 and RM 2.7. Water uses established under the Icicle Creek reserve are not subject to the instream flows established in WAC 173-545-060.

The Wenatchee Instream Flow Rule also prescribes flows in the Wenatchee River at several control points. However, these flows are often not met in drought years, and are regularly not met in average water years. Figure 3-7 shows the Wenatchee Instream Flow Rule at the monitor gaging station with dry, average, and wet year flows.

Figure 3-6. Instream Flow Rule for Icicle Creek and 2015 Flows

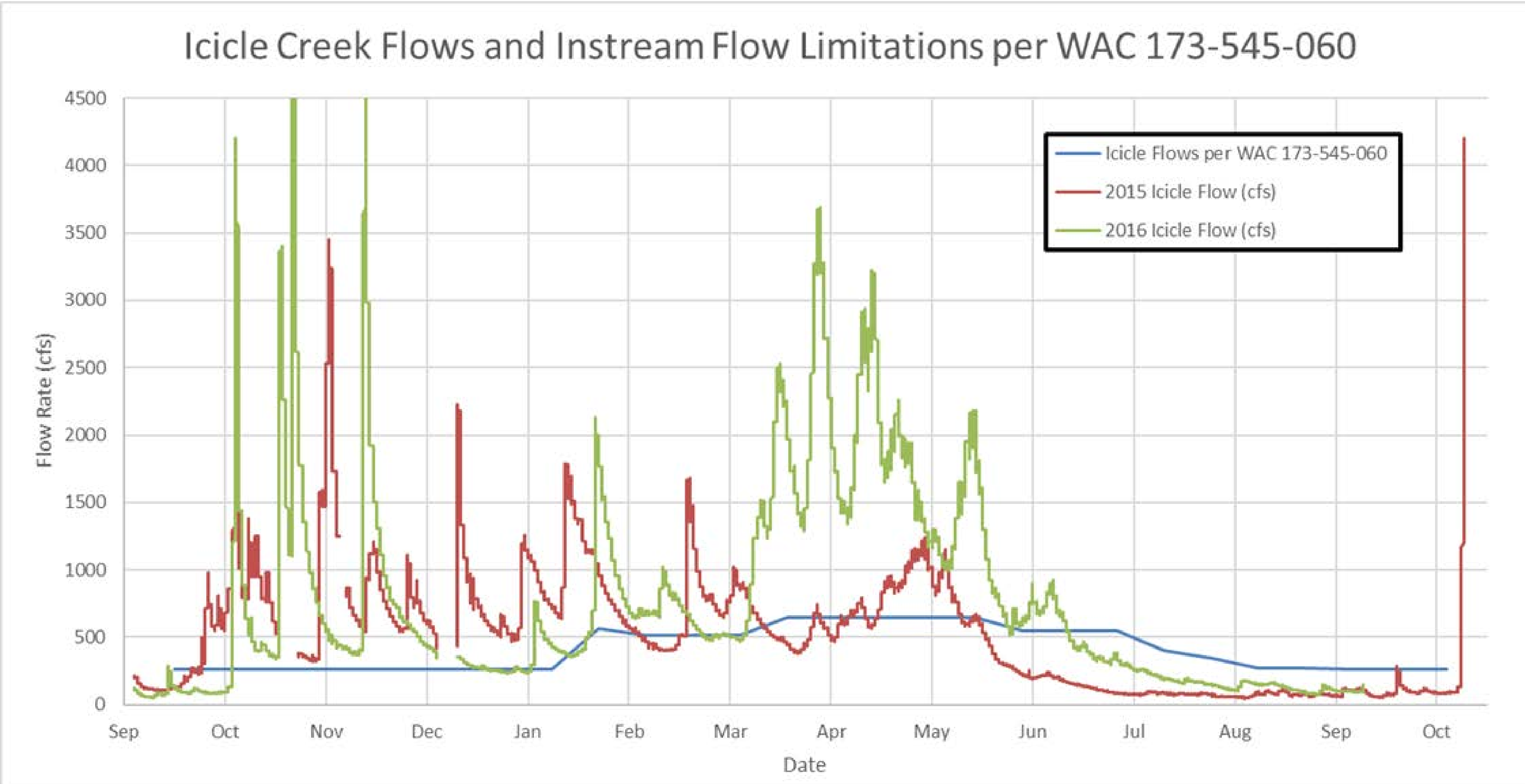
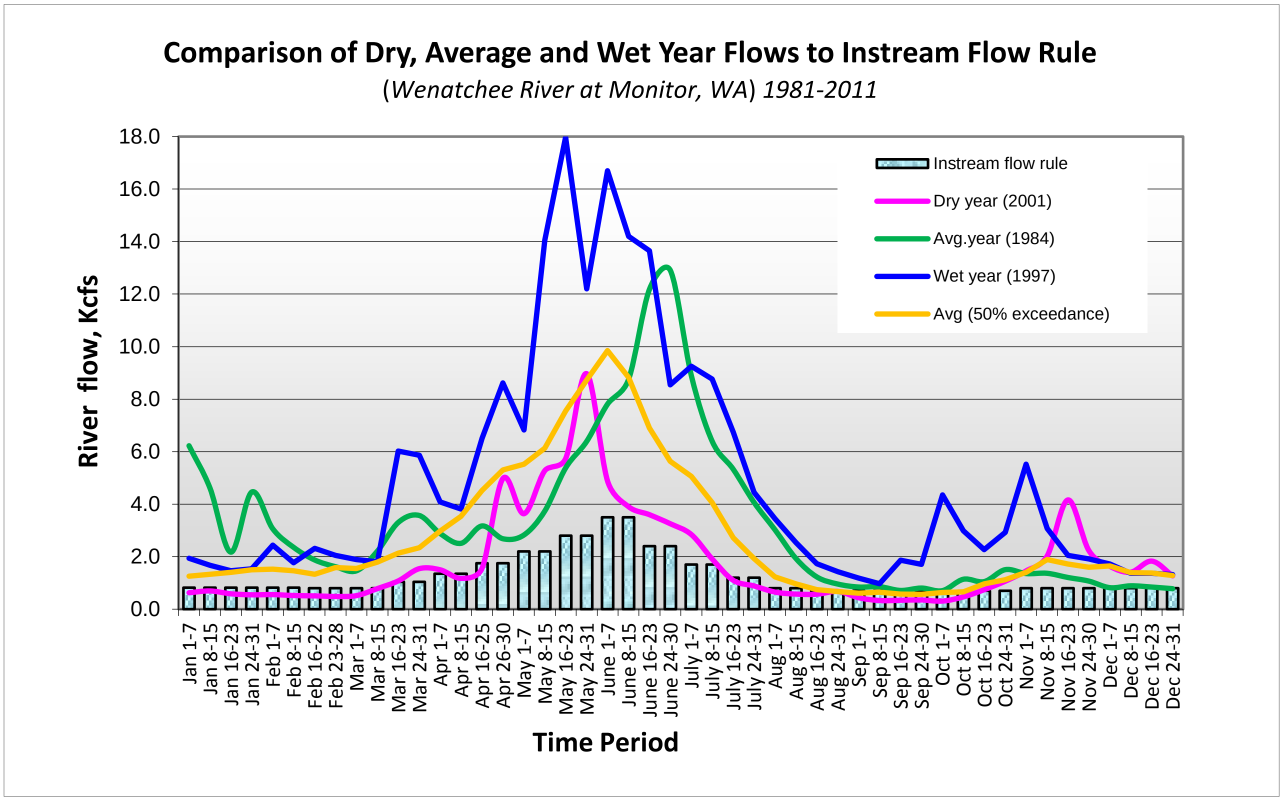


Figure 3-7. Wenatchee Instream Flow Rule at Monitor

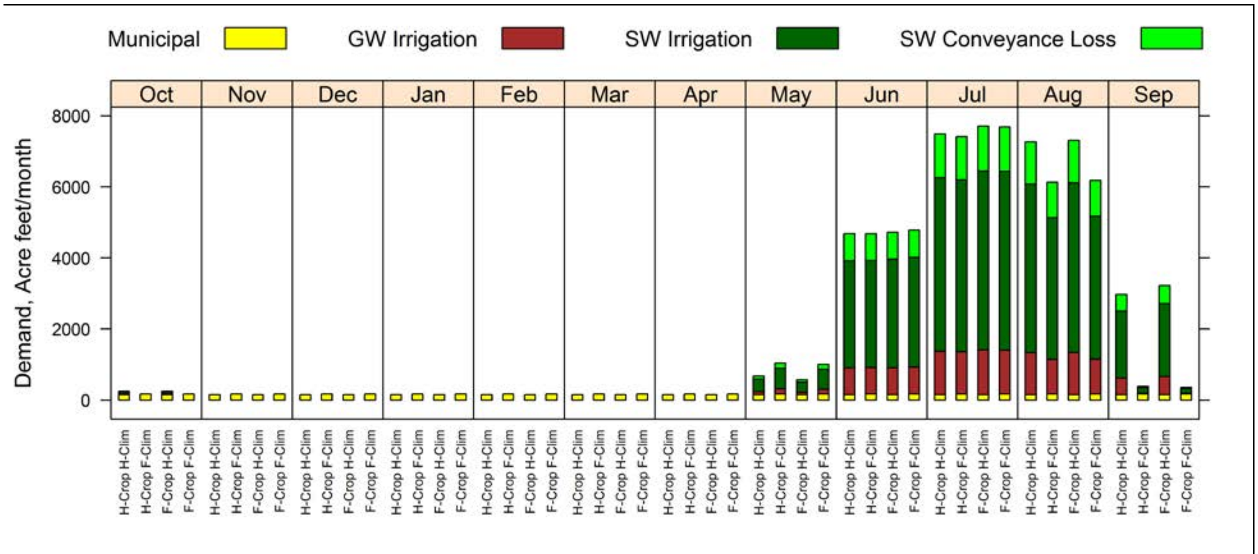


3.6.1.4 Wenatchee Valley Water Rights

The Wenatchee Valley supports a myriad of water uses from municipal to agricultural. Based on Ecology’s records, there are approximately 130 active water right records with the Wenatchee River listed as the primary source. Of these, there are 47 interruptible water rights in the Wenatchee Valley, with 34 being irrigation rights. These interruptible water rights account for 5.6 cfs and 1,150 acre-feet per year. The remaining Wenatchee Valley Water Rights account for 10,345 cfs, 32 percent of which is for fish propagation purposes, which is non-consumptive in nature.

The 2016 Columbia River Basin Long-Term Water Supply and Demand Forecast looked at historical and projected future water use demands in the Wenatchee River Watershed by use category. Figure 3-8 illustrates how much water per month has been used historically and is forecasted to be used through 2035. This does not account for instream flow water rights, which the report concluded is the highest demand use in the Wenatchee River Watershed. Figure 3-9 shows the total demand, including instream flow, compared with various flow scenarios.

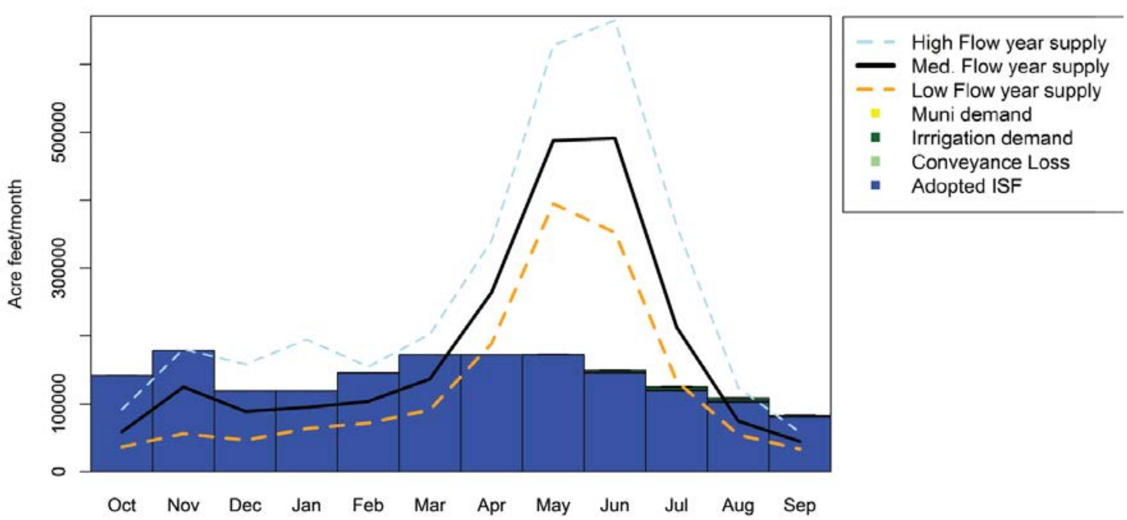
Figure 3-8. Historical and Projected Demand in the Wenatchee River Watershed



Source: Ecology, 2016, *2016 Columbia River Basin Long-Term Water Supply and Demand Forecast*

Note: H-Corp H- Clim = Historical Crops, Historical Climate; H- Crop F- Clim = Historical Crops, Future Climate; F- Crop H- Clim = Future Crop, Historical Climate; F-Crop F- Clim = Future Crops, Future Climate, where H-Crop represents historical crop mix (1981 to 2011); F-Crop as future crop mix (2035) under medium economic scenario; h-Clim as historical climate (1981 to 2011) and F-Slim values represent demand forecast under IPCC 4.5 centering 2035.

Figure 3-9. Comparison of Surface Water Supply and Demand (1981 to 2011)



Source: Ecology, 2016, *2016 Columbia River Basin Long-Term Water Supply and Demand Forecast*

3.6.2 Water Resource Infrastructure

Water Resources Infrastructure includes constructed impoundments (e.g., reservoirs), diversion infrastructure (e.g., diversion boxes and groundwater wells), and conveyance infrastructure (e.g., pipes and canals). A summary of the key water resource infrastructure and water uses are described in the following sections.

3.6.2.1 Storage Reservoirs

There are seven man-made reservoirs in the Icicle project area that coincide with the existence of former natural lakes. Those reservoirs are known as Square, Klonaqua, Eightmile, Colchuck, Upper Snow, Lower Snow, and Nada Lakes.

Square Lake

INFRASTRUCTURE DESCRIPTION

Square Lake is the most hydrologically distant reservoir in the system. Man-made improvements were constructed at Square Lake between the 1920s and 1950s with the goal of impounding approximately 2,400 acre-feet with an operational range of 31 feet. The purpose of storage is to make water seasonally available for irrigation within the IPID service area. Infrastructure at the lake consists of a rock-masonry dam structure that has artificially raised the maximum water surface elevation of the lake from 4,954 feet to approximately 4,985 feet. Mechanical outlet controlling works were also installed and consist of a 30-inch diameter cast iron slide gate with an above-grade mechanized handwheel actuator. The gate itself is installed near the exit of the outlet tunnel, which was blasted through bedrock (approximately 300 linear feet of 5-foot wide by 7-foot tall tunnel). Together, the improvements allow for an active storage volume of approximately 2,130 acre-feet and a release quantity of up to 35 cfs[5]. Other man-made improvements include approximately 230 feet of constructed channel that confluences with the natural channel approximately 260 feet downstream of the lake (spillway). A man-made weir structure was historically used for flow measurement; however, it is in disrepair and is no longer used.

Improvements to Square Lake were reviewed and approved by Washington State Department of Hydraulics in 1939.

OPERATION

Square Lake is one of four storage sites in the Alpine Lakes Wilderness actively managed by IPID. During typical years, only one or two of the lakes is actively managed to increase late summer releases to the Icicle Creek. During drought years, water is withdrawn from most of the lakes. Because Square Lake is more remote and difficult to access, it is operated less frequently than other lakes such as Colchuck and Eightmile Lakes.

During the years when Square Lake is actively managed, IPID personnel hike approximately 13 miles (one way) to the lake to open the gate to start releasing water in July. IPID personnel return in Late September or October to close the gate after the lake has been drawn down and the irrigation season is over. Water flows from the tunnel and

[5] Flows have been measured as high as 35-cfs as recently as 2016; however, significantly higher flows are likely achievable during lake-full conditions.

discharge channel to Prospect Creek, which flows to Leland Creek, which is a tributary to Icicle Creek. The lake refills during the spring when the gate is closed. When the lake is full, water flows over the dam spillway to Prospect Creek. Water continues to flow through the lake and over the dam spillway uncontrolled until the gate is opened again. Although Square Lake is only utilized on a rotational basis, the lake has the potential to refill annually (Aspect and Anchor QEA, 2015).

Upper and Lower Klonaqua Lake

INFRASTRUCTURE DESCRIPTION

Upper and Lower Klonaqua Lake are the second most hydrologically distant lakes and include both an upper and lower lake (two lakes total); however, only one lake (Lower Klonaqua) has been improved to allow for active storage / release of water without pumping. Permanent man-made improvements were constructed at Lower Klonaqua in the 1920s and 1930s with the goal of impounding approximately 2,500 acre-feet of water by IID. The purpose of stored water is for seasonal release into French Creek / Icicle Creek (conveyance purposes) and recapture similar to release from Square Lake. Infrastructure at the lake consists of an earthen and rock-masonry dam structure and spillway that has artificially raised the maximum water surface elevation of the lake to approximately 5,094 feet with an operational range of 28 feet. The dam itself is approximately 10 to 12 feet wide at the dam crest. Mechanical outlet controlling works were also installed as part of the original construction and consist of a 30-inch diameter cast iron slide gate with above-grade mechanized handwheel actuator positioned in a vertical gate shaft accessible from the surface. As-built drawings indicate the outlet works tunnel was constructed as a combination of blasting and cut / cover piping.

Based on LiDAR survey and field observations, the improvements allow for an active storage volume of approximately 1,690 acre-feet. Other man-made improvements include approximately 60 feet of constructed channel that confluences with the natural channel approximately 200 feet downstream of the lake (spillway). The existing outlet tunnel has partially collapsed and is due for maintenance; however, storage release flows of up to 25 cfs[6] have been measured as recently as July 2016 despite apparent flow obstructions.

OPERATION

Klonaqua Lake is one of the four storage sites in the Alpine Lakes Area managed by IPID. During an average water year, only one or two of the IPID-managed lakes is actively managed to increase late summer releases to Icicle Creek. Because Klonaqua Lake (Lower) is more remote and difficult to access, it is operated less frequently than Colchuck and Eightmile Lakes.

During the years when Klonaqua Lake is actively managed, IPID personnel hike more than 10 miles (one way) to the Lower Klonaqua Lake to open the gate in July. IPID personnel return to close the gate in late September or October when the lake is drawn down and the irrigation season is over.

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[6] Flows have been measured as high as 25 cfs; however, significantly higher flows are likely achievable during lake-full conditions.

When the gate is open, water discharges through the tunnel and discharge channel to an unnamed creek, which flows to French Creek, which is a tributary to Icicle Creek. Based on recent experience and observations from IPID personnel, Lower Klonaqua Lake typically refills by the summer following the irrigation season when the lake is drawn down. When the lake is full, water flows over the dam spillway. Water continues to flow through the lake and over the dam spillway uncontrolled until the gate is opened again.

Eightmile Lake

INFRASTRUCTURE DESCRIPTION

Eightmile Lake is a tributary reservoir of Eightmile Creek, which has a confluence with Icicle Creek at approximately RM 9.0. Man-made improvements were constructed at Eightmile Lake in the 1920s, resulting in an approximate reservoir elevation of 4,671 feet and a 27-foot operational range originally. This lake functions similar to the other IPID-managed lakes in that water is seasonally released and conveyed through natural channels to the IPID diversion at RM 5.7 of Icicle Creek.

Infrastructure at Eightmile Lake is a combination of earthen embankment and rock-masonry dam and spillway structure with a slide gate controlling the outlet works in the lake during lake-full conditions. The controlling works at Eightmile Lake included a rock-masonry tower positioned above the outlet pipe that supported a handwheel actuator for the outlet gate that controls flow from the lake to low-level outlet pipeline. The rock-masonry tower was destroyed, and the gate actuator was damaged by ice or debris flows (leaving only the gate and partial stem intact). The gate at Eightmile Lake is functional; however, IPID attaches a log to the gate stem to use as a come-along to open and close the gate. In addition, rocks and debris that settle against the gate make it difficult to open and close.

A portion of the existing earthen embankment portion of the dam at Eightmile Lake was eroded during flooding, which has reduced the maximum water surface elevation by at least 4 feet and has limited the storage available for release without the use of pumps or a siphon. The condition of the existing facilities at Eightmile Lake has limited the active storage volume to 1,370 acre-feet with an operational range of 23 feet.

In addition, portions of the low-level outlet pipeline have collapsed. IPID has noticed a significant, recent reduction in the capacity of the low-level outlet as a result of the constriction in the pipe caused by these collapses. IPID has noted that if the low-level outlet capacity is not restored by the time another drought occurs, they will be very limited in their ability to sustain irrigation supplies diverted from Icicle Creek because of diminished flows.

The Jack Creek fire burned much of the upland watershed, including up to the shore of Eightmile Lake, in the summer of 2017. The fire burned trees and brush over a large catchment of Eightmile Lake. The hydrologic characteristics of runoff from the watershed are likely to change due to the burn, resulting in much higher peak runoff rates in the short term during large storm events. These changes increase the risk of potential overtopping and erosion of the embankment, or even complete failure of the existing dam at Eightmile Lake. To address this risk, IPID declared an emergency on March 13, 2018 and is working with Chelan County, Ecology's Dam Safety Office, USFS, National Weather Service, and others to develop and implement emergency action procedures.

OPERATION

Eightmile Lake is one of the four storage sites in the Alpine Lakes Wilderness Area that are managed by IPID. During a typical year, only one of the IPID-managed lakes is actively managed to increase late summer releases to the Icicle Creek. Because of its proximity to Icicle Creek and relative ease of access, the controls at Eightmile Lake are operated more frequently than the controls at the more remote lakes.

The gate on the low-level outlet pipe of Eightmile Lake controls releases from the lake. To actively manage the storage in Eightmile Lake, IPID personnel hike approximately 4 miles (one-way) to the lake to open the gate on the discharge pipeline in July. IPID personnel return to close the gate in late September or October when the lake is drawn down and the irrigation season is over. Release flows as high as 22 cfs[7] were measured from Eightmile Lake during summer 2016.

When the gate is open, water discharges through the low-level outlet to Eightmile Creek, which is a tributary to Icicle Creek. Based on recent experience and observations from IPID personnel, the lake typically refills by the summer following the irrigation season when the lake is drawn down. The active storage capacity available for release and the equivalent volume that has to be refilled is limited by the condition of the dam at the outlet. When the lake is full, water flows over a deteriorated dam spillway outlet to Eightmile Creek. Water continues to flow through the lake uncontrolled until the gate is opened again.

Colchuck Lake

INFRASTRUCTURE DESCRIPTION

Like Eightmile, Colchuck Lake is a tributary reservoir of Eightmile Creek, which has a confluence with Icicle Creek at approximately RM 9.0. Man-made improvements were constructed at Colchuck Lake in the 1920s and 1930s, raising the elevation level to 5,563 feet with an operational range of 17 feet. This lake functions similar to the other IPID-managed lakes in that water is seasonally released and conveyed through natural channels to the IPID diversion at RM 5.7 of Icicle Creek.

Infrastructure at this lake includes a concrete / rock-masonry dam and spillway with a slide gate controlling the outlet works in the lake during lake-full conditions. The controlling works at Colchuck Lake include a rock-masonry tower positioned above the outlet pipe that supports a handwheel actuator for the outlet gate. The control tower is accessible by footbridge. IPID has made recent improvements to the lake, including installation of a buried liner near the dam to limit unwanted seepage. A controlled outlet from the lake generally follows natural channel alignment.

The existing facilities at Colchuck Lake allow for an active storage volume of 1,480 acre-feet with an operational range of 17 feet.

[7] Flows have been measured as high as 22 cfs; however, higher flows may be achievable during lake-full conditions.

OPERATION

Colchuck Lake is one of the four storage sites in the Alpine Lakes Wilderness Area that are managed by IPID. During an average water year, only one of the IPID-managed lakes is actively managed to increase late summer releases to the Icicle Creek. Because of its proximity to Icicle Creek and relative ease of access, the controls at Colchuck Lake are operated more frequently than the controls at the more remote lakes.

The configuration of the dam and infrastructure at Colchuck Lake is similar to Eightmile Lake. The gate, which is located at the inlet to a corrugated metal low-level outlet pipe, controls releases from the lake. To actively manage the storage in Colchuck Lake, IPID personnel hike approximately 4 miles (one way) to the lake to open the gate on the discharge pipeline in July. IPID personnel return to close the gate in late September or October when the lake is drawn down and the irrigation season is over. Release flows as high as 25 cfs[8] were measured from Colchuck Lake during summer 2016.

In the fall of 2012, IPID lowered the lake level at Colchuck Lake sufficiently to perform maintenance on the dam and the control gate. Concrete was added to repair the dam and plug holes in the foundation, which had been leaking. Debris and logs that had built-up on the upstream side of the dam were removed. Maintenance was performed on the control gate and a plank was installed to improve access to the gate. Additional maintenance was performed in fall of 2016 to reduce seepage losses through the dam infrastructure.

Water discharge from Colchuck Lake flows through the low-level outlet pipe to an unnamed creek, which flows to Mountaineer Creek and subsequently Eightmile Creek, which is a tributary to Icicle Creek. Based on recent experience and observations from IPID personnel, the lake typically refills by the summer following the irrigation season when the lake is drawn down. When the lake is full, water flows over the dam spillway outlet to the unnamed creek. Water continues to flow through the lake uncontrolled until the gate is opened again.

Upper and Lower Snow Lakes and Nada Lake

INFRASTRUCTURE DESCRIPTION

Upper Snow Lake, Lower Snow Lake, and Nada Lake drain to Snow Creek, which is another tributary to Icicle Creek. Reservoir improvements at the lakes consist of three man-made dams and one constructed tunnel. The dams operate to provide maximum normal water surface elevations of 5,433 feet at Upper Snow Lake and 5,429 feet at Lower Snow Lake, and control outflow on Nada Lake. The Lower Snow Lake Dam is a rock-masonry structure constructed across the natural outlet to Snow Creek. There is not currently any control of the flow of water through Lower Snow Lake Dam. Water flows freely over the dam to Snow Creek when the lake is full.

The Upper Snow Lake Dam is also a rock-masonry structure that controls flow from Upper Snow Lake to Lower Snow Lake. When Upper Snow Lake is full, water flows over the dam to Lower Snow Lake and on to Snow Creek. When the Upper Snow Lake is

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[8] Flows have been measured as high as 25 cfs; however, significantly higher flows may be achievable during lake-full conditions.

drawn down sufficiently, water flows from Lower Snow Lake back to Upper Snow Lake through an opening at the base of the Upper Snow Lake dam controlled by a flap gate. The flap gate is designed to allow for one-way flow from Lower Snow Lake back to Upper Snow Lake, but the USFWS has indicated that the gate leaks. Upper Snow Lake has an operational range of approximately 160 feet that is controlled through an outlet works tunnel between Upper Snow and Nada Lakes. The tunnel was constructed in the 1930s and involves three controlling valves that are operated in sequence to control releases. Once the system is operating, only one valve is required to modulate flow from Upper Snow Lake to Nada Lake.

A dam reconstruction project was completed at Nada Dam, downstream of Upper and Lower Snow Lakes, in 2009. The new dam at the outlet from Nada lake is not currently being used to control the water level in the lake. The dam is a concrete structure with two bays for stop-logs or future slide gates. A Parshall flume was installed below the dam for flow measurement and monitoring. Flow depth is recorded by battery powered monitoring equipment in a stilling well adjacent to the flume. A solar panel is used for recharging the batteries of the monitoring equipment (Aspect/Anchor, 2015).

Based on a 2016 LiDAR survey, the active storage of the Snow Lakes is estimated at 12,590 and 140 acre-feet, respectively.

OPERATION

Upper and Lower Snow Lakes and Nada Lake are operated by the USFWS as part of their management of the LNFH. The operation of these facilities was reviewed in the following recent studies:

- *Management Recommendations for Reservoir Releases from Upper Snow Lake: Leavenworth National Fish Hatchery* (Wurster, 2006)
- *Water Storage Report, Wenatchee River Basin* (Anchor QEA, 2011)

The lakes are operated jointly to increase late summer flows in Snow Creek, which is a tributary to Icicle Creek. The increased flows to Icicle Creek help supply the LNFH's operational requirements (approximately 40 cfs between June and October) and supplement flow in Icicle Creek.

Upper Snow Lake

Upper Snow Lake is actively managed by the USFWS. Water is released from Upper Snow Lake to Nada Lake through the outlet works tunnel and penstock. LNFH personnel hike to a valve shed above Nada Lake (more than 6 miles one way) to open the valve on the penstock in July each year. The valve remains open during the late summer months, typically between mid-July and mid-October. LNFH personnel may return to the lake to adjust the valve during that time to increase the rate of release. Historically, the valve was open an average of 77 days each year between 1998 and 2005, with an average annual release of 3,700 acre-feet (Wurster, 2006).

The USFWS currently operates Upper Snow Lake in accordance with the *Management Recommendations for Reservoir Releases from Upper Snow Lake: Leavenworth National Fish Hatchery* (Wurster, 2006). The USFWS currently releases approximately 7,000 acre-feet from Upper Snow Lake to Nada Lake from July to October. Releases start around 30 cfs in late July and may increase to 60 cfs as natural flows in Icicle Creek drop. After the valve on the outlet is closed in the fall, Upper Snow Lake refills. For 6 of the 7 years (1998 to 2005, excluding 2000) that were evaluated in the *Management Recommendations for Reservoir Releases from Upper Snow Lake: Leavenworth National Fish Hatchery*, Upper Snow Lake was full by the time the valve was opened the following summer. The only year when Upper Snow Lake did not fully refill was 2001, which was a drought year.

At the end of the summer when Upper Snow Lake has been drawn down, the water level in Upper Snow Lake is typically lower than the water level in Lower Snow Lake. Water flows from Lower Snow Lake to Upper Snow Lake through a small (approximately 9-square-foot) hole and flap gate at the base of Upper Snow Lake Dam. In 2005, it was estimated that approximately 200 acre-feet of water passed through the opening.

More information regarding the current condition and operations of the infrastructure is available in the Draft Environmental Assessment issued in 2017 (USBORUSBR, 2017). This assessment was completed to analyze the impacts of installing a new valve at the Upper Snow Lake outlet.

Lower Snow Lake

Lower Snow Lake is not actively managed by USFWS. When Lower Snow Lake is full, water spills over the dam or discharges to Snow Creek through a breach that was identified on the east side of the dam during the 2008 *Safety Evaluation of Existing Dams (SEED) Inspection* (WW Wheeler and Associates, 2009a). Water was observed in the channel downstream of the dam during a site visit on September 25, 2009. During that site visit, the water level behind the dam was 2 to 3 feet lower than the crest of the dam, which indicates that water still flows from the lake through a breach or through leaks in the dam, even when the water level is below the crest of the dam.

Hydrologic Monitoring

The USFWS monitors flows at four sites within the Snow Creek Subbasin. Flows are monitored on Snow Creek at the inflow to Upper Snow Lake, at the penstock that discharges from Upper Snow Lake to Nada Lake, at the flume at the outlet of Nada Lake, and at the confluence with Icicle Creek. The USFWS has actively monitored these sites since 2004 using data loggers to collect data over extended periods of time. This data helps the USFWS manage releases from the lakes.

3.6.2.2 Diversion Infrastructure

Use associated with surface water diversion infrastructure is described in Section 3.19 (Utilities); however, additional description is provided below. There are three significant diversion facilities along Icicle Creek, including surface water diversion for IPID, COIC, City of Leavenworth, - LNFH, and USBR. There are also many individual irrigation diversions that are not specifically identified herein. Furthermore, LNFH also utilizes groundwater well sources for supply.

IPID Diversion

The IPID diversion includes both an in-channel reinforced concrete dam / spillway and a controllable concrete intake structure on the right bank of Icicle Creek at RM 5.7 (controllable with flashboards). The intake structure was recently rehabilitated by IPID in 2015 to improve efficiency. Water is diverted to a reinforced concrete channel. Headgates and an overflow in the diversion channel downstream of the intake structure provide additional control of flow in IPID diversion channel. A rotating drum fish screen at the downstream end of the diversion channel delivers flow to the IPID Division 1 Canal. A bypass delivers excess flow and fish back to Icicle Creek at the fish screen. Flow is measured in a rated section of the channel downstream of the headgates. Diverted quantities at this location are approximately 117 cfs.

City of Leavenworth

The City of Leavenworth utilizes a surface water diversion from Icicle Creek at RM 5.7, on the left bank of Icicle Creek across the creek from IPID's diversion facilities. Both facilities draw from the pool created by the IPID Diversion Dam. City of Leavenworth facilities include a vertical flat panel fish screen in a reinforced concrete enclosure that protects the screen and diversion facilities from ice and debris. A gate on the upstream side of the enclosure is opened to provide sweeping velocity across the screen. Diverted quantities by the City of Leavenworth are approximately 6.2 cfs at this location.

COIC / LNFH Diversion

COIC and LNFH share a diversion at RM 4.5. The diversion includes an in-channel reinforced concrete dam / spillway with a fish ladder, a fish screen, and a gate house that controls flow from the creek to buried pipeline. Water flows through approximately 1,400 feet of buried pipeline to a bifurcation facility that splits flow to the COIC and LNFH systems. The bifurcation includes a large valve on the pipeline that can be opened to release flow from the pipeline to a reinforced concrete box operated by COIC. The concrete box includes a rotating drum fish screen, an overflow bypass, and a weir that measures flow delivered to COIC. Flows not delivered to COIC at the bifurcation are conveyed to LNFH. Diverted quantities at this location are approximately 8 cfs delivered to COIC, with the remaining 3.9 cfs authorized under their right going to LNFH, and up to 46 cfs, delivered to LNFH.

3.7 Fish

This section describes the fish species and life stages present, their distributions, species status, and habitat conditions within the project area. Aquatic invertebrate community structure and influence of habitat conditions are also described. Information on special-status species is provided in Section 3.10, Threatened and Endangered Species. Information on tribal fishing harvest is provided in Section 3.23, Indian Trust Assets and Tribal Fish Harvest.

3.7.1 Alpine Lakes

The Alpine Lakes are included in a group of mountain lakes managed in Washington as "high lakes," which in Eastern Washington are generally considered to be those occurring at an elevation greater than 3,500 feet. Historically, most of the high lakes of Washington lack suitable spawning habitat or productive conditions for rearing juveniles, and probably contained no fish prior to introductions of sport fish by humans (Wydoski and Whitney, 2003). Currently, Washington's high lakes are managed to "protect, restore, and enhance fish populations and their habitats in high lakes while maximizing recreational opportunities consistent with natural resource protection guidelines" (Uehara, 2009). The high lakes fishery is now managed by WDFW to support recreation goals in balance with environmental considerations (Pfeifer, Swayne, and Curtis, 2001). Fish abundance and stocking are tracked by WDFW with the help of volunteer high lakes fishing organizations.

Human introduction of trout and char into the high lakes began as early as the late nineteenth century by settlers, loggers, and miners, and perhaps even earlier by Native American tribes. Some lakes were still periodically stocked by WDFW and volunteers into the 2000s to support a high lakes recreational fishery; however, the majority remain fishless (WDFW, 2016a). Although some lakes have self-sustaining populations, the stocked lakes are managed to sustain low densities and more recently are stocked with fish that would not reproduce successfully, limiting the likelihood of unmanaged population growth in the lakes (Pfeifer, Swayne, and Curtis, 2001).

All of the lakes included in the Icicle Strategy were stocked in the past, but stocking has been discontinued because of lack of funding or sufficient natural reproduction (Maitland, 2016). All lakes were stocked with westslope cutthroat trout (*Oncorhynchus clarki lewisi*) at one time, some with rainbow trout (*O. mykiss*), and some with non-native eastern brook trout and lake trout (*Salvelinus fontinalis* and *Salvelinus namaycush*) (Table 3-12).

Table 3-12
Summary of Alpine Lakes Trout Stocking Status

Lake	Trout Species	Last Year Stocked
Colchuck Lake	Cutthroat	2000
Eightmile Lake	Cutthroat, Rainbow, Lake	2005
Lower Klonaqua Lake	Cutthroat, Rainbow	1970
Upper Klonaqua Lake	Cutthroat	1970
Nada Lake*	Eastern Brook	Unknown
Lower Snow Lake*	Cutthroat, Eastern Brook	Unknown
Upper Snow Lake*	Cutthroat, Eastern Brook	Unknown
Square Lake*	Cutthroat, Rainbow	1979

*Sufficient natural reproduction

3.7.1.1 Habitat Conditions

The Alpine Lakes are relatively pristine compared to downstream habitats, having changed little from conditions prior to European settlement. The Alpine Lakes are characterized by naturally low productivity and provide relatively limited habitat potential for fish primarily because of cold water supplied by melting snow or glaciers, a short growing season, location at the head of the watershed, and lack of inputs of organic material. The primary changes to Alpine Lakes habitat include structures constructed to manage surface water and the introduction of sport fish, including non-native trout.

3.7.2 Icicle Creek Corridor

The Alpine Lakes discharge water to a series of small creeks that are tributaries to Icicle Creek, which is a major tributary to the Wenatchee River. Within the watershed, Icicle Creek provides important high quality and relatively undisturbed headwater habitat for a variety of anadromous[9] and resident[10] fish. 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 (*O. tshawytscha*), Upper Columbia summer steelhead (*O. mykiss irideus*), and bull trout (*Salvelinus confluentus*) depending on flows and passage through several natural and artificial barriers (Dominguez et al., 2013). However, as noted in Table 3-13, fish habitat in Lower Icicle Creek is reduced in late summer and early fall because of low instream flows during this time of year.

Table 3-13
Current Habitat Limitations on Lower Icicle Creek

Reach	River Miles	Affected Species/Life Stage	Average Year: Months When Target WUA Not Achieved	Low Flow Year: Months When Target WUA Not Achieved
5	0.2 to 2.4	Steelhead rearing	Late July to late October	Mid-June through October
		Bull trout spawning	None	September through October
4 (Historical Channel)	2.7 to 3.9	Steelhead rearing	Early August to late October	Mid-June through October
		Bull trout rearing	Early August to late October	Mid-June through October
3	3.9 to 4.5	Steelhead rearing	Early August to late October	Early to mid-April and mid-June through October
		Bull trout rearing	Early August to late October	Early to mid-April and mid-June through October
1, 2	6.0 to 9.1	Steelhead rearing	September	ND
		Cutthroat trout rearing	September	ND

Note: conclusions from Granger, 2017
ND = No Data. Analyses have not been performed.
WUA = weighted usable area

[9] Life history pattern of spawning and rearing in tributary streams and migrating to the ocean.
[10] Life history pattern of residing in tributary streams for the fish's entire life without migrating.

Fish passage above LNFH is generally considered to be limited, particularly above the Boulder Field at RM 5.6, which serves as a natural barrier under typical flow conditions. Low numbers of anadromous steelhead and Chinook salmon can pass through the Boulder Field; biologists recently observed two redds[11], and one juvenile anadromous Chinook salmon was observed upstream of the Boulder Field (WDFW, 2016). It is unlikely that coho salmon (*O. kisutch*) can ascend the Boulder Field.

Currently, operation of Structure 5 just downstream of the Boulder Field also limits fish passage during spring and early summer when broodstock collection for LNFH is occurring (mid-May through June). Structure 5 is closed in order to capture and prevent passage of hatchery fish to areas farther upstream. This also prohibits non-hatchery fish from moving upstream of LNFH during this time. Operation of Structure 2 can also limit passage by decreasing flows in this reach when the gates are closed to divert water into the Hatchery Channel. As the operators of LNFH, USFWS coordinates with WDFW, National Oceanic and Atmospheric Administration (NOAA) Fisheries, the Confederated Tribes and Bands of the Yakama Nation, and the Confederated Tribes of the Colville Reservation on the timing of the adjustments for broodstock collection and closing of the gates at Structure 2 to minimize potential impacts on anadromous fish and tribal fishing that occurs at the plunge pool in front of the LNFH.

3.7.2.1 Anadromous Fish

Anadromous fish returning to Icicle Creek are dominated by spring-run Chinook salmon produced at LNFH that pass through Lower Icicle Creek to return to the LNFH facility in spring and early summer. Natural spawning of native anadromous fish is reduced from historical conditions as a result of habitat degradation, including flow diversions, and overfishing. Historical barriers to upstream passage at LNFH also have limited natural anadromous fish spawning to the lower 2 RM of Icicle Creek until improvements to fish passage in recent years.

Icicle Creek also provides spawning habitat for native anadromous fish, including the Upper Columbia spring-run Chinook salmon and Upper Columbia summer steelhead. Both species are listed as endangered under the ESA and are discussed in greater detail in Section 3.10, Threatened and Endangered Species.

LNFH Spring-run Chinook Salmon

Spring-run Chinook salmon are raised at the LNFH as mitigation for the Grand Coulee Dam (USFWS, 2016a). Between 2000 and 2015, the number of adult LNFH spring-run Chinook salmon returning to Icicle Creek each year ranged from 2,403 (in 2013) to 15,082 (in 2001) (O'Brien, 2016). Creel surveys indicate that between 3 percent and 21 percent were caught in the sport fishery in Icicle Creek each year during the same period. A small number were observed in snorkel surveys upstream of LNFH (USFWS, 2016b).

[11] Spawning nests located in stream gravel or lakeshores.

3.7.2.2 Resident Fish

Icicle Creek also supports several key species of resident fish, including bull trout, protected under the ESA: rainbow trout, westslope cutthroat trout, and other species of minnows, sculpins, and suckers.

Bull Trout

Bull trout are distributed throughout the Wenatchee River Watershed, including in Icicle Creek. The Columbia River bull trout distinct population segment (DPS) are listed as threatened under the ESA (USFWS, 1998). A distinct native bull trout population exists in Icicle Creek (USFWS, 2015).

Icicle Creek and other headwater areas of the basin offer some of the best habitat in the Mid-Columbia region. Bull trout spawn in cold, clear headwaters near the crest of the Cascade Mountains that are too cold for other anadromous species. Populations are isolated to headwater areas by downstream conditions that are too warm for incubation and early rearing.

Multiple life-history types of bull trout exist in the Wenatchee River Watershed (USFWS, 2015; Cappellini, 2001). 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. Some resident forms that remain close to spawning areas throughout their life cycle are likely to exist given suitable headwater conditions. A small percentage of the population (15 to 20 percent) may migrate long distances to other subbasins of the Columbia River for foraging or overwintering and may return to spawning areas annually every few years. It is unlikely that many bull trout from the Wenatchee River Watershed are fully anadromous. Bull trout may return to spawning areas weeks to months prior to spawning. Most populations in the Wenatchee River Watershed spawn from mid-September to mid-October (USFWS, 2015).

Juveniles eat invertebrates, and subadults and adults eat mainly fish. Bull trout are a highly effective predator on smaller fishes and can limit juvenile salmon populations in some locations (Wydoski and Whitney, 2003). Bull trout are extremely sensitive to habitat degradation by humans because they require cold, clear water for spawning. Bull trout are also threatened by hybridization with eastern brook trout and overharvest by anglers.

Prior to improvements to fish passage management at LNFH in 2001, low numbers of widely dispersed bull trout were observed in the Icicle Creek drainage, mainly in upper Icicle Creek and lower Jack Creek, and with the majority observed below passage barriers at LNFH (Ringel, 1997; Cappellini, 2001). Since 2003, bull trout snorkel surveys have been conducted in Icicle Creek from the Boulder Field area near the confluence with Snow Creek to the confluence with the Wenatchee River. Fish counts have ranged from 10 fish in 2011 to 157 fish in 2009 (USFWS, 2009, 2016b).

Rainbow Trout

Rainbow trout are the most commonly observed fish species in Icicle Creek and tributaries draining the Alpine Lakes (Ringel, 1997; USFWS, 2016b). Genetically identical to steelhead trout, rainbow trout exhibit a non-migratory resident life history. In some cases, steelhead progeny may take on resident life-histories in subsequent generations and vice-versa. As juveniles, rainbow trout cannot be distinguished from steelhead. 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 varies greatly and occurs between age 1 and 5 years, depending on water conditions. Rainbow trout spawn in the spring between February and June, and unlike salmon, may spawn many times over a lifetime. Rainbow trout feed mainly on drifting aquatic and terrestrial invertebrates, and only occasionally on other fish.

Westslope Cutthroat Trout

Westslope cutthroat trout are widespread throughout Icicle Creek (Wydoski and Whitney, 2003). The historical distribution was limited to two adjacent river basins, the Lake Chelan and Methow Basins, in the mid-Columbia river and in the Pend Oreille River in northeastern Washington; however, widespread stocking of hatchery-reared fish and subsequent establishment of self-reproducing populations has expanded the distribution of the subspecies to nearly all tributary rivers and streams of the mid- and upper-Columbia River. Extensive stream surveys during the 1990s documented naturally reproducing populations of westslope cutthroat trout in nearly every tributary above 3,000 feet elevation across the Cascade Mountains.

Westslope cutthroat trout in Icicle Creek and the Wenatchee River may have a resident or fluvial life-history (Wydoski and Whitney, 2003). Fluvial forms may return to small tributaries for refuge during high flows. Adult westslope cutthroat trout spawn from March to July in in relatively low densities compared to other salmon in small, cold headwater streams with gravel and cobble substrates and well-oxygenated water. Fry emerge in late spring or summer. Both forms remain mostly stationary as juveniles, establishing feeding stations in low-velocity, moving water. Juveniles tend to move into pools in the fall, seeking suitable winter habitat, and fluvial forms will overwinter in deeper pools and beaver ponds. Westslope cutthroat trout feed on drifting insects, zooplankton, and other larval aquatic invertebrates, and their growth is determined by the length of the growing season, productivity, and water temperatures in headwater areas. Fluvial forms that move into more productive and warmer rivers tend to grow faster and larger, up to 10 to 12 inches over 10 years.

Westslope cutthroat trout populations are likely impacted in Icicle Creek by hybridization with rainbow trout introduced for sport fisheries and by displacement by rainbow trout and non-native eastern brook trout. Introduced eastern brook trout have displaced westslope cutthroat trout in many low gradient reaches of tributary streams, including Eightmile Creek, a tributary to Icicle Creek (Griffith and Leary, 1988). Because of their small size and slow growth, westslope cutthroat trout are vulnerable to predation by native bull trout. All cutthroat trout are vulnerable to overfishing by recreational anglers.

Other Resident Fishes

The community of native resident species in Icicle Creek also includes mountain whitefish (*Prosopium williamson*), longnose sucker (*Catostomus catostomus*), bridgelip sucker (*Catostomus columbianus*), longnose dace (*Rhinichthys cataractae*), redside shiner (*Richardsonius balteatus*), northern pikeminnow (*Ptychocheilus oregonensis*), and sculpin (NPCC, 2004; USFWS, 2009, 2016b). Fewer species have been observed upstream of the LNFH diversion, suggesting that this known fish passage barrier may have reduced species diversity above the barrier over time (Ringel, 1997).

Many of these resident fishes eat plant matter or invertebrates, with the exception of sculpins, which eat large numbers of salmon and trout fry in headwater streams (Hillman, 1989), and northern pikeminnow, which can be effective predators on other fishes in larger rivers (LCFRB, 2004).

Non-native eastern brook trout also occur in Icicle Creek and its tributaries (Ringel, 1997; USFWS, 2009, 2016b).

3.7.2.3 Habitat Conditions

Habitat conditions in the lower portions of Icicle Creek are relatively less favorable for fish as one moves farther downstream towards the City of Leavenworth. In the more developed portions of the Icicle project area, habitat has been adversely affected by bank stabilization and flood control projects, loss of riparian vegetation, increased urbanization and related alterations in sediment transport and flows. In Icicle Creek, the primary limiting factors to fish include reduced habitat diversity, low stream flows, elevated stream temperatures, blocked fish passage, and increased competition among fish species compared to historical conditions (NPCC, 2004).

Recent human uses that have contributed to habitat degradation include water withdrawal for irrigation and domestic uses, agriculture and grazing in riparian zones, timber harvest, road building, fire suppression, urban development, and recreation. Potential impacts on water quality as a result of these activities are described in Section 3.5.2, Surface Water Quality. In Icicle Creek and its tributaries, non-native eastern brook trout may limit native salmon and trout from thriving because of competition and displacement. Hybridization between eastern brook trout and bull trout limits bull trout productivity by producing sterile offspring. In some streams, including Icicle Creek, eastern brook trout have greatly reduced numbers of bull trout (USFWS, 2015).

3.7.2.4 Fish Passage Barriers

Potential salmon and trout spawning habitat occurs up to RM 29 in Icicle Creek; however, there are several natural and artificial barriers that can limit migration through the watershed. These include the following.

- The LNFH diversion (RM 4.5) was constructed in 1930 to 1940 to supply surface water to the hatchery. LNFH shares diversion facilities with COIC and operates the facilities under an agreement with COIC. Since 2001, LNFH has been adaptively managing the intake structure to improve passage (Hall, 2012); however, passage continues to be impaired at very low and very high flows (Anglin et al., 2013).

Between 2012 and 2015, it is estimated that between 287 and 1,003 spring-run Chinook salmon were able to pass above the LNFH diversion annually (Hall, 2012; USFWS, 2016c).

- A natural boulder field (RM 5.6) near the confluence with Snow Creek currently blocks fish passage under most flow conditions. However, it is estimated that passage can occur under high-flow (10-year flood) conditions (Ringel, 1997), or as a series of pools form during a window of flows between 100 to 200 cfs (Dominguez et al., 2013). Large bull trout have been observed above the Boulder Field, indicating that opportunistic adult salmon and trout species may find passage during some flows (Dominguez et al., 2013); however, the Boulder Field presented an obstruction to Chinook salmon and steelhead in at least one study (Cappellini, 2001).
- The IPID diversion (RM 5.7) also hinders upstream passage at moderately low flows less than 150 cfs (reviewed in NPCC, 2004; Dominguez et al., 2013).

Other factors limiting fish passage include the potential for fish to become entrained at surface water diversion facilities on Icicle Creek. Fish screens at the LNFH/COIC diversion (RM 4.5), IPID diversion (RM 5.7), and the City of Leavenworth diversion (RM 5.7) do not currently meet National Marine Fisheries Service criteria and require updating (NPCC, 2004).

3.7.2.5 Tribal Fishing

Within the project area there are Usual & Accustomed Fishing Areas where the YN and CTCR tribes have historically fished. These areas are discussed in greater detail in Section 3.23, Indian Trust Assets and Fishing Harvest. Both the Yakama Nation (YN) and Confederal Tribes of the Colville Reservation (CTCR) maintain fishing rights in Icicle Creek and the Wenatchee River. These tribes target non-listed spring-run Chinook salmon (*Oncorhynchus tshawytscha*) returning to the LNFH (YN, 2009; CTCR, 2011). Known fishing areas include the plunge pool immediately downstream of the LNFH Hatchery Channel spillway and in the mainstem Wenatchee River. The YN maintains fishing rights within a mile of Dryden Dam (not within 25 feet of any fishway), in mid-summer targeting summer-run Chinook salmon and summer-run steelhead (*O. mykiss*) (YN, 2009). The CTCR maintains a summer Chinook fishery in Tumwater Canyon and mainstem Wenatchee River (CTCR, 2011).

Since the reintroduction of coho salmon (*O. kisutch*) to the upper Wenatchee River and Icicle Creek drainages, tribal subsistence fisheries for coho salmon have been opened when runs are large and surplus fish are available (CRITFC, 2011). Upriver sockeye salmon (*O. nerka*) and upriver summer-run Chinook salmon (including the Wenatchee stocks) are harvested by treaty tribes (including the YN) in the mainstem Columbia River prior to ascending their natal rivers.

It is the policy of the YN and CTCR fishery codes to sustainably manage fishery resources and enhance fish and habitat off the Yakama and Colville Reservations to support tribal harvest for subsistence, recreational, and economic needs of tribal members (YN, 2009; CTCR, 2011). Refer to Section 3.23, Indian Trust Assets and Tribal Fish Harvest, for more information about fishing limits. From 1999 to 2003, the YN harvest in Icicle Creek averaged 2,905 spring-run Chinook per year and an average of over 3,000 surplus adults returning to LNFH were provided directly to Columbia River tribes (YN, CTCR, Spokane Tribe, and the Kalispell Tribe) and food banks. In 2015, CTCR anglers caught 113 hatchery-origin spring-run Chinook salmon from mid-May to early June (Rayton, 2016).

The harvest of whitefish, sucker, pikeminnow, and other native resident fish and non-native species are open year-round to tribal members unless restricted by specific regulation (YN, 2009). Efforts are also underway to restore harvestable lamprey populations in the Wenatchee River Watershed (YN, 2016).

3.7.3 Wenatchee River Corridor

As noted in Section 3.3, Surface Water Resources, Icicle Creek is a major tributary to the Wenatchee River, which links Icicle Creek to the Columbia River. The Wenatchee River is a major migratory pathway for several fish species, including ESA-listed species. Wenatchee River salmon and steelhead stocks are reduced from historical levels largely as a result of habitat degradation, including flow diversion, lowered water quality, and overfishing. In comparison to other rivers of similar size in Washington, the Wenatchee River continues to provide good quality and diverse habitat for a variety of anadromous and resident fish downstream of Icicle Creek.

3.7.3.1 Anadromous Fish

The Wenatchee River provides habitat to several native populations of anadromous fish, including Upper Columbia spring-run Chinook salmon, Upper Columbia summer-run steelhead, and bull trout that are all protected under the ESA.

Upper Columbia Spring-run Chinook Salmon

Spring-run Chinook salmon within the Icicle project area include the Wenatchee stock[12] of the Upper Columbia Spring Chinook Evolutionarily Significant Unit (ESU), which is listed as endangered under the ESA (NOAA Fisheries, 2016; 64 FR 14308; 70 FR 37160). Wenatchee stock includes fish that spawn in the Wenatchee River and its tributaries, but not those spring-run Chinook that return to LNFH.

Prior to spawning, adults hold in deeper pools and under cover in the mainstem Wenatchee River or natal tributaries. Juveniles (parr) may redistribute downstream from tributaries to the middle and lower Wenatchee River during their first spring or fall, then typically overwinter in fresh water before migrating to sea the following spring (Peven, 2003; Hillman and Chapman 1989 in Chapman, 1989).

The number of adults estimated to return to the Wenatchee River can vary considerably from year to year; however, average abundance declined steadily from greater than 3,000 fish in the 1960s to less than 500 fish in the mid-1990s (10-year average) (WDFW, 2016b). Numbers have increased in recent years to a 10-year average exceeding 1,500 fish since 2010. Hatchery-reared fish have supplemented the number of spawning adults since

[12] This population is considered a distinct stock based on its spawning distribution, early run timing beginning in May, early spawn timing in very late July through September, and genetic composition.

the early 1990s; however, natural production has not recovered to a level that would sustain a recreational fishery (WDFW, 2010).

From 1989 to 2015, an estimated average of 148 Wenatchee River adult spring-run Chinook salmon per year migrated into Icicle Creek to spawn. Evidence of spring-run Chinook spawning has been observed from the mouth of Icicle Creek to the confluence with Snow Creek; however, the majority of redds are observed from the LNFH to Sleeping Lady (RM 2.8 to 3.3) (Hillman et al., 2016). The spring-run Chinook salmon spawners in Icicle Creek are strays that originate from the Chiwawa Hatchery supplementation program and White River in the upper Wenatchee River Watershed.

Summer-run Chinook Salmon

Wenatchee summer-run Chinook salmon[13] are also found in the Wenatchee River. Prior to spawning, adults hold in deeper pools and under cover in the mainstem, and spawning occurs throughout the mainstem with redds observed specifically within 8 miles of the City of Leavenworth near the confluence with Icicle Creek (WDFW, 2016b). Small numbers of summer-run Chinook salmon enter Icicle Creek to spawn. Since the late 1980s, the spawning population has been supplemented by hatchery-reared spawners.

Over the past several decades, the number of Wenatchee summer-run Chinook salmon returning to their native spawning areas has been relatively stable between 6,000 and 8,300 fish (10-year average). The abundance of adults returning to the spawning grounds has exceeded WDFW's goals for achieving sustainability of the population of 7,500 fish in 17 out of 29 years (WDFW, 2016b).

From 2006 to 2015, 2 to 75 summer-run Chinook salmon redds have been observed in Icicle Creek downstream of LNFH (Hillman et al., 2016). Summer-run Chinook salmon spawning in Icicle Creek are a mixture of hatchery-origin strays and wild-origin fish.

Summer-run Steelhead

Summer-run steelhead in the Icicle project area include the Wenatchee stock[14] of the Upper Columbia Summer Steelhead ESU, which is listed as threatened under the ESA (NOAA Fisheries, 2016; 64 FR 14308; 70 FR 37160).

Most spawning takes place in the Wenatchee River and tributaries upstream of the confluence with Icicle Creek, including the Little Wenatchee, Chiwawa, and White Rivers, and Nason Creek. Spawning also takes place in Icicle Creek and other tributaries downstream of Icicle Creek, including Mission and Peshastin Creeks (NPCC, 2004; WDFW, 2016b).

Adult steelhead enter the Wenatchee River from August through the following April and spawn in very late March through May. Steelhead parr may redistribute downstream away from natal streams during their first year to rear in mainstem reaches of the Wenatchee

[13] This population is considered a distinct stock based on its spawning distribution, river entry time in June, spawn timing in late September through mid-November, and genetic composition.
[14] This population is identified as a distinct stock based on their spawning distribution and run timing.

River. Steelhead tend to remain in fresh water until migrating to sea as yearlings the following spring (reviewed in NPCC, 2004).

During the 54 years from 1962 to 2015, the annual goal of 3,000 spawning adults was estimated to have been met in only 9 years, and a minimum abundance of 1,000 spawning adults required for population recovery has been met in 35 years.

From 1962 to 2015, the estimated number of adult spawners has varied considerably. A major decline in the late 1970s and early 1980s occurred when the number of spawners dropped to near or below 100 fish in 6 consecutive years. Since 1987, the Wenatchee summer-run steelhead population has been supplemented by fish raised in hatcheries. Numbers have increased since the early 1990s with an average number of spawners between 1,000 and 2,500 fish (10-year average) (WDFW, 2016b).

In 2014 and 2015, it is estimated that 121 and 135, respectively, Wenatchee summer-run steelhead spawners reached Icicle Creek, representing a mixture of hatchery-origin strays and wild-origin fish (Hillman et al., 2016). The number of summer-run steelhead redds observed in the lower reaches of Icicle Creek has ranged from a low of 6 to a high of 180 from 2001 to 2013.

Coho Salmon

Coho salmon (*O. kisutch)* were once extinct in the Wenatchee River Watershed but were reintroduced in 1999 through an effort led by the CTCR and YN. Currently, coho salmon spawn and rear in the mainstem Wenatchee River between the City of Cashmere to Lake Wenatchee and in Icicle Creek (NPCC, 2004).

Coho salmon enter the Wenatchee River in early September through late November, spawning between mid-October to late December. Coho fry emerge in April or May, then distribute themselves downstream to tributaries or off-channel habitat where they overwinter and rear for 1 year until migrating to sea the following March through May (NPCC, 2004).

Over the past several decades, the number of coho within the Icicle project area has been increasing. Between 1999 and 2011, the number of fish returning to the Wenatchee River ranged from 350 adults to 23,000 adults with the population reaching sufficient numbers in 2009, 2011, 2014, and 2015 for tribal and sport fisheries to be opened (Galbreath et al., 2013; Kraig and Scalici, 2016).

Sockeye Salmon

Sockeye salmon (*O. nerka*) that migrate through the Wenatchee River include the Wenatchee stock of the Upper Columbia River sockeye salmon stocks, which are considered healthy and are not ESA-listed. However, monitoring has been recommended because of the potential for the species to become threatened (64 FR 14528). Wenatchee sockeye salmon originate in tributary sub-watersheds to Lake Wenatchee, upstream of the confluence with Icicle Creek.

Yearling juvenile sockeye salmon migrate to sea in the spring. Adults return to the Wenatchee River Watershed in June and July after 2 to 3 years at sea, with the peak of the run entering the Wenatchee River in mid-July.

Recreational fishing of Wenatchee sockeye salmon occurs in Lake Wenatchee when the numbers of returning fish meet state goals of 23,000 fish (WDFW, 2016c). No sockeye salmon fishery is allowed in the mainstem Wenatchee River.

Pacific Lamprey

Pacific lamprey (*Entosphenus tridentatus*) occur throughout the Wenatchee River downstream of Icicle Creek but have not been observed in Icicle Creek (Beals and Lampman, 2016a). Pacific lamprey are a federal species of concern and state priority species (USFWS, 2010; WDFW, 2008).

Larval lamprey are filter feeders that inhabit silt and mud substrate in slow-moving water for 4 to 7 years in temperatures up to 77 °C (Wydoski and Whitney, 2003). In the Columbia River, juveniles metamorphose in October or November and immediately migrate downstream to sea in the fall or the following spring where they feed parasitically by attaching to larger fish and sucking body fluids using their sucker-like mouths, sharp teeth, and rasping tongues. Adult Pacific lamprey migrate back to fresh water in spring and summer, overwinter in deep pools, then spawn the following spring from April through July. Adults cease feeding after entering fresh water and subsist on energy stores through spawning, after which most will die; however, some may survive and return to sea. Adults spawn by excavating nests in fine gravel and sandy substrate in relatively cool (45 to 50 °C), oxygen-rich water at the tails of pools and riffles.

Pacific lamprey abundance in the Wenatchee River Watershed is estimated to be greatly reduced from historical conditions. Adult lamprey counts at mainstem Columbia River dams since 2000 indicate that the number of lamprey observed in the mid-Columbia River near the confluence with the Wenatchee River has ranged from approximately 31 to 3,036 fish annually (DART, 2016); however, it is unknown how many of this subset of adults enter the Wenatchee River each year to spawn (Johnsen and Nelson, 2012).

3.7.3.2 Resident Fish

Bull trout, rainbow trout, westslope cutthroat trout, and other resident species (listed below) are prevalent throughout the Wenatchee River and tributaries.

Bull Trout

Bull trout reside in headwater areas to tributaries of the Wenatchee River, and fluvial life-history types may use the Wenatchee River as foraging habitat or as a migratory corridor. The Wenatchee River Watershed has high diversity among bull trout populations[15].

Fluvial bull trout that originate in headwaters of the Chiwawa River have been monitored by WDFW since 1989; the total number of redds[16] observed has averaged 233 redds, ranging from 71 redds in 1990 to 377 redds in 1999 (WDFW, 2016a).

[15] Seven distinct spawning populations of bull trout are identified in the Wenatchee River Watershed based on their geographic distribution and isolation from other spawning populations and unique genetics.
[16] Typically, each redd is fertilized by one male bull trout.

Rainbow and Westslope Cutthroat Trout

Rainbow trout and westslope cutthroat trout are common throughout rivers and lakes of Washington, including the Wenatchee River and tributaries (Wydoski and Whitney, 2003). See Section 3.7.2.2, [Icicle Creek] Resident Fish for life-history information.

Other Resident Fishes

Other native resident fish that inhabit the Wenatchee River include mountain whitefish; three-spined stickleback (*Gasterosteus aculeatus*); minnows, including chiselmouth (*Acrocheilus alutaceus*), peamouth (*Mylocheilus caurinus*), longnose dace, speckled dace (*Rhinichthys osculus*), redside shiner, northern pikeminnow, and possibly leopard dace (*Rhinichthys falcatus*) and Umatilla dace (*Rhinichthys umatilla*), which have spotty distributions in the region; suckers, including longnose sucker, bridgelip sucker, largescale sucker (*Catostomus macrocheilus*), and mountain sucker (*Catostomus platyrhynchus*); and sculpins, including mottled sculpin (*Cottus bairdii*), shorthead sculpin (*Cottus confuses*), torrent sculpin (*Cottus rhotheus*), and possibly Paiute sculpin (*Cottus beldingii*) based on one historical account (Chapman, 1989; Wydoski and Whitney, 2003; NPCC, 2004).

As in Icicle Creek, many of these resident fishes eat plant matter or invertebrates, with the exception of sculpins (Hillman, 1989) and northern pikeminnow that become effective predators on other fishes when they grow to larger sizes in larger rivers (e.g., greater than 300 millimeters [mm]) (LCFRB, 2004).

Non-native crappie also occur in the Wenatchee River (NPCC, 2004).

3.7.3.3 Habitat Conditions

In general, fish habitat in the Wenatchee River has been degraded over time through a variety of causes, including agriculture, road and railroad development, and increased urbanization and development. Habitat impacts have resulted from floodplain development for agriculture and urban uses, irrigation diversions, bank armoring, and reduced habitat-forming woody debris, and riparian vegetation removal.

3.7.3.4 Barriers to Passage

Passage through the Wenatchee River up to Icicle Creek is relatively unobstructed compared to rivers of similar size in the Pacific Northwest.

In the Lower Wenatchee River, Dryden Dam, an 8-foot-high irrigation diversion dam, has a fish ladder to facilitate passage, but may cause migration delay for some salmon (Reviewed in NPCC, 2004) and may limit lamprey passage (Johnsen and Nelson, 2012).

Irrigation diversions are typically designed to exclude juvenile salmon and other fish but may impair downstream redistribution and passage of larval and juvenile lamprey in the lower Wenatchee River Watershed (reviewed in Johnsen and Nelson, 2012). Larval lamprey are small enough to easily pass through bypass traps and screens and become entrained in irrigation canals during water diversion in summer and become stranded when canals are dewatered in the fall. Recent salvage efforts at the Dryden Diversion, located just downstream of Peshastin Creek at RM 28.3, have rescued and released approximately 6,500 juveniles in 1 year (Mosey, 2009), and it was estimated that tens of thousands of larval and juvenile lamprey may be entrained in just the Dryden Diversion each year (Beals and Lampman, 2016b).

3.7.4 Aquatic Invertebrates

Invertebrates are a major source of food for fish, and changes in invertebrate communities may result in changes in the condition of fish communities (Waters, 1982; Wilzbach et al., 1986). Salmon and trout commonly feed on larval or recently emerged invertebrates such as mayflies, stoneflies, and caddisflies that are fully aquatic at the larval stage, and zooplankton such as water fleas and tiny crustaceans.

In the Alpine Lakes, trout feed primarily on zooplankton and benthic invertebrates. In outlet streams from the Alpine Lakes, Icicle Creek, and the Wenatchee River, the aquatic invertebrate community appears to increase in diversity with increasing stream order (Adams, 2012), owing to changes in food sources from courser to more fine organic particulate matter (Vannote et al., 1980).

Aquatic invertebrates, like other aquatic organisms, respond to changes in water quality, food abundance, and other habitat parameters. Macroinvertebrate community composition can reflect historical water quality or habitat degradation (Rosenberg and Resh, 1993). In Washington State, benthic macroinvertebrate (invertebrates large enough to be seen without magnification) communities are analyzed to monitor the health of streams (Plotnikoff and Ehinger, 1997). Key conditions that influence the aquatic invertebrate communities in Icicle Creek and the Wenatchee River include elevated water temperature and associated low dissolved oxygen, phosphorus enrichment, and associated elevation of pH (Adams, 2012). A biological assessment of the macroinvertebrate community of Icicle Creek and the Wenatchee River reflects a signal of poor water quality in the lower Wenatchee River downstream of the Town of Monitor, fair water quality between Dryden and Monitor, and good water quality near the Town of Peshastin and in Icicle Creek, with the exception of points immediately downstream of the City of Leavenworth (Adams, 2012). The macroinvertebrate community appeared to be most disturbed in two locations on the Wenatchee River, near and downstream of City of Leavenworth, and downstream of the City of Cashmere to the mouth of the Wenatchee River, with sites of concern in the upper Icicle Creek near two recreational camping areas. Pollution tolerant species were present; however, a clear pattern was not discernable and may reflect localized factors in the stream.

3.8 Vegetation

Vegetation within the Icicle project area supports a variety of different landscapes, ranging from forested areas, riparian corridors, wetlands, and more urbanized development. Within the project area, these vegetation types provide wildlife habitat, ecosystem services, and recreational and aesthetic value.

This section is based primarily on existing information and aerial photograph analysis. Although existing mapping, WDFW Priority Habitat and Species data (WDFW, 2016), and USFWS National Wetlands Inventory data provide an indication of the potential presence or absence of sensitive areas, such as wetlands, this information would be field verified as appropriate during project-level review. Field visits were completed for some parts of the project area as indicated below.

3.8.1 Alpine Lakes

The Alpine Lakes are located on the eastern side of the Cascade Mountain range in an area that includes alpine and subalpine biotic zones. The Alpine Lakes within the Icicle project area include Colchuck, Eightmile, Upper and Lower Klonaqua, Square, Nada, and Upper and Lower Snow Lakes.

These lakes are located east of the Cascade crest. The Icicle project area in and adjacent to these lakes exhibits a range of vegetation communities from west to east as a result of differences in elevation and precipitation. The crest of the Cascades annually receives about 180 inches of precipitation, mostly in the form of snow, while lower elevations in the eastern portion of project area, near the City of Leavenworth, average 25 inches of precipitation a year.

The Alpine Lakes are dominated by forested habitat with species such as silver fir (*Abies amabilis*), subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and mountain hemlock (*Tsuga mertensiana*) in the upper elevation areas. Avalanche chutes are brushy with deciduous species such as Sitka alder (*Alnus sinuata*), vine maple (*Acer circinatum*), and Rocky Mountain maple (*Acer glabrum*). Lower elevations include Douglas fir (*Pseudotsuga menziesii*), western white pine (*Pinus monticola*), ponderosa pine (*Pinus ponderosa*), shore pine (*Pinus contorta*), western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*) (USFS, 2016; Franklin and Dyrness, 1973).

All of these species were observed during a reconnaissance site visit to Colchuck, Eightmile, Upper and Lower Klonaqua, and Square Lakes in July 2016. Similar forest and shrub vegetation communities are likely present at Nada and Upper and Lower Snow Lakes, based on aerial photograph analysis and the similar elevation and location of these lakes.

Dominant shrub and understory species observed during the July 2016 site visits include Scouler willow (*Salix scouleriana*), Cascade azalea (*Rhododendron albiflorum*), twinberry (*Lonicera involucrata*), white spirea (*Spiraea betulifolia*), red huckleberry (*Vaccinium parvifolium*), kinnikinnick (*Arctosaphylos uva-ursi*), and western thimbleberry (*Rubus parviflorus*). Common and scientific names of plant species observed during the July 2016 site visits are provided in Table 3-14.

Existing mapping does not identify any wetland habitats within the vicinity of Colchuck, Eightmile, Upper and Lower Klonaqua, Square, and Upper Snow Lakes; however, palustrine scrub-shrub (PSS) and palustrine forest (PFO) wetland systems have been mapped in a few locations along the shoreline of Lower Snow and Nada Lakes (WDFW, 2016; USFWS, 2016). Reconnaissance surveys confirmed wetland conditions are present at several of the lakes and along the trail to Eightmile Lake. Wetland conditions were also observed along the

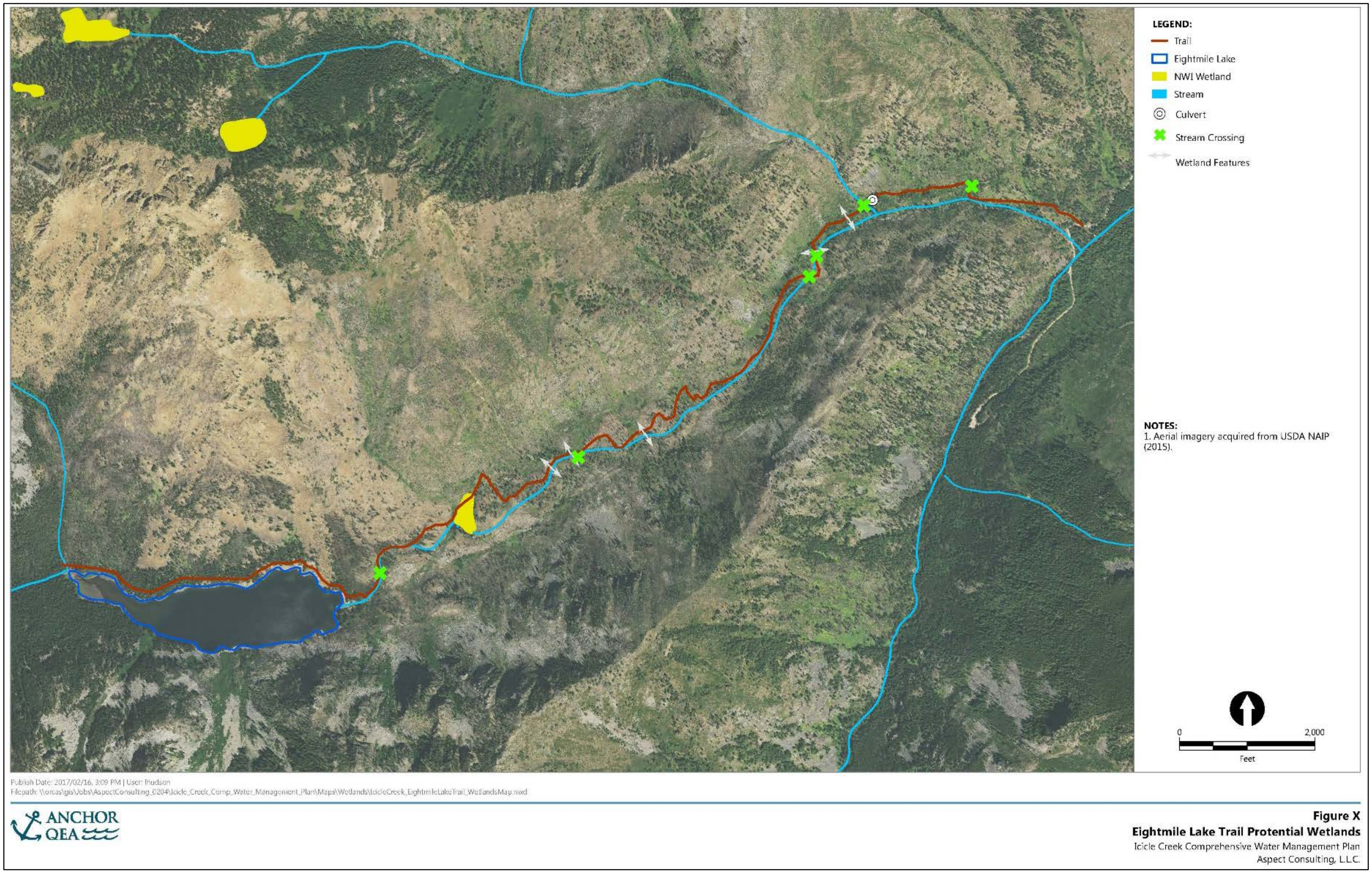
Eightmile Lake trail in several locations. These wetlands included palustrine emergent (PEM), PSS, and PFO wetland systems associated with creeks and streams along the trail (See Figure 3-10).

Table 3-14
Plant Species Observed at the Alpine Lakes during the July 2016 Site Visit

Scientific Name	Common Name	Indicator Status
Abies grandis	Grand fir	FACU-
Abies amabilis	Silver fir	FACU
Abies lasiocarpa	Subalpine fir	FACU
Acer circinatum	Vine maple	FAC-
Acer glabrum	Rocky mountain maple	FACU
Achillea millefolium	Yarrow	FACU
Alnus sinuata	Sitka alder	FACW
Arctostaphylos uva-ursi	Kinnikinnick	FACU
Holodiscus discolor	Oceanspray	UPL
Lonicera involucrata	Twinberry	FAC+
Lupine polyphyllus	Large-leaved lupine	FAC+
Mahonia aquifolium	Tall Oregon grape	UPL
Picea engelmannii	Engelmann spruce	FAC
Pinus monticola	Western white pine	FACU
Pinus ponderosa	Ponderosa pine	FACU-
Plantago major	Common plantain	FACU+
Populus tremuloides	Quaking aspen	FAC+
Populus trichocarpa	Black cottonwood	FAC
Pseudotsuga menziesii	Douglas fir	FACU
Pteridium aquilinum	Bracken fern	FACU
Rhododendron albiflorum	Cascade azalea	FACU
Rosa nutkana	Nootka rose	FAC
Rubus parviflorus	Western thimbleberry	FAC-
Salix lasiandra	Pacific willow	FACW
Salix scouleriana	Scouler willow	FAC
Sambucus cerulea	Blue elderberry	FACU
Smilacina racemosa	False-Soloman's-seal	FAC-
Spiraea betulifolia	White spirea	FACU
Thuja plicata	Western redcedar	FAC
Tsuga mertensiana	Mountain hemlock	FACU
Vaccinium ovatum	Evergreen huckleberry	UPL
Vaccinium parvifolium	Red huckleberry	UPL

Notes: FAC = Facultative, FACU = Facultative Upland, FACW = Facultative Wetland, UPL = Obligate Upland

Figure 3-10. Wetland Near Eightmile Lake



At Eightmile Lake, wetland conditions were not observed at the outlet location, but several potential PEM, PSS, and PFO wetland features were observed along the lake shoreline. PEM and PSS wetland conditions were present near the outlet location at Square Lake and in several areas along the shoreline of Square Lake. Overall, potential wetland habitat was more common at Square Lake than any of the other three lakes investigated during the site visits. At Klonaqua Lake, PEM and PSS wetland conditions were present in the vicinity of the outlet location and appeared to be present in some locations along the lake shoreline, but the majority of the lake shoreline was composed of upland habitat. Wetland features were not present at the outlet location at Colchuck Lake and the majority of the lake shoreline resembled upland conditions.

3.8.2 Icicle Creek

3.8.2.1 Vegetation

Vegetation along the Icicle Creek corridor is dominated by forested communities similar to the species identified in Section 3.8.1, Alpine Lakes. The species composition changes with elevation and corresponding changes in precipitation. At the higher elevations near the upper end of Icicle Creek, vegetation is similar to that found at the Alpine Lakes. At the lower elevations in the valley near the City of Leavenworth, the Icicle Creek riparian corridor includes more roads, agricultural, and rural residential development. Vegetative communities include those associated with more developed areas such as roads, agricultural fields, residential properties, golf courses, and other urban developments. The majority of the riparian corridor along Icicle Creek includes upland habitat; however, existing mapping identifies PEM, PSS, and PFO wetland features along the shoreline of Icicle Creek in several locations (WDFW, 2016; USFWS, 2016).

The following subsections address in greater detail the vegetative communities present in areas with the greatest potential to be affected by the Program Alternatives.

3.8.2.2 Icicle Creek Boulder Field

The Icicle Creek Boulder field is an approximately 2,600-foot-long high-gradient reach of Icicle Creek located upstream of RM 5.6. This is one of the locations where fish passage could be addressed as part of the Strategy Alternatives (Dominguez et al., 2013). Riparian habitat south of this reach along Icicle Creek includes steep sloped upland forest and shrub vegetation communities with rock features as a dominant substrate. To the north, trees and shrubs occur in isolated and sparse patches with rock substrate as the dominant ground cover. A gravel parking lot and a gravel access road are located north of the creek, ranging from 50 to 200 feet from the creek shoreline. Icicle Road is just north of the access road and vegetation is similar to the steep sloped hillside to the south. No wetland habitat is mapped along this reach of Icicle Creek (USFWS, 2016b).

3.8.2.3 Leavenworth National Fish Hatchery

LNFH is located adjacent to Icicle Creek at RM 3.0, about 2 miles south of the City of Leavenworth. LNFH diverts surface water from Icicle Creek at RM 4.5 for fish production at the hatchery. LNFH discharges effluent back to Icicle Creek at RM 2.8.

Proposed activities associated with the alternatives at the LNFH include water quality and fish passage improvements between RM 2.8 and 4.5.

The LNFH property is developed with buildings, raceways, ponds, other structures, and paved and unpaved impervious surfaces. Riparian habitat adjacent to the Hatchery Channel includes upland tree, shrub, grass, and herbaceous habitat typical for the region. Paved and unpaved roads are located near the channel. Rural residential development and pasture are located west and north of LNFH. The Icicle Creek historical channel is located east of the hatchery channel. Upland forest and shrub vegetation communities are located in higher elevations east and south of the Icicle Creek historical channel. No wetland habitat is mapped within the LNFH; however, the Icicle Creek historical channel east of the hatchery channel has been mapped as palustrine scrub-shrub wetland habitat (USFWS, 2016b).

3.8.2.4 Confluence of Icicle Creek and the Wenatchee River

The confluence of Icicle Creek and the Wenatchee River is located at the south end of the Leavenworth city limits. Riparian habitat in this portion of the Icicle project area includes upland tree, shrub, grass, and herbaceous vegetation communities typical for the region. Land use also includes residential development and pasture with associated paved and unpaved roads. The Leavenworth Golf Club and residential development is located on the left bank of the Wenatchee River, across from the Icicle Creek and Wenatchee River confluence. Palustrine emergent wetland habitat is mapped adjacent to Icicle Creek (USFWS, 2016b).

3.8.3 Wenatchee River Corridor

The Icicle project area extends along the Wenatchee River from near Icicle Creek downstream to the confluence with the Columbia River at the City of Wenatchee and includes riparian and upland areas. The majority of land use in this part of the project area consists of agricultural activities, and the main vegetative communities consist largely of orchards. The IPID irrigation canals extend down the valley on the hillsides on both sides of the Wenatchee River and provide water for irrigation of agricultural properties from the City of Leavenworth down to the Town of Monitor. Agricultural lands are intermixed with scattered residential development, intensifying near City of Wenatchee and the confluence with the Columbia River. Riparian trees in this area are limited to narrow bands of deciduous trees such as black cottonwood (*Populus trichocarpa*), along the banks of the Wenatchee River and its tributaries. Along the banks of the Wenatchee River there is scattered riparian habitat, similar to that described in Section 3.8.2, Icicle Creek.

While the majority of the Wenatchee River Corridor is upland, existing mapping identifies palustrine emergent (PEM), palustrine shrub (PSS), and palustrine forested (PFO) wetland features in the Wenatchee River Corridor in numerous locations (WDFW, 2016; USFWS 2016). [17] This includes the area currently being considered for the IPID

[17] The palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity is below 0.5 ppt

Pump Station on the right bank of the Wenatchee River near the Highway 2 Bridge, adjacent to the Town of Dryden (Figure 2-43). Land use in this area is dominated by orchards and rural residential development with associated paved and unpaved roads. No wetland habitat is mapped in this area of the Wenatchee River (USFWS, 2016b).

3.9 Wildlife

Wildlife diversity is generally related to the structure and composition of plant species within vegetative communities. Wetlands and forested areas with well-developed shrub layers are likely to support the greatest number of species and populations of wildlife (Brown, 1985). Coniferous and deciduous forest and wetland environments provide habitat for a variety of wildlife species because of the vegetative diversity and availability of forage and nest sites.

This section is based on existing information and aerial photograph analysis. Field visits were completed for some parts of the Icicle project area as indicated below.

Overall, wildlife habitat in the Alpine Lakes and Icicle Creek portions of the Icicle project area are relatively high quality and provide diverse habitat to support a variety of wildlife species. Habitat within the Wenatchee River Corridor is more impacted by urban development and provides lower quality wildlife habitat for wildlife species to occupy. More developed portions of the project area tend to support wildlife species adapted to human activities and disturbance.

3.9.1 Alpine Lakes

3.9.1.1 Amphibians and Reptiles

Wetlands and riparian areas associated with the Alpine Lakes and receiving streams in this portion of the Icicle project area provide habitat for a variety of amphibians, such as Pacific tree frog *(Pseudacris regilla),* western toad (*Anaxyrus boreas*), tailed frog (*Ascaphus truei*), Cascades frog *(Rana cascadae),* Columbia spotted frog (*Rana luteiventris*), and long-toed salamander *(Ambystoma macrodactylum).* Several frogs, were observed during a reconnaissance field visit to five of the Alpine Lakes (Colchuck, Eightmile, Upper and Lower Klonaqua, and Square Lakes) in July 2016. Frogs observed during the site visit were observed within the lakes, not on land. The frog species were assumed to be the Cascades frog, based on the limited visibility of observing the frogs within the lake water.

The USFS performed large-scale amphibian presence/absence surveys in the Icicle Creek Basin in July and August 2016. Within the Icicle Creek Basin, the surveys included Nada and Upper and Lower Snow Lakes and the five lakes observed during the July site visits, including Colchuck, Eightmile, Upper and Lower Klonaqua, and Square Lakes. Amphibian species observed at these eight lakes during the USFS surveys included Cascades frog (Square Lake), Columbia spotted frog (Upper and Lower Snow Lakes), Pacific tree frog (Upper and Lower Klonaqua, and Square Lakes), and long-toed salamander (Upper and Lower Snow Lakes) (Claeson, 2016).

Reptiles, such as the western garter snake (*Thamnophis elegans*), are likely to occur in the upland habitats surrounding the lakes. Upland habitats with rocks and wood debris support species such as northern alligator lizard (*Elgaria coerulea*) and western fence lizard (*Sceloporus occidentalis*). Common garter snakes *(Thamnophis sirtalis)* and northern alligator lizards were observed during the July 2016 site visits.

3.9.1.2 Mammals

Mammal species associated with forested habitats at the Alpine Lakes include mountain beaver (*Aplodontia rufa*), bobcat (*Lynx rufus*), hoary marmot (*Marmota caligata*), fisher (*Martes pennanti*), Douglas squirrel (*Tamiasciurus douglasii*), voles (*Microtus spp.*), pika (*Ochotona princeps*), and striped skunk (*Mephitis mephitis*). Larger mammals, such as elk (*Cervus elaphus*), black-tailed deer *(Odocoileus hemionus),* black bear (*Ursus americanus*), cougar (*Felis concolor*), and coyote *(Canis latrans),* are also found in the forested habitat. Mountain goats (*Oreamnos americanus*) are found in the high-altitude areas (USFWS, 2016a). Deer tracks and scat were frequently observed during the July 2016 site visit.

Wetlands and riparian areas associated with streams originating from the lakes provide habitat for bats (*Myotis spp.*), shrews *(Sorex spp.),* common opossum *(Didelphis marsupialis),* and raccoon *(Procyon lotor).* These and similar species depend on water for foraging and breeding habitat.

3.9.1.3 Birds

Forested habitats in this portion of the Icicle project area provide foraging and nesting habitat for a wide variety of bird species with more than 150 species of birds recorded (USFWS, 2016a). Songbird species that occupy habitats found within the Alpine Lakes area of the Icicle project area include song sparrow *(Melospiza melodia),* bushtit *(Psaltriparus minimus),* Bewick’s wren *(Thryomanes bewickii),* Stellar’s jay *(Cyanocitta stelleri),* spotted towhee *(Pipilo erythrophthalmus*), Swainson’s thrush (*Catharus ustulatus*), winter wren (*Troglodytes troglodytes*), varied thrush (*Ixoreus naevius*), black-capped chickadee (*Parus atricapillus*), chestnut-backed chickadee (*Parus rufescens*), dark-eyed junco (*Junco hyemalis*), golden-crowned kinglet (*Regulus satrapa*), and red-breasted nuthatch (*Sitta canadensis*).

Migratory bird species, such as black swift (*Cypseloides niger*), Cassin’s finch (*Carpodacus cassinii*), fox sparrow (*Passerella iliaca*), loggerhead shrike (*Lanius ludovicianus*), olive-sided flycatcher (*Contopus borealis*), rufous hummingbird (*Selasphorus rufus*), and willow flycatcher (*Empidonax traillii*), likely use forested habitats for foraging during spring and fall migrations (USFWS, 2016a).

Predatory birds, such as bald eagle (*Haliaeetus leucocephalus*), red-tailed hawk *(Buteo jamaicensis),* and osprey *(Pandion haliaetus),* commonly hunt in these habitat types and occur in forested areas near bodies of water. Snags and downed trees along the lake edges also provide perch sites for these and other raptor species. Snags in forested habitats also provide potential nest sites for cavity-nesting birds, such as great horned owl (*Bubo virginianus*) and species of woodpeckers, including Lewis's woodpecker (*Melanerpes lewis*), downy woodpecker (*Picoides pubescens*), northern flicker (*Colaptes auratus*), and pileated woodpecker (*Dryocopus pileatus*).

Lake and wetland habitats containing riverine, emergent, scrub/shrub, and forested wetland types provide wildlife habitat for a variety of bird species. Lakes can be expected to provide habitat for belted kingfisher *(Ceryle alcyon*) and wintering and migratory waterfowl, including gadwall *(Anas strepera),* American widgeon *(Mareca americana),* mallard *(Anas platyrhynchos),* common loon (*Gavia immer*), and western grebe (*Aechmophorus occidentalis*). Emergent and scrub/shrub wetland areas provide habitat for red-winged blackbird *(Agelaius phoeniceus),* song sparrow *(Melospiza melodia),* and marsh wren *(Cistothorus palustris),* among others. Great blue heron *(Ardea herodias)* may forage in lake and wetland habitats where they could prey on amphibians and other species.

3.9.2 Icicle Creek

The Icicle Creek corridor provides similar forested, riparian, and wetland habitat conditions that would support the same types of wildlife species as the Alpine Lakes area with more variation in plant species and vegetation communities likely to the result of the lower elevation and precipitation in the Lower Icicle Creek area. Species more vulnerable to human activities and development, such as larger mammal species like black bear and cougar, would be less likely to be found near roads and parcels with residential development in the lower elevation areas of Icicle Creek. This part of the Icicle project area includes more native and non-native wildlife species adapted to human activity because of the presence of roads, agricultural fields, residential properties, golf courses, and other developments. Roads also function as a potential barrier to migration of larger mammal species such as deer and elk.

3.9.2.1 Icicle Creek Boulder Field

The Icicle Creek Boulder Field, as described in Section 3.8.2.2, is an approximately 2,600-foot-long high-gradient reach of Icicle Creek located near RM 5.6. Wildlife species likely to occur within this area include birds, mammals, reptiles, and amphibian species similar to those described for the Alpine Lakes in Section 3.9.1. Species adapted to human activity and disturbances would occur associated with roads and residential development in the vicinity.

3.9.2.2 Leavenworth National Fish Hatchery

LNFH, as described in section 3.8.2.3, is located adjacent to Icicle Creek at RM 3.0, about 2 miles south of the City of Leavenworth. Upland wildlife species within this area would also include those better adapted to human activity and disturbance, such as crows, squirrels, etc. Fish and aquatic invertebrates are described in Section 3.7, Fish.

3.9.2.3 Confluence of Icicle Creek and the Wenatchee River

The area near the confluence of Icicle Creek and the Wenatchee River, as described in Section 3.8.2.4, is located at the south end of the Leavenworth city limits. Just upstream, the COIC shares a point of diversion with LNFH located on Icicle Creek at RM

4.5. Riparian habitat in this part of the Icicle project area includes upland tree, shrub, grass, and herbaceous habitats typical for the region as described in Section 3.8, Vegetation. Land use also includes residential development and pasture with associated paved and unpaved roads. The Leavenworth Golf Club and residential development is located on the left bank of the Wenatchee River, across from the Icicle Creek and Wenatchee River confluence. Palustrine emergent wetland habitat is mapped adjacent to Icicle Creek (USFWS, 2016b). Upland wildlife species within this area would also include those better adapted to human activity and disturbance, such as crows, squirrels, etc.

3.9.3 Wenatchee River Corridor

The Icicle project area extends along the Wenatchee River from Icicle Creek downstream to the confluence with the Columbia River at the City of Wenatchee and includes riparian and upland habitat areas and associated wildlife.

The majority of the potential wildlife habitat in the Wenatchee River Corridor area of the Icicle project area is relatively lower quality because of the dominant presence of residential and commercial development, roads, and agricultural land use. Developed areas provide habitat for disturbance-tolerant species such as American crow (*Corvus brachyrhynchos*), American robin (*Turdus migratorius*), European starling (*Sturnus vulgaris*), and house sparrow (*Passer domesticus*).

Developed areas reduce available wildlife habitat for mammals and limit habitat value for larger mammals that require greater areas of unbroken habitat to forage and reproduce. These areas are populated by common, urban-adapted mammal species, including raccoon, opossum, and eastern gray squirrel, and a variety of small mammals, including deer mice and old world rodents (such as the Norway rat).

The IPID irrigation canals extend down the valley on the hillsides on both sides of the Wenatchee River and provide water for irrigation of agricultural properties from City of Leavenworth down to the Town of Monitor. Species in these areas include native and non-native wildlife species adapted to human activity because of the presence of roads, agricultural fields, residential properties, and commercial and other developments.

3.10 Threatened and Endangered Species

This section describes plant, wildlife, and fish species that are listed as threatened or endangered under the ESA that have the potential to occur within the project area. This section also provides information on state priority habitats and species established by WDFW.

Section 9 of the ESA prevents the take of endangered species and, for threatened species, authorizes the agencies (NOAA Fisheries and USFWS) to adopt regulations necessary and advisable for species conservation, which may include prohibiting take (16 U.S. Code §

1538). The ESA defines "take" to mean harass, harm, pursue, hunt, shoot, wound, trap, capture, or collect, or attempt to engage in any such conduct.

The ESA requires NOAA Fisheries and USFWS to designate critical habitat for listed species, defined as follows: 1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and 2) specific areas outside the geographical area occupied by the species at the time of listing if the agency determines that the area itself is essential for conservation.

The Washington State Hydraulic Code serves to protect fish and their habitats. Implementing elements of the Program Alternatives that use, divert, obstruct, or change the natural flow or bed of fresh state waters would require a Hydraulic Project Approval from WDFW. Implementing certain projects related to the Program Alternatives would also likely include compliance with local critical areas codes, zoning ordinances, and other land use requirements.

ESA-listed species were identified based on information from the USFWS endangered species web sites (USFWS, 2016a, 2016b). The statewide *Priority Habitat and Species* (PHS) *List* includes priority terrestrial and aquatic habitats, as well as priority habitat features (WDFW, 2008). The *WDFW PHS List* also identifies specific counties in Washington where priority species have been documented. Field visits were completed for some parts of the Icicle project area as indicated below.

3.10.1 Federal Threatened and Endangered Plant Species

There are three ESA-listed plant species identified by the USFWS (USFWS, 2016a) as potentially occurring within Chelan County: showy stickseed (*Hackelia venusta*), Ute ladies' tresses (*Spiranthes diluvialis*), and Wenatchee Mountains checkermallow (*Sidalcea oregana var. calva*). Of these, two species, showy stickseed and Wenatchee Mountains checkermallow have the potential to occur within the Alpine Lakes, Icicle Creek Corridor, and Wenatchee River Corridor as shown in Table 3-15 (USFWS, 2016b). Ute ladies tresses could potentially be found in the vicinity but is not likely to occur within the Icicle project area. Wenatchee Mountains checkermallow also has critical habitat within Chelan County, although none is located within the project area. The status and preferred habitats of federally listed and proposed plant species protected under the ESA as identified by USFWS, are presented in Table 3-15.

Table 3-15
Federally Listed and Proposed Plant Species

Common Name (Scientific Name)	Agency	Status[1,2]	Preferred Habitat[3]	Chelan County[1]	Alpine Lakes Area[2]	Icicle Creek Corridor Area[2]	Wenatchee River Corridor Area[2]
Flowering Plants							
Showy stickseed (*Hackelia venusta*)	USFWS	Endangered	Grows in openings of ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*) forests on loose, well-drained, granitic rocky or sandy soils. It is found on unstable talus slopes, and ledges or cracks on cliff faces at lower elevations.	X	X	X	X
Ute ladies' tresses (*Spiranthes diluvialis*)	USFWS	Threatened	Adapted to early- to mid-seral, moist to wet conditions, where competition for light, space, water, and other resources is normally kept low by periodic or recent disturbance events. Major occupied habitat types include: 1) alluvial banks, point bars, floodplains, or ox-bows associated with perennial streams, with a high water table and short, perennial graminoid- and forb-dominated vegetation maintained by grazing, periodic flooding, or mowing; 2) river floodplain habitats that experience regular spring flooding and/or frequent large scale floods, but maintain relatively stable, moist to wet soil in summer, within moist meadow, riparian woodland, or riparian shrubland communities; 3) shores of lakes and reservoirs, in mesic meadow-type vegetation maintained by lake level fluctuations or seasonal flooding of gravel bars.	X			
Wenatchee Mountains checkermallow (*Sidalcea oregana var. calva*)	USFWS	Endangered	Moist meadows with surface water or saturated upper soils into early summer. Sites generally dominated by perennial herbs and rhizomatous, perennial grasses; deciduous and coniferous trees and shrubs including ponderosa pine, Douglas fir, and quaking aspen (*Populus tremuloides*) may also be present. May occur along permanent or intermittent streams, near seeps, springs, or small drainages.	X	X	X	X

Notes: 1) USFWS 2016b; 2) USFWS, 2016a; 3) NatureServe, 2015

3.10.2 Federal Threatened and Endangered Wildlife Species

There are six ESA-listed wildlife species with the potential to be found within Chelan County: marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), yellow-billed cuckoo (*Coccyzus americanus*), Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), and grizzly bear (*Ursus arctos horribilis*). Wolverine (*Gulo gulo*) is proposed for listing as threatened (USFWS, 2016b). These seven species are identified by the USFWS as having the potential to occur within the Icicle project area as shown in Table 3-16. Each of these species is identified as potentially occurring in each portion of the Icicle project area with the exception of northern spotted owl, which USFWS does not identify as potentially occurring within the Wenatchee River portion of the project area (USFWS, 2016b). Given the existing habitat conditions within the Wenatchee River portion of the project area, the listed marbled murrelet, Canada lynx, gray wolf, grizzly bear, and wolverine species are very unlikely to occupy the available habitat but could potentially occur in the vicinity of this portion of the project area, per USFWS data. The status and preferred habitats of federally listed and proposed species protected under the ESA within Chelan County and the project area, as identified by USFWS, are presented in Table 3-16.

There are three ESA-listed species with designated critical habitat in Chelan County: marbled murrelet, northern spotted owl, and Canada lynx, and one proposal to list critical habitat for yellow-billed cuckoo (USFWS, 2016a). However, of those species with designated critical habitat in Chelan County, northern spotted owl is the only one that has critical habitat located within the Icicle project area. Northern spotted owl critical habitat covers most of the Alpine Lakes and Icicle Creek portions of the project area. Designated critical habitat for marbled murrelet, Canada lynx, and the proposed critical habitat for yellow-billed cuckoo are not located within the project area (USFWS, 2016b). This information is summarized in Table 3-17.

3.10.3 Federal Threatened and Endangered Fish Species

Wenatchee spring-run Chinook salmon (*Oncorhynchus tshawytscha*) are included in the upper Columbia ESU that is listed as endangered under the ESA (NOAA Fisheries, 2016; 64 FR 14308; 70 FR 37160; 76 FR 50448). Wenatchee summer-run steelhead (*Oncorhynchus mykiss*) are included in the upper Columbia ESU that is listed as threatened under the ESA (NOAA Fisheries, 2016; 71 FR 834; 76 FR 50448). Various federal, state, county, and tribal regulatory mechanisms are in place to minimize or avoid habitat degradation by human uses, and a 5-year review by NOAA Fisheries has recommended specific future actions to improve habitat and sustainability of these species (NOAA Fisheries, 2016).

Bull trout (*Salvelinus confluentus*) are listed as threatened under the ESA (76 FR 50448; 63 FR 42757). The Wenatchee River Watershed (including Icicle Creek and other tributaries) has been designated as one of 24 bull trout core areas within the Mid-Columbia Recovery Unit (USFWS, 2015). The Wenatchee River Watershed is one of four core areas that contain the healthiest and most stable bull trout populations and should be managed to maintain the populations and prevent introduction of new threats.

Table 3-16
Federally Listed and Proposed Species, ESA Status, and Preferred Habitats that Occur in Chelan County and the Alpine Lakes, Icicle Creek, and Wenatchee River Corridor Project Areas

Common Name (Scientific Name)	Agency	Status[1,2]	Preferred Habitat[3]	Chelan County[1]	Alpine Lakes Area[2]	Icicle Creek Corridor Area[2]	Wenatchee River Corridor Area[2]
Birds							
Marbled murrelet (*Brachyramphus marmoratus*)	USFWS	Threatened	Mature, old-growth forests (nesting, roosting)	X	X	X	X
Northern spotted owl (*Strix occidentalis caurina*)	USFWS	Threatened	Mature, old-growth forests (nesting, roosting, foraging); second-growth used for dispersal	X	X	X	
Yellow-billed cuckoo (*Coccyzus americanus*)	USFWS	Threatened (Western U.S. DPS)	Breed in open woodlands, parks, deciduous, riparian woodlands; nest in tall cottonwood and willow riparian woodlands, moist thickets, orchards, or overgrown pasture	X	X	X	X
Terrestrial Mammals							
Canada lynx (*Lynx canadensis*)	USFWS	Threatened	Occurs in boreal and montane regions dominated by coniferous or mixed forest with thick undergrowth, but also sometimes enters open forest, rocky areas, and tundra to forage for abundant prey	X	X	X	X
Gray wolf (*Canis lupus*)	USFWS	Endangered	Security habitat is greater than 300 meters from roads; ungulate prey base	X	X	X	X
Grizzly bear (*Ursus arctos horribilis*)	USFWS	Threatened	Now found mostly in arctic tundra, alpine tundra, and subalpine mountain forests; most populations require huge areas of suitable habitat	X	X	X	X
Wolverine (*Gulo gulo*)	USFWS	Proposed Threatened	Large expanse of minimally disturbed forest	X	X	X	X

Notes: 1) USFWS, 2016b; 2) USFWS, 2016a; 3) NatureServe, 2015

Table 3-17
Federally Listed and Proposed Species Critical Habitat Status that Occur in Chelan County and the Alpine Lakes, Icicle Creek, and Wenatchee River Corridor Project Areas

Common Name (Scientific Name)	Agency	Critical Habitat Status[3]	Chelan County[1]	Alpine Lakes Area[2]	Icicle Creek Corridor Area[2]	Wenatchee River Corridor Area[2]
Birds						
Marbled murrelet (*Brachyramphus marmoratus*)	USFWS	Designated	X			
Northern spotted owl (*Strix occidentalis caurina*)	USFWS	Designated	X	X	X	
Yellow-billed cuckoo (*Coccyzus americanus*)	USFWS	Proposed	X			
Terrestrial Mammals						
Canada lynx (*Lynx canadensis*)	USFWS	Designated	X			

Notes: 1) USFWS, 2016; 2) USFWS, 2016; 3) NatureServe, 2015

Pacific lamprey (*Entosphenus tridentatus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) are designated as "species of special concern" by USFWS (2016b). While a petition to list Pacific lamprey under the ESA was determined not to be warranted, USFWS acknowledges that Pacific lamprey have declined in the Columbia River Basin and has published "Best Management Practices to Minimize Adverse Impacts to Pacific Lamprey (*Entosphenus tridentatus)"* (USFWS, 2010).

Several of the species described in Section 3.7, Fish, occur in the Icicle project area and are Washington State Priority Species, including the described salmon and trout species, Pacific lamprey, mountain sucker (*Catostomus platyrhynchus*), leopard dace (*Rhinichthys falcatus*), and Umatilla dace (*Rhinichthys umatilla*) (WDFW, 2008). State priority species are the focus of specific management recommendations intended to protect and enhance populations and relevant habitats.

For upper Columbia spring-run Chinook salmon and upper Columbia steelhead, areas of critical habitat affected by the Icicle Strategy include the mainstem of the Wenatchee River downstream of Icicle Creek and Icicle Creek upstream to the confluence with Frosty Creek (70 FR 52630), although the specific endpoints are not determined. These waters are shown in Figure 1-8. All of the areas of Wenatchee River, Icicle Creek, and tributaries to Icicle Creek that are accessible to bull trout are designated as bull trout critical habitat (75 FR 63897).

Locally adapted stocks of the listed spring-run Chinook salmon and summer-run steelhead are propagated in hatchery programs for conservation and reintroduction to the upper Wenatchee River Watershed, specifically the Chiwawa and Wenatchee Rivers and Nason Creek. Juveniles are overwintered at Chiwawa Hatchery and released directly to upper Wenatchee River tributaries, subsequently migrating downstream through the mainstem Wenatchee River. Additional information about fish within the Icicle project area is presented in Section 3.7, Fish.

3.10.4 WDFW Priority Habitats and Species

Of the 20 priority habitats recognized in Washington by WDFW, 11 occur in Chelan County (Table 3-18). Within the Alpine Lakes and Icicle Creek portions of the Icicle project area, six of these habitats are likely to be found. These include Biodiversity Areas, Riparian, Freshwater Wetlands, Instream, Old-Growth/Mature Forest, and Snags and Logs. The Wenatchee River Corridor includes these same priority habitat types with the exception of Old-Growth/Mature Forest and Snags and Logs. Given the mountain habitat of the Alpine Lakes, additional priority habitats that are likely to occur include Caves, Cliffs, and Talus (WDFW, 2008, 2009, and 2016).

Two of the eleven priority habitats that occur in Chelan County, Aspen Stands and Shrub-steppe, are not documented within the Icicle project area. Shrub-steppe habitat is located in the upland areas of the Wenatchee River Corridor in the vicinity of the project area. Aspen stands could occur in the vicinity of the project area in forested habitats.

The WDFW priority habitat types likely to occur within the Icicle project area are described below and the potential for occurrence within the project area is presented in Table 3-18.

Table 3-18
WDFW Priority Habitats that Occur in Chelan County and Potentially Occur within the Project Area

PHS Type	Chelan County[1]	Alpine Lakes Area[3]	Icicle Creek Corridor Area[2]	Wenatchee River Corridor Area[2]
Priority Habitats – Terrestrial Habitats[1]				
Aspen Stands	X			
Biodiversity Areas	X	X	X	X
Shrub-steppe	X			
Old-growth/Mature Forest	X	X	X	
Riparian	X	X	X	X
Priority Habitats – Aquatic Habitats[1]				
Freshwater Wetlands and Fresh Deepwater	X	X	X	X
Instream	X	X	X	X
Priority Habitat Features				
Caves	X	X		
Cliffs	X	X		
Snags and logs	X	X	X	
Talus	X	X		

Notes: 1) WDFW, 2008; 2) NatureServe, 2016; 3) WDFW, 2016

3.10.4.1 Biodiversity Areas

Biodiversity areas are defined as follows:

a) The area has been identified as biologically diverse through a scientifically based assessment conducted over a landscape scale (e.g., ecoregion, county- or city-wide, watershed, etc.). Examples include, but are not limited to, WDFW Local Habitat Assessments, Pierce County Biodiversity Network, and Spokane County's Wildlife Corridors and Landscape Linkages; or

b) The area is within a city or an urban growth area (UGA) and contains habitat that is valuable to fish or wildlife and is mostly composed of native vegetation. Relative to other vegetated areas in the same city or UGA, the mapped area is vertically diverse (e.g., multiple canopy layers, snags, or downed wood), horizontally diverse (e.g., contains a mosaic of native habitats), or supports a diverse community of species as identified by a qualified professional who has a degree in biology or closely related field and professional experience related to the habitats or species occurring in the biodiversity area. These areas may have more limited wildlife functions than other priority habitat areas due to the general nature and constraints of these sites in that they are often isolated or surrounded by highly urbanized lands.

3.10.4.2 Corridors

Corridors are areas of relatively undisturbed and unbroken tracts of vegetation that connect fish and wildlife habitat conservation areas, priority habitats, areas identified as biologically diverse (see attribute a above), or valuable habitats within a city or UGA (see attribute b above).

3.10.4.3 Riparian

The riparian habitat type is defined as the area adjacent to flowing or standing freshwater aquatic systems. Riparian habitat encompasses the area beginning at the ordinary high water mark and extends to that portion of the terrestrial landscape that is influenced by, or that directly influences, the aquatic ecosystem. In riparian systems, the vegetation, water tables, soils, microclimate, and wildlife inhabitants of terrestrial ecosystems are often influenced by perennial or intermittent water. Simultaneously, adjacent vegetation, nutrient and sediment loading, terrestrial wildlife, as well as organic and inorganic debris influence the biological and physical properties of the aquatic ecosystem. Riparian habitat includes the entire extent of the floodplain and riparian areas of wetlands that are directly connected to stream courses or other fresh water.

3.10.4.4 Freshwater Wetlands

The freshwater wetlands habitat type includes lands that are transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following attributes: the land supports, at least periodically, predominantly hydrophytic plants; substrate is predominantly undrained hydric soils; and/or the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

3.10.4.5 Instream

Instream habitat type includes the combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.

3.10.4.6 Old Growth/Mature Forest

Old-growth East of Cascade Crest

This habitat type includes stands that are highly variable in tree species composition and structural characteristics as a result of the influence of fire, climate, and soils. In general, stands will be greater than 150 years of age, with 25 trees per hectare (trees/ha; 10 trees/acre) that are greater than 53 centimeters (cm; 21 inches) diameter breast height (dbh), and 2.5 to 7.5 snags/ha (1 to 3 snags/acre) that are greater than 30 to 35 cm (12 to 14 inches) diameter. Downed logs may vary from abundant to absent. Canopies may be single or multi-layered. Evidence of human-caused alterations to the stand will be absent or so slight as to not affect the ecosystem’s essential structures and functions.

Mature Forests

Mature Forest habitat types are defined as stands with average diameters exceeding 53 cm (21 inches) dbh; crown cover may be less than 100 percent; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; and are 80 to 200 years old west and 80 to 160 years old east of the Cascade Crest.

3.10.4.7 Snags and Logs

This habitat type occurs within a variety of habitat types that support trees. Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a dbh of greater than 51 cm (20 inches) in western Washington and greater than 30 cm (12 inches) in eastern Washington and are greater than 2 meters (m; 6.5 feet) in height. Priority logs are greater than 30 cm (12 inches) in diameter at the largest end, and greater than 6 m (20 feet) long. Abundant snags and logs can be found in old-growth and mature forests or unmanaged forests of any age; in damaged, burned, or diseased forests; and in riparian areas. Priority snag and log habitat includes individual snags and/or logs, or groups of snags and/or logs, of exceptional value to wildlife because of their scarcity or location in a particular landscape. Areas with abundant, well-distributed snags and logs are also considered priority snag and log habitat. Examples include large, sturdy snags adjacent to open water, remnant snags in developed or urbanized settings, and areas with a relatively high density of snags.

3.10.4.8 Caves

This habitat type includes caves, which are defined as a naturally occurring cavity, recess, void, or system of interconnected passages (including associated dendritic tubes, cracks, and fissures) that occur under the earth in soils, rock, ice, or other geological formations, and are large enough to contain a human. Mine shafts (a human-made excavation in the earth usually used to extract minerals) may mimic caves and abandoned mine shafts with actual or suspected occurrences of priority species should be treated in a manner similar to caves.

3.10.4.9 Cliffs

Cliffs are defined as being greater than 7.6 m (25 feet) high and occurring below 1,524 m (5,000 feet) high.

3.10.4.10 Talus

This habitat type consists of homogenous areas of rock rubble ranging in average size of 0.15 to 2.0 m (0.5 to 6.5 feet), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. Talus may be associated with cliffs.

Overall, more than 45 priority species of birds, mammals, amphibians, and reptiles have been documented as occurring within Chelan County (WDFW, 2008, 2009). A variety of WDFW priority species have also been specifically documented within the Icicle project area (WDFW, 2016). A complete list of WDFW priority species documented within Chelan County and the project area is presented in Appendix D.

3.11 Aesthetics

There are a number of visual resource programs used by various agencies to catalog and help prioritize the management of visual resources on public lands. These include the Scenery Management System (USFS, 1996), Visual Impact Assessment Guidelines (U.S. Department of Transportation, 2015), and the Visual Resource Management System (Department of the Interior, 1984). Application of the methods, concepts, and terms contained in these guidance documents provide a more standardized way to objectively evaluate aesthetic resources and potential changes affecting these resources.

In managing aesthetic values within public lands, these programs provide guidance on assessing the overall scenic quality of a particular landscape. This generally includes determining the visual character of an area, identifying any unique aesthetic features or views, and considering what sensitive viewer groups may be present.

To describe the visual character of an area, it is necessary to first define important viewpoints. Viewpoints are specific locations from which representative views of the overall area can be seen by sensitive viewer groups. Representative views are typically broken down into foreground (generally 0 to 0.25 miles from the viewer), middleground (0.25 miles to 2 miles), and background (greater than 2 miles). Within the foreground, viewers can detect surface textures and details. Middleground views emphasize the geometric landscape form over details, but development may still be noticeable if it contrasts in line, form, texture, or color with the surroundings. The background view loses all textural detail, and development tends to only be noticeable if change is of a larger scale and there is a stark contrast in form or line between the development and surrounding landscape.

Sensitive viewer groups can include residents, workers, recreationalists, and motorists. Their overall sensitivity to visual changes depends on the extent to which they are exposed to a particular view and how important the visual character is to their activity. In general, viewers are considered to be more sensitive to visual changes if they are repeatedly exposed to the same view and if that view contributes to the underlying activities.

Unique aesthetic resources or views include things like unique or different landscape features or formations. This can include built environments, such as city skylines, or natural features, such as mountains or lakes. Specific corridors can also be designated by the National Scenic Byway Program as having unique visual qualities.

In general, visual character refers to the overall feel or nature of a viewpoint. The character can be more natural with few man-made elements or more urban with many man-made structures. The character is based on the landscape elements found (e.g., landform, vegetation, rocks, water features).

Visual quality refers to how intact the visual character is. If there are conflicting visual elements, such as some man-made structures in an otherwise pristine natural landscape, the visual quality of that landscape would not be as high as areas where the landscape is more uniform.

3.11.1 Alpine Lakes

The Alpine Lakes are located in the northern Cascades in an area that features striking views provided through dramatic terrain, lakes, and creeks, and a wide-variety of ecotypes as a result of elevation and precipitation variability throughout the 400,000 acres.

Land uses and related activities within the Alpine Lakes Wilderness Area (ALWA) are governed in part by the Wilderness Act of 1964 (16 United States Code [USC] 1131). In addition to allowing for certain land uses, including water resources management facilities, the act also designates scenic use as one of the six public purposes of wilderness. The Act requires wilderness character to be preserved consistent with other allowed uses (36 Code of Federal Regulations 293).

Sensitive viewer groups within this part of the Icicle project area consist of recreationalists and some IPID and USFWS staff who conduct periodic operations and maintenance activities at the lakes. Recreational use in this area is described in greater detail in Section 3.15, Recreation. In general, 150,000 visitors (USFS, 2017) hike into the lakes annually, mostly in the summer months, to camp and enjoy the wilderness.

Important viewpoints at each of the potentially affected lakes were selected based in part on recreational use data. In general, trailheads at each lake were selected because those are the areas where the most people arrive at the lakes and experience sweeping views of the lakes and surrounding mountains. Representative views of this area are shown in the figures below.

As shown in Figures 3-11 to 3-13, which include a selection of photographs from the lakes, the Alpine Lakes visual character is defined by the lakes in the foreground, sloped conifer forests punctuated by snags in the middleground, and seasonally snow-capped mountain peaks in the background. In general, these views are relatively intact. The existing dams and outlet infrastructure are visible in certain views; however, most of the facilities are small in scale or compatible with the surrounding landscape (i.e., blend in) or are blocked by vegetation or landform from areas heavily accessed by recreationalists.

Figure 3-11. Eightmile Lake Vista

Figure 3-12. Klonaqua Lake Vista

Figure 3-13. Square Lake Vista

The anthropogenic features present in this part of the Icicle project area vary between the lakes but consist primarily of primitive campgrounds and trails (Figures 3-14 and 3-15), and water resources infrastructure such as valve or gate structures (Figure 3-16), exposed gate operators (Figure 3-17), and dam structures (Figure 3-18). The materials used in both the recreation and irrigation facilities tend to camouflage these features into the surrounding landscape, making the overall character appear more natural and visually intact.

Figure 3-14. Eightmile Lake Trail

Figure 3-15. Campsite near Klonaqua Lake

Figure 3-16. Valve House and Outlet near Nada Lake

Figure 3-17. Gate Actuator and Gate Chamber near Klonaqua Lake

Figure 3-18. Dam Structure at Square Lake

3.11.2 Icicle Creek Corridor

Lower in the watershed, the upper portion of the Icicle Creek Corridor, particularly the portion located within the Wenatchee National Forest, has similar vegetative character as the Alpine Lakes; however, closer to the City of Leavenworth the visual character becomes more developed with urban and agricultural uses that include more man-made features, such as paved roads, parking areas, trails and trailheads, and rural residential development.

Outside of the national forest in the lower portion of the watershed near the City of Leavenworth, recreational vehicle (RV) campgrounds, extensive agriculture, and rural and residential development are present. Infrastructure development is extensive within the LNFH. Throughout the majority of the Icicle Creek Corridor, there are limited creek crossing bridges with the exception of trails, a few residential access bridges, hatchery structures, and the East Leavenworth Road. The creek bank includes a fairly continuous but relatively thin band of riparian vegetation, though gaps in this buffer occur in a few areas of the hatchery and along a few rural or agricultural properties south and east of the City of Leavenworth.

Important viewpoints along the Icicle Creek Corridor were selected based in part on recreational use data. In general, trailheads leading to the Alpine Lakes wilderness and public access routes within the LNFH were selected because these are the areas where the most people experience extended views of Icicle Creek. Representative views are shown in Figures 3-19 and 3-20.

Figure 3-19. Icicle Creek Boulder Field from Snow Lakes Trailhead

Figure 3-20. Icicle Creek from Leavenworth National Fish Hatchery, Structure 5

3.11.3 Wenatchee River Corridor

Further downstream, the Wenatchee River Corridor contains even more intensive residential and agricultural uses. This Wenatchee River Corridor also includes more intensive development, including residential, commercial, and recreational uses within the City of Leavenworth and other towns and cities. Icicle Road and Highway 2 both cross the Wenatchee River at bridges in the City of Leavenworth. Riparian vegetation within the City of Leavenworth is fairly intact, though gaps are present at the golf course and along some residential and agricultural properties. Downstream of the City of Leavenworth, the upland areas are dominated by agricultural activities, providing pastoral landscape views mostly characterized by orchard activities. In this segment of the Wenatchee River Corridor, several roads and bridges cross the river. A railroad and Highway 2 run along the Wenatchee River. Both the railroad and the highway cross the river on bridges at multiple locations. Local roads also cross the river on bridges near Peshastin, Dryden, Cashmere, and Monitor. Riparian vegetation on the riverbank persist, though the vegetation has gaps where there is development near the Town of Peshastin, the Peshastin Mill, and residential development within the Town of Dryden.

The Stevens Pass Greenway was designated a National Scenic Byway in 2005. This corridor includes Highway 2 beginning in the City of Monroe and extending to the orchards around the Town of Peshastin. The National Scenic Byway Program designates specific corridors that contain unique visual qualities. These areas are regulated under the Intermodal Surface Transportation Efficiency Act of 1991 (23 USC 101). This program designates scenic transportation routes and encourages strategies for "protecting and enhancing the landscape and view corridors surrounding such a highway" (USFS, 2003).

Important viewpoints along the Wenatchee River Corridor were selected based on public water access locations and proximity to the scenic byway as these are the areas where the most people experience extended views of the Wenatchee River. Representative views are shown in Figures 3-21 and 3-22.

Figure 3-21. Wenatchee River at Icicle Road Bridge near Public River Access

Figure 3-22. Wenatchee River from Highway 2 Bridge at Town of Dryden

3.12 Air Quality

3.12.1 Regulatory Setting

The Federal Clean Air Act (CAA, U. S. Code Title 42, Chapter 85) is administered by the EPA. The EPA is mandated to set standards on air emissions considered harmful to public health (primary standards) and public welfare (secondary standards). These National Ambient Air Quality Standards (NAAQS) are set for six criteria pollutants, which include carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter[3-18], and sulfur dioxide.

While the EPA is the primary regulatory authority, the CAA is largely implemented by the states and local and tribal authorities. The Ecology Central Regional Office is responsible for air quality control within Chelan County. The CAA requires states to classify air basins as either being in attainment or nonattainment with respect to the

[18] Particulate matter is broken out into two categories: fine particulate matter 2.5 micrometers or smaller (PM 2.5), and large particulate matter less than 10 micrometers (PM 10).

criteria pollutants. In areas designated as nonattainment areas, the local or regional air quality authority must prepare a State Implementation Plan (SIP) that demonstrates how the area will achieve attainment by federally mandated deadlines.

In addition, the CAA includes provisions to maintain scenic vistas within federally designated Class 1 areas (40 Code of Federal Regulations [CFR] 81), which includes the Alpine Lakes (WAC 173-400-118). Ecology has developed a Regional Haze SIP to comply with requirements to minimize impacts on visibility within these designated areas. The SIP focuses on controlling emissions from fixed large facilities, such as smelters and other industrial facilities (Ecology, 2010).

Ecology has also identified Washington State Ambient Air Quality Standards (SAAQS) for the protection of human health (primary standards), which supplement the NAAQS and include limits for emissions of total suspended particulates, lead, particulate matter, sulfur dioxide, carbon monoxide, ozone, and nitrogen dioxide (Chapter 70.94 RCW). Several state regulations also apply to regulating air emissions from operations (e.g., stationary facilities) and construction activities consistent with these standards (Chapter 173-400 WAC).

3.12.2 Current Air Quality Environment

There are two current air quality monitoring stations within the Icicle project area. The first is in the City of Leavenworth and is operated by the USFS to monitor air quality in order to make decisions on initiating controlled burns. The second air quality monitoring station is in the City of Wenatchee and is operated by Ecology. The purpose of this station is to collect wind speed, wind direction, and temperature in support of PM 2.5 monitoring at the City of Wenatchee (Ecology, 2016a). Historically, Chelan County has not exceeded the NAAQS and is currently in attainment for criteria pollutants (Ecology, 2016b).

Within the Alpine Lakes portion of the Icicle project area, haze is a major concern and can affect the views that visitors to the lakes experience. An air quality monitor was established at the Snoqualmie Ski Area in 1993 to assess visibility impairment within the surrounding area. Based on the monitoring data, sulfates were the largest contributor to visibility impairment in the Snoqualmie Ski Area, followed by organic carbon, ammonium nitrate, and elemental carbon. With the implementation of the State Regional Haze SIP in this area, visibility improved 20 percent between 2000 and 2009. Visibility is anticipated to reach background levels (approximately 84 miles) by 2064 based on the current rate of improvement (USFS, 2013).

Major air pollution sources within the Icicle project area occur as the result of outdoor burning (year round, except during summer fire safety burn bans), wildfires, agricultural burning (spring and fall burn seasons), orchard heaters, smudge pots, silvicultural burning, and woodstove use. In rare instances, smoke from some burns may become entrained in evening downslope flow and settle in sheltered valleys (Ecology, 2015). Table 3-19 defines sources of pollutants that contribute to increased haze within the Icicle project area.

Table 3-19
Sources of Regional Haze Pollutants

Pollutant	Anthropogenic Sources	Natural Sources
Sulfates	Coal-fired Power Plants, Diesel Engines, Industrial Boilers	Volcanoes
Organic Carbon	Incineration, Household Heating	Fire, Vegetation
Nitrates	Cars and Trucks, Off-Road Vehicles, Industrial Boilers, Agriculture	Soils, Lightning, Fire
Fine Soil	Off-Road Vehicles, Agriculture	Wind-blown Dust
Elemental Carbon	Soot, Diesel Engines	Fire
Fine Particulate Matter	Combustion Processes, Roads	Fire
Coarse Particulate Matter	Construction, Roads, Woodstoves, Fireplaces	Wind-blown Dust, Fire

Source: USFS, 2013.

Potentially sensitive receptors include any groups or individuals who are particularly vulnerable to air pollution. This typically includes children, the elderly, or any other persons with health complications. Potentially sensitive receptors within the Icicle project area are largely limited to the more urbanized areas, closer to the Cities of Leavenworth and Wenatchee.

3.13 Climate Change

Climate change poses a challenge for water resource planning, protection, and use. This is because of increased uncertainty in timing, form, and distribution of precipitation and water demand. Climate change will impact water supplies within the region, affecting uses such as instream flows, municipal, and agricultural. This section discusses the current and projected climatic conditions regionally and within the Icicle project area. Additionally, predicted impacts of climate change on streamflow is provided for the Alpine Lakes Area and Icicle Creek sub-regions.

3.13.1 Current Climatic Conditions

Climate in the Pacific Northwest is influenced by the interactions and seasonal variation of atmospheric circulation patterns, especially the seasonal migrations of the Aleutian Low pressure system and the North Pacific (Hawaii) High pressure system (CIG, 2004). These patterns generally lead to cold, wet winters and warm, dry summers, with local variation based on marine influences and elevation.

Climate in the valleys west of the Cascades follows the pattern of cool, wet winters and warm-dry summers. However, with the marine influence of this area, mild temperature regimes are dominant. Average annual precipitation in most places west of the Cascades is more than 30 inches. As a result of orographic lift, precipitation on the westerns slopes of the Cascades is extremely high, with most places receiving in excess of 100 inches per year (CIG, 2004).

Climate east of the Cascade crest is more continental, with warmer, drier conditions. This is in stark contrast to the maritime climate of the western portion of the region. The Cascade Mountains create this regional dichotomy in climate, with the rain-shadow effect driving the dry conditions in eastern Washington and creating a barrier between the maritime low pressure and the continental high pressure. In the eastern lowlands, average annual precipitation is generally less than 20 inches, with some places receiving as little as 7 inches (CIG, 2004).

The Wenatchee River Watershed is located on the eastern slopes of the Cascade Mountains. The headwaters, located at high elevations in the Cascades, receive considerable precipitation, which mostly falls as snow. Lower elevations of the Wenatchee River Watershed receive more modest amounts of precipitation. Table 3-20 lists average annual precipitation for weather stations located in and near the Wenatchee River Watershed.

Table 3-20
Available NWS Climate Records in/near Wenatchee River Watershed
(adapted from Wenatchee Watershed Assessment, 2003)

Agency	Station No.	Name/Location	Period of Record	Average Annual Precipitation (inches)
NWS	458089	Stevens Pass	1950-1994	84.5
NWS	454446	Lake Wenatchee	1948-1985	39.3
NWS	456534	Plain	1948-Present	37.0
NWS	454572	Leavenworth 3 S	1948-1973; 1979-Present	25.3
NWS	450929	Wenatchee EXP STN	1950-1951; 1971-1997	10.3
NWS	459074	Wenatchee	1931-Present	8.9
NWS	459082	Wenatchee FFA AP	1959-Present	8.4

This pattern holds true for the Icicle Creek Subbasin. Although, because of its elevation and location, it lowest elevations in the Icicle Creek Subbasin receive more precipitation than the lowest elevations in the Wenatchee River Watershed. The nearest weather station to the upper Icicle Creek Watershed is located at Stevens Pass, which is a little over 2 miles from the most northwestern reaches of the Icicle Creek Subbasin. As illustrated in Table 3-20, the average annual precipitation for Stevens Pass is 84.5 inches.

The City of Leavenworth 3 S is the lowest and eastern-most weather station in the Icicle Creek Subbasin and receives approximately 25.3 inches of precipitation annually.

3.13.2 Projected Future Climatic Conditions

During the past 100 years, the Pacific Northwest has become warmer and wetter (Mote et al., 2005). Models predict a continuation of this trend. Temperatures will continue to increase within the Pacific Northwest region, along with small increases in precipitation, shifts in the seasonality of precipitation, and increased high precipitation events; however, to what degree depends on greenhouse gas emission scenarios (CIG, 2009). These climatic changes are likely going to decrease snow pack in the Cascades, with early snowmelt. The CIG predicted in their 2009 *Washington Climate Change Impacts Assessment*, that probable impacts are decreased April 1 snowpack (by as much as 40 percent in the 2040s), reduced reservoir storage, and increased stream temperatures. This will have profound effects on the Wenatchee River Watershed, which is characterized as a snow dominant basin (Tohver, 2016). By the 2040s, the Wenatchee River Watershed will likely be a rain/snowmelt transient watershed. This will mean lower snowpack, earlier run off, and more precipitation will fall as rain (Tohver, 2016). These future climate conditions are anticipated in the Icicle Creek Subbasin as well.

3.13.3 Implications for Stream Flow in Icicle Creek

Modeling indicates the changes in climate discussed above will have substantial impacts on Icicle Creek streamflow (CIG, 2017). In Icicle Creek, the model predicts an average minimum flow would decrease by as much as 75-percent in 2050 for a 2-year return period (CIG, 2017). Conversely, the results indicate an increase percent change in peak flows in 2050 based on the 2-year return period: 22 percent, 20 percent, and 58 percent, respectively (CIG, 2017). This indicates that systems will become flashier, with lower low flows and higher peak flows. With warmer winters, run off will increase considerable in the early part of the water year, leaving less water instream during critical low flow months. Table 3-21 provides the average change in percentages by month for 2050.

Figure 3-23 through 3-28 details the impacts of these projected changes on the streamflow averages in Icicle Creek. As illustrated in the figures, by 2030 under low and high greenhouse gas scenarios, the model predicts higher flows from December through April, with lower flows from May through November. The model predicts that low flows will also be lower than what has been observed historically. The results indicate a reduced peak flow, which is predicted to occur in mid-April as opposed to June, when the average peak flow has historically occurred. As time progresses, the model predicts that these trends will become more extreme. In 2050, under low greenhouse gas emissions, the results indicate that peak flow will be reduced compared to the historical peak flow, with a greater volume of flow between the month of October and May. By 2080, the model predicts that this trend will be further exaggerated, with a much flatter hydrograph. The results indicate that average flows will increase dramatically in the winter months (October to April) and will be much lower from May to September. Under the high greenhouse gas scenarios, these trends are similar, but accelerated and exaggerated.

Table 3-21
Streamflow Percentage Change Based on Climate Change Modeling 2050 (CIG, 2017)

Month	Percentage Change Based on GHG Scenario		
	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

Figure 3-23. Icicle Creek Modeled 2030 Flows (Low Greenhouse Gas Emissions)

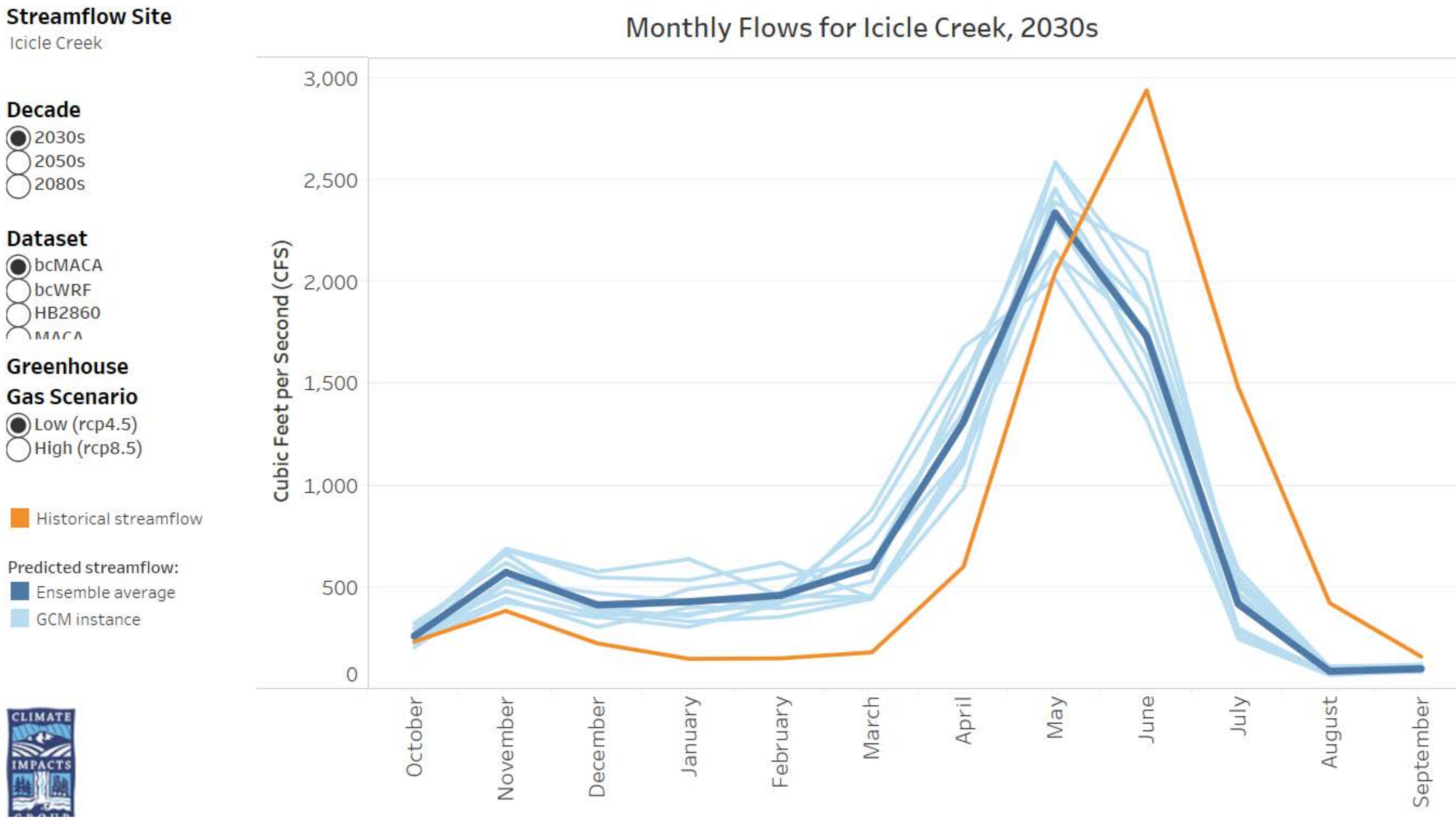


Figure 3-24. Icicle Creek Modeled 2030 (High Greenhouse Gas Emissions)

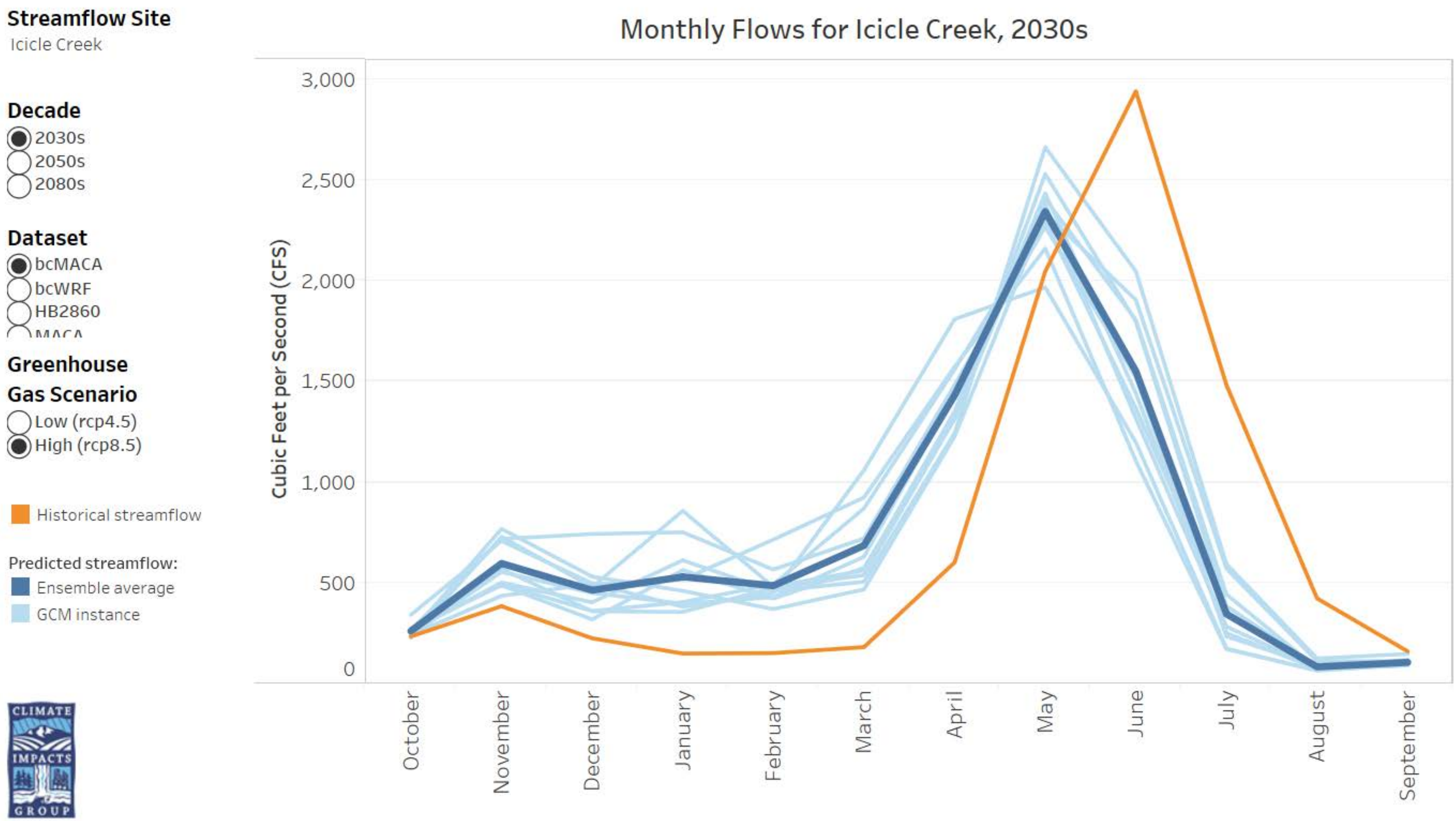


Figure 3-25. Icicle Creek Modeled 2050 Flows (Low Greenhouse Gas Emissions)

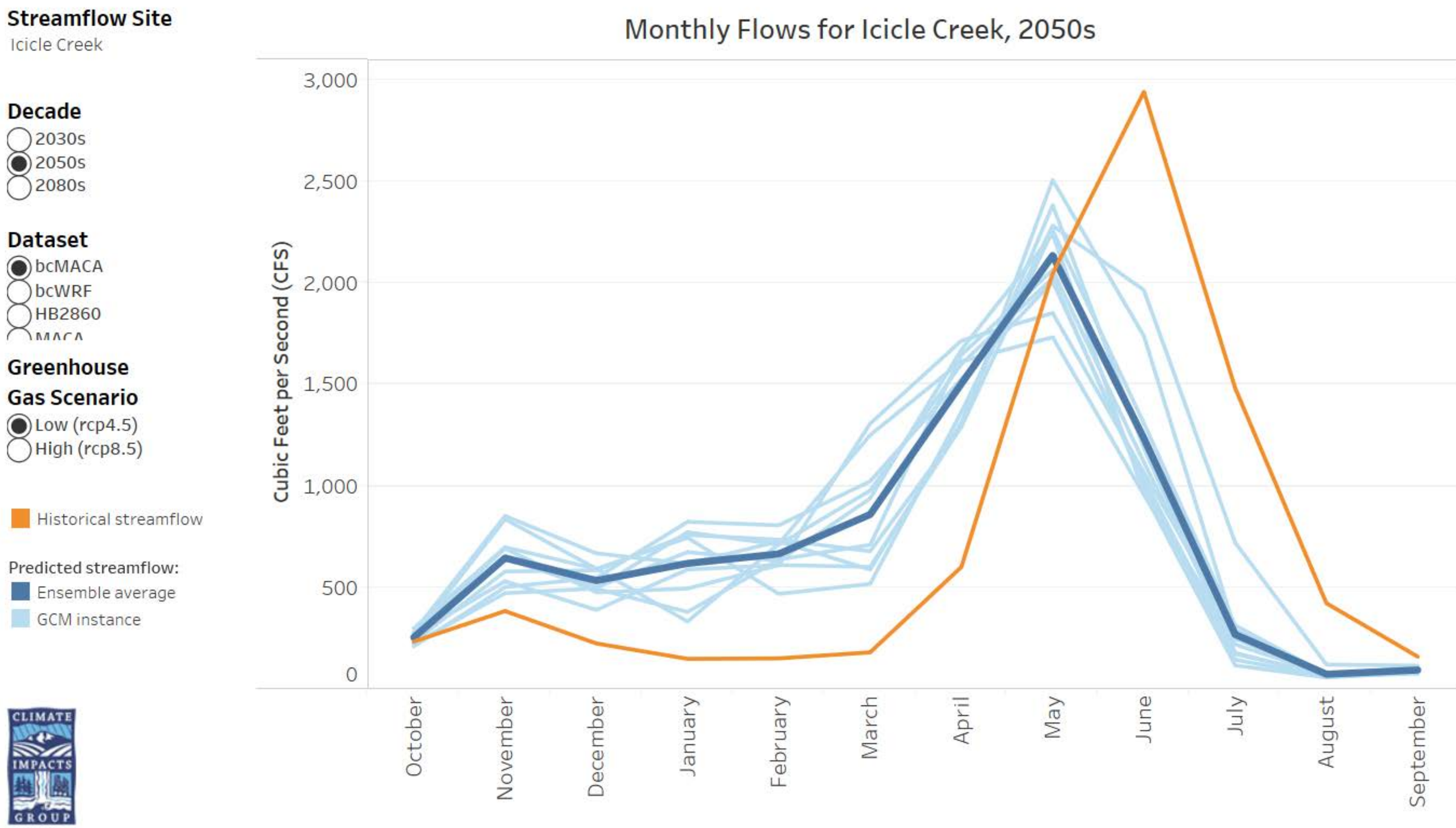


Figure 3-26. Icicle Creek Modeled 2050 Flows (High Greenhouse Gas Emissions)

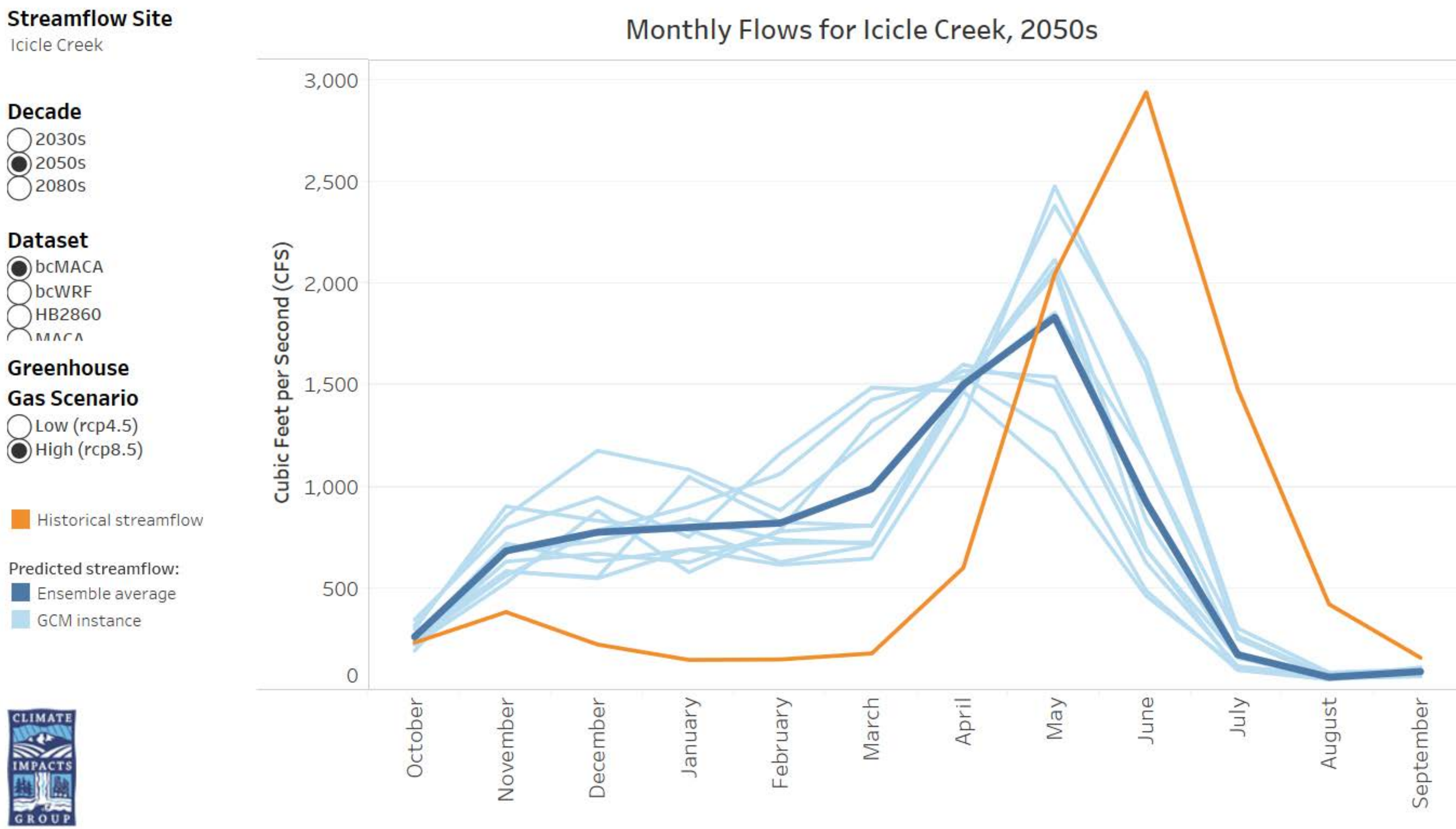


Figure 3-27. Icicle Creek Modeled 2080 Flows (Low Greenhouse Gas Emissions)

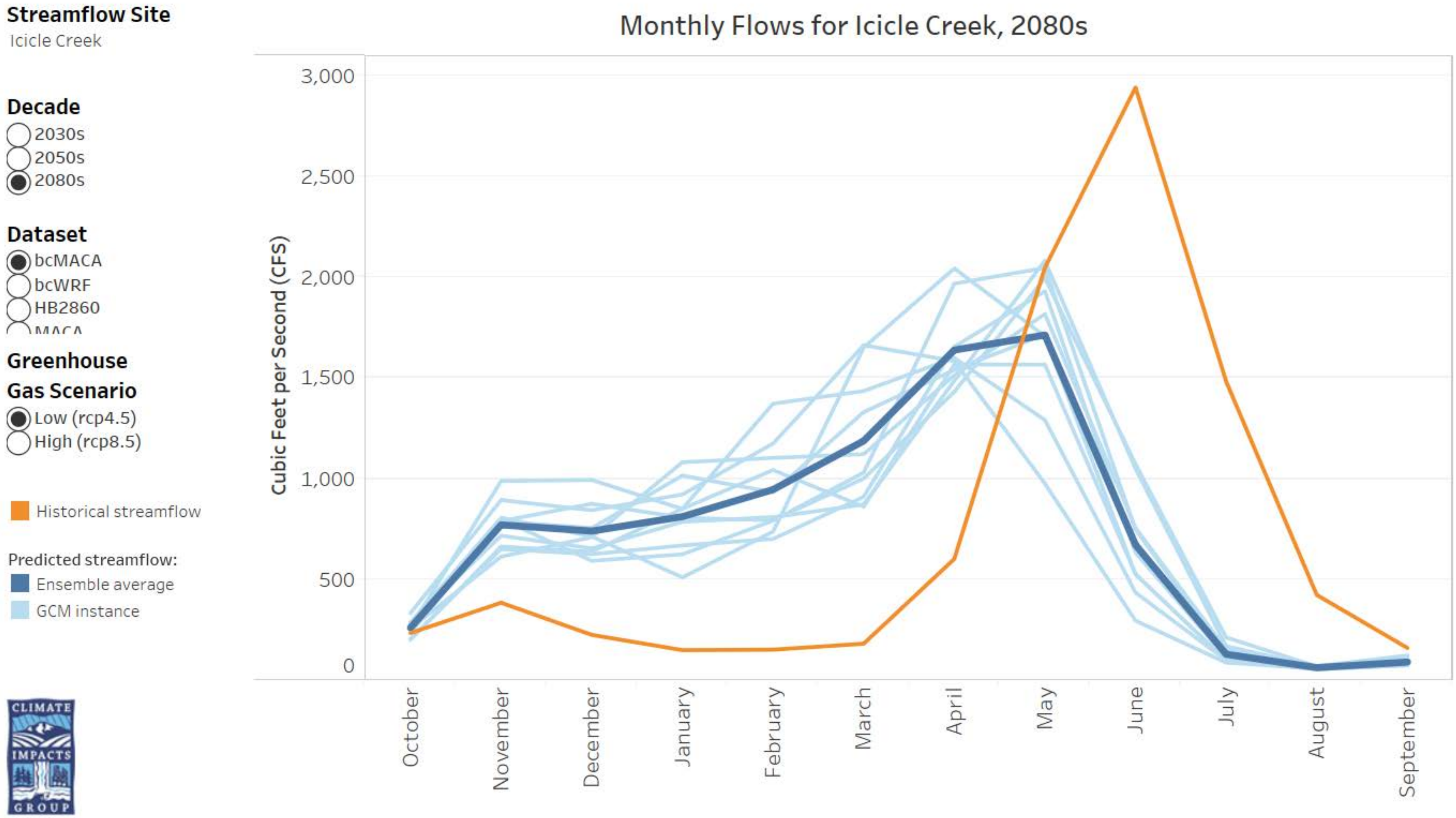
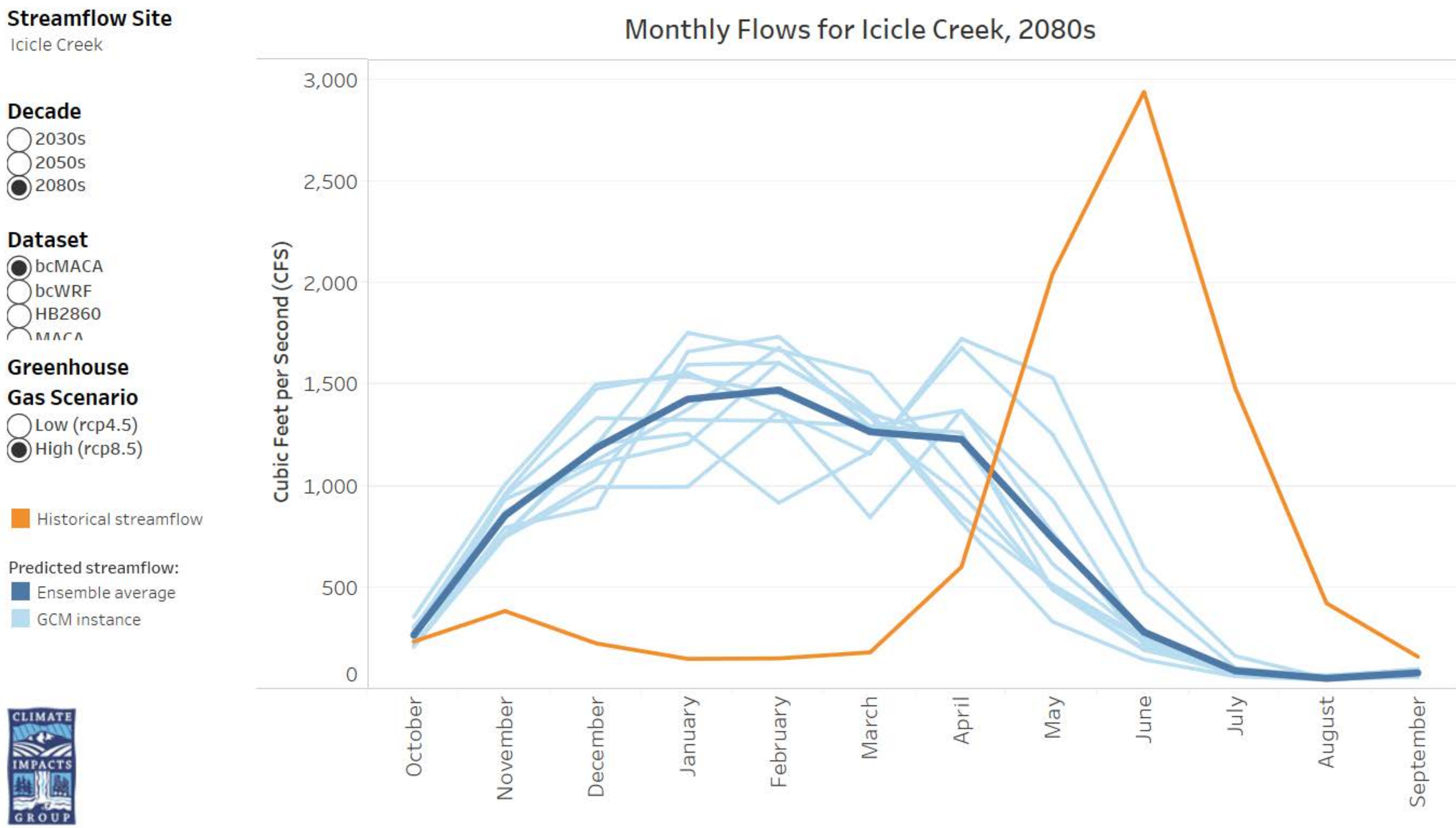


Figure 3-28. Icicle Creek Modeled 2080 Flows (High Greenhouse Gas Emissions)



For the Alpine Lake catchments evaluated as part of the Icicle Strategy, the results predict a similar shift in peak flows from June to May, with a drop in peak flows and low flows. The biggest changes are predicted in the northwestern-most lakes, Klonaqua and Square. These catchments have the largest predicted drop in peak and low flows. However, all catchments appear to have an increase in flows during the winter months. This is likely tied to predicted changes in precipitation type and the timing of snow melt. As time progresses or under high greenhouse gas scenarios, these changes become more extreme. The 2030 modeling under low greenhouse gas scenarios predicts slightly higher winter flow, with peak flows occurring about a month earlier (May rather than June), a rapid decrease in flow from May through July, and low flows in August. Under the 2080 high greenhouse gas scenario, the results indicate much more wintertime flow (October through April), significantly reduced peak flow occurring in April, and severely reduced flows throughout the summer. Figures 3-29 through 3-35 show the predicted flow in these catchments in 2050 based on low greenhouse gas emissions.

Figure 3-29. Colchuck Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

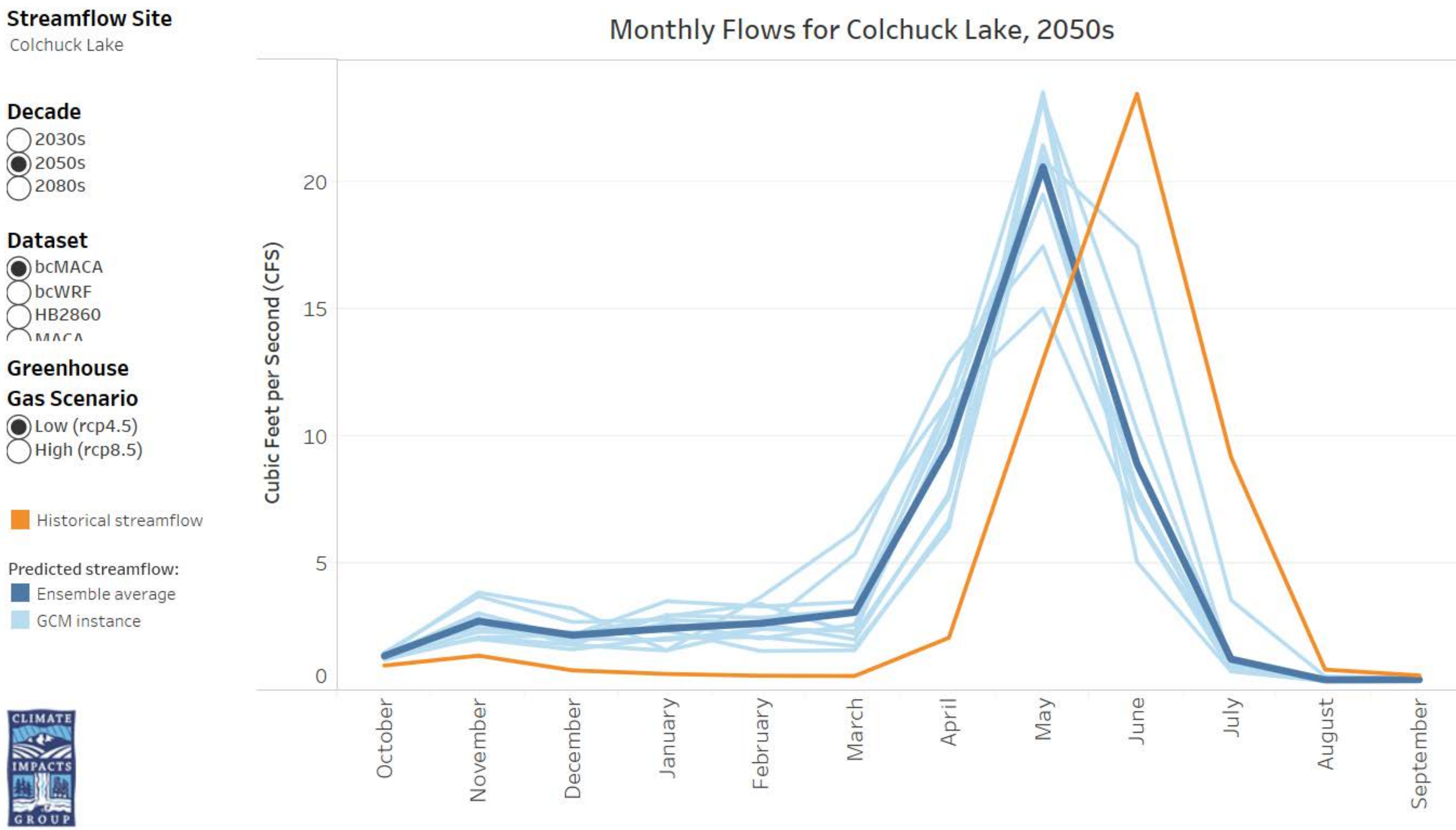


Figure 3-30. Eightmile Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

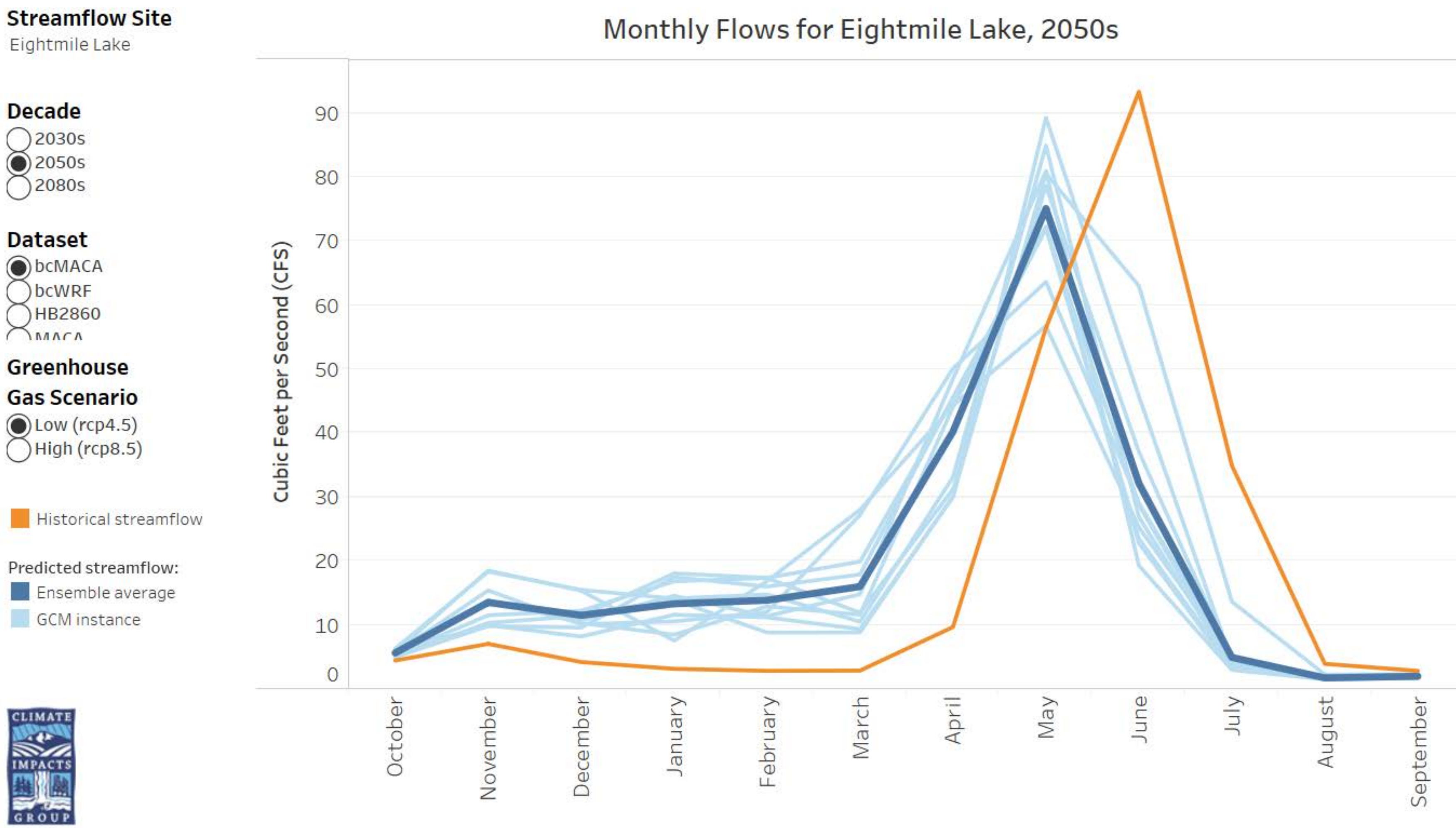


Figure 3-31. Klonaqua Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

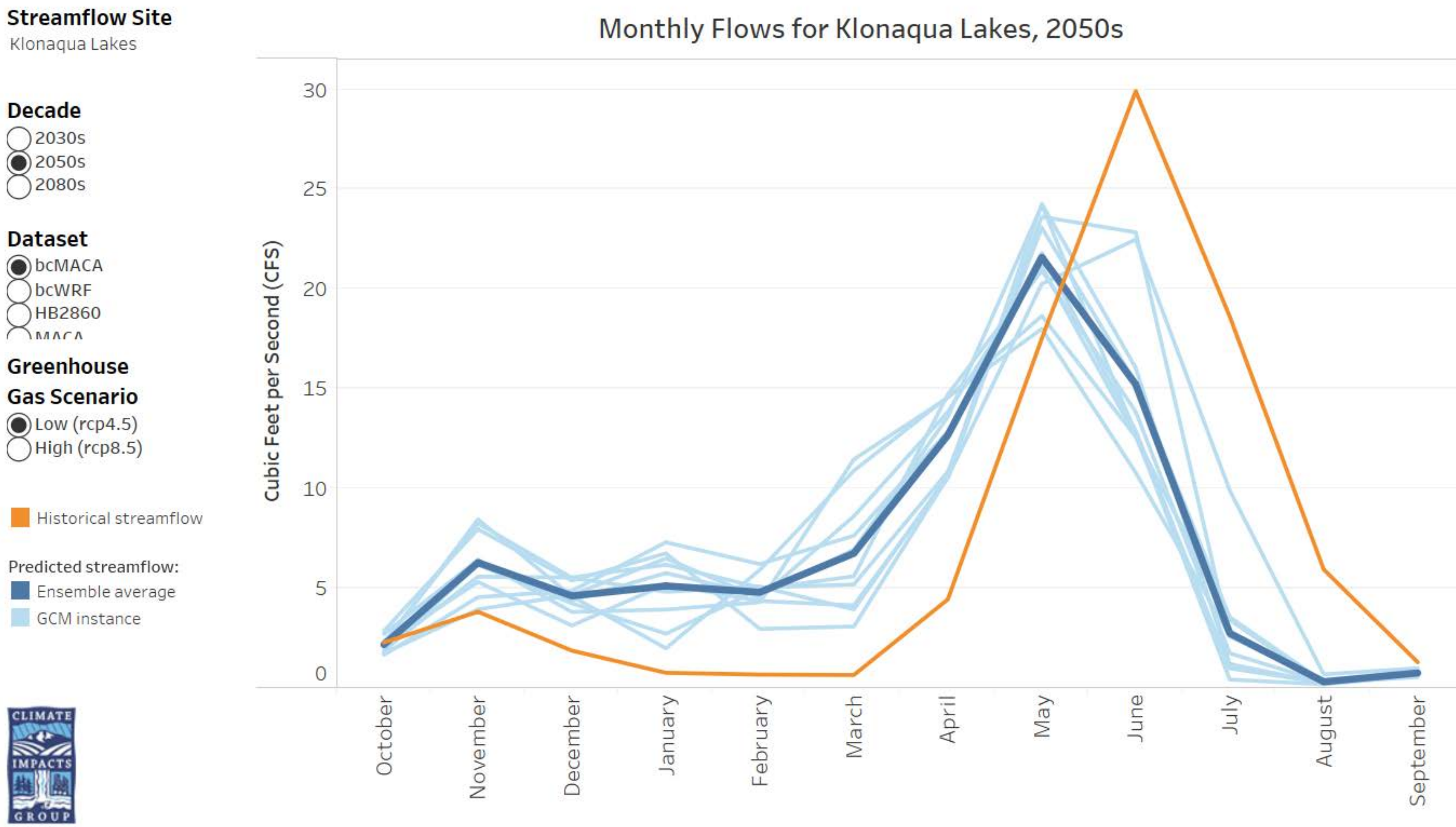


Figure 3-32. Square Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

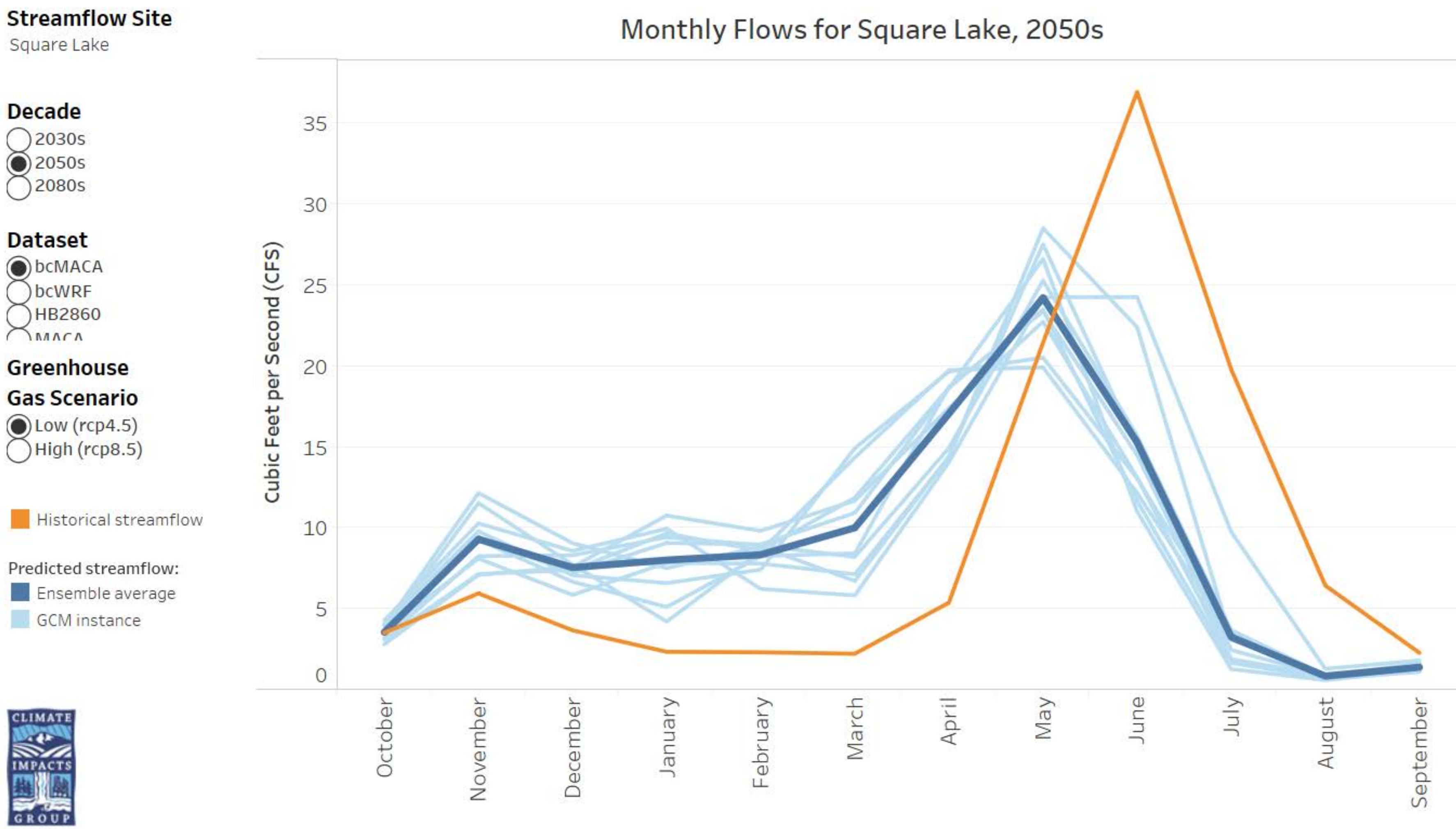


Figure 3-33. Nada Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

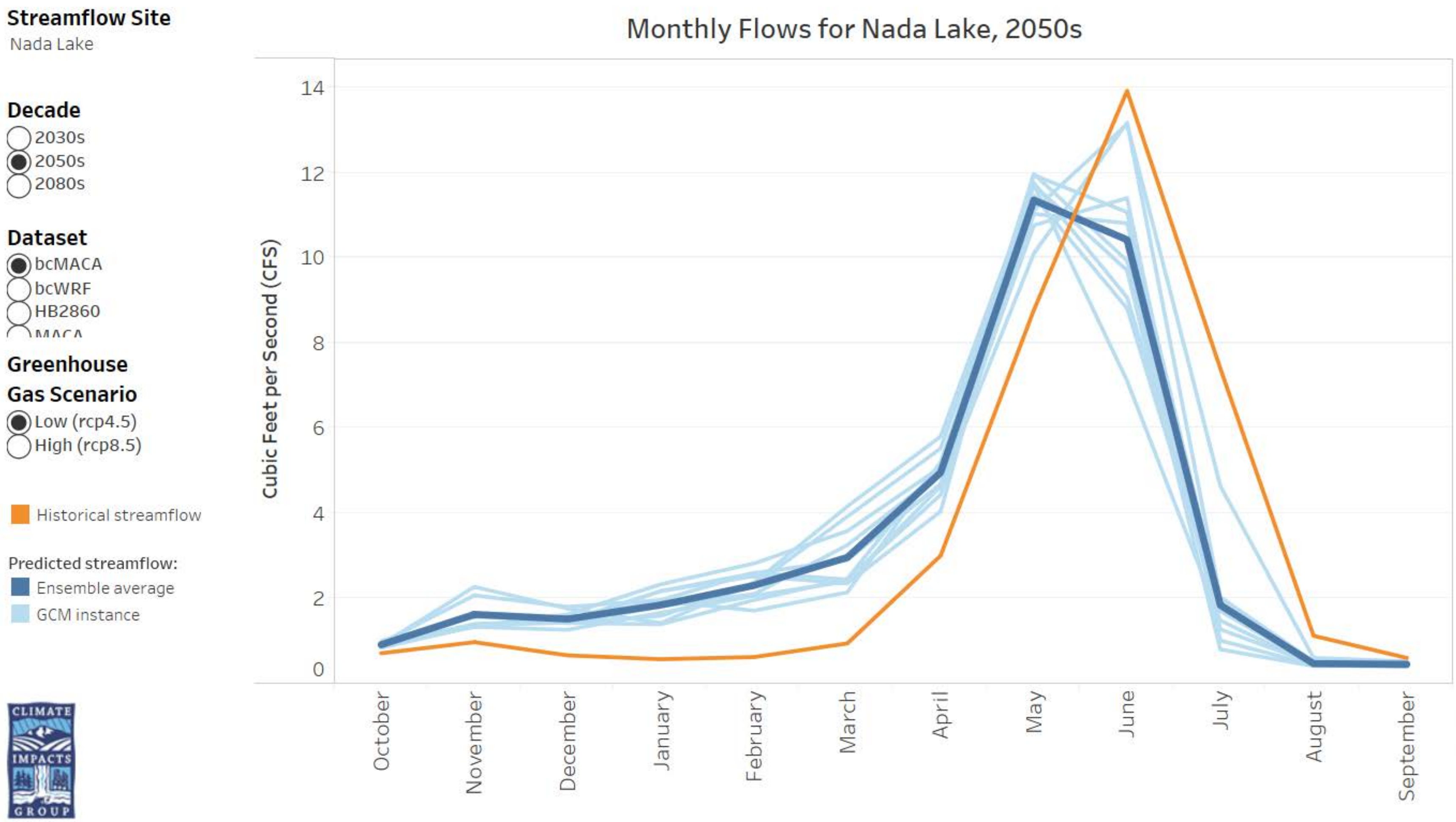


Figure 3-34. Lower Snow Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

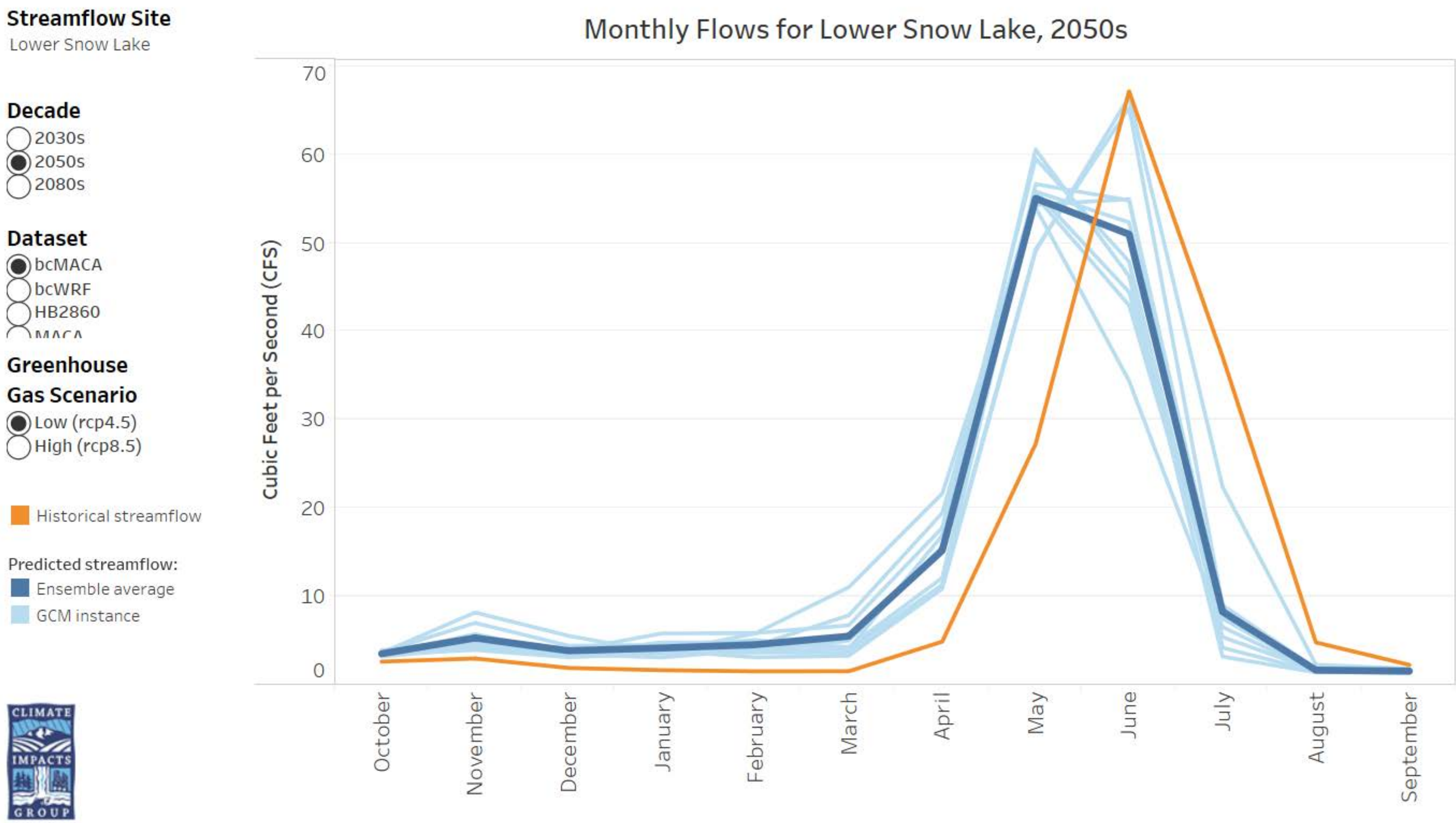
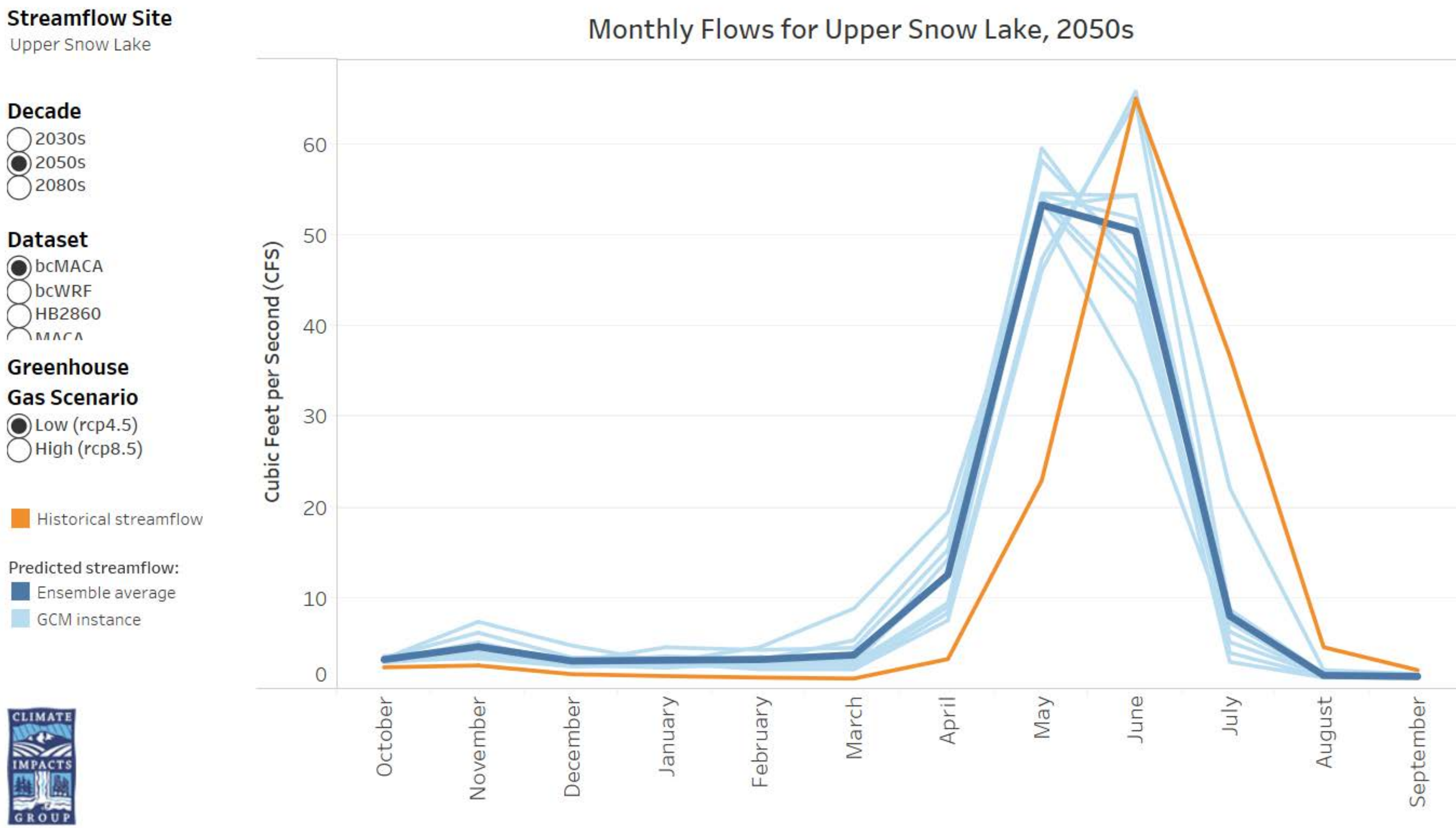


Figure 3-35. Upper Snow Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)



3.14 Noise

Noise is generally defined as unwanted sound. Sound is measured in terms of both pressure and frequency, based on the ear's sensitivity. The human ear is less sensitive to higher and lower frequencies than to mid-range frequencies. Therefore, sound level meters used to measure environmental sound generally incorporate a filtering system that discriminates against higher and lower frequencies in a manner similar to the human ear to produce noise measurements that approximate the normal human perception of noise. Measurements made using this filtering system are termed "A-weighted decibels," abbreviated as dBA. Sound levels referred to in this PEIS are stated as hourly equivalent sound pressure levels (Leq) in terms of dBA.

Sound levels decrease with distance from a sound source. The Leq sound level from a linear source, such as a road, will decrease by 3 to 4.5 dBA for every doubling of distance between the source and the receiver. The Leq sound level from a point source, such as a generator, will decrease by approximately 6 dBA for every doubling of distance between the source and the receiver. A 10-dBA change in noise level is perceived by most people to be approximately a doubling in loudness (e.g., an increase from 50 dBA to 60 dBA causes the perceived loudness to double). Generally, 3 dBA is the minimum change in outdoor sound levels that can be perceived by a person with normal hearing.

Ambient environmental sound is often described in using a day-night average sound level (Ldn). This metric measures sounds using an A-weight equivalent over a 24-hour period. It also uses an additional 10-dBA weighting for nighttime hours (10:00 p.m. to 7:00 a.m.) to account for greater nighttime sensitivity to noise (EPA, 1978). The Program Alternatives are not anticipated to generate long-term sources of noise; however, short-term construction noise could be generated. Table 3-22 shows common types of sound generated by construction activities.

Table 3-22
Typical Construction Noise Levels

Noise Source	Maximum Noise Level (dBA)[1]	Notes
Threshold of hearing	10	Barely audible
Rustling leaves, broadcast and recording studio	20	Extremely quiet
Quiet rural area	30	Very Quiet
Whisper; lowest limit of urban ambient sound	40	One-eighth as loud as 70 dBA.
Quiet suburb	50	One-fourth as loud as 70 dBA.
Conversation (3 feet)	60	Half as loud as 70 dBA. Fairly quiet

Noise Source	Maximum Noise Level (dBA)[1]	Notes
Vacuum cleaner, gas lawn mower at 100 feet	70	Upper 70s are annoyingly loud to some people.
Garbage disposal; freight train (at 100 feet)	80	2 times as loud as 70 dBA. Possible damage in 8 hours of exposure.
Motorcycle at 25 feet; diesel truck at 50 feet	90	4 times as loud as 70 dBA. Likely damage in 8 hours of exposure
Construction site; jackhammer	100	8 times as loud as 70 dBA. Serious damage possible in 8 hours of exposure
Jet flyover (1,000 feet)	110	16 times as loud as 70 dBA.
Thunderclap; chain saw	120	32 times as loud as 70 dBA. Commonly accepted pain threshold.
Jet taking off (200 feet)	130	Painful

Modified from several sources including: https://www.chem.purdue.edu/chemsafety/Training/PPETrain/dblevels.htm; http://www.roads.maryland.gov/Index.aspx?PageId=827; OSHA, 2013
Notes: 1) Noise is measured as A-weighted decibels (dBA) at 50 feet from the source.

3.14.1 Regulatory Setting

3.14.1.1 Federal Noise Control Standards

The Federal Noise Control Act of 1972 (42 U.S.C. §4901 et seq.) established a national policy to protect people from noise that may be harmful to their welfare. This policy generally delegates responsibility for regulating noise to state and local governments (EPA, 2016).

3.14.1.2 State and Local Noise Control Standards

Ecology administers the State Noise Control Standards through Chapter 173-60 WAC, which adopted the Federal Noise Control Act of 1972 in order to establish maximum permissible noise standards based on zones. WAC 173-60-030 defines environmental designation for noise abatement (EDNA) zones into three classifications (A, B, C). Class A EDNA is typically where people reside and sleep, and include residential areas and recreational areas, such as camps, parks, camping facilities, and resorts. Class B areas include those requiring protection against noise interference with speech, such as commercial, retail, and recreational facilities, including theaters or amusement parks. Class C areas include those where economic activities are of such a nature that higher noise levels than experienced in other areas is normally to be anticipated, such as industrial areas or warehouses.

Maximum permissible noise levels are established in WAC 173-60-040. Table 3-23 below shows maximum dBAs from a source and the maximum dBAs that can be received within the three classifications. Exemptions are listed in WAC 173-60-050 and include construction noise generated between 7:00 a.m. and 10:00 p.m.

Table 3-23
Maximum Permissible Noise Levels for Non-Exempt Activities

EDNA of Noise Source (dBA)	EDNA of Receiving Property		
	Class A	**Class B**	**Class C**
Class A	55	57	60
Class B	57	60	65
Class C	60	65	70

Source: WAC 176-60-040
Note: All numbers are in A-weight decibels (dBA)

Along with the maximum permissible noise levels described in Table 3-23, there are additional limitations to Class A lands, where a reduction of 10 dBA is required between the hours of 10:00 p.m. and 7:00 a.m.

Chelan County regulates noise standards through Title 7 of the Chelan County Code. Below are applicable excerpts from Title 7 of the Chelan County Code relating to noise:

7.35.030 Public disturbance noises.

It is unlawful for any person to unreasonably cause or make, or for any person in possession of property to allow to originate from the property, sound which is a public disturbance noise. Public disturbance noises include the creation of loud, raucous, frequent, repetitive or continuous sounds that exceed a reasonable person standard so as to disturb or interfere with the peace, comfort and repose of another. (Res. 2012-36 (part), 4/30/12).

7.35.040 Exceptions.

(a) The provisions of this chapter shall not apply to:

(1) Regularly scheduled community events conducted on property owned by a governmental agency or public school district and conducted with the express permission of an authorized representative of the property owner; and

(2) Preparation for and action of regularly scheduled events held in the County of Chelan and authorized by an appointed representative of the county.

(b) The ordinary and usual ringing of trolley bells by a mass transit carrier, e.g., Link trolley bus.

(c) Sounds from construction activity during the hours of seven a.m. to ten p.m. and any activity necessary for the preservation of the public health, safety and welfare.

(d) Sounds that are the result of agricultural activities.

3.14.2 Current Noise Environment

The Icicle project area for noise includes the Alpine Lakes and the Icicle Creek and Wenatchee River Corridors. The Alpine Lakes portion of the Icicle project area is remote and exposed to little man-made noise. Noise sources in this area are predominantly associated with natural conditions, periodic recreational activity, and periodic noise for operation and maintenance of the IPID facilities. The primary sensitive noise receptors in this area include recreationalists who are hiking to and camping around the lakes. Moving away from the lakes down the watershed, development becomes increasingly more urbanized with higher density agricultural, residential, and commercial land uses (Chelan County, 2016). The predominant noise sources include intermittent sounds related to rural residential and agricultural noise with increasing noise related to urbanization moving closer to the Cities of Leavenworth and Wenatchee. Within the more urbanized areas, typical sound includes traffic noise and noise from commercial activity. Sensitive receptors to noise changes within the more urbanized areas include residents, workers, and recreationalists. Their sensitivity to changes in the noise environment would depend on the relative change in noise conditions and how close to and for how long they are exposed to the change.

3.15 Recreation

Outdoor recreationists are attracted to the project area by the quality of the scenery and by the variety of recreation opportunities, including fishing, hiking and backpacking, horseback riding, rock climbing, white-water kayaking and rafting, river tubing, skiing, snowshoeing and other related activities such as camping, picnicking, and wildlife viewing. Public demand for access to rivers, streams, lakes, and trails continues to increase each year.

A review of existing recreation opportunities and conditions is presented below and broken into the three sub-regions of the project area: the Alpine Lakes Area, Icicle Creek, and the Wenatchee River Corridor.

3.15.1 Alpine Lakes Area

The upper reaches of the Icicle project area include popular recreational destinations. All of the Alpine Lakes sub-region is located within the ALWA. The ALWA encompasses approximately 394,000 acres in the Central Cascades Region (USFS, 2017)[3-19]. The ALWA is accessed by 47 trailheads and 615 miles of trails.

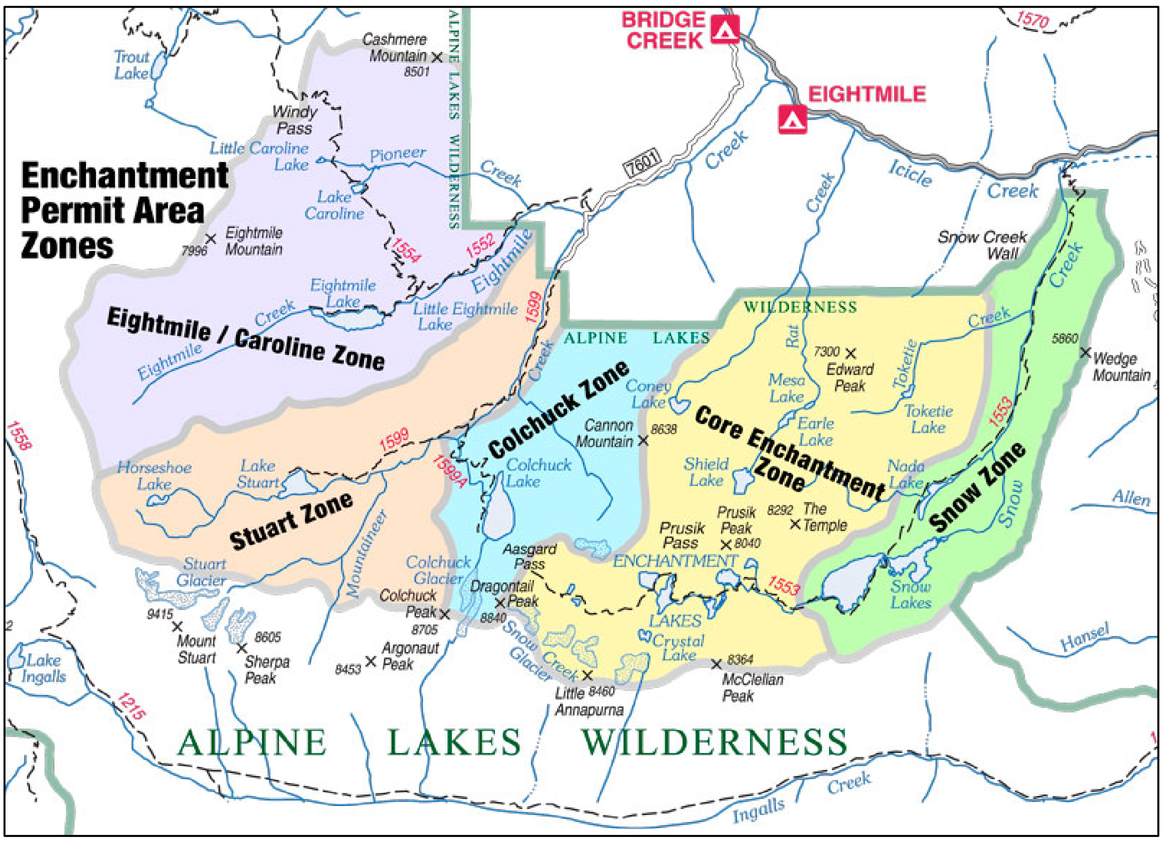
The ALWA is visited by nearly 150,000 people each year (USFS, 2017a)[3-20]. Permits are required for all visitors between May 15 and October 31. The maximum group size is 12 (combined people and stock), except for the Enchantment Permit Area, which is located

[19] https://www.fs.usda.gov/recarea/okawen/recarea/?recid=79432
[20] ALW Regulations Booklet: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5407053.pdf

in the project area, where the maximum group size is 8. Additional restrictions apply to camping, campfires, and stock use. A valid Recreation Pass is required for vehicles parked at trailheads.

Within the ALWA, the Enchantment Permit Area (Figure 3-36) is a particularly popular backpacking destination. The Enchantment's Permit Area is within the Icicle project area and includes Eightmile, Colchuck, Nada, and the Upper and Lower Snow Lakes.

Figure 3-36. Enchantment Permit Area Zones (USFS, 2017b)[3-21]



3.15.1.1 Hiking

Trails were the original transportation system in the Alpine Lakes Area (Alpine Lakes Management Plan, 1981). Most of the trails on the east side of the Cascades were established near the turn of the century by herdsmen moving sheep through the high mountain country. In the early 1900s, following establishment of the National Forests, the trail system became the transportation network between fire lookouts and guard stations. Today, trail use is predominantly for recreation and supports hiking, climbing, backpacking, stock, and other backcountry uses.

[21] Interactive map on recreation.gov: accessed January 2017 (https://www.fs.fed.us/ivm/index.html?minx=-13711415&miny=5848140&maxx=-13124379&maxy=6175290)

The USFS maintains a network of trails that provide access into the ALWA for hiking, climbing, and backpacking. Within the Enchantment Permit Area (Figure 3-35), the Stuart Lake Trail (#1599) provides access to the Stuart Zone, and to the Colchuck and Core Enchantment zones via the Colchuck Lake Trail (#1559.1/1559A). The Snow Lakes Trail (#1553) provides access to the Snow Zone, and the Eightmile Lake Trail (#1552) provides access to the Eightmile/Caroline Zone and to areas outside the Permit Area via the Eightmile-Trout Creek Trail (#1554).

According to the USFS, day-use hiking in the Enchantment Permit Zone continues to increase in popularity each year (Table 3-24). The USFS reports that compliance with day-use permit applications ranges from 50 to 75 percent, depending upon the time of year (USFS, 2016[3-22]). Table 3-24 provides use numbers for self-registered day users at two popular trailheads, Snow Lake Trailhead and Stuart/Colchuck Trailhead. Specific information about final user destination was not readily available, so it is unclear from this dataset how many visitors went to Colchuck Lake vs. Stuart Lake. Although information from local users indicate Colchuck Lake is the more popular destination of the two. Additional permit information was not available for Eightmile Lake, which is one of the most popular destinations in the ALWA.

Table 3-24
Approximate Number of Day-Use Permits in Enchantment Permit Area Zone[1]

Year	Snow Lakes Trailhead	Stuart/Colchuck Trailhead	Total
2012[2]	850	1,350	2,200
2013	900	2,900	3,800
2014	1,000	3,400	4,400
2015	1,100	4,600	5,700

[1] Permits are for groups, which may contain up to 8 persons
[2] Severe fires in 2012 resulted in closure of Enchantments for over a month

Within the project area, hiking to Klonaqua and Square Lakes also occurs. Day-use permits are required and are self-issued at the trailhead. These areas are outside of the Enchantment Permit Area Zone, and details on the number of day-use permits for these areas was not readily available. However, because these lakes are more remote and not included in the Enchantment Permit Area Zone, it is likely these areas have a much lower number of visitors. The Klonaqua Lake Trail (Trail #1563) is located 7.2 miles up the French Creek Trail, with the total one-way distance to Lower Klonaqua Lake of 10.8 miles. The Square Lake Trail (Trail #1567) is accessed via Icicle Creek and Leland Creek Trails, with a total one-way distance to the lake of approximately 13 miles. Trail reports indicate that Square Lake Trail is difficult to hike on due to downed trees and lack of maintenance, which may also discourage use.

Figure 3-37 provides an inventory of recreational facilities and use areas and existing conditions at these sites within the Alpine Lakes Area. These data were collected and provided by USFS.

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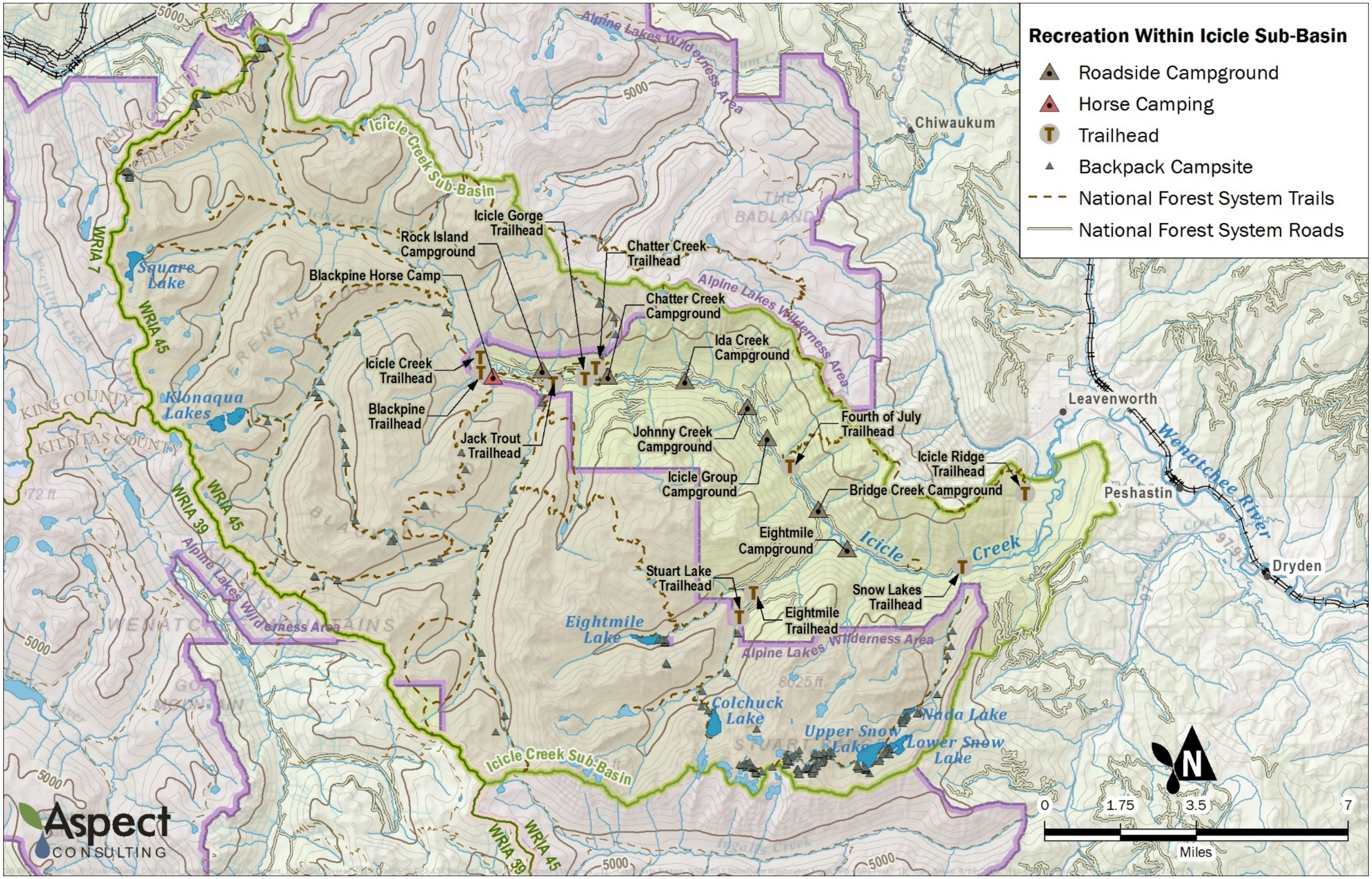
[22] Numbers provided to Aspect via 20161220 USFS PEIS Data Gap Action Plan.doc

Figure 3-37. Recreation Sites and Existing Conditions within the Alpine Lakes Area



(Source: USFS geospatial files)

3.15.1.2 Horseback Riding and Stock Use

Horseback riding and use of stock animals (e.g., llamas and mule) is permitted in the ALWA but not on the Snow Lakes Trail or the Stuart Lake Trail (except from the Saturday following Labor Day to January 1). Additionally, access to the Klonaqua Lakes is prohibited to stock. Stock are allowed on the Eightmile Lake Trail and Square Lake Trail; however, overnight stock use is prohibited. Additionally, Square Lake Trail has had limited maintenance since the 2003 Square Lake Fire, and trail conditions are rough and not recommended for stock. Restrictions for stock use in the ALWA include containment at least 200 feet from lakes, use of processed feed, and use of designated camps near certain lakes and meadows.

3.15.1.3 Backpacking/Camping

Overnight camping in the ALWA requires a permit from the USFS. Maximum length of stay is 14 consecutive days. For areas outside the Enchantments Permit Area, permits are self-issued at the trailhead. For camping within the Enchantments Permit Area between May 15 and October 31, applicants must submit a request to an online, pre-season lottery. Any permits not allocated by the lottery are available on a first come, first served basis through the recreation.gov advance reservation system. Additionally, 25 percent of permits are held by the Leavenworth Ranger District for day-of trips (i.e., walk up lottery).

Demand for overnight permits in the Enchantment Permit Area far exceeds the number available. In 2016, the USFS received 19,646 lottery applications for overnight stays. Even when the available quota of permits was reduced in 2014 and 2015 because of an increasing amount of observable impacts (e.g., widening trails, loss of fragile vegetation, development of new social trails and campsites, proliferation of switchback cuts), the total number of people camping increased as a result of increasing party size. In 2015, an estimated 10,200 people camped in the Enchantment Permit Area. No site-specific numbers are available for Colchuck, Eightmile, or Snow Lakes, however Table 3-25 and Table 3-26 provide details on permit applications by year.

Table 3-25
Lottery Applications by Year

Year	Number of Applications
2009	1,770
2010	
2011	+3,000
2012	
2013	+4,000
2014	+8,000
2015	12,034
2016	19,646

Table 3-26
2015 Enchantment Zone Permit Area Data

Awarded Permits	1,946
Total Applications	12,034
Success Rate	16%

3.15.1.4 Recreational Fishing

There is a non-tribal sport fishery for resident trout in the ALWA. Prior to human settlement, most of the high lakes were barren of fish (Alpine Lakes Area Management Plan). The WDFW has stocked the lakes in the ALWA and Enchantments Permit Area in the past. No stocking currently occurs in Colchuck, Eightmile, Klonaqua, Square, Nada, or Upper and Lower Snow Lakes (Table 3-27).

Table 3-27
WDFW Trout Stocking in the Alpine Lakes Wilderness Area

Lake	Species	Last Year Stocked	Next Year to Stock	Comments
Colchuck	CT	2000	Discontinued	May have been discontinued due to loss of funding for aircraft
Eightmile	RB,CT,LT	2005	Discontinued	May have been discontinued due to loss of funding for aircraft and presence of lake trout
Klonaqua (lower)	RB,CT	1970	Discontinued	May have been discontinued due to loss of funding for aircraft
Klonaqua (upper)	CT	1970	Discontinued	May have been discontinued due to loss of funding for aircraft
Nada	EB	?	Discontinued	Stocking discontinued due to sufficient natural reproduction of eastern brook trout
Snow (lower)	EB,CT	?	Discontinued	Stocking has been discontinued due to sufficient natural reproduction, or lack of funding to plant with aircraft
Snow (upper)	EB,CT	?	Discontinued	Stocking has been discontinued due to sufficient natural reproduction, or lack of funding to plant with aircraft
Square	CT,RB	1979	Discontinued	Stocking has been discontinued due to sufficient natural reproduction

Notes: CT = Cutthroat Trout; RB = Rainbow Trout; EB = Eastern Brook Trout; LT = Lake Trout
Table data provided by T. Maitland, email communication between Dan Haller and Travis Maitland (WDFW).

Fishing for trout in the many of the Alpine Lakes is managed by WDFW. In addition to possessing a freshwater fishing license, anglers age 15 and over must comply with specific size limits, gear restrictions, and bag limits (WDFW, 2017). Eightmile, Square, Klonaqua, and Colchuck Lakes are open to fishing year-round, while access to Nada and Upper and Lower Snow Lakes is limited by seasonal access into the Core Enchantment Zone. For additional information on fish within this part of the project area, see Section 3.7, Fish.

3.15.1.5 Water-Based Recreation

Swimming within the Alpine Lakes likely occurs in conjunction with hiking and backcountry camping activities during the summer. However, this use is likely limited by water temperatures, which are relatively cold even during the summer months.

3.15.1.6 Winter Recreation

Information about wintertime recreation in this portion of the project area is somewhat limited. However, Eightmile Creek Trail is used for snowshoeing. Additionally, Colchuck and Eightmile Trails are known as winter climbing and backcountry skiing destinations, with regular but low density use. Motorized recreation use is prohibited year-round, and skiing and snowshoeing routes are not groomed.

3.15.2 Icicle Creek Corridor

3.15.2.1 Hiking and Stock Use

Six trailheads provide access from Icicle Road to the network of backcountry trails in the project area and beyond: Fourth of July (#1579), Chatter Creek (#1580), Jack Creek (#1558), Jack Pine (#1597), Black Jack Ridge (#1565), and Icicle Creek (#1551) (USFS, 2017[3-23]). Additionally, three trails provide hiking opportunities near and along Icicle Creek: Icicle Gorge (#1596), Jack Pine (#1597), and Bruce's Boulder (#6723). Trails within this part of the program area that provide access to other trails include the Icicle Creek Trail and Icicle Gorge Trail.

Horseback riding and use of stock animals (e.g., llamas and mules) from trailheads along Icicle Creek is permitted, although not on all trails. Stock use is permitted on Icicle Creek Trail.

3.15.2.2 Camping

The campgrounds in this part of the project area are heavily used by paddlers, rock climbers, mountain bikers, and hikers. The USFS operates eight campgrounds along Icicle Creek (Table 3-28). These areas provide campsites for tents and RVs between April and October. Campgrounds range in size from 56 sites (Johnny Creek) to 6 sites (Bridge Creek). Blackpine Creek horse camp provides pull-through sites for horse trailers and related amenities suitable for horseback riders.

[23] USFS Interactive visitor map*

Table 3-28
USFS Campgrounds along Icicle Creek

Campground Name	Number of Sites	Operational Period
Eightmile	45 sites for tents or RVs, one large site that can accommodate up to 70 people and 25 vehicles	April to October
Bridge Creek	6 single sites, one large site that can accommodate up to 70 people and 35 vehicles	April to October
Icicle Group Campground	one large site that can accommodate up to 30 guests and 6 vehicles	June to October
Johnny Creek	65 sites for tents or RVs	May to October
Ida Creek	10 sites for tents or RVs	May to October
Chatter Creek	12 sites for tents only, one large site that can accommodate up to 45 people and 12 vehicles	May to October
Rock Island	22 sites for tents or RVs	May to October
Blackpine Creek Horse Camp	10 sites for tents or RVs to	May to October

3.15.2.3 Recreational Fishing

There are two non-tribal sport fisheries in Icicle Creek: the spring-run Chinook salmon fishery that runs from mid-May through July 31, and the resident trout fishery that occurs from the Saturday before Memorial Day through October 31 (WDFW, 2016[3-24]). Fishing in Icicle Creek is managed by WDFW (WDFW, 2016[3-25]). Targeted species include hatchery-origin spring-run Chinook salmon returning to LNFH, steelhead/rainbow trout, eastern brook trout, westslope cutthroat trout, and mountain whitefish.

WDFW actively conducts creel surveys for the spring-run Chinook salmon fishery in order to gather data for producing estimates of angler effort, harvest, and incidental catch and release of other species such as steelhead and bull trout. This fishery has been a mainstay for many years and can be very popular for both local and out of area anglers. Between 2001 and 2015, an annual average of 2,918 anglers fished approximately 15,187 hours each year and harvested 907 hatchery-origin spring-run Chinook salmon (Table 3-29).

WDFW does not actively creel survey the resident trout fishery. This fishery is mainly composed of rainbow trout, but there are occasional catches of cutthroat, eastern brook, and bull trout; this information is gained through anecdotal angler reports as well as hook-and-line sampling efforts conducted by WDFW.

[24] Personal communication (email) between Dan Haller and Travis Maitland, WDFW District 7 Fish Biologist
[25] http://wdfw.wa.gov/publications/01818/wdfw01818.pdf

Table 3-29
Sport Fishery Effort for Hatchery-origin Spring-run Chinook Salmon on Icicle Creek (WDFW)

Year	Fishery Season	Anglers	Hours Fished	Fish Harvested
2001	May 7 – July 22	2,932	13,194	2,260
2002	May 16 - July 31	3,811	17,150	1,201
2003	May 16 - July 31	4,016	29,133	935
2004	May 16 - July 31	1,339	9,187	347
2005	May 28 - July 31	1,108	8,130	103
2006	May 26 - June 14[1]	--	--	--
2007	May 22 - July 31	1,058	7,754	115
2008	May 15 - July 31	1,147	7,144	347
2009	May 22 - July 31	1,530	8,235	640
2010	May 13 - July 31	5,231	23,549	996
2011	May 21 - July 31	9,201	45,642	3,622
2012	May 19 - July 31	4,922	21,492	971
2013	May 18 - July 31	1,979	9,644	323
2014	May 23 - July 31	1,587	7,299	406
2015	May 20 - July 18	990	5,064	433
	Average:	**2,918**	**15,187**	**907**

[1] Early closure of fishery related to theft of 200 broodstock from LNFH on June 9, 2006 (http://www.outdoors-411.com/news/fishing/060613-hatchery-fish-theft.html)

-- no information found

In addition to possessing a freshwater fishing license, anglers age 15 and over must comply with specific size limits, gear restrictions, and bag limits when fishing in Icicle Creek. Fishing for salmon and steelhead requires a Columbia River Salmon/Steelhead Endorsement. Seasonal regulations apply to three distinct geographic reaches:

- From between the closure signs located 800 feet upstream of the mouth to 500 feet downstream of LNFH, hatchery-origin spring-run Chinook salmon may be targeted from mid-May through July, and when permitted under special rule changes.
- From the shoreline markers where Cyo Road intersects Icicle Creek at the Sleeping Lady Resort upstream to the IPID footbridge, trout and game fish may be targeted from the Saturday before Memorial Day through October; hatchery-origin spring-run Chinook salmon may be targeted from May through July.
- From the IPID footbridge to Leland Creek, and all tributaries (including Leland Creek), trout and other gamefish may be targeted from the Saturday before Memorial Day through October.

3.15.2.4 Water-Based Recreation

Whitewater kayaking occurs between Rock Island Campground and LNFH, a distance of approximately 20.4 miles (American Whitewater, 2017). Kayaking occurs when flow is between 700 and 2,000 cfs. Difficulty ranges from Class II to V+ under normal flow conditions.

The upper section of Icicle Creek includes a mix of Class II to V+ rapids. This run is accessed at Rock Island Campground and ends at Johnny Creek Campground. This section includes the Class V rapid at Icicle Gorge. The middle section of Icicle Creek is classified as an expert run (Wenatchee Outdoors). Popular access points along this reach include Eightmile Campground, Bridge Campground, and Johnny Creek Campground. There are additional pullouts at Snow Creek Trailhead and Ida Creek that can be used as access. The lower section of the Icicle Creek run starts at the Snow Creek trailhead and ends upstream of the dam at LNFH. At normal flows, this run is considered a class IV+ (advanced whitewater experience).

During the summer, at low-flow conditions, stand-up paddleboards (SUP) and tubes are a popular activity on lower Icicle Creek downstream of LNFH. Many local outfitters rent SUPs and tubes and provide shuttle service between access and take-out points. These activities draw many visitors to Icicle Creek.

Portions of Icicle Creek suitable for recreational swimming are generally located between LNFH and the confluence with the Wenatchee River. Recreational swimming is not a well-monitored activity in Icicle Creek, so its popularity is unknown. However, SEPA scoping comments indicate that recreational swimming does occur. It is likely that swimming is generally associated with river tubing and SUP activities or camping during the summer.

3.15.3 Wenatchee River Corridor

3.15.3.1 Hiking and Stock Use

The majority of land along the Wenatchee River is privately owned. However, there are several parks that provide access to walking and hiking along the Wenatchee River. These parks include the City of Leavenworth’s Enchantment Park, Blackbird Island Park, and Waterfront Park, Cashmere’s Riverside Park, the Port of Chelan’s public use trail in Peshastin, and Confluence State Park in Wenatchee.

3.15.3.2 Camping

The majority of land along the Wenatchee River is privately owned. Limited camping opportunities exist in the adjacent uplands. Chelan County operates the Wenatchee River County Park campground near the Town of Monitor, which includes tent and RV sites, picnic areas, and riverfront access. This park is a popular take-out point for river tubers. Confluence State park also provides camping at the confluence of the Wenatchee and Columbia Rivers.

3.15.3.3 Recreational Fishing

Fishing in the Wenatchee River for salmon and steelhead is managed by the WDFW (WDFW, 2016[26]). Targeted species include summer-run Chinook salmon and steelhead, when permitted.

In addition to possessing a freshwater fishing license, anglers must comply with specific size limits, gear restrictions, and bag limits when fishing in the Wenatchee River. Fishing for salmon and steelhead requires a Columbia River Salmon/Steelhead Endorsement. Seasonal regulations apply to one distinct geographic reach:

- From the mouth to Icicle River Road Bridge, salmon may be targeted during August and September, and when permitted under special rule changes. Within this reach, the Wenatchee River is closed from 400 feet below Dryden Dam upstream to Peshastin Creek.

3.15.3.4 Water-Based Recreation

The Wenatchee River is a popular destination for whitewater kayakers and rafters during high-flow periods, and for tubers during summer low-flow conditions. Up to 15 commercial rafting companies offer guided whitewater rafting trips on the Wenatchee River during the spring and summer. The City of Cashmere has developed Riverside Park with accommodations for whitewater enthusiasts, including a take-out ramp for commercial and private rafters to exit the river, restrooms, picnic areas, and parking.

During the summer, swimming, tubing, kayaking, and stand up paddleboarding are popular activities on the Wenatchee River. Popular access sites include parks in Leavenworth, Cashmere, and Peshastin, and Confluence State Park. Several local outfitters rent tubes and provide shuttle service between access and take-out points. WDFW also maintains eight access sites on the Wenatchee River, that are heavily used for water-based recreation during the summer months.

3.16 Land Use

The broad range of land use activities in the project area can be attributed to the highly variable landscape over which surface waters flow, from wilderness area, to forested hills, through orchards in the Wenatchee River Valley, to the shrub-steppe of the eastern watershed at the confluence of the Wenatchee and Columbia Rivers.

The land uses in the rural areas of the project area, as a whole, are primarily forest management and production, orchard production, scattered residences, agricultural support facilities, and small home-based industries. Nearly all land in the Alpine Lakes Area is congressionally designated wilderness area.

[26] http://wdfw.wa.gov/publications/01818/wdfw01818.pdf

This section addresses the regulatory framework of land use within the project area, this includes the current land uses and ownership.

3.16.1 Regulatory Setting

The following Federal, state, and local regulations and policies apply specifically to land uses within the project area. Additional regulations applicable to other resources within the project area are presented in Chapter 1.

- The Wilderness Act
- The National Forest Management Act
- State Shoreline Management Act
- The Forest Practices Act
- Zoning
- Comprehensive land use planning
- Sensitive areas ordinances.

These policies and regulations are described in more detail below. The following subsections are organized based on jurisdiction.

3.16.1.1 Federal Land Use Regulations

Wilderness Act, 1964

The Wilderness Act of 1964 (Wilderness Act) established the National Wilderness Preservation System. Additionally, wilderness uses and rules are established in the Wilderness Act. As noted in Section 3.15, Recreation, part of the upper reaches of the project area includes the ALWA, which was established under the Wilderness Act and under the Alpine Lakes Management Act of 1976. Much of the lands within the upper portions of the project area are governed by these acts. The regulation of wilderness lands is discussed in greater detail in the Section 3.17, Wilderness Area.

National Forest Management Act, 1976

Every forest managed by the USFS must develop a Forest Plan, as mandated in the National Forest Management Act. The upper portions of the project area are located within the Okanogan-Wenatchee National Forest. Methods for developing and revising the plan are outlined in the Act, including required content. The direction of the planning document provides the basis for any land-use decisions made within the National Forest. The Wenatchee National Forest’s plan, adopted in 1990, is currently being revised and updated as the Okanogan-Wenatchee Forest Plan. The Alpine Lakes Management Plan, adopted in 1982, is the plan used to manage the lands within the ALWA.

3.16.1.2 State Land Use Regulations

Washington Shoreline Management Act

Shorelines of the state (defined in RCW 90.58.030(2)) are regulated through the Shoreline Management Act (SMA) of 1971; as amended. 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). Within the project area, Chelan County and the Cities of Leavenworth, Wenatchee, and Cashmere all have accepted SMPs. The intent of each jurisdiction's approved SMP is ensure protection of shoreline ecosystems, public access, and water uses. The permitting matrix located in Section 5-3 (Table 5-1) provides details on which projects being considered under the Icicle Strategy are subject to the SMA.

Washington Forest Practices Act

Forest practices on all non-federal and non-tribal lands in Washington are regulated by means of the Forest Practices Act. The Washington Forest Practices Board governs forestry practices by adopting rules and regulations such as maintenance and restoration of aquatic and riparian lands. These rules are implemented and enforced by WDNR.

Growth Management Act

The Growth Management Act, Chapter 36.70A RCW is a state regulation that requires local governments to designate urban growth boundaries, creating critical area ordinances, and developing comprehensive plans.

3.16.1.3 Local Land Use Regulations

Critical Areas Ordinance

Under the Growth Management Act, Chelan County developed a Critical Areas Ordinance to protect wetlands, areas with critical recharging effects on aquifers, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas. These areas have been incorporated into the County zoning codes, which includes setback requirements.

Comprehensive Plan and Zoning

In Washington State, counties manage land use through comprehensive planning and zoning. In Chelan County, these activities are conducted by the Community Development Department. Under the framework provided in the Growth Management Act, Chelan County adopted its Comprehensive Plan in 2000, which was updated in 2007, and is currently undergoing another update. Included in the comprehensive planning process was the establishment of urban growth areas to promote contiguous and orderly development. Each of the municipalities within the project area have an established urban growth area. Comprehensive planning and zoning designates the geography, frequency, and density of land uses. Table 3-30 describes the types of land uses regulated by Chelan County.

Table 3-30
Zoning designations in Chelan County

Land Use Designation	Area (acres)
Agriculture In Open Space (Chapter 84.34 RCW)	9,300.1
Agriculture Related Activities	87.2
Agriculture-Not In Open Space	6,562.7
Aircraft Transportation	20.5
All Other Residential	1,556.9
Amusements	4.8
Automobile Parking	2.6
Business Services	9.5
Communication	19.9
Contract Construction Services	39.3
Cultural Activities	0.0
Designated Forest Land (Chapter 84.33 RCW)	64,606.6
Educational Services	98.4
Fabricated Metal Products	1.4
Finance, Insurance/Real Estate Services	4.2
Food/Kindred Products	8.8
Furniture and Fixtures	0.6
Governmental Services	344,757.1
Highway/Street Right-Of-Way	15.4
Hotels/Motels	119.7
Household 2-4 Units	13.8
Institutional Lodging	82.5
Lumber/Wood Prod Exc Furniture	148.2
Mining Activities	487.9
Miscellaneous Manufacturing	2.5
Miscellaneous Services	3,284.8
Mobile Home Parks/Courts	76.2
Multi-Units 5 Or More	14.5
Non-Residential Condominiums	0.2
Noncommercial Forest	23,590.9
Open Space (Chapter 84.34 RCW)	544.0
Other Cultural & Recreational	3.0
Other Resource Production	4,812.7
Other Retail Trade	10.1
Other Trans, Comm, & Utilities	2.9
Other Undeveloped Land	259.2
Parks	435.5
Personal Services	6.2
Petroleum Refining/Related Industries	9.6

Land Use Designation	Area (acres)
Primary Metal Industries	7.9
Professional Services	15.9
Public Assembly	356.7
Railroad/Transit Trans	118.9
Recreational Activities	428.2
Repair Services	10.6
Residential Hotels-Condominium	7.3
Resorts and Group Camps	382.0
Retail Trade-Apparel/Access	0.2
Retail Trade-Bld. Mat., Farm Eqpt	18.8
Retail Trade-Eating/Drinking	41.8
Retail Trade-Food	31.1
Retail Trade-Furniture	666.5
Retail Trade-Gen Merchandise	4.6
Retail Trade-Trans/Accessories	3.2
Rubber/Misc Plastic Products	1.1
Single Family Units	16,807.1
Stone, Clay & Glass Products	2.4
Timberland in Open Space (Chapter 84.34 RCW)	2,017.7
Undeveloped Land	38,040.6
Utilities	1,060.6
Vacation and Cabin	7,344.2

In addition to county planning and zoning, each municipality within the project area has zoning ordinances and urban area comprehensive plans that have been developed under the framework provided in the Growth Management Act.

3.16.1.4 Current Land Use

Table 3-31 provides a breakdown of the primary land uses within the project area.

Table 3-31
Land Use in Acres

Land Use Type (Zone Districts)	Area (Acres)
Forest lands	13,1380.2
Rural public lands and facilities	170.7
Rural residential	5,376.0
Rural village	0.3
Rural waterfront	0.4
Water	119.3

In the project area, land use generally falls within two major categories, Federal and private. These uses are described in more detail below.

3.16.1.5 Federal Ownership and Land Use

The USFS manages 87 percent of the land in the Icicle Creek Subbasin, which makes up a large portion of the project area. Much the land located within the Alpine Lakes Area and Reach 1 through 3 of the Icicle Creek Corridor is under federal management, with most land in the Alpine Lakes Area being managed under the Alpine Lakes Management Plan. However, there are private in-holdings within the Alpine Lakes Area, which are not subject to the management requirements in the Alpine Lakes Management Plan.

The other major area of Federal ownership within the project area includes the LNFH, which is located along the Icicle Creek Corridor and is owned and operated by USFWS. The current target species for the hatchery is spring Chinook salmon. The CTCR and the YN are partners in the operation of the LNFH (Chelan County Shoreline Inventory and Analysis, 2009). LNFH operates as mitigation for Grand Coulee Dam with an interim release target of 1.2 million fish, and a long-term target release goal of 1.625 million fish.

To support the operation of LNFH, USFWS owns 157.69 acres in the lower Icicle watershed, near Icicle Creek RM 2.7. This includes the hatchery itself and administrative buildings. Additionally, USFWS owns the majority of lands associated with the Nada/Snow Lakes systems within the ALWA. These lands, shorelines, and lakes are operated to provide water for fish propagation at the hatchery. The ownership and operation of the lands are described in more detail in Section 3.6, Water Use, and 3.17, Wilderness Area.

3.16.1.6 Private Ownership and Land Use

Much of the project area located in the Wenatchee River Corridor and Reach 5 of the Icicle Creek Corridor is privately owned. Private land use is primarily agriculture and residential. In addition to the private land in Reach 5 and the Wenatchee River Corridor, there are approximately 50 private creek-side parcels located in the Icicle Island development in Reach 2. Land Use Planning

3.16.1.7 Comprehensive Planning

As discussed in section 3.16.1.3, Comprehensive Planning, which is required under the state's Growth Management Act, occurs at the county and municipality level. Comprehensive planning provides guidance and direction to the County and City governments on development and land use. Comprehensive Plans within the project area include the Chelan County Comprehensive Plan, the City of Leavenworth Comprehensive Plan, the Peshastin Urban Growth Area Comprehensive Plan, the Town of Dryden Comprehensive Plan, the City of Cashmere Comprehensive Land Use Plan, and Wenatchee Urban Area Comprehensive Plan.

3.16.1.8 Upper Wenatchee Community Lands Plan

The Upper Wenatchee Community Lands Plan is a proposal to look at how community ownership of high-priority parcels can benefit the community while supporting diverse stakeholder needs related to the properties. The initial phase began in December 2014 and concluded in September 2016. The process was led by the Trust for Public Land, along with Chelan County, The Nature Conservancy, and the Chelan-Douglas Land Trust.

Together with local stakeholders, these groups created a vision for future growth within the plan study area, that includes in part the project area.

The plan study area reaches from City of Cashmere to Stevens Pass. Broken into the following three sub-regions, each is characterized by a checkerboard of both private and public land ownership:

- Nason Ridge/Lake Wenatchee
- Peshastin/Blewett Pass
- Chumstick Valley/Leavenworth

The plan identifies the following goals that are also consistent in part with the Icicle Strategy Guiding Principles.

1. Sustainable forests that support biodiversity, are maintained to reduce fire intensity, and increase resilience to climate change.
2. Working lands for a thriving economy.
3. Existing access to public land to be maintained while also increasing year-round recreation opportunities.
4. Lands that support wildlife (habitat, including for fish).
5. High-quality water resources (and sufficient quantity).
6. Private property availability (for development, business, and other uses).

It is likely, any projects developed through the Icicle Strategy targeting habitat enhancement would be achieved through a partnership with the Community Lands Plan program.

More detail about the Upper Wenatchee Community Plan can be found on Chelan County's website[27].

3.17 Wilderness Area

As noted in Section 3.16, Land Use, a large part of the project area's Alpine Lakes Area sub-region is within the federally designated ALWA (Figure 3-38). Designated wilderness is the highest level of conservation protection for federal lands. Congress has directed four federal land management agencies—USFS, Bureau of Land Management, USFWS, and National Park Service—to manage wilderness areas to preserve and, where possible, to restore their wilderness character.[28] Therefore, this section addresses more specifically, the management and use of wilderness lands within the project area.

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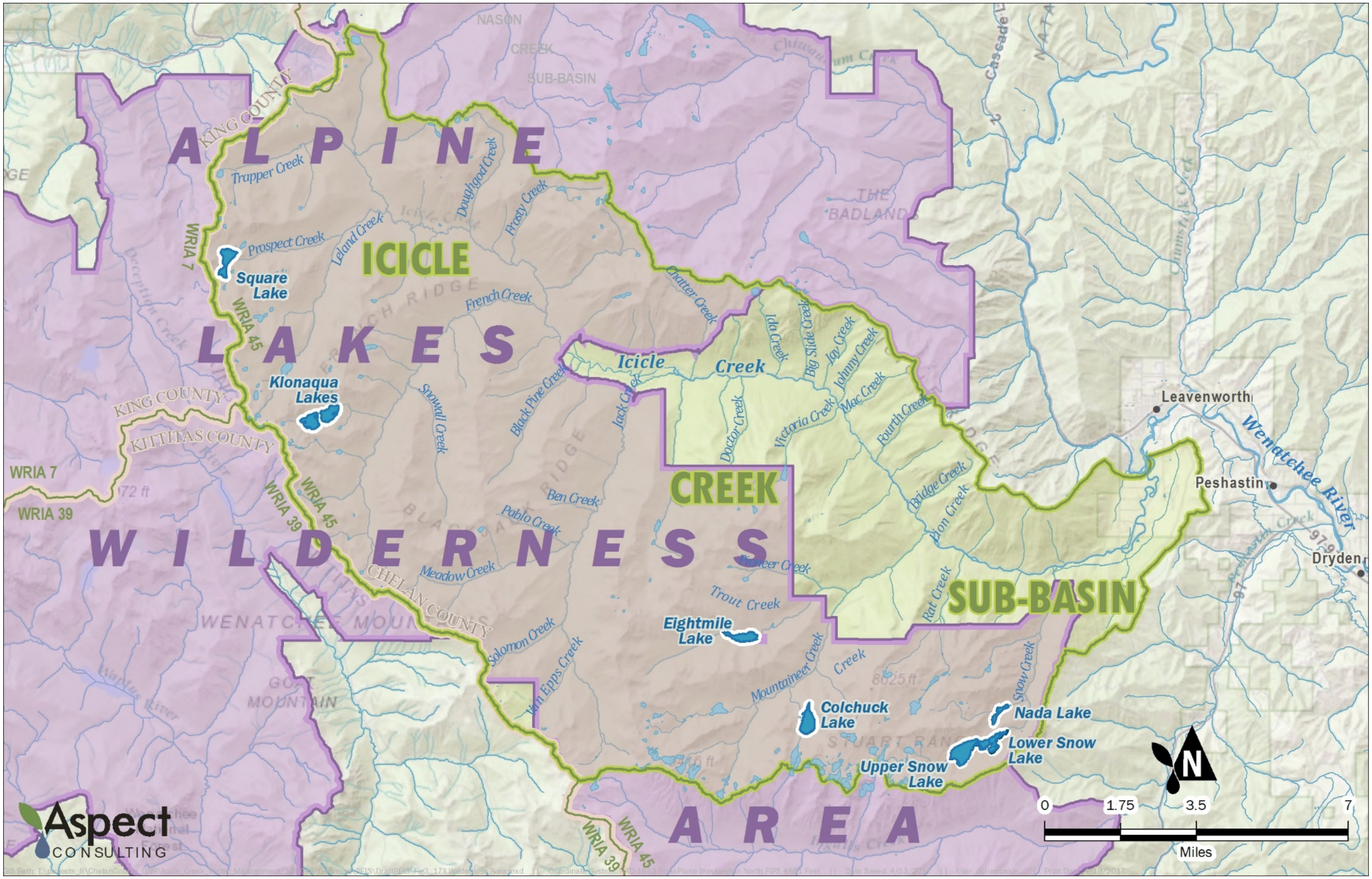
[27] http://www.co.chelan.wa.us/natural-resources/uwclp-minutes?parent=planning
[28] https://wilderness.nps.gov/faqnew.cfm

Figure 3-38. Alpine Lakes Wilderness Area



3.17.1 Wilderness Act History

In 1964 Congress passed the National Wilderness Act for purposes of protecting federal lands. In 1976, the Alpine Lakes Wilderness Management Act was passed, setting aside over 300,000 acres as federally designated wilderness.[29] In 2014, the ALWA was expanded to include over 414,000 acres.

3.17.1.1 Pre-Wilderness Act Use

The ALWA was originally designated the Alpine Lakes Limited Area in 1946 when the Regional Forester set aside 256,000 acres of federal lands for protection and study until they could be further classified and management designation could be assigned.[30] This designation did not offer protection from resource extractions and was exclusively regulated by the USFS.[31] The region and adjacent areas were being extensively used for mining and timber extraction.[32] Efforts to further protect the lower valley forests of the Alpine Lakes began in the 1950s through the 1960s.

3.17.1.2 Wilderness Act History and Designation

The Wilderness Act, signed into law in 1964, created the National Wilderness Preservation System and recognized wilderness 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." The Act further defined wilderness as "an area of undeveloped federal land retaining its primeval character and influence without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions…."[33]

The Wilderness Act prohibits permanent roads and commercial enterprises, except for commercial services that may provide for recreational or other purposes of the Wilderness Act. Wilderness areas generally do not allow motorized equipment, motor vehicles, mechanical transport, temporary roads, permanent structures, or installations. Wilderness areas are to be primarily affected by the forces of nature, though 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.[34] Wilderness areas are managed under the direction of the Wilderness Act, subsequent legislation (such as the Alaska National Interest Lands Conservation Act), and agency policy.

3.17.1.3 Alpine Lakes Management Act

The purpose of the 1976 Alpine Lakes Management Act was to "…provide for public outdoor recreation and use and for economic utilization of commercial forest lands,

[29] https://www.wilderness.net/NWPS/documents/publiclaws/PDF/94-357.pdf
[30] 1979 Wenatchee National Forest (N.F.)/Mt. Baker National Forest (N.F.)/Snoqualmie National Forest (N.F.), Alpine Lakes Area Acquisitions: Environmental Impact Statement (https://books.google.ca/books?id=7zw3AQAAMAAJ&dq=In+1946,+256,000+acres+was+designated+as+the+Alpine+Lakes+Limited+Area+by+the+Forest+Service.&source=gbs_navlinks_s)
[31] http://www.washington.edu/uwpress/search/books/MARDRC.html
[32] http://www.washington.edu/uwpress/search/books/MARDRC.html
[33] https://wilderness.nps.gov/faqnew.cfm
[34] https://wilderness.nps.gov/faqnew.cfm

geological features, lakes, streams and other resources…by present and future generations…" For administrative purposes, the Management Act considers the Alpine Lakes area as three subareas: the Alpine Lakes Wilderness, the Intended Wilderness, and the Management Unit (Figure 3-39). The federal lands in the ALWA are administered in accordance with the 1976 Management Act and the 1964 Wilderness Act. The Intended Wilderness is adjacent non-federal land that becomes federal land upon acquisition. A peripheral Management Unit area surrounds the ALWA and Intended Wilderness and is administered in accordance with laws and regulations applicable to national forests.

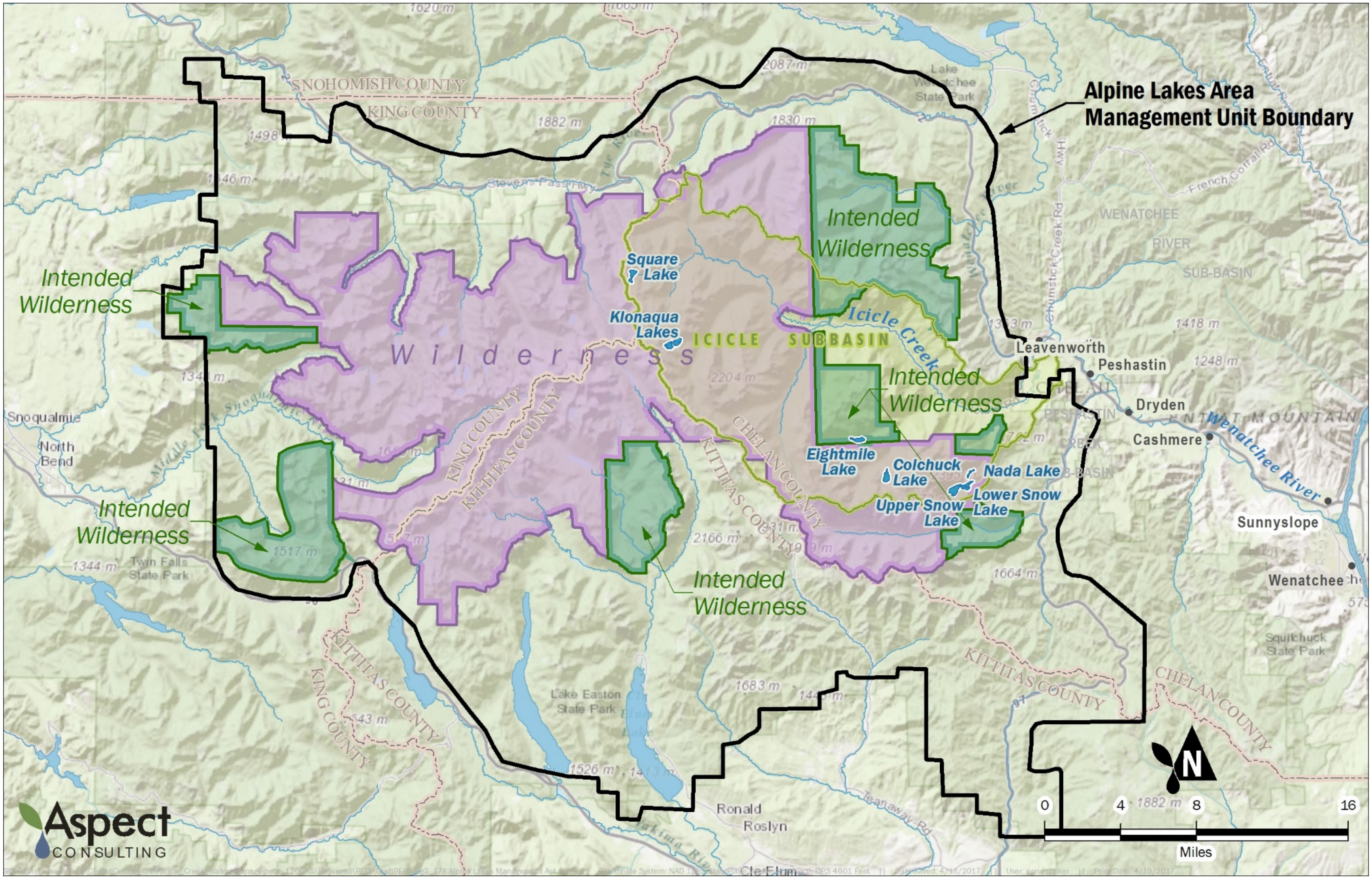
3.17.1.4 Intended Wilderness

In an effort to acquire Intended Wilderness, Congress appropriated Land and Water Conservation Fund funds to purchase three in-holdings: Burlington Northern Santa Fe Railway (BNSF), Pack River Company, and IPID. BNSF and Pack River were purchased. IPID sold and exchanged some lands within the Wilderness Area.

As part of the IPID land sale and exchange agreement, IPID and the USFS entered into a contract in 1986 that stipulated which land would be exchanged by the two entities and what rights IPID would reserve on sold and exchanged lands. In 1990, IPID and USFS executed the land exchange. The result was USFS acquisition of several key parcels of land around Klonaqua, Eightmile, and Colchuck Lakes and the Snow Lakes trailhead with IPID reserving several rights to the properties associated with Klonaqua, Eightmile, and Colchuck Lakes:

> "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."

Figure 3-39. Alpine Lakes Management Act Area



Additionally, the USFS issued agriculture irrigation and livestock watering easements for those portions of Colchuck Lake that were not covered by the easement described above and Square Lake. These easements grant IPID the right to operate and maintain their water facilities with consultation and concurrence from the USFS. Before the issuance of these easements, Square Lake was operated by IPID under a special use permit because USFS determined Square Lake was not under the jurisdiction of Washington State DNR because of navigability criteria.

The land exchange documents and easements are provided in Appendix E.

USFWS owns the shorelines and potentially the lakebed of Upper Snow, Lower Snow, and Nada Lakes. In 1971, USFWS and USFS investigated the possibility of USFS obtaining ownership of these lands. However, this investigation found that USFS acquisition of these lands was prohibited by the Fish and Wildlife Coordination Act of 1934. In 1971, USFS and USFWS drafted a Memorandum of Agreement (MOA) regarding management around these lakes. A copy of the unsigned MOA is provided in Appendix E; however, it is unclear whether or not this MOA was executed and confirmation was not obtained prior to publication of this document.

3.17.2 Use

3.17.2.1 Wilderness Use

The intent of wilderness areas, as designated in the 1964 Wilderness Act, is to preserve wilderness character rather than to establish any particular use. Thus, descriptions of use in the 1964 Wilderness Act and 1976 Management Act generally focus on prohibitions of use. The Wilderness Act prohibits permanent roads or commercial enterprises, except where they provide for recreation or other purposes of the Act, and generally prohibits the use of motorized equipment; however, certain nonconforming uses are permitted as described within the act, including access to non-federal inholdings and for the maintenance and reconstruction of existing water infrastructure, such as dams.

3.17.2.2 Non-Wilderness Use

Non-wilderness uses that are authorized and do occur within the boundaries of the ALWA include reservoir operations and use of motorized equipment for maintenance of these reservoirs and helicopter transport to and from the reservoirs. These non-wilderness uses are permissible under various ownership structure and agreements, easements, and permits, with helicopter transport being approved in a 1981 Environmental Assessment (USFS, 1981). Table 3-32 provides a description of the various use authorities for select lakes where proposed activities may occur: Eightmile, Upper Klonaqua, Lower Klonaqua, Colchuck, Square, Upper Snow, Lower Snow, and Nada Lakes. Additionally, this section discusses those authorities.

Table 3-32
Easement and Permit Summary for Select Alpine Lakes

Lake	Operator	Current Owner	Former Owner	Primary Use Authority	Additional Authority	Key Language in Use Authority
Eightmile	IPID	USFS	IPID	1990 Special Warranty Deed	n/a	Excepting and reserving the right to overflow and inundate the bed and shore; water rights granted; perpetual easement across, through, along, and upon the property for maintenance, repair, operation, modification, upgrading, and replacement of all facilities presently located in and upon the property. IPID may exercise the rights by any means reasonable... including... motorized transport and equipment or aircraft. These rights include... regulating water level. Grantor will not without the prior written consent of the Forest Service, which consent shall not unreasonably be withheld, materially increase the size or scope of the facilities.
Lower Klonaqua	IPID	USFS	IPID	1990 Special Warranty Deed	n/a	
Upper Klonaqua	-	USFS	IPID	1990 Special Warranty Deed	n/a	
Colchuck	IPID	USFS	IPID/ USFS	1990 Special Warranty Deed	2000 Agriculture Irrigation and Livestock Watering System Easement and Special Use Permit	
Square	IPID	USFS	USFS	2000 Agriculture Irrigation and Livestock Watering System Easement	Special Use Permit	Authorizes right-of-way and water conveyance systems; does not authorize extension or enlargements; authorizes operation and maintenance of facilities with consultation and concurrence from USFS.
Upper Snow	USFWS	USFWS	USFWS	Ownership	MOA	USFWS owns these lakes or owns easement from the state for the shorelines, depending on whether the lakes are navigable. Ownership grants USFWS the ability to manage the lakes in compliance with applicable local, state, and federal laws. Documents obtained from the USFS through a FOIA request indicates there may be an MOA between USFWS and USFS regarding the management of trails near the shoreline of these lakes. However, a signed copy of an MOA was not made available through the FOIA request.
Lower Snow	USFWS	USFWS	USFWS	Ownership	MOA	
Nada	USFWS	USFWS	BOR/USFWS	Ownership	MOA	

Ownership

There are parcels within the ALWA that are not owned by the USFS. Such parcels that are related to the Icicle Strategy are those owned by USFWS. Ownership of these lakes provides USFWS continued use of these lakes as reservoirs and provides them the right to maintain and upgrade their facilities in compliance with applicable regulations and permits.

Easements

When conveying land to a new owner, a property owner can reserve rights or easements to that land. As discussed above, this was the case when USFS acquired IPID lands within the Wilderness Area boundary. IPID reserved the right to continue operating the lakes in accordance with their water rights. Additionally, IPID reserved the right to maintain and upgrade the facilities. Based on background documents between IPID and USFS from the 1980s and 1990s, this includes the use of motorized equipment for work on the facilities and access to the sites.

USFS Special Use Permit

The USFS special use authorization is a legal document, such as a permit, lease, or easement, that allows occupancy, use, rights, or privileges on USFS land. Special uses within the project area currently allowed by USFS include the following:

- Square Lake and the northern section of Colchuck Lake were historically operated under special use permits. In 2000, USFS issued an Agriculture Irrigation and Livestock Water System Easement that permits the use of these lakes for irrigation operations. These easements authorize right-of-way and water conveyance systems. Any extension or enlargement of the lakes is not authorized. Additionally, operation and maintenance of the facilities must occur with concurrence from the USFS.
- The Icicle radio repeater station is located outside the ALWA on Icicle Ridge. The station is on USFS land and is operated with a special use permit. Implementation of Alternative 1 and Alternative 4 may require the use of this radio repeater station for the automation project, although locations on private land are also being considered.

3.17.3 Wilderness Character

As established in the 1964 Wilderness Act, wilderness preservation is “for the protection of these areas, the preservation of their wilderness character.” There has been no legal definition of wilderness character since the 1964 Wilderness Act; however, four distinct and necessary “qualities” of wilderness character have been identified by wilderness scholars [35]. These four qualities—naturalness, opportunities for solitude or a primitive and unconfined type of recreation, undeveloped, and untrammeled—were selected to link local conditions and management with the statutory language of the 1964 Wilderness

[35] In Focus: Wilderness Character, Landres, Vagias, Stutzman, 2012, ttps://www.fs.fed.us/rm/pubs_other/rmrs_2012_landres_p001.pdf

Act.[36] A summary of these four attributes are presented below.[37] For the ALWA, no scientific or systematic approach has been developed or referenced to date to specifically depict the condition of this wilderness area's wilderness character.

Natural

The natural quality defines wilderness as containing ecological systems that are substantially free from the effects of modern civilization. This quality is degraded by the intended or unintended effects of modern people on the ecological systems inside the wilderness since it was designated.

Solitude

The solitude, or primitive and unconfined recreation quality, defines wilderness as containing outstanding opportunities to experience solitude, remoteness, and primitive recreation free from the constraints of modern society. This quality is degraded by settings that reduce these opportunities, such as visitor encounters, signs of modern civilization, recreation facilities, and management restriction on visitor behavior.

Undeveloped

The undeveloped quality defines wilderness as an area without permanent improvements or modern human occupation. This quality is degraded by the presence of non-recreational structures and installations, habitations, and by the use of motor vehicles, motorized equipment, or mechanical transport, because these increase people's ability to occupy or modify the environment.

Untrammeled

The untrammeled quality is the degree to which wilderness is unhindered and free from modern human control or manipulation. The untrammeled quality is degraded by actions that intentionally manipulate or control ecological systems, whereas the natural quality is degraded by the intentional and unintentional effects from actions taken inside wilderness, as well as from external forces on these systems.

3.18 Shorelines

Shorelines of the State (defined in RCW 90.58.030[2]) are regulated through the SMA of 1971, as amended. The SMA is administered by Ecology, who delegates authority to local jurisdictions to manage their shorelines through the preparation and implementation of a SMP.

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[36] https://www.fs.fed.us/rm/pubs_other/rmrs_2012_landres_p001.pdf

[37] Landres, P., C. Barns, J.G. Dennis, T. Devine, P. Geissler, C.S. McCasland, L. Merigliano, J. Seastrand, and R. Swain. 2008. Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System. 81 pages. USDA Forest Service, Rocky Mountain Research Station General Technical Report RMRS-GTR-212, Fort Collins, Colorado.

Within the Icicle project area, Chelan County and the Cities of Leavenworth, Wenatchee, and Cashmere all have approved SMPs. Specific SMP policies applicable to the Icicle project area include, among other things, protections to address flood hazards and regulate frequently flooded areas.

Frequently flooded areas, as designated by these local jurisdictions, are defined in part by mapping, studies, and guidance from the Federal Emergency Management Agency (FEMA). FEMA mapping and studies delineate an area with a 1 percent annual chance of flooding as the 100-year flood zone or floodplain. For development to be approved in the 100-year floodplain, it is typically required that a qualified professional certify that there will be no net loss of flood storage capacity and that the development results in no increase (“zero rise”) in water surface elevation during a flood.

Higher potential for flooding can also contribute to increased risk or erosion along these waterways. In general, surface water moves across land or within stream channels at higher velocity during flood or peak flow events, increasing the water potential to pick up sediment and transport it to other areas. To some extent these processes are natural; however, during high flow events, large amounts of sediment can be moved and, depending on the extent of erosion, can cause damage to streambanks, impact aquatic habitat, degrade water quality, and in some cases, damage private property.

3.18.1 Alpine Lakes

As discussed in greater detail in Section 3.3, Surface Water Resources, the primary waterbodies in this part of the Icicle project area include several high-altitude lakes that are fed by rain and snowmelt. Located in the uppermost portion of the Icicle Creek Basin, they drain into adjacent streams that are tributaries to Icicle Creek, which is a tributary to the Wenatchee River.

As noted in Section 3.17, Wilderness Area, the USFS owns and administers the ALWA, which encompasses the lakes within the Icicle project area. IPID has an easement agreement with the USFS that was established when the Wilderness Area was created and the lakes were transferred to the USFS. The easement establishes additional rights for use, management, maintenance, and operation of the lakes by IPID. The USFWS owns the property adjacent to Upper and Lower Snow Lakes and Nada Lake within the ALWA and has landowner rights related to the use, management, maintenance, and operation of those lakes. In addition, Chelan County has jurisdiction over Shorelines of the State in this part of the project area.

The shorelines of these lakes are generally rocky. In some cases, there are steeper slopes leading up to the lake edge, consisting of loose rocks and talus. In other areas, the shoreline is more gradual and consists of larger boulders and vegetation, mainly pine trees, growing up to the shoreline. Important shoreline functions within this part of the Icicle project area include flood retention and habitat and ecosystem functions and values.

Under existing conditions, these lakes are managed to store and release flows for downstream uses. IPID manages Eightmile, Klonaqua, Square, and Colchuck Lakes for downstream irrigation use. The USFWS manages Nada and Upper and Lower Snow Lakes for downstream use by the LNFH. Small dams and related infrastructure (e.g., gates, pipes) were constructed at the outlets of each lake in the early half of the twentieth century to control the releases into adjacent streams.

Current IPID operating procedures result in the release of water from one to two of the IPID-managed lakes each year beginning in early summer (July) until early fall (October). The length and extent of releases depends on water conditions in Icicle Creek near the IPID diversion facilities. During drought years, water may be released from all of the IPID-managed lakes. The USFWS service releases water from Upper Snow Lake through a tunnel, penstock, and release valve to Nada Lake. Releases from Upper Snow Lake typically occur between July and October. Lake levels at the lakes that are targeted for release are typically drawn down over a period of approximately 2 to 3 months before release valves or gates are closed, rain and snow increases, and lake levels begin to rise again. Lake levels in all of the lakes are typically highest in the spring and early summer and lowest in the late summer and early fall.

In this part of the Icicle project area, managed and natural flows from the lakes result in fluctuating water levels that influence the potential for erosion and flooding along the lakeshores and in downstream tributaries. Under existing conditions, erosion and flooding potential along the lakeshores is relatively small because the shorelines are typically rocky and the watershed is adapted to seasonal fluctuations in lake levels. When a lake is full, excess water in the lake spills over the small dam structure and flows downstream at a flow rate that matches the natural inflow from the watershed above the lake. Most of the lakes are typically full during the spring and early summer and water flows through the lakes without any attenuation from the storage volume in the lake. Lake draw down occurs slowly over a period of 2 to 3 months during the late summer, which results in relatively minor, if any, lakeshore erosion. Flows from the lakes contribute to typical patterns of erosion in downstream tributaries with the potential being highest at all lakes in the spring when the lakes are full and natural runoff rates are at their peak.

Because the lakes are fed by rainwater and snowmelt, during years where precipitation is higher than average, lake levels increase and the lakes fill earlier in the spring. When the lakes are full, there is greater potential for localized flooding and erosion because peak flows are not attenuated by the storage capacity in the lakes. When the lakes are not full and peak flow events occur, the storage volume in the lake is available to capture inflows and attenuate flow rates downstream to reduce potential for downstream flooding and erosion. However, the lakes are not generally managed to reduce downstream flooding or attenuate peak flow rates. They are managed to capture water for release in the late summer to meet downstream water supply needs.

3.18.2 Icicle Creek Corridor

As discussed in greater detail in Section 3.3, Surface Water Resources, Icicle Creek is one of the primary tributaries to the Wenatchee River. It is primarily fed by rain and snowmelt from the ALWA and other forest areas.

Depending on the specific location, shoreline jurisdiction along Icicle Creek is granted to Chelan County or the City of Leavenworth. The shoreline typically consists of large boulders and rocks with some riparian forested vegetation, consisting of vegetation very similar to the Alpine Lakes in the higher altitudes. Further downstream and closer to the City of Leavenworth, the shoreline becomes less rocky and less heavily vegetated with larger trees. Shoreline vegetation in the lower reaches of Icicle Creek includes more shrubs and smaller trees. Important shoreline functions within this part of the Icicle project area include flood retention and habitat and ecosystem functions and values.

Similar to the Alpine Lakes tributaries, the timing and volume of flows along Icicle Creek influence the potential for localized flooding and erosion. In general, this system is adapted to a range of flow rates, with higher flows in the winter and spring, and lower flows in the late summer and early fall. Under typical conditions, minor streambank erosion occurs in a manner typical to stream systems with peak spring flows resulting in increased stream turbidity. Because the lakes in the upper watershed and diversion facilities downstream are typically operated to manage flows and water supply in the late summer, their operation does not have as much impact on peak flow rates in Icicle Creek, which typically occur during the winter or spring.

During years when precipitation is higher than average, increased creek flows may contribute to increased localized flooding, erosion, and stream turbidity. Areas with a higher risk of flooding include areas along the banks and floodplain of Icicle Creek from the Boulder Field at RM 5.6 to the City of Leavenworth. Floodplain mapping within the Icicle Creek corridor has not yet been updated by FEMA. Based on the available floodplain mapping, the 100-year floodplain (area with 1 percent annual chance or greater of flooding) is generally limited to a narrow corridor in the canyon upstream of LNFH that includes the banks of a limited floodplain area along Icicle Creek. The 100-year floodplain expands farther upland where Icicle Creek enters the broader valley near LNFH and expands downstream of the LNFH to the City of Leavenworth (FEMA, 2016).

3.18.3 Wenatchee River Corridor

Shoreline jurisdiction along the Wenatchee River near its confluence with Icicle Creek is granted to Chelan County or the Cities of Leavenworth, Cashmere, or Wenatchee, depending on the specific location. Near the City of Leavenworth, the shoreline is generally similar to Icicle Creek. As the river flows downstream toward its confluence with the Columbia River, the shoreline becomes less densely vegetated and more open with some areas of sandy beach. Important shoreline functions also include flood retention and habitat and ecosystem functions and values.

Similar to the upper watershed, this river system is also adapted to a range of flow rates, with higher flows occurring in the winter and spring and lower flows occurring in the late summer and early fall. Under typical conditions, minor streambank erosion occurs in a manner typical to river systems with peak spring flows resulting in increased stream turbidity. During peak storm events, the potential for flooding and erosion increases. Floodplain mapping within the Wenatchee River Corridor has not yet been updated by

FEMA. Based on available floodplain mapping, the 100-year floodplain (area with 1 percent annual chance or greater of flooding) generally includes the river banks and a narrow floodplain area along the Wenatchee River from Icicle Creek to the Columbia River. The extent of the 100-year floodplain extends farther upland as the valley broadens toward the City of Wenatchee (FEMA, 2016).

3.19 Utilities

This section discusses utilities within the Icicle project area. Most public utilities are provided by Chelan County, cities, special districts such as public utility districts, and private suppliers. These utilities include water service, solid waste, water treatment, and electricity.

Water service utilities are the most likely to be impacted by the Icicle Strategy and the Program Alternatives and are the focus of this section. However, several other utilities are in the project area, especial the lower portion of the Icicle Creek Corridor sub-region and the Wenatchee River Corridor sub-region. These utilities include electricity provided by Chelan County PUD, wastewater services provided by Chelan County PUD, City of Leavenworth, City of Cashmere, and City of Wenatchee. They are mainly concentrated in more developed areas and may need to be addressed during project construction.

3.19.1 Water Purveyors

3.19.1.1 City of Leavenworth

City of Leavenworth is the only major municipal water purveyor that uses Icicle Creek surface water as part of their water supply. Details of the City of Leavenworth water right and diversionary infrastructure is provided in Section 3.6.1, Water Rights. This section details their municipal water production.

Historical Water Use

In 1988, Leavenworth produced 501 million gallons of water from its water treatment plant and wells for 986 service connections (WSP, 2011). The number of service connections increased to 1,380 in 2013 while the production of water decreased to 279 million gallons[38]. Both the service connection increase and the production decrease have been fairly steady over the period of record. This downward trend in water use can be attributed largely to a variety of conservation efforts the City of Leavenworth has implemented. Although this significant reduction could also be related to structural improvements, implementation of metering, and other operational changes.

[38] Data from City of Leavenworth 2013 Water Use Efficiency Annual Performance Report submitted to Washington State Department of Health May 4, 2014

Water Conservation

Since 2008, the City of Leavenworth has invested approximately $3.6 million to improve distribution, storage, and metering of water to decrease water loss and improve accountability. A breakdown of these projects is listed below in Table 3-33.

Increased water conservation by the City of Leavenworth is one of the projects included in the Program Alternatives of the Icicle Strategy, with the exception of the No-action Alternative. These conservation efforts are detailed in Section 2.5.4, Domestic Conservation, and is anticipated to save up to 400 acre-feet per year, which will be made available for additional water service by the City of Leavenworth.

Table 3-33
Capital Improvement Projects Made by the City of Leavenworth to Improve Conservation and Accountability of Water Use (Aspect, 2014)

Year	Project	Cost
2008	Icicle Road Reservoir Reconstruction	$2,212,618
	9th Street Watermain	$295,258
	Commercial Street Watermain	$134,539
	Meter Upgrades	$3,336
2009	Meter Upgrades	$10,648
2010	Meter Upgrades	$12,714
2012	Meter Upgrades	$8,370
	Front/Div - 14th Watermain	$233,708
	Source Water Meters	$5,453
2013	Meter Upgrades	$1,483
	East Leavenworth Road Watermain	$681,009
	Front Street Watermain	$9,900
	Source Water Meters	$1,877
Total		$3,610,913

Current Water Use

In 2017, the City of Leavenworth served approximately 1,404 connections (Varela & Associates, 2018). The City of Leavenworth's water comes from both groundwater wells and surface water diversions from Icicle Creek. The City maintains dual sources for supply redundancy. Surface water withdrawals from Icicle Creek are routed through the City's water treatment plant, which treats approximately 2.0 million gallons per day (gpd) during peak demand in the summer irrigation season. Conservation efforts have decreased usage from 389 gpd per Equivalent Residential Unit (ERU) in 2002 to 304 gpd per ERU in 2012, a decrease of 85 gpd per ERU or approximately 22 percent (Aspect, 2014). The City of Leavenworth recently revised their water system plan (WSP) and found the average gpd per ERU in 2016 to be 266 gpd/ERU (Varela & Associates, 2018). Table 3-11 shows the number or parcels and the size class of those parcels for the City of Leavenworth and other water purveyors who divert from Icicle Creek.

Projected Future Need

The City of Leavenworth WSP projects long-term population and water demand growth (Varela & Associates, 2018). Based on this analysis, projected water demanded in 20-yeas is estimated at 495 million gallons annually (Varela & Associates, 2018). Production in 2017 was 320 million gallons. However, implementation of water use efficiency efforts may impact this demand projection.

3.20 Transportation

This section addresses transportation networks throughout the Icicle project area. Transportation facilities include trails, roadways, railways, water transport, and air transport. Not all of these transportation types are located in the sub-regions discussed in this section (Alpine Lakes, Icicle Creek, Wenatchee River) and will be omitted from the subsections as appropriate.

3.20.1 Alpine Lakes

Trails were the original transportation network throughout the upper Icicle Creek Subbasin in the Alpine Lakes region and remains one of the few ways to access the Alpine Lakes today. This area contains several hundred miles of trails. Some of the trails contained in the subbasin are well maintained and frequently used while others have fallen into disrepair or have been covered by debris as a result of fires in the region. Trail use is closely tied to outdoor recreation and discussed further in Section 3.15, Recreation.

Air transport via helicopters is the only way other than trails to access the Alpine Lakes area. Helicopter use is limited in this area because of wilderness regulations, as discussed in Section 3.17, Wilderness Area. Helicopters are used for emergency purposes and for maintenance and operation transport for IPID. In 1981, the USFS conducted an environmental assessment on IPID's helicopter use and found it permissible.

3.20.2 Icicle Creek Corridor

Icicle Creek Road runs from the City of Leavenworth near the confluence of Icicle Creek and the Wenatchee River for approximately 18 miles up Icicle Canyon. This road is used primarily for recreational purposes as it accesses various trailheads, climbing routes, and swimming areas along Icicle Creek. There are also USFS roads that diverge from Icicle Creek Road and meander through the Wilderness Area. Except for the City of Leavenworth, Icicle Creek Road and the adjoining USFS roads are the only roadways within the Icicle Subbasin. Because Icicle Creek Road comes to a dead end after 18 miles up the Icicle Canyon, it is not a primary transportation route and generally exists for recreational purposes.

3.20.3 Wenatchee River Corridor

The Wenatchee River Corridor contains several major roadways. These include federal Highways 97 and 2, and a small portion of State Route 209. There are also several county and city roads located in this area. Highway 2, which runs along the Wenatchee River, is designated as a National Scenic Highway, which is discussed in more detail in Section 3.11.3, Wenatchee River Corridor [Aesthetics].

There is also one railroad that runs parallel to the Wenatchee River from the City of Leavenworth to City of Wenatchee. This rail line is owned by BNSF and serves both passengers and freight. This rail line connects the Wenatchee area to City of Seattle and City of Spokane.

3.21 Cultural Resources

Cultural resources can be buildings and other man-made structures or objects, or a site, landscape, or district associated with human use in the past. For the purposes of this evaluation, cultural resources are considered to be those eligible for listing in local, state, or national preservation registers. Tribal resources within the Icicle project area are addressed in Section 3.22, Indian Sacred Sites, and Section 3.23, Indian Trust Assets and Fishing Harvest.

3.21.1 Environmental Context

The Icicle project area is in the Wenatchee River Watershed on the east slopes of the Cascade Range. The project area includes the Alpine Lakes in the Icicle Creek Basin, Icicle Creek to its confluence with the Wenatchee River, and the Wenatchee River from just upstream of Icicle Creek to its confluence with the Columbia River. The area is part of the Northern Cascades physiographic province, characterized by deeply dissected mountains with glacially created features, crossed by east- and west-flowing streams (Franklin and Dyrness, 1973:17-20). Bare rock outcrops are common.

The upper portion of the Icicle project area is characterized by high relief and relatively sparse vegetation. Soils are typically thin and formed in glacially derived sediments, colluvium, and volcanic ash (NRCS, 2016). The lower portion of the project area, extending to the Wenatchee River Corridor, is characterized by landforms and vegetation more common in the valley bottoms. Soils can be much deeper and formed in alluvium and loess as well as glacial till (NRCS, 2016).

Prior to historic-era and modern changes, the alpine terrain in the upper Icicle project area would have been a source of toolstone for local communities and certain faunal species such as bighorn sheep. The valley-bottom terrain in the lower elevations would have hosted a wider variety of large mammals, as well as anadromous and resident fish, birds, and various species of edible and usable plants.

3.21.2 Cultural Context

The Icicle project area is located within the Columbia Plateau. General cultural histories have been developed for the plateau as a whole (Chatters and Pokotylo, 1998), as well as various sub-regions and drainages. Most are focused on river valleys where larger sites are more plentiful (e.g., Grabert, 1968). Because the prehistory of the mountain regions of Washington is poorly understood compared to the coasts and riverine lowlands, this section is primarily based on the better-understood riverine valley cultures; however, these communities also likely used the surrounding mountains as part of their seasonal movements.

At the end of the Pleistocene, hunters of large mammals fanned out across North America. This culture is known in the Columbia Plateau as Paleoindian (Ames and Maschner, 1999:64 66), and dates to the Early Period, about 12,000 to 8,000 years ago. The earliest Paleoindian sites recorded in the Columbia Plateau are attributed to the Clovis culture, a regional expression of Paleoindian. Clovis sites are rare across the region, and in mountain environments "game density would have been too low, and exploitation costs too high relative to the lowlands to have attracted significant use" (Burtchard, 2007: 17). However, there are a few sites near the Icicle project area, including the Ritchey-Roberts Clovis cache in nearby East Wenatchee, dating to 12,250 before present (BP) (Mehringer and Foit, 1990). An undated Clovis projectile point has also been found near Cle Elum, near Snoqualmie Pass (Burtchard, 2007).

After the brief but widespread Clovis occupation, a "broad-spectrum" hunter-gatherer culture developed in the Columbia Plateau region and persisted until the middle Holocene, around 5,300 years ago. A number of dated sites in the Cascade Range are attributed to this period, primarily lithic quarries and scatters (Mierendorf, 1986).

A shift toward more permanent settlement began around 6,000 years ago. Known as the Late Middle Period in the Columbia Plateau, this period lasted until the beginning of the early Holocene around 3,000 years ago (Chatters and Pokotylo, 1998; Ames et al., 1998). In Cascade Mountain environments, there is an increase in dated sites consistent with the expectation of more intensive resource use (Burtchard, 2007).

Late Holocene cultures in the Columbia Plateau region exhibit a "shift in adaptations…to storage-dependent collector strategies" (Chatters and Pokotylo, 1998:76), which are characterized by intensive salmon fishing and associated storage features, social inequality, large permanent winter villages, and diverse tool assemblages. The Cascade Range continued to be used during this time, despite some expectation that long-range travel might decrease as villages became more important (Schalk, 1984). Some sites contain multiple non-local toolstone types, indicating that they may have functioned as larger camps (Mierendorf, 2004). The late Holocene archaeological cultures correlate with historic ethnographic descriptions.

The Icicle project area is in the traditional territory of the Wenatchee (Wenatchi) Tribe, a Middle Columbia Salishan group speaking Columbian, an Interior Salishan language. The cultural pattern in the Columbia River Basin at the time of historic contact was based on a seasonal round that took advantage of fish runs, abundant game, and root resources, as well as trade, kinship ties, and intermarriage among groups (Walker, 1998). Prior to historic resettlement, permanent winter villages anchored the seasonal round. Villages often contained a large communal structure or "longhouse," as well as smaller auxiliary structures (Miller, 1998). Before the adoption of the horse, these structures were semisubterranean, but after about anno domini (AD) 1720, even winter village structures were aboveground mat houses. Villages were the basic political unit (Miller, 1998).

The communities of the southern Columbia Plateau began to see the effects of Euro-American contact decades before the first explorers and traders arrived in the area. These effects, beginning around AD 1600, included introduced diseases, trade goods, and the introduction of the horse (Walker and Sprague, 1998).

The Wenatchee Tribe signed the Yakima Treaty in 1855 at Walla Walla, which was followed by several years of warfare (Wilma, 2006; Yakama Nation, 2016). Many descendants are now part of the YN while others belong to the CTCR (Wilma, 2006). Additional information about tribal resources is provided in Sections 3.22, Indian Sacred Sites, and 3.23, Indian Trust Assets and Tribal Fish Harvest.

Prospectors, traders, and missionaries began to arrive in the Wenatchee River area in the 1860s and 1870s, followed by homesteaders. The railroad arrived in 1892, and the City of Wenatchee incorporated the same year (Wilma, 2006). With construction of the railroad and the growth of irrigation, the Wenatchee River area became primarily agricultural, known as the “Apple Capital of the World” (Wilma, 2006).

The Wenatchee National Forest was created by President Theodore Roosevelt in 1907, headquartered in the City of Leavenworth. Shortly thereafter, forester Albert “Hal” Sylvester began surveying the new forest and assigning place names (Bentley, 2010). Sylvester named Icicle Creek and Icicle Ridge after the Columbian language name *na-sik-elt*, which means “narrow canyon” (Bentley, 2010). A guard station was constructed at Chatter Creek in 1916, and a bridge in 1922 (Beidl, 2010).

Water quickly became the single most important factor restricting the success of the agricultural industry. The earliest cooperative irrigation projects in the Peshastin area began in the 1800s, and IID and PID were formed in the early 1900s (Grubb, 2016). The Reclamation Act of 1902 allowed the federal government to manage water use. Early projects were primarily agricultural, but in the 1930s, large hydroelectric dams were constructed, including those on the Columbia River (Reclamation, 2010). The LNFH was built in 1939 as partial mitigation for impacts to fish resulting from the construction and operation of the Grand Coulee Dam on the Columbia River.

Water storage and release systems were constructed for irrigation, including facilities at Colchuck, Klonaqua, Square, and Eightmile Lakes. The facilities at Colchuck Lake were constructed in the early 1920s and Klonaqua Lake in the early 1930s—though the dam at Colchuck Lake appears to have been replaced in the 1950s (Jantzer, 2016). The water release systems at Square Lake and Eightmile Lake were built later, in the 1930s and 1940s (Jantzer, 2016). IID and PID constructed the facilities jointly and have historically shared the operation and maintenance of the systems. The systems generally consist of a low rock-masonry dam and a combination of pipes or tunnels with gates that control the release of stored water from the upper portions of each lake. The water released augments flow in Icicle Creek for maintenance of withdrawals by IPID. The dams have been altered and maintained throughout the decades, with various components of the infrastructure upgraded and replaced (Jantzer, 2016).

Water is also managed at Upper Snow, Lower Snow, and Nada Lakes by the USFWS. A tunnel runs from the northeast corner of Upper Snow Lake to a gatehouse containing control valves that release water to Nada Lake. There is also a small rock-masonry dam at Upper Snow Lake where it connects to Lower Snow Lake, another at Lower Snow Lake at its outlet to Snow Creek, and a reinforced concrete structure at the outlet of Nada Lake. These were originally constructed in the 1930s and early 1940s by the USBR for the USFWS to maintain the supply of cold surface water to LNFH (USFWS, 2014). The tunnel and valve unit were designed and built by USBR Engineer Louis Ackerman (USFWS, 2014).

The ALWA was designated in 1976. The Okanogan National Forest and the Wenatchee National Forest were administratively joined in 2000 and became the Okanogan-Wenatchee National Forest (USFS, 2016).

3.21.3 Previously Recorded Resources

Within the Icicle project area, there are 19 documented archaeological sites and 4 historic structures according to DAHP's Washington Information System for Architectural and Archaeological Data (WISAARD) lists. Four of these resources have been determined to be eligible for listing on the National Register of Historic Places (NRHP)[39]. These are the LNFH, the Chatter Creek Guard Station, and culturally modified trees (cedars that have been peeled to harvest the bark) locations (sites FS1624 and FFS1573). The peeled cedars and the Chatter Creek Guard Station are not in the vicinity of any of the proposed projects that compose the Program Alternatives and are not discussed further.

Potential changes at the LNFH are included in all the Program Alternatives. The property is NRHP-listed under Criterion A because of its association with the history of fish conservation and restoration, and under Criterion C because it embodies the distinctive characteristics of hatchery conception and design between 1939 and 1941 (Speulda, 1997).

WISAARD indicates that 17 cultural resources surveys have been completed within the upper portions of the Icicle project area, including the Alpine Lakes and Icicle Creek. Of those, most are outside the area that would likely be affected by any of the Program Alternatives. Five of the surveys were conducted at the LNFH, and none revealed any significant historic, archaeological, or cultural resources other than the LNFH complex itself.

In lower portions of the Icicle project area, including the Wenatchee River Corridor, 75 cultural resources surveys have been conducted, resulting in the identification of 21 archaeological sites (5 precontact sites, 10 historic sites, 4 precontact isolates, and 2 sites with both precontact and historic components). There are also four recorded cemeteries and one burial. None of these resources are in the vicinity of any of the Program Alternatives.

[39] To be eligible for listing in the NRHP, a property must retain its integrity and meet one or more of four criteria for significance: association with broad patterns of history, direct association with a historically important person(s), masterful design or engineering, or the potential to yield important data.

3.21.4 Archaeological Survey

To provide additional information about the potential to encounter cultural resources within the Icicle project area, an archaeological survey at four of the Alpine Lakes was completed in July 2016 (Bundy, 2017). This survey included a pedestrian survey and recordation of irrigation structures.

The survey revealed no cultural resources along the existing Eightmile Trail. At four lakes—Colchuck, Square, Klonaqua, and Eightmile—historical water release systems were recorded. The four water release systems were evaluated for their NRHP eligibility, individually and as a historic district. The systems share similar structure and serve the same function of providing water to the City of Leavenworth and surrounding agricultural areas. The water release systems are recommended NRHP-eligible both individually and as a historic district. The structures are recommended eligible under the following:

- Criterion A for their association with historically significant and controversial water management in Chelan County
- Criterion B for the unique style influenced by the extremely difficult terrain and constraints of mid-century construction methods
- Criterion D for the potential to yield data about early twentieth century engineering and construction

Although the systems have been upgraded and modified through the decades, this sort of maintenance is common for industrial and agricultural historic properties. The water release systems retain integrity of location and setting because they are in their original locations and the surrounding landscape has changed little. They retain integrity of design, workmanship, and materials, with the local stone, concrete, and timber components consistent—even between structures built 30 years apart. They retain integrity of feeling and association, which is expressed in the contrast between the rustic construction (native stone, hand-cranked machinery) and the wilderness setting.

In addition to the four water release systems, a construction work camp was observed at Klonaqua Lake. This site is also potentially eligible for listing in the NRHP both individually and as contributing to the historic district under Criterion D. The site has a surface artifact scatter and remnant structure, and potentially buried artifacts and features. It has the potential to yield data important to the study of working conditions and methods in an alpine environment in the early twentieth century.

The dams at Upper and Lower Snow Lakes have not been surveyed and no recommendation for eligibility in the NRHP has been made. Photos show simple rock-masonry structures, similar to those constructed at the IPID water release systems.

3.22 Indian Sacred Sites

Sacred sites may include ceremonial areas and natural landmarks that are religious or symbolic representations. Indian Trust Assets, including Usual and Accustomed Areas, are addressed in Section 3.23, Indian Trust Assets and Fishing Harvest.

Sacred sites are considered cultural resources and require consideration under the State Environmental Policy Act. Sacred sites can also be recorded as Traditional Cultural Properties (TCPs) under Section 106 of the National Historic Preservation Act, which applies to projects involving federal actions (Parker and King, 1998).

The Icicle project area is in the traditional territory of the Wenatchee (Wenatchi) Tribe. The Wenatchee Tribe signed the Yakima Treaty in 1855 at Walla Walla (Wilma, 2006; Yakama Nation, 2016). Many descendants are now part of the Confederated Tribes and Bands of the Yakama Nation, while others belong to the Confederated Tribes of the Colville Reservation or other tribes (Wilma, 2006).

No sacred sites or TCPs have been recorded in the Icicle project area in Washington State DAHP's database; however, Indian tribes may have written or oral records of sacred sites that are not recorded in the DAHP database.

The Confederated Tribes and Bands of the Yakama Nation are members of the Icicle Work Group. Coordination with tribes and tribal organizations will continue throughout the program.

3.23 Indian Trust Assets and Fishing Harvest

This section describes Indian Trust Assets (ITAs), including Usual and Accustomed (U&A) Areas with the potential to be affected by the Program Alternatives. ITAs are legal interests in property held in trust by the United States for federally recognized Indian tribes or individual Indians. ITAs may include land, minerals, federally reserved hunting and fishing rights, federally reserved water rights, and instream flows associated with trust land. U&A Areas are areas where tribes have historically hunted, gathered, and fished.

Information about the specific tribes and other tribal resources within the Icicle project area is presented in Section 3.22, Indian Sacred Sites. Information about fisheries in general is presented in Section 3.7, Fish.

3.23.1 Legal Framework for Protection

Beneficiaries of the Indian trust relationship are federally recognized Indian tribes with trust land, and the United States acting as trustee. By definition, ITAs cannot be sold, leased, or otherwise encumbered without approval of the U.S. government.

The federal government has a trust relationship with Indian tribes, and federal agencies are required to engage and consult federally recognized tribal governments on a government-to-government level when their actions affect ITAs. This relationship is governed by treaties, statutes, federal judicial decisions, and the historical evolution of the trust doctrine.

The U.S. Department of Interior (DOI) Departmental Manual Part 512.2 delegates the responsibility for ensuring protection of ITAs to the heads of bureaus and offices (DOI, 1995). The DOI is required to “protect and preserve ITAs from loss, damage, unlawful alienation, waste, and depletion” (DOI, 2000). Depending on federal involvement for individual projects, there could be a requirement to formally consult with potentially affected federally recognized tribes. Additionally, state-funded capital construction projects or land acquisition projects for the purpose of capital construction require Governor’s Executive Order 05-05 review. This order requires all state agencies to integrate Washington State DAHP, the Governor’s Office of Indian Affairs, and concerned tribes into the capital improvement project planning process to protect the public interest in historic and cultural sites.

In 1854 to 1855, representatives of the U.S. government negotiated separate treaties with the tribes and bands of the Columbia River Basin, which included the YN. The treaty between the YN and the U.S. government protects the YN’s rights to continue traditional fishing practices and reserves to the tribes the right to take “fish at all usual and accustomed places in common with citizens of the United States” within their respective reservations, at all U&A fishing sites on lands ceded to the U.S. government, and at all U&A fishing sites outside the reservation or ceded areas (YN and U.S. Government, 1855).

Although the CTCR did not sign a treaty during the 1855 council between tribes and the U.S. government, non-treaty agreements made with U.S. government representatives protect similar fishing rights of CTCR tribal members (CTCR, 2016).

3.23.2 Usual and Accustomed Areas

U&A Areas include areas where tribes have historically hunted, gathered, and fished. Within the Wenatchee River Watershed, there are U&A fishing areas for the YN and CTCR. The YN also has U&A fishing places in many locations along the Columbia River and outside of the Columbia River Basin in accordance with treaty fishing rights (YN, 2009). Both the YN and CTCR maintain fishing rights in Icicle Creek, targeting non-listed spring-run Chinook salmon (*Oncorhynchus tshawytscha*), returning to the LNFH in the area adjacent to LNFH downstream to the confluence with the Wenatchee River (YN, 2009; CTCR, 2011), including the plunge pool immediately downstream of the LNFH Hatchery Channel spillway.

In the mainstem Wenatchee River, the YN maintains fishing rights within a mile of Dryden Dam (not within 25 feet of any fishway), in mid-summer targeting summer-run Chinook salmon and summer-run steelhead (*O. mykiss*) (YN, 2009). The CTCR maintains a summer Chinook salmon fishery in Tumwater Canyon and mainstem Wenatchee River (CTCR, 2011). Since the reintroduction of coho salmon (*O. kisutch*) to the upper Wenatchee River and Icicle Creek drainages, tribal subsistence fisheries for coho salmon have been opened when runs are large and surplus fish are available (CRITFC, 2011). Upriver sockeye salmon (*O. nerka*) and upriver summer-run Chinook salmon (including the Wenatchee stocks) are harvested by treaty tribes (including the YN) in the mainstem Columbia River, prior to ascending their natal rivers.

It is the policy of the YN and CTCR fishery codes to sustainably manage fishery resources and enhance fish and habitat off the Yakama and Colville Reservations to support tribal harvest for subsistence, recreational, and economic needs of tribal members (YN, 2009; CTCR, 2011). The harvest of trout, salmon, and steelhead is allowed only by fishery regulation passed by tribal fish and wildlife committees. Harvest rates and fishery openings are determined annually by tribal and state fishery co-managers based on preseason run-size estimates and in-season observations of numbers of fish entering the Lower Columbia River. From 1999 to 2003, the YN harvest in Icicle Creek averaged 2,905 spring-run Chinook salmon per year and an average of over 3,000 surplus adults returning to LNFH were provided directly to Columbia River tribes (YN, CTCR, Spokane Tribe, and Kalispell Tribes) and food banks. In 2015, CTCR anglers caught 113 hatchery-origin spring-run Chinook salmon from mid-May to early June (Rayton, 2016).

The harvest of whitefish, sucker, pikeminnow, and other native resident fish and non-native species are open year-round to tribal members unless restricted by specific regulation (YN, 2009). Pacific lamprey (*Entosphenus tridentatus*) is a culturally and commercially important species for the tribes and is a tribal trust species. Pacific lamprey are a traditional delicacy harvested by many Northwest Indians for use as food, ceremonial, and medicinal purposes. Efforts are underway to restore harvestable lamprey populations in the Wenatchee River Watershed (YN, 2016).

3.24 Socioeconomics

This section provides information on the social and economic conditions within the Icicle project area to provide context for comparing the costs and benefits of the Program Alternatives to each other and to the No-action Alternative. This section provides an overview of the regional economy, including the labor force, employment by industry, and wages and income. This section also includes a discussion of OCR investment considerations relevant to evaluating the costs and benefits associated with large-scale fish recovery efforts. Information for this section was gathered from the U.S. Census Bureau; the Chelan County Auditor’s Office; Chelan and Douglas Counties Profile, prepared by the Washington Employment Security Department (ESD; 2015); and from the Washington State Department of Ecology’s Office of Columbia River.

3.24.1 Regional Economic Setting

The Icicle project area is located within the Wenatchee Metropolitan Statistical Area (WMSA), which is composed of Chelan and Douglas Counties. The WMSA relies on agriculture as the main source of employment. In Chelan County, agriculture is the largest industry, making up 24.1 percent of total employment, followed by private health care services (13.5 percent). In addition, other substantial sources of employment include government, retail, and leisure and hospitality. Tourism plays a large part in the local economy in Chelan County due in part to attractions like Lake Chelan and the City of Leavenworth (ESD, 2015).

As the largest source of employment, agriculture is the primary economic driver for the region. In particular, tree fruit, including apples, cherries, pears, and peaches, provides a significant contribution to the local economy. Grape production and wineries also contribute to both agriculture and tourism. Agricultural employment also directly links to nonfarm employment through support services such as food processing, packaging, and distribution (ESD, 2015).

Flows from Icicle Creek support agricultural uses in the Icicle project area as well as a range of other demands, including providing water for domestic uses and habitat for fish. Taken together, these demands are often greater than the water supply needed to meet them, resulting in the need to collaboratively and collectively identify solutions to balance water resource needs with the County's needs for economic growth and security.

3.24.2 Population, Housing Stock, and Property Values

The total population in Chelan County in 2015 was 75,644. This represents a 10 percent increase over the 2005 population of 68,747. In comparison, the Washington State population increased by 14 percent over the same period, from 6,257,305 to 7,170,351 (Census, 2017a, 2017b).

The increase in housing stock was similar to the increase in population in Chelan County. In 2005, there were 32,738 housing units. In 2015, there were 36,452 housing units, an increase of 11 percent. Housing stock in Washington State also increased by 11 percent over that period of time, from 2,691,015 to 2,991,484 (Census, 2017a, 2017b).

Property values in Chelan County have increased significantly over the past 10 years. In 2016, the total taxable assessed value was $9.7 billion. This represents a 60 percent increase over the 2006 total taxable assessed value of $6.1 billion. However, property tax revenue only increased by 37 percent between 2006 and 2016, from $75 million to $103 million, respectively (Walter, 2016).

Table 3-34 provides a summary of changes in population, housing stock and property values in Chelan County.

Table 3-34
Chelan County Population, Housing Stock, and Property Value Changes

	2005	**2015**	**% Change**
Population	68,747	75,644	10%
Housing Units	32,738	36,452	11%
	2006	**2016**	**% Change**
Total Taxable Assessed Value	6,066,908,249	9,709,253,746	60%
Total Property Tax Revenue	75,220,200	103,275,501	37%

3.24.3 Labor Force

The recent recession had a delayed effect on the WMSA labor market with the worst impacts occurring primarily in 2009 and 2010. Nonfarm employment in the two-county WMSA peaked at an average of 40,200 jobs in 2008, then declined until bottoming out in 2010 with 38,100 jobs (ESD, 2015).

In 2014, the WMSA's nonfarm economy averaged 40,600 jobs, which was a 3.2 percent growth rate from the previous year and back to pre-recession conditions. The statewide job growth rate was 2.7 percent for the same period. Over 75 percent of the jobs added in 2014 were in construction, health services, and leisure and hospitality (ESD, 2015).

3.24.4 Employment by Industry

More than 66 percent of all jobs in 2014 in Chelan County fall into five industries: agriculture, health services, local government, retail trade, and accommodations and food services. Table 3-35 shows jobs by industry and the percent of employment it represents.

Table 3-35
2014 Chelan County Employment

Sector	Number of Jobs	Share of Employment
Agriculture, forestry and fishing	9,962	24.1%
Health services	5,602	13.5%
Local government	4,766	11.5%
Retail trade	4,379	10.6%
Accommodations and food services	4,097	9.9%
All other industries	12,539	30.3%
Total covered employment	41,345	100%*

Source: Washington Employment Security Department, 2015
* Values do not equal 100% due to rounding.

3.24.5 Wages and Income

In 2014, Chelan County's workers received $1.48 billion in wages. Although agriculture was the largest job provider in Chelan County in 2014, agricultural wages represent a proportionally lower percentage of the County's total wage income. Table 3-36 presents the payroll and the percentage of total wages for each industry within Chelan County.

Table 3-36
2014 Chelan County Wages

Industry	Payroll	Share of Payrolls
Health services	$304,232,620	20.5%
Local government	$234,376,378	15.8%
Agriculture, forestry and fishing	$228,904,393	15.4%
Retail trade	$115,390,841	7.8%
Wholesale trade	$103,679,515	7.0%
All other industries	$498,177,888	33.6%
Total covered payrolls	$1,484,761,635	100%

Source: Washington Employment Security Department, 2015
* Values do not equal 100% due to rounding.

3.24.6 Costs and Benefits

In 2006, Washington State passed legislation establishing the Columbia River Management Program, which tasked Ecology to seek out new water supplies within the state of Washington for instream and out-of-stream uses, leading to the development of the OCR. Since that time, OCR has improved water supply in eastern Washington through the development of additional water sources, totaling 410,000 acre-feet with an additional 337,878 acre-feet to be developed in the near term (Ecology 2016).

OCR has funded numerous projects to meet its directive. The costs to develop water supplies, which have to do with making the water physically and legally available for instream flows or out-of-stream allocations, ranges considerably depending on project specifics, but the average is $500/acre-foot. These costs typically include project conceptualization, appraisal, feasibility study, pre-design, design, environmental review, stakeholder outreach, construction, and permitting to authorize the source of water.

Implementation of the Icicle Strategy would require similar costs to develop the additional water supply. This would mainly result in short-term costs in exchange for longer-term benefits.

The costs and benefits specific to each Program Alternative are discussed in Section 4.24, Socioeconomics. Relevant to this discussion, implementation of the Icicle Strategy is anticipated to affect the following components of socioeconomic conditions within the Icicle project area:

- Land value and annual property tax revenue
- Jobs and labor income
- Increased instream values

3.24.6.1 Land Value and Annual Property Tax Revenue

In Washington State, all real and personal property is subject to taxation, unless specifically exempted by law. There are many taxing districts in Chelan County, including fire districts, the regional library, cities, county government, roads, hospitals, ports, and many others. The amount of money that taxing districts raise is determined by the local government and its budget-making authority. As land value changes, so can the revenue generated for each taxing district.

3.24.6.2 Jobs and Labor Income

Investment in public projects creates jobs; however, the actual increase in jobs at the regional level depends on the funding source. If the construction funding is entirely local and from existing sources, the effect can be small because funds may be diverted from other efforts. If the funding is from external sources, the effect can be greater. However, with large-scale construction projects in rural areas, much of the labor and materials can come from outside the local and regional economies, muting the potential benefit. Nonetheless, increases in construction at the local level contributes to greater economic activity as workers spend more of their labor income in the local economy.

3.24.6.3 Increased Instream Values

Although the concept is difficult to quantify or monetize, a clear connection between healthy aquatic ecosystems and the economic livelihood of local communities is identified by the National Research Council in the book *Valuing Ecosystem Services: Toward Better Environmental Decision-Making* (NRC, 2005). As described by EPA in their report *Valuing the Protection of Ecological Systems and Services: A Report of the EPA Science Advisory Board*, the value associated with increased instream flows is a function of how ecological goods and services contribute to human well-being (EPA, 2009). However, there is "non-use value" that must also be considered. The idea of "non-use value" has to do with the preference for a public good or service that is not derived directly from its use, as explored by Mansfield in her report *Klamath River Basin Restoration Nonuse Value Survey* (RTI, 2012). That is, some people will value recovery of a fish run not because they want to consume the fish, but rather because they value the existence of the fish run.

3.25 Environmental Justice

Environmental Justice is the fair treatment of all people regardless of race, color, national origin, or income. Fair treatment means that disadvantaged populations do not bear disproportionate adverse impacts from a particular action compared to the rest of the population. For the purposes of this analysis, this section looks at minority and low-income data for the Icicle project area using data provided by the U.S. Census Bureau and the Washington Office of Financial Management (OFM). Information about tribal resources within the Icicle project area, including the potential for Indian Sacred Sites and Indian Trust Assets and Fish Harvest, are described in Sections 3.22, Indian Sacred Sites, and 3.23, Indian Trust Assets and Fishing Harvest, respectively.

3.25.1 Minority Populations

Table 3-37 provides statistics on the minority population composition for the State of Washington, Chelan County, and within the Icicle project area defined as Census Tracts 9602, 9605, 9606, 9607, 9608.01, and 9608.02[40]. As shown, minority populations within the Icicle project area are generally proportionate to those in the county and state,[41] with the exception of a slightly higher percentage of Hispanic or Latino populations. However, these differences are not assumed to be substantial because of the wide margin of error posed by the data used for this study. Additionally, as discussed in greater detail in Section 3.23, Indian Trust Assets and Fishing Harvest, potentially affected minority populations include members of area Indian groups. While census data are available for recognized Indian reservations, specific data for tribal members are not. Tribal members may be affected regardless of whether or not they reside on their reservations.

Table 3-37
Race and Ethnicity

	State of Washington	Chelan County	Icicle Project Area[a]
Total Population	7,061,410	75,030	31,304
One Race			
White	5,698,518 (81%)	70,669 (94%)	29,600 (95%)
Black or African American	278,360 (4%)	409 (<1%)	127 (<1%)
American Indian and Alaska Native	130,780 (2%)	1,337 (2%)	469 (2%)
Asian	562,903 (8%)	779 (1%)	355 (1%)
Native Hawaiian and Other Pacific Islander	50,698 (<1%)	169 (<1%)	83 (<1%)
Two or more races	340,151 (5%)	1,667 (2%)	671 (2%)
Hispanic or Latino[a]	879,410 (13%)	21,501 (29%)	6,375 (20%)

Source: OFM, 2015; percentages are rounded.
Notes: a) The Icicle project area includes Census Tracts 9602, 9605, 9606, 9607, 9608.01, and 9608.02. b) As defined by the OFM, Hispanic or Latino race included as subset of White category.

[40] Census tracts selected include those located within the Icicle Creek Basin and Wenatchee River Watershed where the proposed projects composing the Program Alternatives are focused. Census tracts that include the Alpine Lakes are not listed because project activities are proposed for areas where no residences are allowed. As noted, tribal resources with the potential to be affected are addressed in Section 3.23, Indian Trust Assets and Fishing Harvest.
[41] For context, the U.S. EPA considers impacts on minority populations to be disproportionate if the minority population exceeds 50 percent of the study area population or if the minority population percentage of the study area is meaningfully greater than the minority population percentage in the general population or the reference area (Council on Environmental Quality, 1997).

3.25.2 Low-income Populations

Table 3-38 provides information about low-income populations for the same geographic areas. Similar to data presented for minority populations, low-income populations within the Icicle project area are proportionate to populations at the state- and county-level.

Table 3-38
Income, Poverty and Unemployment

	State of Washington	Chelan County	Icicle Project Area[a]
Income			
Median household Income	$60,294	$50,876	$58,158
Per capita income	$37,640	$25,619	$29,613
Percent Below Poverty			
Individuals	13.5%	14.8%	14.9%
Percent unemployed	8.8%	9.2%	12.8%

Source: ACS, 2014
Notes: a) The Icicle project area includes Census Tracts 9602, 9605, 9606, 9607, 9608.01, and 9608.02.

CHAPTER 4.0 IMPACTS AND MITIGATION MEASURES

4.1 Introduction

This chapter of the PEIS describes the short- and long-term impacts of the Icicle Strategy Program Alternatives (Program Alternatives). Short-term impacts are those that are limited in duration and are not permanent or ongoing, and are often related to construction. Long-term impacts are those that would occur as a result from project operation. This chapter also identifies mitigation measures that would help to address short-term and long-term impacts.

Because this is a programmatic EIS, the level of project descriptions varies. The impacts discussed are based on a conceptual understanding of many of the proposed project elements. Some projects may require a project-level EIS if additional significant adverse impacts are identified over the course of project development.

This chapter discusses probable environmental impacts associated with the Program Alternatives and the no-action Alternative for each of the resources described in Chapter 3. Each section provides a description of the impacts of each alternative, with a detailed project-by-project discussion of the potential impacts associated with the individual project elements. Projects that are common to more than one alternative are only described once, in the first alternative where they are included, and subsequent mentions are cross-referenced to this description.

Potential mitigation measures are described at the end of each environmental element section to address both short- and long-term impacts. Overall, cumulative and unavoidable adverse impacts are described near the end of this chapter, along with environmental commitments.

4.2 Earth

This section addresses potential short-term and long-term impacts of the Icicle Strategy's Program Alternatives to Earth elements including topography, geology, and soils.

4.2.1 No-action Alternative

4.2.1.1 Short-term Impacts

Under the No-action Alternative, various construction and maintenance activities of individual entities would continue that could result in short-term impacts to Earth elements. This is anticipated to entail construction of water diversions modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile lake Dam, and improvements to existing domestic and irrigation water use systems.

Ground-disturbing activities have the greatest potential to increase erosion and sedimentation, particularly when they occur near water courses. These impacts would be localized at construction sites on lower Icicle Creek and at the Alpine Lakes, resulting from construction of new water diversion and flow control structures, various types of fish passage improvements, and improvements to irrigation canal and pipe systems. The modification of existing structures would occur at the Alpine Lakes as gate infrastructure and outlet works are improved and the Eightmile Lake Dam is repaired to historic working conditions. Construction activities along the banks of streams and lakes and in adjacent uplands would likely result in the removal of vegetation, disturbance of soil, and the stockpiling of materials in areas near the work sites. Such activities could cause local, temporary increases in erosion potential.

The agencies or entities implementing projects under the No-action Alternative would be required to comply with applicable local, state, and federal environmental review requirements and permits as described in Section 1.9, Related Permits, Actions, and Laws, as is the case with all alternatives contemplated in this document. Applicable permits would require appropriate mitigation measures to reduce impacts on water quality, such as implementing construction BMPs designed to reduce the potential for erosion (Section 4.5.7, Mitigation Measures). Therefore, the No-action Alternative would not be expected to result in significant short-term impacts.

4.2.1.2 Long-term Impacts

The long-term impacts to earth elements under the No-action alternative are expected to be less than the Program Alternatives because fewer projects would be implemented. However, construction of water diversions modification, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile lake Dam, and improvements to existing domestic and irrigation water use systems are expected albeit for potentially different purposes than described in the Guiding Principles. The primary long-term impacts include erosion and sedimentation resulting from increased streamflow. However, the increase in streamflow would be on the order of 32 cfs, which is well within the range of naturally occurring variability, and would restore flow to more natural conditions in the late summer.

4.2.2 Alternative 1 (Base Package)

The short-term and long-term impacts of Alternative 1 are primarily related to construction activities and increased streamflow in Icicle Creek and its tributaries, respectively. The primary construction-related impacts involve ground disturbance and erosion. The primary long-term impacts include erosion and sedimentation resulting from increased streamflow. However, the increase in streamflow is within the range of naturally occurring variability, and would restore flow to more natural conditions in the late summer. The increased stream flow would mostly occur during the low-flow period when erosion, sedimentation, and bedload transport are least likely to occur. The impacts to Earth elements are expected to be less than significant. The following section describes the potential impacts associated with individual project elements proposed as part of Alternative 1.

4.2.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Improvements to lake infrastructure would involve hand labor construction methods resulting in minor ground disturbance over small areas. Ground-disturbing activities would include excavations of footings and borrow/placement of fill for building small enclosures to house control equipment. Modifications to existing concrete head gate control towers at Klonaqua and Colchuck Lakes could require partial demolition of the structures and disposal of demolition materials onsite. While some ground disturbance would occur, the scale of the activities is minimal and is not likely to result in significant increases in erosion.

Ground-disturbing impacts can be mitigated by completing construction during periods when lake levels are drawn down to allow the majority of construction staging to occur on the lake bed as opposed to upland and shoreline areas. Use of on-site sources of fill material would reduce the number of haul trips to/from the site. Construction would occur in the dry season when the lakes are drawn down and BMPs would be used to minimize erosion.

IPID Irrigation Efficiencies

IPID Irrigation Efficiencies would include construction of conservation project, including canal to pipeline conversion and canal lining. The projects would use heavy equipment construction methods resulting in ground disturbance along affected canal alignments. Multiple access routes would be anticipated for ingress/egress of equipment and import material including pipe, aggregate and fill material, and concrete. One or more staging areas are likely. Grading along the alignment could increase the potential for erosion and sediment transport. Slope stability of the earth along the canal alignment could be impacted in areas where the canal traverses steep slopes or otherwise unstable ground because of new loading from material used to backfill along the pipeline. No impacts to Earth elements are anticipated for the on-farm efficiencies component of this alternative.

Ground-disturbing impacts from the IPID Irrigation Efficiencies Project can be mitigated by identifying pre-existing ingress/egress and haul routes, such as ditch access routes. Construction would, which means when irrigation facilities are not in use, and temporary erosion and sedimentation control BMPs would be used to minimize impacts and prevent transport of sediment to nearby streams and other surface water bodies. Slope stability considerations would be mitigated by adhering to geotechnical engineering practices.

COIC Irrigation Efficiencies and Pump Exchange

COIC Irrigation Efficiencies and Pump Exchange would use heavy equipment construction methods resulting in ground disturbance associated with constructing a new pump station near the confluence of Icicle Creek and the Wenatchee River and along the COIC canal and lateral alignment, where existing facilities would be replaced with pressurized pipelines. Impacts associated with these activities are the same as for the IPID Irrigation Efficiencies Project except that construction of a new pump station could require excavation below the water table and below the ordinary high water mark on Icicle Creek or the Wenatchee River, requiring dewatering techniques such as coffer dams.

Ground-disturbing impacts of the COIC Irrigation Efficiencies and Pump Exchange Project can be mitigated by identifying pre-existing ingress/egress and haul routes, such as public right-of-way and ditch access routes. Construction would likely occur when irrigation facilities are not in use and temporary erosion and sediment control BMPs would be used to minimize erosion and prevent transport of sediment to nearby streams and other surface water bodies. BMPs would also be implemented where construction would take place below ordinary high water to protect adjacent surface water. Slope stability considerations would be mitigated by adhering to geotechnical engineering practices. Work below ordinary high water in streams would occur during low water periods and in accordance with applicable regulations.

Domestic Conservation Efficiencies

Short-term impacts resulting from the Domestic Conservation Efficiencies Project would include the potential for increased erosion resulting from ground disturbance activities associated with repairing leaky infrastructure, including water mains, and replace meters.

These impacts would be mitigated by performing construction in the dry season and implementing BMPs to minimize erosion.

Eightmile Lake Storage Restoration

Restoration of the Eightmile Lake Storage would include removal of the existing concrete dam structure, excavation and removal of the low-level outlet pipeline, and placement of new materials for construction of a new low-level outlet pipeline and dam facilities. This work would require use of some heavy mechanized construction equipment. The site is a relatively remote location without road access within ALWA. The volume of earth material and large boulders that would need to be moved at the site would require use of an excavator. Depending on the construction means and methods used, a small tracked loader and some type of mechanical sorting equipment may also be needed to sort, move, and place earth and rocks.

Impacts to Earth elements would include ground disturbance at the dam site and staging areas. The largest construction challenge for the project would be determining how to mobilize an excavator and other heavy equipment to the site. A few options for this were evaluated as part of the *Eightmile Lake Storage Restoration Feasibility Study* (Anchor

QEA 2017) prepared concurrently with this PEIS and included in Appendix B. Mobilization of heavy equipment to the site would likely either require transport by a large helicopter, which would limit the size of equipment that can be transported to a small excavator, or mobilization overland via ingress/egress route that more or less would parallel follow the Eightmile Lake Trail. Ground-disturbing activities at the dam site would include excavation of remaining existing concrete and earth fill dam structures, excavation to remove the low-level outlet pipeline, excavation of footings for a new dam, excavation of borrow material, placement of concrete and earth materials for a new dam, backfill for a new low-level outlet pipeline and associated control equipment, and staging for equipment and material. Erosion and stability of construction slopes, borrow locations, and stockpiles could also impact Earth elements by increasing sediment transport to water bodies and increasing slope instability.

Ground-disturbing impacts can be mitigated by completing construction during periods when lake levels are drawn down to allow construction staging to occur “in the dry”. Rock and earth materials used for embankment construction and backfill would be sourced locally, to the extent possible, from areas that are already cleared or have been disturbed in the past. Re-use of on-site sources of fill material including any demolition-related concrete would reduce the need for excavation from borrow areas and the number of haul trips to/from the site. Excess excavated material and stockpiled soils would be used to reclaim on-site borrow areas. Construction would occur in late summer and fall, when snow is not on the ground, and BMPs would be used to minimize erosion and prevent transport of sediment to nearby surface water bodies at the dam site and along the excavator ingress/egress route. Adherence to geotechnical design standards and Ecology Dam Safety Office regulations would be required to minimize stability concerns to natural and constructed slopes.

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effect on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. The specifics of this project are not yet determined, but would involve elements of restoration along the Lower Icicle Creek that could result in localized ground disturbance activities. At this stage, the primary options under consideration include the construction of facilities, such as a plumbing to create a bubble curtain, a sprayer, or other minor modifications to the Hatchery Channel spillway at LNFH to promote favorable fishing conditions in the pool at the bottom of the spillway. Depending on the extent of the disturbance, there is the potential for some short-term increase in erosion. However, as noted in Section 4.2.6, Mitigation Measures, work within Icicle Creek would require compliance with applicable local, state, and federal regulations, which would require BMPs to ensure that potential impacts would be less than significant.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project would use heavy equipment and hand labor construction methods. Constructing engineered logjams and performing other stream restoration activities, such as anchoring large woody debris or stream channel modification, would require heavy equipment that would impact Earth elements through ground-disturbing construction activities. These activities would include excavating and placing anchors, modifying stream beds, establishing routes for ingress/egress and for hauling material, and constructing staging areas. Much of this work would be performed below ordinary high water in water bodies. Establishing riparian plantings could be performed by hand labor assisted by heavy equipment to haul material, grade topography, and remove undesirable vegetation. These activities could result in short-term erosion and sedimentation to water bodies.

Any adverse impacts would be likely minor because compliance with applicable local, state, and federal permits or approvals would require appropriate mitigation measures to reduce any potentially significant long-term impacts, such as ensuring that stream channel morphology would not adversely affected (see Section 4.2.6, Mitigation Measures).

Instream Flow Rule Amendment

The Instream Flow Rule Amendment Project is administrative in nature and does not involve construction. No short-term impacts to Earth elements would occur.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

LNFH Conservation and Water Quality Improvements Project would use heavy equipment construction methods to implement on-site re-use, effluent pump-back, and well field enhancements. These actions could impact Earth elements through ground-disturbing construction activities occurring at the hatchery site near the raceways, at the well field, and on Hatchery Island. Staging areas and access for hauling and equipment ingress/egress would mostly occur along established access routes in paved or graveled areas. Excavations and placement of fill near the raceways would mostly occur in paved areas having controlled drainage to water bodies. Drilling new wells or modifying existing ones could require equipment access to areas that may not have established access routes, but these activities are otherwise not anticipated to result in major ground disturbance. Construction of a groundwater gallery on Hatchery Island would consist of excavations below the water table, requiring dewatering, pipeline construction, backfill, and grading.

Ground-disturbing impacts would be mitigated by maximizing use of pre-existing ingress/egress and haul routes and staging areas away from water bodies. Construction would occur in the dry season and BMPs would be used to minimize erosion and prevent transport of sediment to adjacent surface water bodies.

Because this facility is owned by the USBR and operated by USFWS, an additional evaluation of the potential short-term impacts under NEPA will be completed.

Fish Passage

The Fish Passage Project would use heavy equipment construction methods to modify instream structures to improve passage, including those at LNFH and the Boulder Field. Boulder Field modification impacts to Earth elements would include ground disturbance from construction and slope instability during construction. Ground-disturbing activities would include modifying the Boulder Field using heavy equipment. This work would occur below the ordinary high water of Icicle Creek and on the bank above the creek. The hill slope between Icicle Road and Icicle Creek would be regraded to increase stability following Boulder Field modification. A water line for the City of Leavenworth would be relocated. Excavations, regrading, stockpiles, placement of fill, access routes, and staging areas could contribute to ground disturbance that results in erosion and sedimentation in the adjacent creek. Stability of temporary slopes could be impacted during construction.

Any adverse impacts would be likely minor because compliance with applicable local, state, and federal permits or approvals would require appropriate mitigation measures to reduce any potentially significant long-term impacts, such as ensuring that stream channel morphology would not adversely affected (see Section 4.2.6, Mitigation Measures).

Fish Screen Compliance

The Fish Screen Compliance Project would use heavy equipment construction methods to replace existing screens at major diversions on Icicle Creek. Impacts to Earth elements include ground disturbance from construction activities occurring near the stream bank and below ordinary high water. Ground-disturbing activities would include excavation at existing structures and footings of new structures, pouring concrete, backfill, grading, access routes for ingress/egress, and staging areas.

Ground-disturbing impacts would be mitigated by identifying pre-existing ingress/egress and haul routes and through off-site staging away from stream banks and water bodies. Work below ordinary high water in streams would occur during low water periods and in accordance with applicable regulations. Construction would occur in the dry season and BMPs would be used to minimize erosion and prevent transport of sediment to adjacent surface waters, including where construction would take place below ordinary high water.

Water Markets

The Water Markets Project does not require construction. No short-term impacts to Earth elements would occur.

4.2.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Long-term impacts to Earth elements from changing outflow patterns from the Alpine Lakes could include increased erosion of stream beds and stream banks, and increased sedimentation Icicle Creek and its tributaries. However, because flow rates released from reservoirs would be far less than natural peak flows and increased late summer flows would restore flows to a more natural condition, there is low risk of increased erosion sedimentation. Additionally, the increased stream flow would mostly occur during the low-flow period when erosion, sedimentation, and bedload transport are least likely to occur. The long-term impacts of this project are anticipated to be less than significant.

IPID Irrigation Efficiencies

Long-term impacts to Earth elements from the IPID Irrigation Efficiencies Project could improve slope stability along canal alignments. Slope stability could decrease locally in areas having steep slopes along IPID canal alignments because of increased loading where open canal is replaced by backfill and pipeline. However, slope stability is anticipated to increase overall as a result of decreased seepage of water into the subsurface, which would result in decreased subsurface erosion. Potential impacts of increased slope load would be mitigated by adhering to geotechnical engineering practices.

COIC Irrigation Efficiencies and Pump Exchange

The long-term impacts of the COIC Irrigation Efficiencies and Pump Exchange Project would be similar to the IPID Irrigation Efficiencies with the exception of construction of a pump station near the confluence of Icicle Creek and the Wenatchee River. The new COIC pump station and intake facilities would have the potential to change instream flow dynamics that could contribute to increased potential for shoreline erosion.

Any adverse impacts would be likely minor because compliance with applicable local, state, and federal permits or approvals would require appropriate mitigation measures to reduce any potentially significant long-term impacts, such as ensuring that stream channel morphology would not be adversely affected (see Section 4.2.6, Mitigation Measures).

Domestic Conservation Efficiencies

Replacing leaking water mains and upgrading meters would have a positive impact on Earth elements. Addressing and preventing leaks can decrease underground erosion that can undermine soils as a result of catastrophic pipe failure. In addition to decreasing erosion, fixing leaking pipes can increase slope stability by decreasing soil water content in areas having unstable slopes.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would restore water levels in Eightmile Lake to the historic maximum water surface elevation. The water surface has decreased over time due to erosion of the earthen embankment portion of the dam. Long-term impacts of restoring the maximum water surface elevation would be minimal because the shoreline consists mostly of exposed, shallow bedrock, and impacts would be similar to those experiences under past conditions.

Adhering to geotechnical design standards and Ecology Dam Safety Office regulations would mitigate stability concerns to natural and constructed slopes. Shoreline erosion could be mitigated by limiting periods when the water levels are at their peak. Lake bed erosion and instability can be mitigated by managing water level draw down rates.

Tribal Fishery Preservation and Enhancement

The purpose of this project is to protect and enhance the tribal fishery, which, depending on the specific actions, could result in long-term changes to stream channel that could increase the potential for erosion and sedimentation. Projects within Icicle Creek and near its shoreline would require multiple authorizations from local, state, and federal regulatory agencies. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce any potentially significant long-term impacts affecting shorelines (see Section 4.2.6, Mitigation Measures). These requirements would be developed once project-specific details were available.

Habitat Protection and Enhancement

Implementing actions associated with Habitat Protection and Enhancement could have long-term impacts on Earth elements. Construction of engineered logjams and stream bed modifications, and planting riparian vegetation could improve local stream morphology, reduce erosion, and protect stream banks.

Instream Flow Rule Amendment

No long-term impacts to Earth elements are anticipated from this project.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The potential long-term adverse impacts on Earth elements could occur in areas where new facilities were constructed near Icicle Creek that could change stream morphology or bank erosion. Potential adverse impacts would likely be minor because work within the shoreline would require compliance with various local, state, and federal regulations, including NEPA, which would address the need for mitigation to reduce potential long-term impacts (see Section 4.2.6, Mitigation Measures).

Fish Passage

The Fish Passage Project could have long-term impacts to Earth elements. Modifications to Lower Icicle Creek to improve passage could change local stream morphology, increase stream erosion and sedimentation. However, work within the Icicle Creek would require multiple authorizations from local, state, and federal regulatory agencies. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce any potentially significant long-term impacts affecting erosion and sedimentation in Icicle Creek (see Section 4.18.6, Mitigation Measures).

Fish Screen Compliance

The Fish Screen Compliance Project could have long-term impacts to Earth elements. Modifying diversion structures to allow for fish screen improvements could change local stream morphology leading to increased erosion. Work within Icicle Creek would require multiple authorizations from local, state, and federal regulatory agencies. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce any potentially significant long-term impacts affecting erosion. These requirements would be developed once project-specific designs and details were available.

Water Markets

The Water Markets Project would provide instream flow benefit in reaches of Icicle Creek and the Wenatchee River, from retired water rights to the out-of-stream mitigation locations. In non-drought years, this project would provide instream flow benefit throughout Icicle Creek and the Wenatchee River. This increased streamflow could result in increased erosion of stream channels and banks in higher gradient reaches and increased sedimentation in lower gradient reaches. However, this would not be significant because streamflow increases would be far below peaks and would restore flow to more natural conditions.

4.2.3 Alternative 2

Most of the projects in Alternative 2 are common to Alternative 1, with the exception of the Alpine Lakes Optimization, Modernization, and Automation Project, which is not included in Alternative 2, and the IPID Dryden Pump Exchange Project, which is included in Alternative 2. Because of these commonalities, the overall short-term and long-term impacts to Earth elements are similar. This section provides details on the impact of the IPID Dryden Pump Exchange Project to Earth elements. Impacts of the other projects are available in Section 4.2.2, Alternative 1 (Base Package).

4.2.3.1 Short-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project would use heavy equipment construction methods resulting in ground disturbance associated with constructing a new pump station on the right bank of the Wenatchee River near Dryden and new pipeline alignment connecting to the PID and IID canals. Access routes would be anticipated for ingress/egress of equipment and import material, including pipe, aggregate and fill material, and concrete. One or more staging areas are likely. Grading along the alignment could increase the potential for sediment delivery to the nearby river system. Some work below ordinary high water in the Wenatchee River is anticipated.

Work within and near the Wenatchee River would require compliance with applicable local, state, and federal regulations, which would require BMPs to ensure that potential impacts would be less than significant.

4.2.3.2 Long-term Impacts

IPID Dryden Pump Exchange

The project would result in new pump station and intake facilities constructed along the right bank of the Wenatchee River. Depending on the specific location, long-term impacts could potentially affect Earth elements by increasing the potential for stream bank erosion and flooding over the long term.

Any adverse impacts would be likely minor because compliance with applicable local, state, and federal permits or approvals would require appropriate mitigation measures to reduce any potentially significant long-term impacts, such as ensuring that stream channel morphology and floodplain storage capacity are not adversely affected (see Section 4.2.6, Mitigation Measures) and that no increase in flood elevations result from the proposed project.

4.2.4 Alternative 3

Alternative 3 has many of the same projects and thus many of the same impacts of Alternative 2. Under this alternative, the Eightmile Lakes Storage Restoration Project would be replaced with Legislative Changes Creating OCPI Authority for Alternative 3, which is not anticipated to have any short- or long-term impacts to Earth elements.

4.2.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

No short-term impacts to Earth elements are anticipated from this project.

4.2.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

No long-term impacts to Earth elements are anticipated from this action.

4.2.5 Alternative 4

Alternative 4 has many of the same projects as Alternative 1, with the addition of three storage enhancement projects, and the removal of the Eightmile Lake Storage Restoration Project. Construction-related impacts are expected for all three storage enhancement projects, with the primarily long-term impacts including erosion and sedimentation associated with increased instream flows. However, as discussed under Alternative 1, increased streamflow would be much lower than peak flow, and increasing late summer streamflow would result in more natural flow conditions. The impacts to Earth elements resulting from Alternative 4 are expected to be less than significant.

4.2.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

Short-term impacts to Earth elements and mitigation measures for the Eightmile Lake Storage Enhancement Project would be the similar to for the Eightmile Lake Storage Restoration Project, as described in Section 4.2.2.1. However, the facilities would be larger and so the area of disturbance, the volumes of earthwork, and other construction impacts would be greater.

In addition, as noted in Section 4.2.6, Mitigation Measures, work within and around the lakes would require compliance with applicable local, state, and federal regulations, which would require BMPs to ensure that potential impacts would be less than significant.

Upper Klonaqua Lake Storage Enhancement

With Upper Klonaqua Lake Storage Enhancement Project being at the conceptual stage, it is unclear if heavy equipment or hand labor construction methods would be used. However, given the magnitude of the project, it is likely that heavy construction equipment would be required.

The resulting ground disturbance associated with this project would include bedrock excavation of an outlet tunnel or clearing to install a siphon to allow for additional releases from Upper Klonaqua Lake to Lower Klonaqua Lake. Additional disturbance could be caused by clearing and excavation required for borrow/placement of fill for a head gate control structure, a small enclosure housing control equipment, and diesel pumps for drawing down lake levels for construction. Tunnel cuttings would be disposed on-site. If a pipeline is not constructed within the tunnel, erosion would occur during initial discharge operations along the bottom of the outlet tunnel and in the outlet channel transporting sediments to Lower Klonaqua Lake. Bedrock topography would be impacted by construction of a new tunnel and disposal of cuttings. Stability of bedrock could be impacted by tunnel excavation.

Ground-disturbing impacts can be mitigated by completing construction after Upper Klonaqua Lake levels are pumped down the majority of construction staging to occur on the lake bed as opposed to upland and shoreline areas. Use of on-site sources of fill material including any demolition-related concrete would minimize the need for establishing borrow areas and the number of haul trips to/from the site. Excess excavated material and stockpiled soils could be used to reclaim on-site borrow areas. Construction would occur in the dry season and BMPs would be used to minimize erosion. Adhering to geotechnical design standards and Ecology Dam Safety Office regulations would mitigate slope stability concerns.

In addition, as noted in Section 4.2.6, Mitigation Measures, work within and around the lakes would require compliance with applicable local, state, and federal regulations, which would require BMPs to ensure that potential impacts would be less than significant.

Upper and Lower Snow Lakes Storage Enhancement

Short-term impacts and mitigation measures for Upper and Lower Snow Lakes Storage Enhancement Project would be similar to those for the Eightmile Lake Storage Restoration project, except that there is no ancient landslide impounding the lake. Heavy construction equipment would likely be required for construction of these improvements, similar to what would be required for the Eightmile Lake Storage Restoration project.

In addition, as noted in Section 4.2.6, Mitigation Measures, work within and around the lakes would require compliance with applicable local, state, and federal regulations, which would require BMPs to ensure that potential impacts would be less than significant.

4.2.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would result in water levels that are higher than historical levels, leading to long-term impacts on Earth elements. Increasing lake levels could increase bank erosion potential and decrease stability of upland slopes and the ancient landslide mass impounding the west end of the lake. However, this impact is expected to be less than significant because of the bedrock structure of the shoreline. Any potential decreased stability to the landslide mass at the west end of the lake would be mitigated through adhering to geotechnical design standards and Ecology Dam Safety Office regulations would mitigate stability concerns to natural and constructed slopes.

The project would also allow for the lake to be drawn down below existing lake levels to an elevation of 4,619 feet, which is approximately 24.4 feet lower than the existing low. This change would result in the exposure of slightly more lake bed, mainly in the later summer month and early fall up to the point when the water would no longer be drawn down, generally around the end of September. The additional draw down is not expected to adversely affect Earth elements by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project would result in lake levels that are drawn down below the historical range, which would have long-term impacts on Earth elements. Drawing the lake down further than currently practiced could cause increased lake bed erosion and decreased stability of lake bed slopes. However, these impacts would be unlikely and less than significant because of the bedrock structure of the shoreline and lake bed at Upper Klonaqua Lake.

Drawing the lake down further than currently practiced could cause turbidity in stream. However, because draw down of the lake would occur over a period of a couple of months, it is expected that increased turbidity would be less than substantial.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project would result in water levels that are higher than historical levels, which would have long-term impacts on Earth elements. Increasing lake levels could increase bank erosion. However, this impact is considered less than significant given that the lake beds and shorelines are composed of bedrock. Drawing the lake down further than currently practiced could cause turbidity in stream. However, because draw down of the lake would occur over a period of a couple of months, it is expected that increased turbidity would be less than substantial.

4.2.6 Alternative 5

Most of the projects in Alternative 5 are common to Alternative 1, with the exception of the IPID Irrigation Efficiencies, which is replaced by the IPID Full Piping and Pump Exchange Project. Because of these commonalities, the overall short-term and long-term impacts to Earth elements are similar. This section provides details on the impact of the IPID Full Piping and Pump Exchange Project to Earth elements. Impacts of the other projects are available in Section 4.2.2, Alternative 1 (Base Package).

4.2.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

The IPID Full Piping Pump Exchange Project would use heavy equipment construction methods resulting in ground disturbance associated with constructing pump stations at three locations on the Wenatchee River and new pipeline alignment connecting to the PID and IID canals. Open canals would be replaced with pressurized pipeline. Access routes would be anticipated for ingress/egress of equipment and import material, including pipe, aggregate and fill material, and concrete. One or more staging areas are likely. Grading along the alignment could increase the potential for sediment delivery to the nearby river system. Some work below ordinary high water in the Wenatchee River is anticipated.

Work within and near the Wenatchee River would require compliance with applicable local, state, and federal regulations, which would require BMPs to ensure that potential impacts would be less than significant.

4.2.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

The project would result in three new pump stations and intake facilities constructed along the Wenatchee River. Depending on the specific location, long-term impacts could potentially affect Earth elements by increasing the potential for stream bank erosion and flooding over the long term.

Any adverse impacts would be likely minor because compliance with applicable local, state, and federal permits or approvals would require appropriate mitigation measures to reduce any potentially significant long-term impacts, such as ensuring that stream channel morphology and floodplain storage capacity are not adversely affected (see Section 4.2.7, Mitigation Measures) and that no increase in flood elevations result from the proposed project.

4.2.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.2.7.1 Short-term Impacts

Short-term impacts to Earth elements related to increased erosion would be mitigated by complying with the terms and conditions of local, state, and federal regulations and project-specific permits and approvals, including local building, grading, state stormwater construction permits, Shoreline Management Act shoreline permits, HPAs, and CWA Section 404 permits and their associated Section 401 Water Quality Certificates, among others. Common permit conditions are likely to include working in a manner to minimize soil disturbance, implementing BMPs to control erosion and prevent transport of sediment to surface water bodies, and, to the extent possible, completing work in the summer and fall when water levels are low and the potential for impact is reduced.

Short-term impacts related to slope stability would be minimized through adherence to geotechnical design standards and Ecology Dam Safety Office Regulations.

4.2.7.2 Long-term Impacts

Long-term impacts on Earth elements would be mitigated by complying with the terms and conditions of local, state, and federal regulations and project-specific permits and approvals, as described above.

4.3 Surface Water

This section describes the potential short- and long-term impacts of the Program Alternatives on surface water quantity. The short-term impacts are related to construction impacts, with long-term impacts being impacts resulting from the operation of projects. The primary long-term impact to surface water associated with the Icicle Strategy is increased instream flows. These instream flow changes are summarized in Table 4-1. Greater detail on changes to surface water are noted in the subsections below. Impacts affecting water quality are presented in Section 4.5, Water Quality and impacts to water rights and use are presented in Section 4.6, Water Use.

Table 4-1
Instream Flow Changes

Alternative	Instantaneous Change (cfs)	Annual Change (ac-ft)
No-action	32	18,094
Alternative 1	88	28,458
Alternative 2	83	24,478
Alternative 3	71	23,978
Alternative 4	131	34,585
Alternative 5	195	55,458

Notes: Instantaneous water quantities are expressed in cfs and represent the amount of water moving downstream at a moment in time. Annual water quantity is expressed in ac-ft and represent the instantaneous quantity accrued over a year. Instantaneous increases would occur in the summer.

4.3.1 No-action Alternative

4.3.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that could result in short-term impacts on water quality in the Icicle Creek Watershed project area. This is anticipated to entail construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability.

In-water, streambank, and lakeshore work would likely include the modification of existing features, construction of new water diversion and flow control structures, various types of fish passage improvement work, and improvements to irrigation canal and pipe systems. The modification of existing structures would occur at the Alpine Lakes as gate infrastructure and outlet works are improved and the Eightmile Lake Dam is repaired to working conditions. Work would likely require the placement of temporary cofferdams in water bodies to isolate work areas and could also involve the temporary diversion of stream flow or construction dewatering.

These impacts would be temporary and the duration and timing are currently unknown.

4.3.1.2 Long-term Impacts

The No-action Alternative would provide some instream flow benefit. Projects that are likely to move forward would provide up to an estimated 32 cfs of instream flow benefit in Reach 3 and 4. Up to 20 cfs of this increased streamflow will be available year-round, in Reach 3 and 4. Approximately 11 cfs of this instream flow benefit would be available during the irrigation season, when flows are often at their lowest, in Reach 3, 4 and 5.

While construction and upgrades at the IPID dam sites would likely occur, releases would occur on a rotational basis and under drought-year scenarios, which is consistent with the current operation schedule. Water releases would not be optimized for instream flows and fish benefit, meaning there would not be an additional 30 cfs of flow benefit to lower Icicle Creek in Reaches 1, 2, 3, 4, and 5 during most years.

While the IPID Irrigation Efficiencies Project and IPID Dryden Pump Exchange Project might be implemented under the No-action Alternative, the focus and project goals would be primarily for agricultural reliability, and instream flow benefit might not occur. This would be a lost opportunity to increase streamflow during the irrigation season by 10 and 25 cfs, respectively.

Although some type of reconstruction of the Eightmile Lake dam would likely occur under the No-action Alternative, it is unclear what the scale of the reconstruction would be, and it is unlikely that water would be made available to instream flow and new uses. This would be a lost opportunity to increase stream flow by 12.6 cfs in Reach 1.

4.3.2 Alternative 1 (Base Package)

Alternative 1 is expected to increase instream flows in Icicle Creek by up to 88 cfs or 28,458 acre-feet, with smaller benefits in tributaries to Icicle Creek depending on project location. The duration of flow improvement would primarily be during the irrigation season, with emphasis in the late summer/early fall time period. Some projects may also include year-round benefit where adaptation to low wintertime instream flows is possible. Short-term impacts discussed are related to construction activities and would include the use of cofferdams and dewatering.

4.3.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction activities at the dam sites would include work on gates and outlet tunnels, and installation of solar panels, actuators, flow monitoring equipment, and other new equipment. Lakes would need to be drawn down for construction activities, which would provide flow benefit in Prospect, Leland, Klonaqua, French, Colchuck, Mountaineer, and Eightmile Creek, as well as Reaches 1 through 5 of Icicle Creek. These impacts are not considered new, as they are part of the current conditions and operations at the lakes, which are drawn down at least once every five years for maintenance activities.

Dewatering during construction would not likely be required.

IPID Irrigation Efficiency

Under this project, the Comprehensive Water Conservation Plan would be updated and irrigation efficiency upgrades would be implemented, as recommended in the plan. The update of the IPID Comprehensive Water Conservation Plan is currently under way. The recommended irrigation efficiency projects would likely involve piping and lining sections of canal and increasing on-farm application efficiency. Construction activities would occur within the area of current canals and outside the irrigation season when the canals are dry. There are no anticipated construction impacts to surface water.

COIC Irrigation Efficiencies and Pump Exchange

This project consists of replacing the existing COIC system with a pressurized delivery system, relocating the point of diversion to a location near the confluence of the Wenatchee River and Icicle Creek, and intake facilities at that location. In general, the majority of the impacts would be similar to the IPID Irrigation Efficiencies. Construction of the COIC pump station would involve instream work below the ordinary high water on the Wenatchee River or Icicle Creek. Impacts to surface water would likely include the use of coffer dams and temporary dewatering at the construction site.

Domestic Conservation Efficiencies

Conservation efforts taken by the City of Leavenworth and Chelan County could include pipe replacements, meter installation, and water use conservation. These construction activities are not anticipated to have impacts on surface water.

Eightmile Lake Storage Restoration

Eightmile Lake Storage Restoration would require demolition and reconstruction of the dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures. The lake would need to be drawn down for construction activities, which would provide flow benefit in Eightmile Creek, as well as Reaches 1 through 5 of Icicle Creek. This impact is not considered new, as it is part of the current conditions and operations at Eightmile Lake, which is drawn down at least once every five years for maintenance activities.

The use of cofferdams and dewatering could be required for some of the reconstruction work.

Tribal Fishery Preservation and Enhancement

The focus of the Tribal Fishery Preservation and Enhancement Project is to ensure that there would be no adverse effect on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. Specific projects may include installing a sprayer to provide cover for fish, or other minor modifications at the Hatchery Channel spillway. Short-term impacts would be determined during project-level review, once project location and details are known.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project involves the restoration and enhancement of habitat in the Icicle Creek Subbasin through riparian plantings, engineered log jams, and conservation easements. Some construction may require temporary dewatering or rerouting water.

Instream Flow Rule Amendment

There are no construction activities proposed under the Instream Flow Rule Amendment Project and, therefore, no potential short-term impacts on surface water.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The LNFH Conservation and Water Quality Improvements Project includes various elements geared toward improving water quality and hatchery rearing conditions at the LNFH. In general, construction of these elements has the potential to affect surface water, depending on the specific location and type of disturbance. Likely short-term impacts would include the use of cofferdam to temporarily reroute water, and dewatering activities for construction on the diversion intake. Because this facility is owned by the U.S. Bureau of Reclamation and operated by U.S. Fish and Wildlife Service, an evaluation of the potential short-term impacts under NEPA would be completed once the full scope of the project is determined.

Fish Passage

Removing fish passage barriers could require instream construction work and the use of cofferdams to temporarily reroute water, and dewatering activities.

Fish Screen Compliance

The installation of fish screens would require instream construction work and could require the use of cofferdams and dewatering activities.

Water Markets

There are no construction activities proposed under the Water Markets Project and therefore no potential short-term impacts on surface water.

4.3.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Implementation of the Alpine Lakes Optimization, Modernization, and Automation Project would allow for remote control releases from the lakes, providing more frequent and more precise releases of water to Icicle Creek. One objective of this project is to release water from the lakes in response to streamflow conditions. This would increase flows in Reaches 1 through 5 during low flow conditions. Additionally, this project would provide additional cold water and increase streamflow to tributaries downstream of the dam sites: Prospect, Leland, Klonaqua, French, Colchuck, Mountaineer, and Eightmile Creeks. It is anticipated that this project would add 30 cfs and 5,465 acre-feet of water to Icicle Creek and its tributaries during the late summer, when stream flow are below targets. This increase in streamflow would be within the naturally occurring range of stream flows in Icicle Creek. The timing and quantities of these flows would be a beneficial change to the riverine system. In drought-years, IPID would exercise their current water rights for irrigation use as needed.

In the Alpine Lakes, the frequency of draw-down would increase from approximately 1-in-5 years to nearly every year. During high water years, it is possible that not all storage from the lakes would be utilized to enhance streamflow. Despite the increased draw down frequency, the Automation Appraisal study found that the lakes are still expected to fully refill each spring (Aspect, 2015). These findings indicate that this project would not have a significant impact on the water quantity within the Alpine Lakes and their catchments.

IPID Irrigation Efficiencies

Improving IPID's efficiency through system upgrades is expected to increase flow during the irrigation season, which typically occurs from April through October. This period includes low flow months in late summer and early fall, as identified on the Icicle Creek hydrograph (Figure 3-2). The estimated flow benefit resulting from this project is approximately 10 cfs and 3,000 acre-feet per year. Because IPID diverts water from Icicle Creek and exports it to the Wenatchee Valley, project benefits would occur in all the reaches of Icicle Creek downstream of IPID's point of diversion at RM 5.7 (Reaches 2 through 5).

Reach benefit would continue into the Wenatchee River, to the point where return flows typically enter the system. Because IPID's irrigated lands parallel the Wenatchee River over a long distance, return flows likely occur from near RM 28 to RM 5. Benefit would diminish between these two points and end near RM 5. Figure 2-25 provides an overview of lands served by IPID and the location of increased instream flows.

COIC Irrigation Efficiencies and Pump Exchange

The COIC Irrigation Efficiencies and Pump Exchange Project is expected to increase flows in Icicle Creek from RM 4.5 to the location of the new point of diversion. This benefit would occur from approximately April through October, which includes the low flow period in late summer and early fall. The estimated benefit in Icicle Creek is 8.0 to 11.9 cfs and 2,100 to 3,500 acre-feet. The variation in this number is based on COIC's historical and future water use.

The primary source of instream flow benefit from this project is moving the COIC point of diversion from Icicle Creek to a location near the confluence of Icicle Creek and the Wenatchee River. The proposed pump station would be at one of the following locations:

- On the right bank of the Wenatchee River just upstream of the Leavenworth Road Bridge, approximately 0.8 miles upstream of its confluence with Icicle Creek
- On the right bank of the Wenatchee River on a bend in the river approximately 0.3 miles upstream of its confluence with Icicle Creek
- On the left bank of Icicle Creek on a bend in the creek approximately 0.75 miles upstream of its confluence with the Wenatchee River

Locating the pump station near Icicle Road would create an impact on Wenatchee River flows equal to the benefit to Icicle Creek flows between the new pump station and the confluence with Icicle Creek. This would be an 8.0 to 11.9 cfs reduction in flows for approximately 0.8 miles of the Wenatchee River. The second location would result in a similar impact, but only on 0.3 miles of the Wenatchee River. The third location provide flow benefit on Icicle Creek from the historical point of diversion to the location of the new pumps station.

Domestic Conservation Efficiencies

Under the Domestic Conservation Efficiencies Project, domestic conservation would increase and water made available through this process would be used for new domestic use. Depending on the location of conservation and new use, this project could result in some reach benefit in Icicle Creek.

Increasing domestic conservation in the City of Leavenworth and putting conserved water to new uses could result in a minor decrease in the amount of excess water, or return flow, discharged to the Wenatchee River from the City of Leavenworth's wastewater treatment plant (Figure 2-27). This would lead to slight reductions to instream flows in the Wenatchee River. However, these impacts would be offset by benefit from other projects.

Eightmile Lake Storage Restoration

Under the Eightmile Lake Storage Restoration Project, storage volumes would be restored to historical levels that occurred before Eightmile Dam partially eroded, which reduced usable storage by 900 acre-feet. This additional 900 acre-feet of water would be used for improving domestic reliability and instream flows. The primary impact of this project on surface water would occur in Eightmile Lake, Eightmile Creek, and Reach 1 of Icicle Creek.

Under this project, accessible water storage in the Eightmile catchment would be restored to 2,500 acre-feet, as depicted on the adjudicated certificate. The Eightmile Lake maximum water surface elevation would be restored to the historical spillway elevation (4,671 feet). That represents an increase of 4 feet over the current maximum operating water surface, 4,667 feet. This storage limitation is a result of erosion that has occurred over the embankment portion of the dam. Draw down would increase by 22.4 feet. Impacts to Eightmile Lake levels are presented in Figures 2-28. Based on evaluations conducted for the Eightmile Lake Storage Restoration Feasibility Study (Anchor QEA, 2017), Eightmile Lake would still be expected to fully refill each spring, even in dry years. These findings indicate that this project would not have a significant impact on the water quantity within the Eightmile catchment.

This project would provide for the release of an additional 12.6 cfs and 900 acre-feet from Eightmile Lake into its tributary, Eightmile Creek, and Reach 1 of Icicle Creek. Flows could be adaptively managed to reduce low flow impacts in late summer or winter. These increase flows would be within the natural occurring range of flows and would be beneficial.

Tribal Fishery Preservation and Enhancement

The preservation and enhancement of tribal fisheries is not expected to result in long-term impacts on surface water in Icicle Creek, its tributaries, or the Wenatchee River.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project includes activities such as grading and installing engineered logjams with the goal of creating better ecological conditions in Icicle Creek. Long-term impacts of installing habitat improvement projects may include alteration of stream velocity and characteristics in Icicle Creek. There are no anticipated long-term impacts on the quantity of water in Icicle Creek resulting from this project.

Instream Flow Rule Amendment

The long-term impacts of amending the Instream Flow Rule is decreased streamflow in Icicle Creek by 0.4 cfs. It is unclear at this time where reach impacts would occur, although they would likely appreciate from Reach 1 to Reach 5. These impacts are expected to be offset by instream flow benefit provided by other projects.

There are no long-term streamflow impacts anticipated in the Wenatchee River because amending the Instream Flow Rule would move part of the Wenatchee Reserve into Icicle Creek. This would be a net neutral impact to the Wenatchee River.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The LNFH Conservation and Water Quality Improvements Project would likely impact surface water by increasing flow between RM 4.5 and 2.7 (Reaches 3 and 4). Anticipated impacts are up to 20 cfs and 14,454 acre-feet increase in flows year-round. This would include the low-flow periods experienced in Icicle Creek in late summer and early fall, as well as the winter (see Figure 3-2). These increased flows would be beneficial to Icicle Creek. However, flow benefit would not be measured at the Ecology Gage in Reach 5, which is the control point for the Instream Flow Rule, because operations at LNFH are primarily non-consumptive and benefits would not occur downstream of the hatchery outfall.

Fish Passage

Altering instream structures to improve fish passage is not anticipated to have long-term impacts on surface water.

Fish Screen Compliance

Compliance with current fish screening regulations is not expected to result in long-term impacts on surface water.

Water Markets

The Water Markets Project is expected to have a net neutral impact on surface water in years when the Instream Flow Rule is not met and interruptible water users would be ordered to turn off. This is because the water market would provide mitigation in those instances to allow interruptible water users to continue irrigating. Depending on where senior water rights are retired to seed the water bank, there may be a reach benefit in Icicle Creek. However, this benefit is expected to be offset by withdrawals downstream in the Wenatchee River Watershed.

In years when the Instream Flow Rule is met, the water bank would not be used as mitigation to offset interruptible water users, and instream flow benefits would occur in Icicle Creek and the Wenatchee River. The increase in streamflow would be 3.4 cfs and 1,000 acre-feet. These benefits would occur during the irrigation season, including the critical low flow period of late summer to early fall.

4.3.3 Alternative 2

The overall expected surface water impact associated with Alternative 2 is an increase of up to 83 cfs and 24,478 acre-feet in instream flow in Icicle Creek, with smaller benefits in tributaries to Icicle Creek depending on project location. Alternative 2 would result in implementation of many of the same projects included in Alternative 1, with the exception that the IPID Dryden Pump Exchange Project would also be included and the Alpine Lakes Optimization, Modernization, and Automation Project would not be included. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. The impacts of all other Alternative 2 projects are discussed under Alternative 1.

4.3.3.1 Short-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project includes the construction of a pump station to divert water to IPID from the Wenatchee River and would involve instream work on the Wenatchee River. Impacts to surface water would likely include the use of cofferdams and dewatering at the construction site.

4.3.3.2 Long-term Impacts

IPID Dryden Pump Exchange

The primary long-term impact of implementing the IPID Dryden Pump Exchange Project is increased streamflow in Icicle Creek, Peshastin Creek, and the Wenatchee River. This pump station would reduce IPID’s diversion on Icicle Creek by as much as 25 cfs. The instream flow benefit from this project would occur during the irrigation season, which typically occurs from April through October. This period includes low flow months in late summer and early fall, as identified on the Icicle Creek hydrograph (Figure 3-2). These increased flows would benefit Icicle Creek downstream of IPID’s point of diversion at RM 5.7 in Reaches 2 through 5. Releases from ALWS storage would still be required to sustain diversion quantities at the new pump station location. The benefit would continue into the Wenatchee River to the location of the new pump station near RM 16.2. Reach benefits can be seen in Figure 2-43.

There would also be additional benefit to Peshastin Creek, as water currently diverted by IPID from this creek would also be replaced by this project.

4.3.4 Alternative 3

The overall expected surface water impact associated with Alternative 3 is an instream flow benefit of up to 71 cfs and 23,978 acre-feet in Icicle Creek, with smaller benefits in tributaries to Icicle Creek depending on project location. Alternative 3 would result in implementation of many of the same projects included in Alternative 2, with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 would also be included and the Eightmile Lake Storage Restoration Project would not be included. This section describes the specific short- and long-term impacts associated with Legislative Change Creating OCPI Authority for Alternative 3 Project. The impacts of all other Alternative 3 projects are discussed under Alternative 1 and Alternative 2.

4.3.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

The Legislative Change Creating OCPI Authority Project does not have a construction component. Consequently, there are no anticipated short-term impacts.

4.3.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

Under the Legislative Change Creating OCPI Authority for Alternative 3 Project, the small number of out-of-stream uses proposed by the IWG cannot be perfectly matched with the much larger instream flow benefit made available if the standard for impairment is perfectly in-time. Under current state law, meeting the domestic Guiding Principle with water made available slightly out-of-time would impair existing rights.

Similarly, there are some projects that are out-of-place with respect to the instream flow and potential new demands. For example, the COIC Irrigation Efficiencies and Pump Exchange Project would involve a slight upstream move on the Wenatchee River, which would be impermissible. If the City of Leavenworth exercised surplus water made available from Icicle Creek from its wellfield located upstream on the Wenatchee River, it would also impair instream flows.

The IWG could seek and the Legislature could grant an OCPI waiver of impacts to the instream flow rule from junior domestic uses given the greater instream flow benefit aggregated under Alternative 3. If Legislative approval to waive impairment was not forthcoming, Alternative 3 could not move forward because Ecology's OCPI authority is too limited to address long-term impacts.

4.3.5 Alternative 4

The overall expected surface water impact associated with Alternative 4 is a benefit to instream flows of up to 131 cfs and 34,585 acre-feet in Icicle Creek, with smaller benefits in tributaries to Icicle Creek depending on project location. Alternative 4 would result in implementation of many of the same projects included in Alternative 1, with the exception that the Eightmile Lake Storage Enhancement, Upper Klonaqua Lake Storage Enhancement, and Upper and Lower Snow Lakes Storage Enhancement Projects would be included, and the Eightmile Lake Storage Restoration Project would not be included. This section describes the specific short- and long-term impacts associated with the storage enhancement projects. The impacts of all other projects are discussed under Alternative 1.

4.3.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would require demolition and reconstruction of the dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures. The lake would need to be drawn down for construction activities, which would provide flow benefit in Eightmile Creek as well as Reaches 1 through 5 of Icicle Creek.

The use of cofferdams and dewatering may be required for some work.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project would require developing a conveyance structure between Upper and Lower Klonaqua Lakes. This may require in-water work and the use of cofferdams, and dewatering may be required for some work near outlet tunnels. However, this project is conceptual at this stage, and exact impacts of construction activities on surface water is unknown.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project would require demolition and reconstruction of the dam at Upper and Lower Snow Lakes, installing a new low-level outlet, and constructing new impoundment and water control structures. The lakes would need to be drawn down for construction activities, which would provide flow benefit in Snow Creek as well as Reaches 2 through 5 of Icicle Creek.

The use of cofferdams and dewatering may be required for some work near outlet tunnels.

4.3.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Under the Eightmile Lake Storage Enhancement Project, storage levels would be increased above historical levels. This additional water would be used for improving domestic reliability and instream flows.

Under this project, water storage in the Eightmile catchment would increase by 1,000 acre-feet over the storage volume listed in IPID's water right for the lake. Eightmile's lake level would rise 11 feet above the historic spillway level, and draw down would increase by 22.4 feet below the current low level outlet. Impacts to Eightmile Lake levels are presented in Figure 2-44.

This project would provide for the release of up to an additional 17.9 cfs and 1,000 acre-feet, relatively to the storage allowed by IPID's water right, from Eightmile Lake into its tributary, Eightmile Creek, and Reach 1 of Icicle Creek. There would be additional flow benefit in Reaches 2 through 5 of Icicle Creek. Flows would be adaptively managed to reduce low flow impacts in late summer. These flows would be within the naturally occurring flow range, and would benefit the riverine system.

Upper Klonaqua Lake Storage Enhancement

Building a conveyance system between Upper Klonaqua Lake and Lower Klonaqua Lake would allow for these lakes to be drawndown, making more water available in the Icicle Creek Subbasin. This would lead to increased stream flows in Icicle Creek Reaches 1 through 5. Streamflow would also increase in Klonaqua Creek and French Creek. This project is currently in the conceptual stage. Additional impacts on surface water would be identified after more detailed information is available on this project.

Upper and Lower Snow Lakes Storage Enhancement

Under the Upper and Lower Snow Lakes Storage Enhancement Project, storage levels would be increased by 1,079 acre-feet. This additional water would be used for improving domestic reliability and instream flows. The primary impact of this project on surface water would occur in Upper Snow Lake, Snow Creek, and Reaches 2 through 5 of Icicle Creek.

Under this project, water storage in the Snow Lakes catchment would increase by 1,079 acre-feet. The maximum storage level in Upper Snow Lake's level would rise 5 feet, and draw down would increase by 3 feet. Impacts to Upper and Lower Snow Lake levels are presented in Figure 2-46.

This project would provide for the release of an additional 18 cfs (maximum) and 1,079 acre-feet from Upper and Lower Snow Lake into Snow Creek, and Reach 2 through 5 of Icicle Creek. Flows could be adaptively managed to reduce low flow impacts in late summer, and would be beneficial to the riverine ecosystem.

4.3.6 Alternative 5

The overall expected surface water impact associated with Alternative 5 is an increase of up to 195 cfs and 55,458 acre-feet in instream flow in Icicle Creek. Alternative 5 would result in implementation of many of the same projects included in Alternative 1, with the exception that the IPID Irrigation Efficiencies Project would be replaced by the IPID Full Piping and Pump Exchange. This section describes the specific short- and long-term impacts associated with the IPID Full Piping and Pump Exchange Project. The impacts of all other Alternative 5 projects are discussed under Alternative 1.

4.3.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

The IPID Full Piping and Pump Exchange Project includes the construction of three pump station to divert water to the IPID from the Wenatchee River and would involve instream work on the Wenatchee River. Impacts to surface water would likely include the use of cofferdams and dewatering at each pump station construction site.

4.3.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

The primary long-term impact of implementing the IPID Full Piping and Pump Exchange Project is increased streamflow in Icicle Creek and Peshastin Creek. In Icicle Creek, stream flow would be increased by as much as 117 cfs. These pump stations would allow for complete removal of IPID’s diversion on Icicle Creek and Peshastin Creeks. However, IPID would still rely on releases from storage reservoirs in the ALWS to sustain water supply at the new pumped diversion locations on the Wenatchee River. The instream flow benefit from this project would occur during the irrigation season, which typically occurs from April through October. This period includes low flow months in late summer and early fall, as identified on the Icicle Creek hydrograph (Figure 3-2). These increased flows would benefit Icicle Creek downstream of IPID’s point of diversion at RM 5.7 in Reaches 2 through 5. The benefit would continue into the Wenatchee River to the location of the new pump stations. Reach benefits can be seen in Figure 2-49.

There would also be additional benefit to Peshastin Creek, as water currently diverted by IPID from this creek would also be replaced with Wenatchee River water by this project.

4.3.7 Mitigation Measures

4.3.7.1 Short-term Impacts

Potential short-term impacts to surface waters are related to use of a cofferdam, rerouting water, and construction dewatering to support construction of the various project actions. These impacts are one time in nature for each project discussed above and are expected to occur only through the duration of active in-water construction work, likely for a few weeks or months. Dewatering to support construction would fall under the State Construction Stormwater General Permit, which contains BMP requirements for management and discharge of dewatering water. Additional BMPs or conditions for dewatering may be imposed under county grading permits, shoreline permits, or through NEPA review, depending on the project action and whether the project location is under state or federal jurisdiction.

4.3.7.2 Long-term Impacts

Long-term impacts to surface water resources are primarily related to increased stream flow in Icicle Creek and its tributaries. Additional surface water resource impacts include increased frequency of drawing down the Alpine Lakes. These potential impacts are not considered significant. The frequency of draw down is not anticipated to impact refill scenarios for the Alpine Lakes, and is not expected to create new impacts on surface water resources. Permitting of trust water related to increased stream flow would be subject to Ecology water right permitting. The Ecology water right permitting process would include review of the potential for impairment to existing water rights, including the Instream Flow Rule, and would include the opportunity for mitigation should the potential for impairment be identified.

4.4 Groundwater

This section describes potential short- and long-term impacts to groundwater expected under each alternative, with a focus on potential changes in the timing and quantity of groundwater resources. Potential impacts to groundwater quality are discussed in Section 4.5, Water Quality.

4.4.1 No-action Alternative

4.4.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that could result in short-term impacts on water quality in the Icicle Creek Watershed project area. This is anticipated to entail construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability.

Potential impacts would primarily be associated with projects that require construction in or near water bodies that would require dewatering of groundwater. Additionally, groundwater development activities associated with LNFH projects would involve pumping of groundwater to test the capacity of new wells or a groundwater collector gallery.

These impacts would be short-term in nature and are expected to have no significant impact on groundwater.

4.4.1.2 Long-term Impacts

Long-term impacts under the No-Action Alternative include reduced seepage and increased groundwater pumping that would result from domestic and irrigation conservation projects and groundwater development at LNFH.

Potential long-term impacts to groundwater that could result from implementing domestic conservation and irrigation efficiency project would be reduced recharge from leakage along the City of Leavenworth, IPID, and COIC conveyance systems and from reduced return flows near the mouth of Icicle Creek and along the Wenatchee River.

Given the high transmissivity of the sand and gravel alluvial aquifer along the Wenatchee River and the high degree of hydraulic continuity between the river and groundwater (refer to Section 3.4, Groundwater Resources), reduction in recharge resulting from conservation is not expected to significantly affect groundwater elevations in these areas. Groundwater discharge to surface water of Icicle Creek and the Wenatchee River could be reduced in proportion to the water efficiency savings; however, this reduction in groundwater discharge would be offset by the reduction in surface water diversion from Icicle Creek, approximately 32 cfs under the No-action Alternative. Potential impacts to groundwater resources under these projects are not considered significant.

Under the No-action Alternative, projects at LNFH will likely proceed. The effluent pump-back system and wellfield improvements to enhance groundwater supply under the LNFH Conservation and Water Quality Improvements Project each have the potential to impact groundwater resources near the LNFH facility through increased groundwater recharge and withdrawals. However, the impacts of wellfield improvements at LNFH would not be greater than historically when wells were operating at full capacity. Water conservation efforts under this project (e.g., onsite water re-use) also have the potential to impact groundwater resources through reduced groundwater pumping or surface water diversions needed to meet LNFH water demands.

Previous investigations of the LNFH groundwater supply and pilot testing and evaluation of the pump-back system have confirmed the strong hydraulic connection between groundwater at the facility and surface water in Hatchery Channel when hydrated. Hydrating the Hatchery Channel via the effluent pump-back system would increase groundwater recharge and water levels in the adjacent aquifer. This in turn would support higher pumping rates from LNFH wells completed in this aquifer than could be sustained without the pump-back. Additional groundwater withdrawal capacity could be achieved by installing additional wells or a shallow groundwater collector on Hatchery Island. If implemented, impacts to groundwater from the well field improvements and effluent pump-back are expected to largely cancel out, with increased groundwater withdrawals offset by increased recharge from the pump-back system. Further, by reducing total LNFH water use through increased efficiency (water re-use), total surface water diversions and groundwater withdrawals would be reduced relative to current conditions, maintaining more water instream and in the adjacent alluvial aquifer to support instream flows and groundwater levels.

Based on these considerations, no significant impacts to groundwater resources were identified for this project.

4.4.2 Alternative 1 (Base Package)

Under Alternative 1, expected short-term impacts include construction dewatering and pumping groundwater to test the capacity of new wells or a groundwater collector. Long-term impacts include increased groundwater recharge near Icicle Creek, decreased groundwater recharge near areas of canal lining and piping, and increased groundwater use.

4.4.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction activities associated with this project would be limited to upland areas around the lakes and would likely not require dewatering during construction. No potential short-term impacts to groundwater resources were identified for this project.

IPID Irrigation Efficiencies

Potential construction activities associated with the IPID Irrigation Efficiencies Project include the conversion of irrigation canals to pipelines and the lining of irrigation canals with concrete. Assuming the canals and pipelines are located above the local water table, construction dewatering is not expected to be required and no potential short-term impacts to groundwater resources were identified for this project.

COIC Irrigation Efficiencies and Pump Exchange

Potential construction activities associated with this project include the conversion of irrigation canals to pipelines and construction of a new COIC surface water intake and pump station. Potential groundwater impacts from implementing these actions include construction dewatering as needed during pump station construction. Duration of these impacts would be limited to the period of active dewatering during construction.

Domestic Conservation Efficiencies

Potential construction activities associated with the Domestic Conservation Efficiencies Project include detection and replacement of leaking conveyance pipes and installation of water meters. Potential groundwater impacts from implementing these actions include construction dewatering as needed during pipe replacement. Duration of these impacts would be limited to the period of active dewatering during construction. No potential short-term impacts to groundwater resources were identified for installation of water service meters or other conservation efforts.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would involve demolishing the existing dam and low-level outlet pipeline, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures. Construction activities would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down. Limited construction dewatering of groundwater could be required during installation of the new outlet pipeline. Duration of these impacts would be limited to the period of active dewatering during construction.

Tribal Fishery Preservation and Enhancement

The focus of Fishery Preservation and Enhancement Project is to ensure that there would be no adverse effect on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. This project includes monitoring of fishery effectiveness and potential implementation of actions to improve the resource. Specific project actions for implementation have not been finalized, but could include small-scale construction actions to promote favorable fishing conditions in the pool at the bottom of the LNFH spillway. Construction dewatering is not expected to be required and no potential short-term impacts to groundwater resources were identified for this project.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project includes stream restoration and protection projects to improve habitat in the Icicle Creek Subbasin. Construction activities associated with these projects would include grading, vegetation planting and removal, and placement of logs and rocks in riparian areas. Some dewatering of groundwater during construction could be needed. Duration of these impacts would be limited to the period of active dewatering during construction.

Instream Flow Rule Amendment

Under the Instream Flow Rule Amendment Project approximately 0.4 cfs of water reserved under the rule for future out-of-stream uses in the Wenatchee River would be reallocated to the Icicle Creek Subbasin, allowing for continued groundwater development. This would likely lead to more well construction than would occur under the current rule. Short-term impacts to groundwater associated with this project would be limited to withdrawals during well construction and testing.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes reducing LNFH’s surface water use and improving the reliability and capacity of groundwater supply. Specific project actions could include onsite re-use, an effluent pump-back system to hydrate the Hatchery Channel and augment groundwater levels at nearby groundwater production wells, and wellfield enhancements. Potential short-term impacts to groundwater could include temporary dewatering during construction activities, and pumping of groundwater to test the capacity of new wells or a groundwater collector gallery. Duration of these impacts would be limited to the period of active dewatering during construction or active pumping to test new wells.

Because this is a federal facility, an additional evaluation of the potential short-term impacts to groundwater under NEPA would be completed once the full scope of the project is determined.

Fish Passage

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek as well as instream modifications to the Boulder Field near RM 5.6. Construction dewatering is not expected to be required at the Boulder Field but would likely be needed to improve the instream structures. Duration of dewatering impacts would be limited to the period of active dewatering during construction.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on Lower Icicle Creek. Construction activities could include building a temporary cofferdam and dewatering on the downstream side to accommodate screen replacement. Duration of dewatering impacts would be limited to the period of active dewatering during construction.

Water Markets

There are no construction activities proposed under the Water Markets Project and therefore no potential short-term impacts on groundwater are expected.

4.4.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Under this project, management and releases of stored water at the Alpine Lakes would be automated and optimized to improve instream flows. This would result in some changes in how lake levels are managed. Lake levels would be drawn down every year instead of rotating 1-in-5 year basis. The high and low lake levels and the general pattern of releases would be adapted to fish needs in the particular water year.

Modifying the storage and release operations could have minor effects on groundwater levels in soils adjacent to the lakes. For example, if Alpine Lakes Optimization, Modernization, and Automation allows lake levels to be maintained higher later in the season, then groundwater levels near the lakes would also be higher during the late season than under current operations. This in turn would lead to an increase in groundwater discharge to the lakes and outlet creeks during the later summer and early fall months. Conversely, if the lakes were drawn down earlier in the season than under current operations, then groundwater levels and associated late season discharge to surface water near the lakes would be reduced. In either event, these effects are expected to be very minor relative to the overall groundwater and surface water budgets for the Icicle Creek Subbasin.

Although the cycling of storage and releases may be increased to each lake every year instead of rotating, the impacts to groundwater, including groundwater discharge to surface water, would be within the variation already occurring within the system as currently managed. Based on this observation, potential impacts to groundwater resources under this project are not considered significant.

IPID Irrigation Efficiencies

Under the IPID Irrigation Efficiencies Project, IPID's water management plan would be updated with a goal of identifying opportunities for irrigation efficiency upgrades and infrastructure improvements to reduce water diversions from Icicle Creek. Activities could include canal piping or lining and on-farm efficiency upgrades.

The primary effect of this project would be to reduce surface water diversions from Icicle Creek, resulting in increased instream flows downstream from the diversion. Potential long-term impacts to groundwater could result from reduced recharge from leakage along the IPID conveyance system and from reduced irrigation return flows in the IPID service area near the mouth of Icicle Creek and along the Wenatchee River.

Given the high transmissivity of the sand and gravel alluvial aquifer along the Wenatchee River and the high degree of hydraulic continuity between the river and groundwater (refer to Section 3.4, Groundwater Resources), reduction in recharge resulting from IPID irrigation efficiencies is not expected to significantly affect groundwater elevations in these areas. Groundwater discharge to surface water of Icicle Creek and the Wenatchee River could be reduced in proportion to the water efficiency savings; however, this reduction in groundwater discharge would be more than offset by the reduction in surface water diversion from Icicle Creek that would be realized through this project. As such, potential impacts to groundwater resources under this project are not considered significant.

COIC Irrigation Efficiencies and Pump Exchange

Potential project actions related to the COIC irrigation system include irrigation efficiency upgrades and infrastructure improvements like those considered for IPID (e.g., canal piping and on-farm efficiency upgrades) as well as a source exchange option to move COIC's diversion from Icicle Creek downstream to a location near the confluence of the Icicle Creek and the Wenatchee River.

COIC's service area is along Icicle Creek, extending to the Wenatchee River. Effects of improved irrigation system efficiencies would be similar to those expected for IPID improvements—a reduction in groundwater recharge along the conveyance system and within the service area, an associated reduction in groundwater discharge to surface waters, and an overall increase in instream flows as reduced diversions offset reduced groundwater discharge.

Assuming no other on-farm irrigation efficiencies, the potential source exchange project would not alter the amount of groundwater recharge from irrigation return flows within the COIC service area. The source exchange would reduce diversions from Icicle Creek, allowing higher flows to remain instream and slightly increasing creek stage. The higher creek stage would support slightly higher groundwater elevations in the adjacent alluvial aquifer, although groundwater elevations would be expected to remain within historical ranges, and these impacts are not considered significant.

Domestic Conservation Efficiencies

The Domestic Conservation Efficiencies Project would improve domestic water use efficiency by the City of Leavenworth and Chelan County through pipe replacements, water meter installation, and other water use conservation efforts. The overall effects of increased domestic water use efficiency are targeted to other domestic uses as the City of Leavenworth and Chelan County grow, so in general, increased efficiency is expected to reduce groundwater recharge as leaking pipes are replaced and irrigation and septic return flows decline with declining water use. Potential impacts to groundwater resources from increased domestic conservation efforts are expected not to be significant.

Eightmile Lake Storage Restoration

Under this project, the Eightmile Lake Dam would be restored to the historical and permitted levels, increasing the useable storage capacity. Full storage elevations would be increased to match the historical spillway elevation (4,671 feet). That is about 4 feet higher than the current full operating water surface in the lake, which has been limited by erosion of the embankment portion of the dam to 4,667 feet. Other changes to the dam and lake operations would allow about 22.4 more feet of draw down to release water relative to current operations.

Groundwater elevations in soils adjacent to the lake are expected to rise and fall with changes in lake elevation. Given the increase in full elevation and the greater planned draw down, the range of groundwater elevations adjacent to the lake would likely exceed the range of elevations (high and low) experienced under recent lake operations, although elevations would be within the historical maximum range when the dam was at full capacity.

Potential impacts to groundwater adjacent to the lake are important to the Icicle Creek Subbasin to the extent that the groundwater discharges to and supports surface water levels and flows in Eightmile Lake and Eightmile Creek downstream to Icicle Creek. Filling the lake to higher levels would increase groundwater storage near the lake early in the season. As the lake is drawndown through the summer, groundwater would be released from storage and would discharge to the lake and headwaters of Eightmile Creek and support surface water flows. Overall, changes to groundwater near Eightmile Lake under this project are expected to have minor but beneficial impacts to the Icicle Creek Subbasin.

Tribal Fishery Preservation and Enhancement

The preservation and enhancement of tribal fisheries is not expected to change groundwater levels. No long-term impacts to groundwater resources were identified for this project.

Habitat Protection and Enhancement

Improving habitat in Icicle Creek by installing engineered logjams is expected to slow down stream, which could increase groundwater storage. These impacts are expected to be less than significant.

Instream Flow Rule Amendment

Under the Instream Flow Rule Amendment Project, approximately 0.4 cfs of water reserved under the rule for future out-of-stream uses in the Wenatchee River would be reallocated to the Icicle Creek Subbasin. There would be no net change in the reserve available under the rule, but there would likely be more water well construction and groundwater pumping in the Icicle Creek Subbasin than would occur under the current rule, with a similar decrease in future groundwater development in the mainstem Wenatchee River Watershed. Long-term impacts to groundwater associated with this project action would include future groundwater withdrawals in the Icicle Creek Subbasin.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The effluent pump-back system and wellfield improvements to enhance groundwater supply under the LNFH Conservation and Water Quality Improvements Project each have the potential to impact groundwater resources near the LNFH facility through increased groundwater recharge and withdrawals. However, the impacts of wellfield improvements at LNFH would not be greater than historically when wells were operating at full capacity. Water conservation efforts under this project (e.g., onsite water re-use) also have the potential to impact groundwater resources through reduced groundwater pumping or surface water diversions needed to meet LNFH water demands.

Previous investigations of the LNFH groundwater supply and pilot testing and evaluation of the pump-back system have confirmed the strong hydraulic connection between groundwater at the facility and surface water in Hatchery Channel when hydrated. Hydrating the Hatchery Channel via the effluent pump-back system would increase groundwater recharge and water levels in the adjacent aquifer. This in turn would support higher pumping rates from LNFH wells completed in this aquifer than could be sustained without the pump-back. Additional groundwater withdrawal capacity could be achieved by installing additional wells or a shallow groundwater collector on Hatchery Island. If implemented, impacts to groundwater from the well field improvements and effluent pump-back are expected to largely cancel out, with increased groundwater withdrawals offset by increased recharge from the pump-back system. Further, by reducing total LNFH water use through increased efficiency (water re-use), total surface water diversions and groundwater withdrawals would be reduced relative to current conditions, maintaining more water instream and in the adjacent alluvial aquifer to support instream flows and groundwater levels.

Based on these considerations, no significant impacts to groundwater resources were identified for this project. However, because this is a federal facility, additional evaluation of the potential long-term impacts under NEPA would be completed once the full scope of the project is determined.

Fish Passage

No long-term impacts to groundwater resources were identified for this project.

Fish Screen Compliance

No long-term impacts to groundwater resources were identified for this project.

Water Markets

No significant long-term impacts to groundwater resources were identified for the Water Markets Project. If a water market is supplied by a groundwater right acquisition, historical groundwater diversions from that right would cease. If that right allowed currently interruptible rights to avoid curtailment, then some proportionate groundwater use would increase.

4.4.3 Alternative 2

This alternative includes the same projects as Alternative 1, with the exception that the Alpine Lakes Optimization, Modernization, and Automation project is not included and the IPID Dryden Pump Exchange Project is added. The discussion of short- and long-term impacts focuses on impacts associated with the IPID Dryden Pump Exchange Project. The impacts of all other Alternative 2 projects are discussed under Alternative 1.

4.4.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Under the IPID Dryden Pump Exchange Project, a new pump station would be constructed along the Wenatchee River near Dryden to augment water supply in the IPID canals. Potential groundwater impacts include construction dewatering as needed during pump station construction. Duration of these impacts would be limited to the period of active dewatering during construction.

4.4.3.2 Long-term Impacts

IPID Dryden Pump Exchange

Assuming no other on-farm irrigation efficiencies, the potential pump exchange project would not alter the amount of groundwater recharge from irrigation return flows within the IPID service area. However, the source exchange would reduce diversions from Icicle Creek, allowing higher flows to remain instream and slightly increasing creek stage. The higher creek stage would support slightly higher groundwater elevations in the adjacent alluvial aquifer, although groundwater elevations would be expected to remain within historical ranges. These impacts are not considered significant.

4.4.4 Alternative 3

This alternative includes the same projects as Alternative 2, with the exception that the Eightmile Lake Storage Restoration Project is removed and the Legislative Change Creating OCPI Authority for Alternative 3 Project is added. The discussion of short- and long-term impacts focuses on impacts associated with Legislative Change Creating OCPI Authority for Alternative 3 Project. The impacts of all other Alternative 3 projects are discussed under Alternative 1 and Alternative 2.

4.4.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

No short-term impacts to groundwater resources were identified for this project.

4.4.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

Under the Legislative Change Creating OCPI Authority Project, the small amount of out-of-stream uses cannot be perfectly matched with the much larger instream flow benefit made available if the standard for impairment is perfectly in-time. The IWG could seek and the Legislature could grant an OCPI waiver for impacts to the instream flow rule. If granted, this would provide for decreased flows and corresponding decreases in groundwater to the creek. However, given the greater instream flow benefit aggregated under Alternative 3, these impacts are expected to be very minor.

4.4.5 Alternative 4

This alternative includes the same projects Alternative 1, but includes Eightmile Lake Storage Enhancement, Upper Klonaqua Lake Storage Enhancement, and Upper and Lower Snow Lakes Storage Enhancement Projects. The discussion of short- and long-term impacts focuses on impacts associated with these projects. The impacts of all other Alternative 4 projects are discussed under Alternative 1 and Alternative 2.

4.4.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

Short-term impacts for the Eightmile Lake Storage Enhancement are similar to those described for Eightmile Lake Storage Restoration Project. Specifically, limited construction dewatering may be required during installation of the new outlet pipeline. The duration of these impacts would be limited to the period of active dewatering during construction.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project includes installing infrastructure to increase draw down in the lake and expand achievable storage releases. Short-term impacts for this project are similar to those expected for the Eightmile Lake Storage Restoration project. Specifically, limited construction dewatering may be required during installation of the new outlet pipeline. The duration of these impacts would be limited to the period of active dewatering during construction.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project includes raising the dam height on Upper Snow Lake to increase storage capacity and changing reservoir operations to allow more draw down during releases. Limited construction dewatering may be required during installation of the new outlet pipeline. The duration of these impacts would be limited to the period of active dewatering during construction.

4.4.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Long-term impacts to groundwater resources under the Eightmile Lake Storage Enhancement Project are expected to be the similar to those identified for the Eightmile Lake Storage Restoration Project discussed in Section 4.4.2. Filling the lake to higher levels would increase groundwater storage near the lake early in the summer. As the lake is drawn down through the summer, groundwater would be released from storage and would discharge to the lake and headwaters of Eightmile Creek and support surface water flows. Overall, changes to groundwater near Eightmile Lake under this project are expected to have be very minor but beneficial impacts to the Icicle Creek Subbasin.

Upper Klonaqua Lake Storage Enhancement

Long-term impacts to groundwater resources under the Upper Klonaqua Lake Storage Enhancement Project would be similar to impacts expected under the Eightmile Lake Storage Enhancement Project. Increasing draw down in the lake to allow greater storage release would result in more late summer groundwater discharge to Upper Klonaqua Lake and its outlet creek. As the lake is allowed to fill over the winter and spring, groundwater adjacent to the lake would be recharged from surface water and groundwater levels would recover. Overall, changes to groundwater near Upper Klonaqua Lake under this project are expected to have minor but beneficial impacts to the Icicle Creek Subbasin.

Upper and Lower Snow Lakes Storage Enhancement

Long-term impacts to groundwater resources under the Upper and Lower Snow Lakes Storage Enhancement Project would be similar to impacts expected under the Eightmile Lake Storage Enhancement Project. Increasing the dam height and full pool elevation of the lake would increase groundwater storage near the lake early in the summer. As the lake is drawn down through the summer, groundwater would be released from storage and would discharge to the lake and headwaters of Snow Creek and support surface water flows. Overall, changes to groundwater near Upper Snow Lake under this project are expected to have minor but beneficial impacts to the Icicle Creek Subbasin.

4.4.6 Alternative 5

This alternative includes the same projects as Alternative 1, with the exception that the IPID Irrigation Efficiency Project has been replaced by the IPID Full Piping and Pump Exchange. The discussion of short- and long-term impacts focuses on impacts associated with the IPID Full Piping and Pump Exchange Project. The impacts of all other Alternative 5 projects are discussed under Alternative 1.

4.4.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

Under the IPID Full Piping and Pump Exchange Project, three new pump stations would be constructed along the Wenatchee River near Leavenworth, Dryden, and Monitor to replace the IPID diversion on Icicle and Peshastin Creek. Potential groundwater impacts include construction dewatering as needed during pump station and piping construction. Duration of these impacts would be limited to the period of active dewatering during construction.

4.4.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

Piping IPID would likely result in a reduction in groundwater recharge along the conveyance system and within the service area, an associated reduction in groundwater discharge to surface waters, and an overall increase in instream flows as reduced diversions offset reduced groundwater discharge.

Assuming no other on-farm irrigation efficiencies, the potential source exchange project would not alter the amount of groundwater recharge from irrigation return flows within the IPID service area. The source exchange would reduce diversions from Icicle Creek, allowing higher flows to remain instream and slightly increasing creek stage. The higher creek stage would support slightly higher groundwater elevations in the adjacent alluvial aquifer, although groundwater elevations would be expected to remain within historical ranges, and these impacts are not considered significant.

4.4.7 Mitigation Measures

4.4.7.1 Short-term Impacts

Short-term impacts to groundwater are expected to be related to temporary construction dewatering to support implementation of the various project actions and construction and testing of groundwater supply wells. These impacts are expected to be localized and to occur only through the duration of active construction work or well testing. Dewatering to support construction would fall under the State Construction Stormwater General Permit, which contains BMP requirements for management and discharge of dewatering water. Additional BMPs or conditions for dewatering could be imposed under Chelan

County grading permits, shoreline permits, or through NEPA review, depending on the project and whether the project location is under state or federal jurisdiction.

Water well construction is governed by Chapter 173-160 WAC *Minimum Standards for Construction and Maintenance of Wells*, and would require filing a Notice of Intent to construct a well with Ecology. Well testing for non-permit exempt wells would likely require a preliminary permit from Ecology, which would specify testing durations, rates, and monitoring requirements.

4.4.7.2 Long-term Impacts

Long-term impacts to groundwater resources include indirect effects from actions intended to improve flows and reliability of water in Icicle Creek and direct effects from actions related to groundwater withdrawals and supply improvements. Actions with indirect effects on groundwater quantity include changes in storage and operations of the Alpine Lakes, irrigation district improvements and pump exchanges to reduce diversions from Icicle Creek, water conservation measures by LNFH, and domestic water conservation efforts. These actions are expected to affect groundwater by increasing surface water quantities and levels, thereby increasing groundwater storage in adjacent soils, and conversely by reducing return flows from domestic and irrigation conveyance and uses, groundwater quantities would be reduced.

The Instream Flow Rule amendment and the LNFH groundwater augmentation actions are expected to have direct effects on groundwater quantity. The Instream Flow Rule amendment to reallocate water reserves from the mainstem Wenatchee River to the Icicle Creek Subbasin would directly reduce groundwater quantity in the Icicle Creek Subbasin via increased withdrawals while increasing groundwater in the Wenatchee River mainstem relative to the current rule. Groundwater augmentation at LNFH would maintain or increase groundwater elevations near the hatchery and support hatchery groundwater production.

The potential long-term impacts are not considered significant and are expected to partially offset each other (e.g., reduced groundwater recharge from domestic water conservation efforts may be offset by reduced pumping in the Wenatchee River Watershed following a rule amendment). Additionally, long-term impacts are not expected to alter groundwater elevations or quantities to the degree that they fall outside historical ranges in the Icicle Creek Watershed project area. Ecology water right permitting would be required for non-permit-exempt groundwater wells and would include an evaluation of the potential for withdrawals to impair other groundwater or surface water rights, including instream flows. Water right decisions would include the opportunity for mitigation should the potential for impairment be identified.

4.5 Water Quality

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.5, Water Quality, from construction and operation related to the No-action Alternative and Program Alternatives.

4.5.1 No-action Alternative

4.5.1.1 Short-term Impacts

Potential impacts would primarily be associated with projects that require construction in or near water bodies and could include short-term increases in sedimentation and turbidity, changes in water temperature, and increased risk of contamination from such activities as concrete placement, use of construction equipment, and dewatering of groundwater. These impacts would be localized to specific areas of disturbance at the seven Alpine Lakes, Icicle and Peshastin Creeks, and the Wenatchee River. could include the modification of existing features, construction of new water diversion and flow control structures, various types of fish passage improvement work, and improvements to irrigation canal and pipe systems. Work would likely require the placement of temporary cofferdams in water bodies to isolate work areas and could also involve the temporary diversion of stream flow. Such activities could cause local, temporary increases in turbidity in the affected water bodies and could increase erosion potential from adjacent areas. Increases in turbidity and sedimentation could in turn lead to short-term increases in water temperature and decreases in available dissolved oxygen.

Placement of cast-in-place concrete either instream or in adjacent areas could increase the potential for water to meet uncured concrete, which could affect the pH of the water. The use of mechanized equipment for construction would also increase the potential for water contamination through the inadvertent release of fuel or other vehicle fluids (e.g., oil, grease, antifreeze, hydraulic fluids).

Activities involving ground disturbance near waterways are also likely to encounter groundwater. Exposed groundwater and groundwater dewatering can lead to increased risk of contamination similar to that described above from increased turbidity and potential spills.

Applicable permits would require appropriate mitigation measures to reduce impacts on water quality, such as restricting in-water access to periods of low flows and species-specific in-water work windows and implementing construction BMPs designed to reduce the potential for erosion and inadvertent contamination from vehicle fluids (Section 4.5.7, Mitigation Measures). Therefore, the No-action Alternative would not be expected to result in short-term violations of the water quality standards that would adversely affect designated uses in the Icicle project area as described in Section 3.5, Water Quality. Short-term impacts on water quality would be less than significant and are unlikely to result in violation of the water quality standards associated with the designated uses within the Icicle project area.

4.5.1.2 Long-term Impacts

Long-term impacts under the No-action Alternative are anticipated to be largely beneficial for water quality, especially water temperature, because many projects would seek to improve instream flows during the late summer. Implementation of projects at the Alpine Lakes would also result in some changes in lake levels. Compared to existing conditions, the frequency in fluctuations in lake levels would increase. Lake levels at Eightmile Lake would also be able to reach higher or lower levels compared to existing conditions; however, this variation would remain within the levels historically achieved at the lake. Long-term water quality impacts include less than significant increases in erosion potential and turbidity in the lakes and associated creeks as a result of the changes in lake level management.

In the long term, projects implemented under the No-action Alternative that contribute to increased instream flows along Icicle Creek and the Wenatchee River would also contribute to some increase in shallow groundwater recharge that would also be generally beneficial. However, because instream flow enhancement projects would not generally be coordinated with other activities in the Icicle project area and few projects would be implemented, these benefits are not anticipated to be as great as they would be under the other Program Alternatives. Potential long-term water quality benefits from such projects are also expected to be more localized, providing only minor overall benefits within the larger Icicle Creek Subbasin.

4.5.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in both increased adverse and beneficial impacts on water quality compared with the No-action Alternative because there would be greater likelihood that multiple projects would be implemented and the scale of certain efforts would likely be greater. Compliance with the Guiding Principles addresses water quality in general by improving instream flows, sustainability at the LNFH, and Icicle Creek aquatic and riparian habitat. The following subsections describe the short- and long-term impacts that would likely occur under Alternative 1.

4.5.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

In the short term, this project has relatively limited potential to affect water quality at the Alpine Lakes. Construction activities would involve replacing existing flow control structures and installing automation equipment and would mostly affect upland areas. These activities would not require dewatering of groundwater and are therefore not expected to have the potential to adversely affect groundwater quality.

Some limited work would occur within the lake shorelines but within dry areas of the lake margins once lakes are drawn down at the end of the summer. This would include the replacement of existing water control gates at each of the five lakes, reconstruction of impoundment structures and upgrades of spillways where needed, and the demolition and reconstruction of the gate tower at Colchuck Lake. The latter of these would involve either the installation of a pre-cast concrete, rock masonry, or plastic pipe riser structure. The inlet pipe at Colchuck Lake may also need to be slip lined or repaired, which could require limited excavation and fill placement in the lake bottom. Work along the shoreline could include some limited vegetation removal and soil disturbance for construction access, and installation of equipment (e.g., solar panels, antennas) and water control equipment enclosures.

Minor water quality impacts associated with these types of activities could include temporary increases in turbidity and sedimentation both in the lakes and their receiving waters. As compared to existing conditions, there would also be an increased risk of water contamination from fuels and other fluids used in gasoline or diesel-powered equipment (e.g., generators), the placement of uncured concrete (if used), and from human waste generated by workers.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include requiring all in-water work to be performed in the dry and implementing construction BMPs designed to reduce the potential for erosion and inadvertent water contamination (Section 4.5.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on water quality would be less than significant and would be unlikely to result in violation of the water quality standards associated with the designated uses assigned to the Wenatchee River and its tributaries.

IPID Irrigation Efficiencies

The IPID Irrigation Efficiencies Project could cause short-term impacts on water quality if efficiency projects are implemented that require work in or adjacent to existing irrigation canals with potential to release flow back into the Wenatchee River or its tributaries through spillways. However, it is anticipated that any ground-disturbing work required to complete these projects would be completed during the off season, when the irrigation canals and spillways are completely dewatered.

Potential construction work under this plan that could affect surface water quality includes converting irrigation canals to pipelines, replacing or abandoning pipelines, and lining of irrigation canals with concrete. Water quality impacts that could occur from such work could include temporary increases in turbidity, increased erosion potential from disturbed areas along canal banks, re-suspension of contaminated sediments from canal substrates by excavation activities, and an increased risk of contamination from activities such as raw concrete placement and construction equipment usage. Because most of this work would occur when the canals are dry, the opportunity for these types of water quality impacts to occur would be minimized. As noted in Section 4.4, Groundwater, the irrigation canals are expected to be located above the water table, meaning there is also limited potential to adversely affect groundwater quality in the short term.

Work within irrigation canals or spillways that reconnect to waters of the United States or State of Washington could require a CWA Section 404 Permit and associated Section 401 Water Quality Certification. Work in other portions of the irrigation system could require local review and authorization.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include restricting work to periods when the irrigation canals are dewatered, restricting in-water access to periods of low flows, and implementing BMPs designed to reduce the potential for erosion and inadvertent water contamination from construction equipment and other sources (Section 4.5.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on water quality would be less than significant and would be unlikely to result in violation of the water quality standards associated with the designated uses assigned to the Wenatchee River and its tributaries.

COIC Irrigation Efficiencies and Pump Exchange

Under the COIC Irrigation Efficiencies and Pump Exchange Project, canal to pipeline conversion would occur in or adjacent to existing irrigation canals that return flow back into the Wenatchee River or its tributaries through spillways and could cause some short-term impacts on water quality in those water bodies. However, similar to the IPID Efficiencies Project, it is anticipated that any ground-disturbing work required to complete efficiency projects would be completed during the off season when the irrigation canals and spillways are completely dewatered, and encountering groundwater is not likely.

Impacts could include temporary increases in turbidity, increases in erosion potential from disturbed areas along canal banks, re-suspension of contaminated sediments from canal substrates during excavation activities, and increases in the risk of contamination from the placement of raw concrete and the use of construction equipment in or near waterways. These potential impacts are expected to be minimized by local, state, and federal permit requirements and through the required implementation of standard construction BMPs.

Construction of a new pump station under this project would require both in-water and riverbank work on the Wenatchee River or Icicle Creek. Such activities could result in many of the same construction-related short-term impacts on water quality described above and would also include the potential for short-term impacts on groundwater.

Because Ecology's current Water Quality Assessment (Ecology, 2016) records multiple Category 5 water quality impairment listings for the Wenatchee River, including five for polychlorinated biphenyls, five for 4,4'-DDE, and one for endosulfan, any excavation work in the river to construct the intake for the COIC pump station would need to address the potential presence of these and other contaminants in the substrate. As long as construction activities comply with required permit terms and conditions, including those in the Water Quality Certification that would be required by Ecology, it is unlikely that this project would result in violations of the water quality standards associated with the designated uses of the affected water bodies. Short-term impacts on water quality would not be significant.

Domestic Conservation Efficiencies

The Domestic Conservation Efficiencies Project does not involve any instream or stream bank construction work. Therefore, it is not expected to result in any short-term impacts on water quality.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would involve construction activities that could result in short-term impacts on water quality at Eightmile Lake and its receiving waters (Eightmile Creek and Icicle Creek). Construction activities could affect water quality of the lake primarily by increasing the potential for erosion or sediment disturbance that could lead to increased turbidity. Increased turbidity can occur as the result of either direct disturbance, for example the result of in-water work, or from runoff of sediment-laden stormwater into receiving waterways. Construction activities would also involve the use of chemicals, such as fuel, cement, and solvents, that could adversely affect water quality if accidentally spilled and subsequently entered water bodies.

While most construction equipment (potentially including a small tracked excavator) and materials would likely be flown into the Eightmile Lake Storage Restoration Project site via helicopter, IPID is considering the option of walking in a larger tracked excavator or a spider excavator. The trail to access the project site requires several stream crossings and parallels several potential wetlands (Figure 3-10). Potential water quality impacts would include increased turbidity in any streams that would be crossed by machinery, increased erosion potential in areas where soils or vegetation would be disturbed, and an increased risk of water contamination from inadvertent fuel and vehicle fluid leaks and spills.

Construction activity would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down and immediately downstream of the dam within Eightmile Creek. Demolition of the existing dam, installation of new piping, and construction of the new impoundment and water control structures would result in ground disturbance and could potentially cause a temporary increase in turbidity in both Eightmile Lake and Eightmile Creek. Some groundwater dewatering may be required for construction of the pipe inlet. Construction work would also increase the potential for erosion at the project site and the potential for surface and groundwater contamination from vehicle fluids and from the placement of concrete and grout. The extended presence of workers on the site would present similar risks of water contamination from human waste as occurs as the result of recreationalists that visit the area.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include requiring that the lake be drawn down to the lowest level feasible prior to work near or below the ordinary high water mark of the lake, requiring that the lake be dewatered using temporary cofferdams or other measures so that the work area is separated and protected from the lake and stream, and implementing construction BMPs designed to reduce the potential for erosion and inadvertent contamination from vehicle fluids, uncured concrete, human waste, and other sources (Section 4.5.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on water quality would be less than significant and would be unlikely to result in violation of the water quality standards associated with the designated uses assigned to the Wenatchee River and its tributaries.

Tribal Fishery Preservation and Enhancement

The focus of the Tribal Fishery Preservation and Enhancement Project is to ensure that there would be no adverse effect on tribal, as well as non-tribal, fishing as a result of implementing other projects as part of the overall Icicle Strategy. The specifics of this project are not yet determined, but would involve elements of restoration along the lower Icicle Creek that could result in localized construction-related noise. At this stage, the primary options under consideration include the construction of facilities such as a bubble curtain, sprayer, or other modifications near the spillway in front of the LNFH to promote favorable fishing conditions. These activities are not expected to require groundwater dewatering.

Potential short-term water quality impacts from this project could occur if any instream or streambank work is needed to install the various project elements (e.g., spillway diversion piping, effluent discharge piping, bubble curtain, sprinklers) designed to mimic beneficial flow conditions near LNFH to support the tribal fishery in Icicle Creek. Such work could include the installation and removal of temporary cofferdams, excavation of the streambed or banks, placement of fill material and in-water structures, and the placement of cast-in-place concrete. Likely impacts would include a temporary increase in turbidity in the LNFH spillway and Icicle Creek during construction, increased potential for erosion, increased potential for the re-suspension of contaminated sediments, and the increased risk of accidental water contamination from vehicle fluids and water contact with uncured concrete. These types of impacts would most commonly occur near the construction sites and would decrease over time and distance.

Potential short-term water quality impacts associated with construction of Tribal Fishery Preservation and Enhancement Project elements would be mitigated through compliance with the terms and conditions of required local, state, and federal permits as described in Section 4.5.6, Mitigation Measures. Potential impacts would also be reduced through the implementation of standard BMPs for construction work in and around streams and rivers. Overall, potential impacts on water quality from construction activities associated with this project would be less than significant and would not result in any violations of the water quality standards associated with the designated uses assigned to Icicle Creek or the Wenatchee River.

Habitat Protection and Enhancement

Construction of in-water or streambank habitat protection and enhancement structures under the Habitat Protection and Enhancement Project could result in short-term increases in turbidity and erosion potential. No groundwater dewatering is expected. For activities located in the Wenatchee River and lower portions of Icicle Creek, re-suspension of contaminated sediments could also occur. Because all in-water work and most work along the river and stream banks would require local, state, and federal authorizations, these potential effects would be minimized by permit terms and conditions and through the required implementation of standard construction BMPs for the reduction of soil erosion and water quality degradation, as described in Section 4.5.7, Mitigation Measures. Overall, potential impacts on water quality from construction activities under this project would be less than significant and would not result in any violations of the water quality standards associated with the designated uses assigned to Icicle Creek or the Wenatchee River.

Instream Flow Rule Amendment

Short-term water quality impacts are not anticipated to occur under the Instream Flow Rule Amendment Project because it would not involve any construction work within or adjacent to any water bodies in the Icicle Creek Watershed project area.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

Proposed improvements at LNFH would require some in-water and streambank construction activities that could cause a temporary increase in turbidity and erosion potential in Icicle Creek. Modification or replacement of the existing intake screens and surface water transmission piping may require the placement (and subsequent removal) of cofferdams in the stream channel and the use of dewatering methods (e.g., pumping) to isolate work areas. Potential short-term impacts affecting groundwater could include temporary dewatering during construction activities and pumping of groundwater to test the capacity of new wells or a groundwater collector gallery. The use of construction equipment to complete these improvements would also increase the risk of water contamination from inadvertent spills or leaks of vehicle fluids.

Short-term impacts on water quality from construction of the LNFH Conservation and Water Quality Improvements Project would be minimized through compliance with the terms and conditions of required local, state, and federal permits as described in

Section 4.5.7, Mitigation Measures, which would include specific requirements for the timing and duration of in-water work, erosion control, and handling of potentially contaminated sediments. Potential impacts would also be reduced through the implementation of standard BMPs for construction work in and around streams and rivers. Overall, potential impacts on water quality from construction activities are anticipated to be less than significant and not result in any violations of the water quality standards associated with the designated uses assigned to Icicle Creek or the Wenatchee River.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek as well as instream modifications to the Boulder Field near RM 5.6. All of these activities would require the installation and removal of cofferdams, construction of temporary stream bypass structures, excavation of the streambed and banks, and the placement of cast-in-place concrete; however, these activities are not expected to require any contact with groundwater resources. Such activities would result in short-term increases in sedimentation and turbidity, an increased potential for erosion, and an increased risk of accidental spills of fuel, oil, grease, antifreeze, and other fluids associated with the use of heavy equipment. Surface water contamination is also possible from placement of concrete and grout during structure modification or replacement. Water quality parameters that could be affected by these impacts include temperature, dissolved oxygen, and pH.

All of the proposed fish passage improvements under this project would require local, state, and federal authorizations that would contain project-specific terms and conditions designed to reduce adverse impacts on water quality and other natural resources as described in Section 4.5.7, Mitigation Measures. As such, potential impacts on water quality from construction activities are anticipated to be less than significant and not result in any violations of the water quality standards associated with the designated uses assigned to Icicle Creek or the Wenatchee River.

Fish Screen Compliance

The Fish Screen Compliance Project would require both in-water and shoreline work to upgrade and replace non-compliant fish screens on existing water diversion and intake structures used by LNFH and COIC, the City of Leavenworth, and IPID. Such work may require the isolation and dewatering of instream work areas using cofferdams and pumps, disturbance of streambank vegetation and soils for equipment access, and excavation of the streambed and bank for piping replacement. Construction activities would occur at ground surface and no dewatering is expected to be required. All of these actions could cause short-term increases in turbidity in Icicle Creek and an increased potential for streambank erosion. The use of construction equipment near the creek and the potential need to use cast-in-place concrete would also increase the potential for water contamination from these sources.

Potential short-term water quality impacts associated with the Fish Screen Compliance Project elements would be minimized through compliance with the terms and conditions of required local, state, and federal permits as described in Section 4.5.7, Mitigation Measures. Potential impacts would also be reduced through the implementation of standard BMPs for construction work in and around streams and rivers. Overall, potential impacts on water quality from construction activities are anticipated to be less than significant and not result in any violations of the water quality standards associated with the designated uses assigned to Icicle Creek or the Wenatchee River.

Water Markets

Short-term water quality impacts are not anticipated to occur under the Water Markets Project because it would not involve any construction work within the Wenatchee River or any of its tributaries, including Icicle Creek.

4.5.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Long-term water quality impacts resulting from the Alpine Lakes Optimization, Modernization, and Automation Project would primarily be associated with the way in which the lakes would be managed for downstream releases and are anticipated to be beneficial overall. With remote actuators in place, releases from the five managed lakes could be better timed based on flow levels in Icicle Creek, local and regional climatic conditions, and water demands of users in the basin. Rather than opening a gate in mid-summer and closing it in late fall, this project would allow for improved control of water releases throughout the year to better mimic more natural flow conditions in the system.

Currently, water is typically released from one lake each year on a rotating basis, meaning that water is released for any given lake about once every 5 years. Under the proposed project, flows could be released from up to all five lakes on an as-needed basis each year. This would provide more flexibility for how flows from the lakes could be managed and greater security that there would be more water in Lower Icicle Creek available to users, including fish, in the later summer months when instream flows are typically lower.

While all the lakes would experience some level of draw down each year (versus less frequently under existing conditions), the overall impact on water quality in the lakes is expected to be beneficial. This is because the proposed project would likely reduce the annual extent of draw down in individual lakes, which would help reduce temperature fluctuations. In addition, the high and low lake levels would not change and water levels would continue to be drawn down at each lake over the course of several months similar to existing conditions. Groundwater around the lakes is limited because they are mostly surrounded by rock. Therefore, this project is not anticipated to result in substantial changes to water quality related to increased turbidity in the lakes or impacts on groundwater quality.

Annual usage of all five lakes could also reduce the amount of sediment accumulation around the outlet structures when gates are closed for extended periods of time. This would result in a reduction in sediment released into receiving waters when the gates are again opened for streamflow augmentation.

Likewise, the resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. During high-flow years, there could also be a potential for this project to result in a reduced contribution by the lakes to peak flows that might otherwise contribute to increased erosion and flooding.

Overall, increased instream flows, particularly in the summer and fall when flows are lower, would help to lower water temperatures, increase dissolved oxygen, and improve other water quality parameters. The potential impacts are not expected to exceed the water quality standards that are important to the beneficial uses designated for Icicle Creek or the Wenatchee River.

IPID Irrigation Efficiencies

In the long term, water conservation achieved through the implementation of irrigation efficiency measures by IPID would reduce the volume of water carried by spillways that return unused water and agricultural runoff from irrigated areas to the Wenatchee River and its tributaries. This condition could have both adverse and beneficial effects on water quality in these receiving waters and further downstream in the Columbia River. The reduction in flow moving through these features would reduce the opportunity for dilution, potentially increasing the nutrient concentration of the water being discharged. Over time, however, nutrient loading in spillways might decrease as on-farm conservation strategies reduce the amount of nutrient-laden runoff that is returned to these spillways. The transport of pesticide residues and other contaminants into these features may also decrease over time for the same reason. Decreased flows in these systems could also reduce the potential for bank erosion and the transport of sediments and other contaminants into receiving waters. Aside from some changes in the quantity of groundwater recharge, no long-term changes affecting groundwater quality would occur. Overall, long-term impacts are not expected to exceed the water quality standards that are important to the beneficial uses designated for Icicle Creek or the Wenatchee River.

COIC Irrigation Efficiencies and Pump Exchange

Effects of the COIC Irrigation Efficiencies and Pump Exchange Project would be similar to those expected for the IPID Irrigation Efficiencies Project. In addition, relocating the COIC diversion would conserve water and potentially increase instream flow downstream of RM 5.7 to the Wenatchee River. This would also contribute to lowering stream temperatures and increasing dissolved oxygen in that portion of Icicle Creek.

Domestic Conservation Efficiencies

Long-term water quality impacts from the implementation of domestic conservation activities are expected to be minimal. Water conserved through this project would be made available to improve domestic supply, and domestic conservation is expected to have negligible effects on streamflow in Icicle Creek. Over the long term, implementation of domestic conservation would not cause water quality degradation such that the designated use water quality criteria for Icicle Creek and the Wenatchee River would be violated.

Eightmile Lake Storage Restoration

Operation of the proposed facilities for the Eightmile Lake Storage Restoration Project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. Because the facilities would be remotely operated by IPID, the greatest potential for impacts to water quality over the long term would occur as the result of maintenance trips to and from the lake, which are anticipated to be less than would occur under the No-action Alternative, and any changes in operations with respect to how lake levels are managed.

The frequency in fluctuations in lake levels would increase compared to existing conditions but could be similar to the No-action Alternative should this project move forward. Lake levels would also be able to reach higher or lower levels compared to existing conditions; however, this variation would remain within the levels historically achieved at the lake. Long-term water quality impacts include less than significant increases in erosion potential and turbidity in the lake and Eightmile Creek as a result of the changes in lake level management.

Groundwater immediately surrounding the lake in many cases is limited by the presence of large rocks and boulders. Lake fluctuation could potentially alter the pattern of groundwater recharge as discussed in Section 4.4, Groundwater Resources, but would generally be similar to existing natural processes and would not result in substantial changes such that groundwater quality would be significantly affected.

Downstream of the lake, water quality impacts are expected to be largely beneficial as the ability to release flow into Icicle Creek in the late summer or in drought years would increase in frequency and duration. Overall, expected water quality impacts would not result in the exceedance of the water quality criteria associated with any of the designated uses for Eightmile Lake or its receiving waters.

Tribal Fishery Preservation and Enhancement

Because the overall goal of this project is to protect and enhance the tribal fishery, it is expected that most of the impacts on water quality would be beneficial and would improve fish habitat in Icicle Creek. Long-term impacts to water quality from the Tribal Fishery Preservation and Enhancement Project could alter sedimentation and scour patterns and increase turbidity in sections of Icicle Creek as a result of changes in water flow management practices at LNFH Structures 2 and 5. Although maintenance of flows over the LNFH Hatchery Channel spillway would induce turbulence and scour, potentially increasing turbidity downstream from the spillway, the increased air entrainment resulting from this turbulence would increase dissolved oxygen levels in the stream, which would be beneficial. Overall, the proposed Tribal Fishery Preservation and Enhancement Project would not result in the exceedance of the water quality criteria associated with any of the designated uses for Icicle Creek or its receiving waters.

Habitat Protection and Enhancement

Riparian and instream habitat protection and enhancement projects are expected to improve water quality in Icicle Creek and the Wenatchee River over the long term, and no changes are proposed that would affect groundwater. Potential improvements include reduction in water temperatures from increased riparian shading and instream structures, decreased sedimentation and erosion potential from improved riparian runoff filtration and bank stabilization, and increased nutrient and dissolved oxygen concentrations from improved instream structure and fish habitat. Minor increases in turbidity may occur in certain locations (e.g., downstream of scour holes) but are expected to be within the range of natural variation. Depending on past and current land use, reconnection of floodplains in the lower reach could allow the introduction of contaminated sediment into the system during flood events and the transportation of this sediment to downstream water bodies.

Overall, the proposed habitat protection and enhancement projects would contribute to enhanced stream health, increased watershed functions, and improved water quality in the basin. This project is not anticipated to adversely affect any of the water quality criteria for designated uses in Icicle Creek or the Wenatchee River. Corresponding effects on groundwater quality are anticipated to be minimal.

Instream Flow Rule Amendment

Under the Instream Flow Rule Amendment Project, the Icicle Creek Reserve established under Chapter 173-545 WAC would be increased by 0.4 cfs. Over the long term, this amendment would ultimately result in the removal of additional water from Icicle Creek but only after habitat restoration elements are implemented. Additional water withdrawals could result in reduced instream flows, which could adversely affect water quality in portions of Icicle Creek. Reduced instream flow could lead to higher water temperatures, reduced dissolved oxygen concentrations, and increased pollutant concentrations in the stream. Corresponding effects on groundwater are anticipated to be minimal and similar to existing recharge processes. No instream flow reduction would occur in the Wenatchee River because this project would move 0.4 cfs out of the Wenatchee River Reserve specifically for Icicle Creek withdrawals.

Potential water quality impacts associated with the Instream Flow Rule Amendment Project are anticipated to be offset by the implementation of required instream flow and habitat restoration actions under this Program Alternative as well as several other projects associated with Alternative 1. The water quality benefits from habitat project implementation will exceed any water quality impacts from flow reduction of this element.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

Over the long term, the water conservation and water quality improvement elements proposed at LNFH under this project are expected to benefit water quality in Icicle Creek and the Wenatchee River and improve groundwater recharge near LNFH. Water quality improvements at LNFH are expected through the implementation of facility upgrades and operational improvements. These actions would lead to compliance with relevant TMDLs for the Wenatchee River Watershed and would ultimately be designed to avoid additional water quality impacts in the basin.

In addition, most of the work included under this project is designed to improve water use efficiency at LNFH and to develop additional groundwater supplies such that less water would need to be diverted from Icicle Creek for hatchery operations. Such actions would potentially support higher flows in the system, which would benefit multiple water quality parameters, including temperature and dissolved oxygen content. However, the effluent pumpback could impact shallow groundwater quality, particularly temperature and phosphorus. This shallow groundwater is expected to release to surface water in a relatively short timeframe. The temperature and phosphorus discharge to surface water is an already existing condition. This impact is expected to be less than significant, but will be examined more during NEPA review.

Overall, improvements to the LNFH are expected to provide water quality benefits and would not adversely affect designated uses in Icicle Creek or the Wenatchee River.

Fish Passage Improvements

Over time, the Fish Passage Improvement Project could result in increased fish populations in portions of Icicle Creek where access was previously restricted; however, no long-term changes in water quality would be expected and no changes are proposed that would affect groundwater quality.

These types of water quality impacts would most likely occur during periods of low flow and would likely be mitigated by the other projects proposed under Alternative 1 that are designed to increase instream flows. Overall, this project is not anticipated to adversely affect any of the water quality criteria for designated uses in Icicle Creek or the Wenatchee River.

Fish Screen Compliance

Once the Fish Screen Compliance Project is completed, there is a potential for minor impacts to water quality related to increased fish in Icicle Creek similar to the long-term impacts related to the Fish Passage Improvements Project described above.

Water Markets

Implementation of the Water Markets Project could alter water use in Icicle Creek and thereby affect water quantity and quality in the system. This project would provide mitigation water to interruptible agricultural water users during years when the instream flow rule is not met, and provide instream flow benefit in years that mitigation would not be needed. During years when mitigation is not needed, the increase in instream flows from the unexercised water rights could be beneficial for multiple water quality parameters, including temperature and dissolved oxygen, while potentially causing minor increases in turbidity. Effects would depend on the location, volume, and sources of the flow increases. The Water Markets Project is not expected to have an adverse impact on designated uses in Icicle Creek or the Wenatchee River. Corresponding effects on groundwater are anticipated to be minimal and similar to existing recharge processes.

4.5.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. Compliance with the Guiding Principles addresses water quality in general by improving instream flows, sustainability at the LNFH, and Icicle Creek aquatic and riparian habitat. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Other project impacts are discussed under Alternative 1 and impacts of not implementing projects under the No-action Alternative.

4.5.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction of a new IPID Dryden Pump Exchange would require both in-water and riverbank work on the Wenatchee River, including the placement and removal of instream cofferdams, removal of streamside vegetation, excavation of the streambed and bank, and dewatering groundwater in the construction zone. These activities could result in short-term impacts on water quality including temporary increases in turbidity, sedimentation, and the potential re-suspension of contaminated sediments. Increased risk of contamination from the placement of raw concrete and the use of construction equipment in or near waterways, including potential short-term impacts on groundwater, would also occur. Construction of the proposed delivery facilities could also result in similar water quality impacts in the PID Canal. However, it is anticipated that delivery facilities would be constructed in the off-season when the canal is completely dewatered, which would reduce or eliminate potential impacts to waters conveyed in the PID Canal to spillways that discharge water back to the Wenatchee River or its tributaries.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include restricting work to periods when the irrigation canals are dewatered, restricting in-water access to periods of low flows, and implementing BMPs designed to reduce the potential for erosion and inadvertent water contamination from construction equipment and other sources (Section 4.5.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on water quality would be less than significant and are unlikely to result in violation of the water quality standards associated with the designated uses assigned to the Wenatchee River and its tributaries.

4.5.3.2 Long-term Impacts

IPID Dryden Pump Exchange

Potential long-term impacts on water quality from the IPID Dryden Pump Exchange Project are expected to be largely beneficial. By installing the pump station downstream from IPID's current diversion, IPID could reduce the volume of water withdrawn from their existing diversions on Icicle Creek, augmenting late summer streamflow in the creek below RM 5.7 by 25 cfs. There would also be stream flow benefit in the Wenatchee River from its confluence with Icicle Creek. Increasing streamflow during this period would have positive effects on instream water temperatures and dissolved oxygen content. The project would also augment streamflow in Peshastin Creek below the IPID diversion at RM 2.4. In addition, other elements of this project would enable the more efficient delivery of irrigation water, which could reduce withdrawals from the system. Overall, long-term impacts are not expected to exceed the water quality standards that are important to the beneficial uses designated for Icicle Creek or the Wenatchee River. Corresponding effects on groundwater are anticipated to be minimal and similar to existing recharge processes.

4.5.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 Project needed to allow for permitting additional domestic supplies would be included while the Eightmile Lake Storage Restoration Project would not. This section describes the specific short- and long-term impacts associated with the legislative change. Compliance with the Guiding Principles addresses water quality in general by improving instream flows, sustainability at the LNFH, and Icicle Creek aquatic and riparian habitat. The short- and long-term impacts of all other projects proposed under Alternative 3 are discussed under Alternative 1 and Alternative 2. Water quality impacts from not implementing the Eightmile Lake Storage Restoration Project are discussed under the No-action Alternative.

4.5.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

The proposed legislative change to OCPI to address domestic use and instream flow impacts is a legislative change that would not involve any construction work. As such, it would not cause any short-term impacts on water quality.

4.5.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority Project were enacted, there could be potential conflicts with instream flow allocations. Under the proposed changes, junior domestic water rights could be exercised even when the instream flow rule is not met, resulting in potential adverse impacts on water quality as a result of low flow conditions. Water quality parameters that could be affected include temperature, dissolved oxygen, and concentrations of nutrients and contaminants. Potential changes affecting groundwater quality are not expected. Depending on the instream conditions at the time domestic rights are exercised, water quality standards for some of the other uses designated for Icicle Creek (e.g., aquatic life uses, recreation) may not be able to be met and could violate the antidegradation regulations. However, Alternative 3 provides up to 71 cfs of instream flow benefit, but given the timing of the project benefits, perfect in-time flow mitigation would not be available.

4.5.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1 with the exception that the Eightmile Lake, Upper Klonaqua, and Upper and Lower Snow Lakes Storage Enhancement Projects would be included. Compliance with the Guiding Principles addresses water quality in general by improving instream flows, sustainability at the LNFH, and Icicle Creek aquatic and riparian habitat. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No Action Alternative.

4.5.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

Short-term impacts on water quality from the Eightmile Lake Storage Enhancement Project would primarily be associated with construction and are similar in type and mechanism to the short-term water quality impacts identified for the Eightmile Lake Storage Restoration Project (Section 4.5.2.1, Alternative 1, Eightmile Lake Storage Restoration), but longer in duration and greater in extent.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include requiring all in-water work to be performed in the dry and implementing construction BMPs designed to reduce the potential for erosion and inadvertent contamination from vehicle fluids, uncured concrete, human waste, and other sources (Section 4.5.6, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on water quality would be less than significant and are unlikely to result in violation of the water quality standards associated with the designated uses assigned to the Wenatchee River and its tributaries.

Upper Klonaqua Lake Storage Enhancement

Short-term impacts on water quality from the Upper Klonaqua Lake Storage Enhancement project would be primarily related to construction activities and are similar in type and mechanism to those discussed for the Eightmile Lake Storage Enhancement Project.

Specific construction activities that could result in water quality impacts include the transportation of construction equipment and materials to the project site; draw down of the lakes to isolate in-water work areas; groundwater dewatering during installation of the new outlet and pipeline; demolition of the existing dams and water control structures; removal of vegetation, excavation, and fill placement to install new low-level outlet piping; and the placement of concrete and other materials to construct new dam. Water quality impacts that could result from these activities include short-term increases in turbidity, water temperature, erosion potential, and the risk of contamination from vehicle fluids and uncured concrete.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include requiring all in-water work to be performed in the dry and implementing construction BMPs designed to reduce the potential for erosion and inadvertent contamination from vehicle fluids, uncured concrete, human waste, and other sources (Section 4.5.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on water quality would be less than significant and are unlikely to result in violation of the water quality standards associated with the designated uses assigned to the Wenatchee River and its tributaries.

Upper and Lower Snow Lakes Storage Enhancement

Short-term impacts on water quality from the Upper and Lower Snow Lakes Storage Enhancement Project would be primarily related to construction activities and are similar in type and mechanism to those discussed for the Eightmile Lake Storage Enhancement Project except no groundwater dewatering would be needed.

Specific construction activities that could result in water quality impacts include the transportation of construction equipment and materials to the project site; draw down of the lakes to isolate in-water work areas; demolition of the existing dams and water control structures; removal of vegetation, excavation, and fill placement to install new low-level outlet piping; and the placement of concrete and other materials to construct new dams. Water quality impacts that could result from these activities include short-term increases in turbidity, water temperature, erosion potential, and the risk of contamination from vehicle fluids and uncured concrete.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include requiring all in-water work to be performed in the dry and implementing construction

BMPs designed to reduce the potential for erosion and inadvertent contamination from vehicle fluids, uncured concrete, human waste, and other sources (Section 4.5.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on water quality would be less than significant and are unlikely to result in violation of the water quality standards associated with the designated uses assigned to the Wenatchee River and its tributaries.

4.5.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. The greatest potential for impacts on water quality over the long term would occur as the result of disturbance during maintenance and changes in operations with respect to how lake levels are managed that might influence increased erosion and turbidity.

Because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, this project would result in the ability to maintain the lake at higher than historical levels compared to existing conditions and the No-action Alternative.

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. If the dam height is increased to enhance storage, the lake would be able to fill to a new high water surface of 4,682 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,677 feet to the height of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch in the early summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,682 feet. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline would be under water. Shoreline areas up to 4,671 feet have been historically inundated, but areas above 4,671 feet to 4,682 feet have not been inundated. The additional area would be under water for a little less than a month each summer. The project would also allow for the lake to be drawn down below existing lake levels to an elevation of 4,619 feet, which is approximately 24.4 feet lower than the existing low. This change would result in the exposure of slightly more lake bed, mainly in the later summer months and early fall up to the point when the water would no longer be drawn down, generally around the end of September. The additional draw down is not expected to result in increased erosion by comparison, because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

Groundwater immediately surrounding the lakes in many cases is limited by the presence of large rocks and boulders. Lake fluctuation could potentially alter the pattern of groundwater recharge as discussed in Section 4.4, Groundwater Resources, but would generally be similar to existing natural processes and would not result in substantial changes such that groundwater quality would be significantly affected.

Likewise, the resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. There could also be a potential for this project to result in a reduced contribution by the lakes to peak flows that might otherwise contribute to increased erosion and flooding. Even though flows in Icicle Creek would be increased compared to existing conditions, as discussed in Section 4.3, Surface Water Resources, instream flow targets under this project would remain within existing high and low flow rates. Potential effects on fish, wildlife, aesthetics, and recreation are discussed in Sections 4.7, Fish; 4.9, Wildlife; 4.11, Aesthetics; and 4.15, Recreation. Overall, potential long-term impacts on water quality are not expected to conflict with the designated uses assigned to Icicle Creek or the Wenatchee River.

Upper Klonaqua Lake Storage Enhancement

Potential long-term impacts to shorelines of Klonaqua Lake would be similar to those described under the Eightmile Lake Storage Enhancement Project (Section 4.5.5.2, Long-term Impacts, Eightmile Lake Storage Enhancement). Potential benefits would mainly occur in Icicle Creek and would include an increased ability to augment stream flow in the late summer or during drought years, with flow augmentation primarily benefitting Reach 1.

The frequency in fluctuations in lake levels in Upper Klonaqua Lake would increase compared to existing conditions and the No-action Alternative. Lake levels would also be drawn down further compared to existing conditions.

The high lake level in Upper Klonaqua Lake would not change. The lake would still refill and outlet naturally through an existing channel to Lower Klonaqua Lake during most of the year. However, the new facilities would allow for the lake to be drawn down an additional 20 to 50 feet and allow for access to an additional 1,146 to 2,448 acre-feet of storage. The draw down would likely occur over a couple of months in the late summer. The additional draw down is not expected to adversely affect water quality by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

Groundwater immediately surrounding the lakes in many cases is limited by the presence of large rocks and boulders. Lake fluctuation could potentially alter the pattern of groundwater recharge as discussed in Section 4.4, Groundwater Resources, but would generally be similar to existing natural processes and would not result in substantial changes such that groundwater quality would be significantly affected.

Likewise, the resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. During high-flow years, there could also be a potential for this project to result in a reduced contribution by the lakes to peak flows that might otherwise contribute to increased erosion and flooding.

Even though flows in Icicle Creek would be increased compared to existing conditions, as discussed in Section 4.3, Surface Water Resources, instream flow targets under this project would remain within existing high- and low-flow rates. Potential effects on fish, wildlife, aesthetics, and recreation are discussed in Sections 4.7, Fish; 4.9, Wildlife; 4.11, Aesthetics; and 4.15, Recreation. Overall, potential long-term impacts to water quality are not expected to conflict with the designated uses assigned to Icicle Creek or the Wenatchee River.

Upper and Lower Snow Lakes Storage Enhancement

Potential long-term impacts to shorelines would be similar to those described under the Eightmile Lake Storage Enhancement Project (Section 4.5.5.2, Long-term Impacts, Eightmile Lake Storage Enhancement). Potential benefits would mainly occur in Icicle Creek and would include an increased ability to augment stream flow in the late summer or during drought years, with flow augmentation primarily benefitting the section of Icicle Creek in Reaches 2 through 5.

The proposed enhancement project would increase the high-water storage levels in both Upper and Lower Snow Lakes by 5 feet compared with existing high levels. This change would result in the inundation of some upland vegetation that has grown along the shoreline areas between the current and proposed high lake levels, most likely occurring in the fall through the early summer when releases would be likely to begin. The project would also allow for the Lower Snow Lake to be drawn down 3 feet below the current lake level, which would result in the exposure of slightly more lake bed. The additional draw down is not expected to adversely affect water quality by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

Groundwater immediately surrounding the lakes in many cases is limited by the presence of large rocks and boulders. Lake fluctuation could potentially alter the pattern of groundwater recharge as discussed in Section 4.4, Groundwater Resources, but would generally be similar to existing natural processes and would not result in substantial changes such that groundwater quality would be significantly affected.

Likewise, the resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. During high-flow years, there could also be a potential for this project to result in a reduced contribution by the lakes to peak flows that might otherwise contribute to increased erosion and flooding.

Even though flows in Icicle Creek would be increased compared to existing conditions, as discussed in Section 4.3, Surface Water Resources, instream flow targets under this project would remain within existing high and low flow rates. Potential effects on fish, wildlife, aesthetics, and recreation are discussed in Sections 4.7, Fish; 4.9, Wildlife; 4.11, Aesthetics; and 4.15, Recreation. Overall, potential long-term impacts on water quality are not expected to conflict with the designated uses assigned to Icicle Creek or the Wenatchee River.

4.5.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange project would be included.

4.5.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

Construction of the new IPID Full Piping and Pump Exchange Project includes removal of existing diversion facilities and construction of new pump stations and intake facilities. The work would require both in-water and riverbank work on the Wenatchee River, including the placement and removal of instream cofferdams, removal of streamside vegetation, excavation of the streambed and bank, and dewatering groundwater in the construction zone. The project also involves fully replacing the existing IPID canal systems with a pressurized pipe delivery system, which would require ground disturbance throughout the system. The existing intakes on Icicle and Peshastin Creeks would also be removed or abandoned. These activities could result in short-term impacts on water quality including temporary increases in turbidity, sedimentation, and the potential re-suspension of contaminated sediments. Increased risk of contamination from the placement of raw concrete and the use of construction equipment in or near waterways, including potential short-term impacts on groundwater, would also occur.

Conversion of the IPID conveyance system to pipelines could also result in similar water quality impacts in the IPID canal system. However, it is anticipated that any work to these features would be done in the off-season when the canals are dewatered, which would reduce or eliminate potential impacts to waters conveyed in the IPID system that discharge water back to the Wenatchee River or its tributaries.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include restricting work to periods when the irrigation canals are dewatered, restricting in-water access to periods of low flows, and implementing BMPs designed to reduce the potential for erosion and inadvertent water contamination from construction equipment and other sources (Section 4.5.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on water quality would be less than significant and are unlikely to result in violation of the water quality standards associated with the designated uses assigned to the Wenatchee River and its tributaries.

Because Ecology's current Water Quality Assessment (Ecology, 2016) records multiple Category 5 water quality impairment listings for the Wenatchee River, including five for polychlorinated biphenyls, five for 4,4'-DDE, and one for endosulfan, any excavation work in the river to construct the pump stations would need to address the potential presence of these and other contaminants in the substrate. As long as construction activities comply with required permit terms and conditions, including those in the Water Quality Certification that would be required by Ecology, it is unlikely that this project would result in violations of the water quality standards associated with the designated uses of the affected water bodies. Short-term impacts on water quality would not be significant.

4.5.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange Project

Potential long-term impacts on water quality from the IPID Full Piping and Pump Exchange Project are expected to be largely beneficial. By installing the pump station downstream from IPID's current diversion, IPID could reduce the volume of water withdrawn from their existing diversions on Icicle Creek and Peshastin Creek, with more water instead being drawn from the Wenatchee River. This project would increase stream flow in both Icicle and Peshastin Creeks. Increasing streamflow during this period would have positive effects on instream water temperatures and dissolved oxygen content. In addition, other elements of this project would enable the more efficient delivery of irrigation water, which could reduce withdrawals from the system. Overall, long-term impacts are not expected to exceed the water quality standards that are important to the beneficial uses designated for Icicle Creek or the Wenatchee River. Corresponding effects on groundwater are anticipated to be minimal and similar to existing recharge processes.

4.5.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.5.7.1 Short-term Impacts

Short-term impacts on water quality would be mitigated by complying with the terms and conditions of local, state, and federal water quality regulations and project-specific permits, including local building, grading, and stormwater construction permits; state stormwater permits; SMA shoreline permits; HPAs; and CWA Section 404 permits and their associated Section 401 Water Quality Certifications, among others.

Local approvals could include building and grading permits and other construction-related authorizations for construction work within the limits of a municipality or county. Construction projects could also require a Construction Stormwater General Permit from Ecology. Projects involving work along shorelines or banks of lakes and streams would potentially require some type of shoreline permit under the state's SMA, which is administered by either local entities (e.g., City of Leavenworth, Chelan County) or Ecology. Projects that would use, divert, obstruct, or otherwise change the natural flow or bed of any water of the state require an HPA authorization from WDFW under the Washington State Hydraulic Code.

In addition to these state and local permits, any work that would involve the placement of dredged or fill material below the ordinary high water mark (OHWM) of a water of the United States (e.g., streams, rivers, lakes, wetlands) would require authorization from the USACE, Seattle District, under Section 404 of the CWA. Projects requiring a Section 404 Permit would also need a Water Quality Certification from Ecology under Section 401 of the CWA, which certifies that a project will comply with state water quality standards and other aquatic resources protection requirements under Ecology's authority.

Common permit conditions are likely to include specific in-water work restrictions, worksite isolation procedures, and post-construction restoration requirements designed to avoid and minimize impacts on multiple types of natural resources, including water quality. In addition, contractors would be required to prepare and implement a spill prevention, control, and countermeasure plan and develop and implement a temporary erosion and sediment control plan prior to the commencement of construction activities.

During construction, BMPs to control, isolate, and contain stormwater runoff, erosion, fluids from construction equipment, and uncured concrete would also be used to further minimize potential impacts on water quality. Turbid or contaminated dewatering water would be treated prior to discharge as necessary to comply with the requirements of the Washington Administrative Code, HPA, construction NPDES permit, and/or the local grading permit. Contracts for construction projects would also include site-specific restoration requirements to ensure that all disturbed areas are appropriately stabilized and routinely monitored following the completion of construction.

4.5.7.2 Long-term Impacts

Local long-term effects on water quality are possible for some of the projects, but they would be mitigated with both local measures and net benefits from changes in the operations of the system. Water quality impacts could further be mitigated through evaluations that consider site-specific characteristics to aid in design and selection of individual projects.

In most cases, the potential for long-term water quality impacts would be mitigated by applicable permit requirements for the construction and operation of the project. Project design and permitting would occur within the existing TMDL implementation framework. Water quality monitoring throughout the system would be used to document the effectiveness of the various flow augmentation, water conservation, and habitat enhancement projects. Long-term adaptive management plans and monitoring would also be beneficial for maintaining and enhancing water quality. Lake operational practices related to the timing and volume of storage releases can be structured to mitigate water quality impacts.

All long-term operational activities that relate to individual projects would require monitoring and approval to meet local, state, or federal regulatory requirements for water quality. Ecology is the lead agency in charge of administering and enforcing the various rules and regulations governing water use and water quality in the State of Washington. Ecology's Water Quality Program is responsible for reviewing plans before construction to ensure all state and local water quality standards and requirements are met.

4.6 Water Use

4.6.1 No-action Alternative

4.6.1.1 Short-term Impacts

Under the No-action Alternative, various agencies and other entities would continue to undertake individual actions to restore and enhance fish and aquatic resources in the Icicle Creek Watershed project area, but those actions would not be part of a coordinated program implemented with the support of the IWG. Actions implemented by individual agencies and entities could include construction of diversion improvements, irrigation system upgrades, LNFH improvements, and fish passage work.

Project construction could temporarily impact water supply, especially for construction work on or near a point of diversion. These projects could be timed and coordinated to minimize these impacts. Generally, short-term, construction related impacts to water use would be less than significant.

4.6.1.2 Long-term Impacts

Under the No-action Alternative, some water quantity issues may be eased, while some would likely persist.

Several projects aimed at out-of-stream uses may persist under the No-action Alternative. These would likely include improvements to irrigation reliability by implementing piping and lining efforts, and maintenance and improvements at IPID's alpine lakes infrastructure. However, the timing and magnitude of these projects will likely be different under the No-action Alterative.

Some domestic conservation is likely to occur under the No-action Alternative, and the instream flow rule might be amended if sufficient habitat improvements occur. This would allow for improved domestic supply. However, this increased supply would not meet projected demand through 2050 particularly for rural residents.

While it is expected that COIC and LNFH would continue to pursue water conservation to improve instream flow, there would only be modest progress made towards meeting the flows prescribed in the rule. Additionally, stream flow goals set for Reach 4 would consistently fail to reach to goals set by the IWG.

4.6.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in greater short-term impacts on use compared with the No-action Alternative because there would be higher likelihood that projects would be constructed, which could temporarily impact water use at construction projects near diversions. Alternative 1 would also improve water use conditions over the No-action Alternative. Long-term benefits would include increased water available for instream and out-of-stream uses, including water to meet growth projections. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.6.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction activities associated with the Alpine Lakes Optimization, Modernization, and Automation Project would involve replacing existing gates and installing solar panels, actuators, flow monitoring equipment, and other new equipment. This work would occur when the lakes are drawn down in late summer. Construction related impacts to water use could occur for construction projects near points of diversion, which would impact the ability to divert water. Construction associated with this project is not near an out-of-stream diversion. No short-term impacts to water use is expected to result from this project.

IPID Irrigation Efficiencies

Construction activities associated with the IPID Irrigation Efficiencies Project include the conversion of irrigation canals to pipelines, on-farm efficiency upgrades, and other traditional irrigation efficiency projects. Construction on the irrigation infrastructure could result in impacts to IPID water use. However, construction activities on water distribution infrastructure would likely occur outside the irrigation season to minimize effects on water use.

COIC Irrigation Efficiencies and Pump Exchange

Construction activities associated with the COIC Irrigation Efficiencies and Pump Exchange Project include a new surface water intake and pump station as well as piping existing canals. These construction activities could result in impacts to COIC water use. However, these construction actives would likely occur in a manner so as to not affect COIC’s water deliveries.

Domestic Conservation Efficiencies

Construction activities associated with the Domestic Conservation Efficiencies Project would include pipe replacement and meter installations. Additionally, some landscape modification could occur. These construction activities would be staged to minimize any impacts on water delivery to domestic customers.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would involve demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures. Construction activities would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down. Construction related impacts to water use could occur for construction projects near points of diversion, which would impact the ability to divert water. Construction associated with this project is not near an out-of-stream diversion. No short-term impacts to water use is expected to result from this project.

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effect on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. While to details of this project are not fully known, it is unlikely any construction activities would prevent a water use from diverting water from Icicle Creek. No short-term effects on what use have been identified.

Habitat Protection and Enhancement

Habitat protection and enhancement proposed under this project could involve grading, planting and thinning vegetation, and hauling and placing logs, rock, soil, and other materials. While to details of this project are not fully known, it is unlikely any construction activities would prevent a water use from diverting water from Icicle Creek. No short-term effects on what use have been identified.

Instream Flow Rule Amendment

There are no construction activities proposed under this project and therefore no potential short-term impacts on water use.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements geared toward improving water quality and hatchery rearing conditions at the LNFH. Reconstruction of the facilities intake structure could impact the facilities water use. Alterative water sources or temporary points of diversion would need to be identified prior to construction.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek, as well as instream modifications to the Boulder Field near RM 5.6. Work at the Boulder Field may have short-term impacts to IPID and the City of Leavenworth's diversion points. Construction activities would need to be coordinated with IPID and the City of Leavenworth to ensure service would not be interrupted.

Fish Screen Compliance

This project would involve replacing fish screens at three different diversions on Lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws. This construction work would occur at active water diversions, and could result in short-term disruptions to water use. Construction schedules would need to be coordinated with diverters to minimize any potential impacts.

Water Markets

There are no construction activities proposed under the Water Markets Project and therefore no potential short-term impacts on water use.

4.6.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Operation of the proposed facilities for the Alpine Lakes Optimization, Modernization, and Automation Project would involve a more efficient and flexible system for releasing flows from the lakes. This project would provide an additional 30 cfs and 5,465 acre-feet per year to the Icicle Creek System. This water would be managed exclusively for instream flow benefit during non-drought years. This would affect summer instream flows and likely increase the frequency when the flows prescribed in the Wenatchee Instream Flow Rule for Icicle Creek are met.

In drought years, IPID would continue operating these lakes for irrigation of lands within their service area. This project would improve operation so the district could more accurately and responsively release water from the lakes for their operational needs. The Snow Lake systems would continue to be operated by USFWS for streamflow benefit and for the operation of their diversion on Icicle Creek.

This project is not anticipated to have any negative long-term impacts on Icicle Creek diversionary rights. The resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. To protect this water instream, a change authorization or a new secondary use permit authorizing instream flows as a beneficial use for these storage rights would need to be issued for each lake. Issuance of these water rights would require analysis of beneficial use, impairment of senior users, potential detriment to the public interest, and water availability.

IPID Irrigation Efficiencies

Many elements of the IPID Irrigation Efficiencies Project include pipelines or canal improvements. The anticipated effect of this project is a decrease in IPID's water demand, and, consequently, a reduction in the amount of water diverted by the district from Icicle Creek. The reduction in demand is anticipated to increase stream flows in Icicle Creek and the Wenatchee River by 10 cfs and 3,000 acre-feet per year, from the historical point of diversion at Icicle Creek RM 7.5 to the historical point of return flows on the Wenatchee River.

This project is not anticipated to have any negative long-term impacts on Icicle Creek diversionary rights. The resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system.

COIC Irrigation Efficiencies and Pump Exchange

A new COIC pump station and intake facilities would be constructed on the Wenatchee River or Lower Icicle Creek. Moving the point of diversion would require a water right change authorization.

This project would increase flows by up to 11.9 cfs and 3,500 acre-feet per year on Icicle Creek.

Domestic Conservation Efficiencies

Implementing the Domestic Conservation Efficiencies Project would include improved leak detection, metering, conservation incentive, and conservation-oriented rate structure. Conserved water would be used to provide service to more ERUs within the City of Leavenworth service area and for rural domestic users.

Domestic conservation is not anticipated to affect instream flows or other water uses in the Icicle Creek Subbasin or in the Wenatchee River Watershed, where the City well field is located. Conserved water within the City of Leavenworth will help meet future municipal demand.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project involves restoring the Eightmile Lake Dam to its historical high water mark. This would provide an additional 900 acre-feet per year of storage in the Icicle Creek Subbasin over current conditions. This water would be utilized for instream flows and domestic use. The effects of this project on water use are related to these two uses.

The additional storage water would provide increased stream flow from Eightmile Lake Dam downstream to either RM 7.5 or RM 0, depending on where domestic and municipal water would be diverted. Providing additional water for instream flow would increase water use security for out-of-stream users who are junior to the instream flow rule. The resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. To protect this water instream, a new secondary use permit would need to be issued for instream flows as a beneficial use for the storage right. Issuance of this water right would require analysis of beneficial use, impairment of senior users, potential determent to the public interest, and water availability.

This water would also be used to provide for rural domestic and City of Leavenworth demand through 2050, which would also require a secondary use permit. This would increase the City of Leavenworth water right and water potentially available to other domestic uses without having impact on instream flows or affecting other water users in the Icicle Creek Subbasin. City of Leavenworth has expressed interest in taking available water resulting from this project from its Wenatchee River well fields, which would require a water right permitting action.

Tribal Fishery Preservation and Enhancement

The purpose of this project is to protect and enhance the tribal, as well as non-tribal, fishery. There are no anticipated long-term negative effects to water use associated with this project.

Habitat Protection and Enhancement

The purpose of this project is to protect and enhance habitat within the Lower Icicle Creek corridor, which is not anticipated to have long-term effects to water use.

Instream Flow Rule Amendment

Under the Instream Flow Rule Amendment Project, the City of Leavenworth's water reserve from Icicle Creek would be increased to support future domestic water supply demands projected through 2050. Over the long term, this amendment would ultimately result in the removal of additional water (up to 0.4 cfs) from Icicle Creek for domestic use, which would reduce stream flow in Icicle Creek. This is offset by the addition of water from other projects as part of this alternative. Additionally, this shifts a portion of the existing reserve from the Wenatchee River to Icicle Creek as contemplated by the original watershed planning effort, with no net increase for the basin. Additionally, streamflow and habitat restoration efforts, as required by WAC 173-545-090(1)(d)(iv), are expected to offset these long-term effects.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project consists of several proposals to improve instream water conservation and water quality at LNFH. The water conservation component is the most likely to have long-term effects on water use. Through implementing operational changes to reduce LNFH demand, more water would be left instream from RM 4.5 to RM 2.7. This would increase stream flow in Reaches 3 and 4 by up to 20 cfs and 14,454 acre-feet year-round. Because of the non-consumptive nature of the LNFH water right, the instream flow benefit would not extend past the hatchery outfall at RM 2.7. Additionally, restored groundwater use to historical permitted levels would create increased balance in hatchery water use between its surface and groundwater sources.

Fish Passage Improvements

This project involves modifying passage barriers in Icicle Creek to improve fish passage. While potential short-term impacts have been identified for construction at the Boulder Field, no long-term effects to water use are anticipated as a result of this project.

Fish Screen Compliance

The Fish Screen Compliance Project is not anticipated to have long-term effects on water use.

Water Markets

The Water Markets Project would create a water market on Icicle Creek and downstream on the Wenatchee River. This would result in fallowing senior agricultural lands, placing the water right into the TWRP, and issuing mitigated permits to downstream interruptible agricultural users that is offset by the retired use. The effects on water use would include increased stream flow and water resources for fish from the historical point(s) of diversion to the new points of diversion. This would likely include several reaches in Icicle Creek examined by the IWG, as well as in the Wenatchee River. Additionally, it would convert irrigators whose use was not permitted during water-short years into uninterruptible water users. Senior water rights that might be purchased and retired for a water bank have not been identified, so specific reach benefits to instream flow are unknown at this time.

4.6.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included and the Alpine Lakes Optimization, Modernization, and Automation Project would not be included. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Other project impacts are discussed under Alternative 1 and impacts of not implementing projects are discussed under the No-action Alternative.

4.6.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction of a new pump station under this project would likely not affect water use.

4.6.3.2 Long-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project would result in new pump exchange and intake facilities on the Wenatchee River. These intake facilities would decrease diversion on both Icicle Creek and Peshastin Creek by using Wenatchee River water to supply irrigation demand instead. This would result in a 25 cfs and 1,484 acre-feet per year increase in flows in Icicle Creek and the Wenatchee River from Icicle Creek RM 7.5 to Wenatchee RM 16.5. This would provide additional water resources for fish benefit and increased flow in Reaches 1 through 5 on Icicle Creek. Additionally, this project would likely increase the frequency when the flows prescribed in the Wenatchee Instream Flow Rule for Icicle Creek are met during summer months.

This project is not anticipated to have any negative long-term impacts on Icicle Creek, Peshastin Creek, or Wenatchee River diversionary rights. The resulting downstream changes in flows in these systems would be within the natural variation already occurring within the system.

4.6.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 Projects would also be included while the Eightmile Lake Storage Restoration Projects would not. This section describes the specific short- and long-term impacts associated with the Legislative Change Creating OCPI Authority for Alternative 3 Projects. Other project impacts are discussed under Alternative 1 and 2, and impacts of not implementing projects are discussed under the No-action Alternative.

4.6.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts with the potential to affect water use.

4.6.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority Project were enacted, there could be potential conflicts with instream flow allocations. Under the proposed changes, junior domestic water rights could be exercised even when the Instream Flow Rule is not met. This is particularly true for the winter months when flows often fall short of those prescribed in the Wenatchee Instream Flow Rule for Icicle Creek and no in-kind mitigation is available; although, these changes would be generally adverse for instream flow water rights established by WAC 173-545-060. Because these impacts are primarily anticipated for winter months, it is not anticipated to increase interruption of other water rights junior to the Instream Flow Rule.

This project would increase the amount of water available to the City of Leavenworth and provide for future residential and commercial growth within the City of Leavenworth's service area.

4.6.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1. The Eightmile Lake Storage Restoration Project would be replaced with the Eightmile Lake Storage Enhancement Project, and the Upper Klonaqua and Upper and Lower Snow Lakes Storage Enhancement Projects would also be included. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.6.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would involve demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures that would allow for an increase in the accessible storage at Eightmile Lake to 3,500 acre-feet. Construction activities would not likely affect water use.

Upper Klonaqua Lake Storage Enhancement

This project's construction activities would require the construction of a low-level outlet from Upper Klonaqua Lake to Lower Klonaqua Lake using one of the three conceptual connection options discussed in Chapter 2. Construction activities are not anticipated to affect water use.

Upper and Lower Snow Lakes Storage Enhancement

Construction activities related to this project are not anticipated to affect water use.

4.6.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is enhanced, the lake would be able to fill to a new high water surface of 4,682 feet. These changes would increase the accessible storage to 3,500 acre-feet, which is 1,000 acre-feet more than currently permitted by IPID's water right. This additional storage water would be used for instream flows and domestic use.

The additional storage water would provide increased stream flow from Eightmile Lake Dam downstream to either RM 7.5 or RM 0, depending on where domestic and municipal water would be diverted. The resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. To protect this water instream, a new secondary use permit would need to be issued for instream flows as a beneficial use for the storage right. Issuance of this water right would require analysis of beneficial use, impairment of senior users, potential detriment to the public interest, and water availability.

This water would also be used to provide for rural domestic and City of Leavenworth demand through 2050, which would also require a secondary use permit. This would increase the City of Leavenworth water right and water potentially available to other domestic uses without having impact on instream flows or affecting other water users in the Icicle Creek Subbasin. City of Leavenworth has expressed interest in taking available water resulting from this project from its Wenatchee River well fields, which would require a water right permitting action.

It is not anticipated that this project would have any other long-term effects on water use in the basin.

This activity would require a new storage permit and additional secondary use permits, as discussed in Section 4.6.6, Mitigation Measures.

Upper Klonaqua Lake Storage Enhancement

Potential long-term impacts to water use would be similar to those described under the Eightmile Lake Storage Enhancement Project. This project could provide up to 2,448 acre-feet of additional discharge from the Klonaqua Lake system. This additional storage water would be used for instream flows and domestic use.

The additional storage water would provide increased stream flow from Eightmile Lake Dam downstream to either RM 7.5 or RM 0, depending on where domestic and municipal water would be diverted. The resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. To protect this water instream, a new secondary use permit would need to be issued for instream flows as a beneficial use for the storage right. Issuance of this water right would require analysis of beneficial use, impairment of senior users, potential detriment to the public interest, and water availability.

This water would also be used to provide for rural domestic and City of Leavenworth demand through 2050, which would also require a secondary use permit. This would increase the City of Leavenworth water right and water potentially available to other domestic uses without having impact on instream flows or affecting other water users in the Icicle Creek Subbasin. City of Leavenworth has expressed interest in taking available water resulting from this project from its Wenatchee River well fields, which would require a water right permitting action.

It is not anticipated that this project would have any other long-term effects on water use in the basin.

This activity would require a new storage permit and additional secondary use permits, as discussed in Section 4.6.6, Mitigation Measures.

Upper and Lower Snow Lakes Storage Enhancement

Potential long-term impacts to water use would be similar to those described under the Eightmile Lake Storage Enhancement Project (4.6.5.2, Long-term Impacts). Increased storage capacity in the Snow Lakes system would be 1,079 acre-feet. This additional storage water would be used for instream flows and domestic use.

The additional storage water would provide increased stream flow from Upper Snow Lake Dam downstream to either RM 7.5 or RM 0, depending on where domestic and municipal water would be diverted. The resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. To protect this water instream, a new secondary use permit would need to be issued for instream flows as a beneficial use for the storage right. Issuance of this water right would require analysis of beneficial use, impairment of senior users, potential detriment to the public interest, and water availability.

This water would also be used to provide for rural domestic and City of Leavenworth demand through 2050, which would also require a secondary use permit. This would increase the City of Leavenworth water right and water potentially available to other domestic uses without having impact on instream flows or affecting other water users in the Icicle Creek Subbasin. City of Leavenworth has expressed interest in taking available water resulting from this project from its Wenatchee River well fields, which would require a water right permitting action

It is not anticipated that this project would have any other long-term effects on water use in the basin.

This activity would require a new storage permit and additional secondary use permits, as discussed in Section 4.6.6, Mitigation Measures.

4.6.6 Alternative 5

Alternative 5 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Full Piping and Pump Exchange Project would replace IPID Irrigation Efficiencies project. This section describes the specific short- and long-term impacts associated with the IPID Full Piping and Pump Exchange Project. Other project impacts are discussed under Alternative 1.

4.6.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

Construction of new pump stations under this project would likely not affect water use in the short-term. Construction of piping would occur outside the window of the irrigation season, and would not impact water use.

4.6.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

The IPID Full Piping and Pump Exchange Project would result in new pump stations and intake facilities on the Wenatchee River. These intake facilities would remove IPID's diversions on both Icicle Creek and Peshastin Creek by using Wenatchee River water to supply irrigation demand instead. This would result in a 117 cfs and 30,000 acre-feet per year increase in flows in Icicle Creek and the Wenatchee River from Icicle Creek RM 5.7 to the pump stations located in Leavenworth, Dryden, and Cashmere. This would provide additional water resources for fish benefit and increased flow in Reaches 1 through 5 on Icicle Creek. Additionally, this project would likely increase the frequency when the flows prescribed in the Wenatchee Instream Flow Rule for Icicle Creek are met during summer months.

This project is not anticipated to have any negative long-term impacts on Icicle Creek, Peshastin Creek, or Wenatchee River diversionary rights. The resulting downstream changes in flows in these systems would be within the natural variation already occurring within the system. This project would require water right change authorization to move the points of diversion from their historical locations to the proposed pump stations.

4.6.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.6.7.1 Short-term Impacts

Short-term impacts on water use is expected to be relatively limited. Specific mitigation measures would include coordination with water users whose infrastructure could be limited by construction activities.

4.6.7.2 Long-term Impacts

Long-term impacts on water use primarily relate to instream flows, reduced return flows, increased domestic use, and water right change authorizations. Nearly all of the projects require either a new or changed water right authority under Chapters 90.03 and 90.44 RCW. These statutes require no impairment to senior water rights, no detriment to the public interest, beneficial use, and availability. Meeting these criteria would mitigate potential effects on water use.

4.7 Fish

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.7, Fish, from construction and operation related to the No-action Alternative and Program Alternatives. Impacts on special-status species are addressed in Section 4.10, Threatened and Endangered Species.

4.7.1 No-action Alternative

4.7.1.1 Short-term Impacts

Projects likely to occur under the No-Action Alternative would likely result in short-term impacts that could affect aquatic habitat such as would occur from activities within the Alpine Lakes at the existing dam or from work within or adjacent to Icicle Creek or the Wenatchee River, such as might occur from dewatering of instream habitat, potential disturbance and displacement of juvenile salmonids and resident species, disturbance of shoreline habitat, increased water temperatures, sedimentation, fish passage obstruction, and potential for accidental spills of hazardous materials (i.e., uncured cement, fuel, hydraulic fluid). Short-term impacts affecting water quality are addressed in Section 4.5, Water Quality.

The agencies or entities implementing projects under the No-action Alternative would be required to comply with applicable local, state, and federal environmental review requirements as described in Section 5.2, Table 5-2. In the event of any potential adverse impacts, project applicants would be required to implement appropriate mitigation measures to reduce impacts on aquatic species, such as minimizing potential disturbance of aquatic habitat, including possibly excluding species from work areas or implementing any necessary timing restrictions for construction work (Section 4.7.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on fish would not be significant.

4.7.1.2 Long-term Impacts

The long-term impacts under the No-action Alternative are generally anticipated to be beneficial due largely to obligations that the USFWS has at LNFH to improve fish passage through hatchery structures, improve water diversion intake screening, maintain instream flow in the historical channel, and support the tribal and sport fisheries in Icicle Creek. In addition, conservation projects, irrigation improvements, and restoration projects implemented individually by other agencies and entities would provide a long-term benefit to fish and aquatic habitat through increased flow.

Currently, LNFH operators have observed an increase in fish mortality at LNFH (Irving, pers. comm.), which has been attributed in part to improved fish passage and decreased water supply into the hatchery. To address these issues, LNFH has reduced fish densities at the hatchery and increased flushing and chemical treatment. Improving water quality and quantity as part of the planned LNFH improvements would further help to reduce these impacts. While these measures are also expected to be implemented under the No-Action Alternative, the potential for this impact would likely remain.

In addition, because instream flow and fish habitat enhancement projects would not generally be coordinated with other activities in the Icicle project area, the benefits are not anticipated to be as great as they would under the other Program Alternatives. For example, proposed modifications at the Alpine Lakes would not result in management of the lakes for the benefit of fish. Depending on the specific location and extent of long-term changes affecting aquatic habitat, there is a potential for some projects to result in localized adverse impacts.

4.7.2 Alternative 1 (Base Package)

4.7.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

As discussed in Section 3.7, Fish, the Alpine Lakes do not appear to have naturally occurring fish populations. The lakes typically have low temperatures (8°C to 15°C in summer) (Dion et al., 1976) and low nutrient inputs that naturally limit fish metabolism, growth, and the development of food resources for fish. Because of the high altitude and cold temperatures, these lakes have low productivity levels and lack fish passage that would naturally support fish populations.

Several of the lakes have been artificially stocked with trout species that contribute to the recreational high lakes fishery, although none of the project lakes have been stocked or managed for these fish in recent years. Fish present in these lakes are likely descendants of stocked fish and most likely include cutthroat trout (*Oncorhynchus clarkii*), rainbow trout (*O. mykiss*), and lake trout (*Salvelinus namaycush*).

Most of the work would occur in upland areas. Some limited work would occur within the lake shorelines but within the dry areas on the lake margins when the lakes are drawn down at the end of the summer. As discussed in Section 4.5, Water Quality, construction is not anticipated to result in significant water quality impacts and would, therefore, not be expected to adversely affect fish or aquatic invertebrates. However, construction activities would result in increased noise that could affect these species, depending on the type of activity and whether these species were located in close proximity.

As noted in Section 4.14, Noise, the majority of construction activities would result in relatively minor noise increases associated primarily with hand-held tools. Normal fish behavior, such as foraging or use of refuge areas within the lakes, would not likely be adversely affected because fish would be able to move to other areas of the lake during construction. These activities are generally consistent with routine operation and maintenance activities that have occurred and would otherwise continue under the No-action Alternative.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions (Section 4.7.7, Mitigation Measures).

IPID Irrigation Efficiencies

Construction activities associated with the IPID Irrigation Efficiencies Project include the conversion of irrigation canals to pipelines, replacing or abandoning pipelines, lining of irrigation canals with concrete, and on-farm application efficiency upgrades. These activities are unlikely to adversely affect fish because the work would be done in the off-season when the irrigation canals are dry, and away from where these species may be found. As noted in Section 4.5, Water Quality, there would also be relatively limited potential for water quality impacts that could adversely affect aquatic habitat related to these activities.

COIC Irrigation Efficiencies and Pump Exchange

The COIC Irrigation Efficiencies and Pump Exchange Project includes conversion of irrigation canals to pipelines and construction of the new pump station along Icicle Creek or the Wenatchee River. Short-term impacts that could adversely affect fish and aquatic invertebrates include direct disturbance associated with work near or in water and any associated temporary impacts on aquatic habitat.

Canal work is unlikely to adversely affect fish because the work would be done in the dry during the off-season when the irrigation canals are dry, and away from where these species may be found. As noted in Section 4.5, Water Quality, there would also be relatively limited potential for water quality impacts that could adversely affect aquatic habitat related to these activities.

Construction of the COIC pump station would require in-water work along lower Icicle Creek or the Wenatchee River and has a higher potential to adversely affect fish and aquatic invertebrates. Potential impacts include increased risk of disturbance or harm from construction activities such as from installation of a cofferdam, increased potential for harm from noise and vibration, increased risks of water quality impacts adversely affecting aquatic habitat, and temporary loss of aquatic habitat during dewatering for in-water construction. Depending on the location and extent of these activities and the number and type of fish or aquatic invertebrates likely to be affected, short-term impacts could be significant.

Work within waters of the United States or State of Washington or within irrigation canals or spillways that reconnect to these waters would require a CWA Section 404

Permit and associated Section 401 Water Quality Certification; work in other portions of the irrigation system could require local review and authorization.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions (Section 4.7.7, Mitigation Measures.

Domestic Conservation Efficiencies

Construction activities proposed under the Domestic Conservation Efficiencies Project include pipeline replacement and meter installation. These activities are unlikely to adversely affect fish because the work would be done in the dry and away from where these species may be found. As noted in Section 4.5, Water Quality, there would also be relatively limited potential for water quality impacts that could adversely affect aquatic habitat related to these activities.

Eightmile Lake Storage Restoration

As noted previously, the Alpine Lakes typically have low temperatures (8°C to 15°C in summer) (Dion et al., 1976) and low nutrient inputs that limit fish metabolism and growth, and the development of food resources for fish. Because of high altitude and cold temperatures, Eightmile Lake has low productivity levels and lacks fish passage that would naturally support fish populations; however, as noted in Section 3.7, Fish, Eightmile Lake was stocked most recently in 2005 and descendants of these stocked fish may exist in this lake, most likely cutthroat trout, rainbow trout, and lake trout.

Construction activities would occur primarily in the dry lake margins in the later summer when the lake is drawn down and in Eightmile Creek immediately downstream of the dam. As discussed in Section 4.5, Water Quality, these activities are not anticipated to result in significant water quality impacts and would therefore not be expected to adversely affect fish or aquatic invertebrates. However, construction activities would result in increased noise that could affect these species, depending on the type of activity and whether these species were located in close proximity.

As noted in Section 4.14, Noise, most construction activities would result in relatively minor noise increases and normal fish behavior such as foraging or use of refuge areas within the lakes would not likely be adversely affected because fish would be able to move to other areas of the lake =. However, construction could involve some blasting. Blasting can directly harm fish and aquatic invertebrates from increases in noise and vibration. Depending on the species that may be within close proximity when blasting occurs, there is a potential for those species to be affected.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions (Section 4.7.7, Mitigation Measures).

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effect on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. The specifics of this project are not yet determined, but would involve elements of restoration along lower Icicle Creek that could result in streambank and in-water construction. At this stage, the primary options under consideration include the construction of facilities, such as plumbing to create a bubble curtain, sprayer, or other minor modifications to the LNFH, to promote favorable fishing conditions in the pool at the bottom of the spillway.

Potential short-term impacts on fish and aquatic invertebrates would occur mainly as a result of work in or within close proximity to water. Potential impacts include increased risk of disturbance or harm from construction activities such as from installation of a cofferdam, increased potential for harm from noise and vibration, increased risks of water quality impacts adversely affecting aquatic habitat, and temporary loss of aquatic habitat during dewatering for in-water construction. Depending on the location and extent of these activities and the number and type of fish or aquatic invertebrates likely to be affected, short-term impacts could be significant.

These types of activities would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to address these impacts (Section 4.7.6, Mitigation Measures).

Habitat Protection and Enhancement

Habitat protection and enhancement proposed under this project could involve grading, planting and thinning vegetation, and hauling and placing logs, rock, soil, and other materials along lower Icicle Creek. Potential short-term impacts on fish and aquatic invertebrates would occur mainly as a result of work in or within close proximity to water.

Potential impacts include increased risk of disturbance or harm from construction activities such as installation of a cofferdam, increased potential for harm from noise and vibration, increased risks of water quality impacts adversely affecting aquatic habitat, temporary loss of aquatic habitat during dewatering for in-water construction, and potential loss of riparian habitat. Depending on the location and extent of these activities and the number and type of fish or aquatic invertebrates likely to be affected, short-term impacts could be significant.

These types of activities would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to address these impacts (Section 4.7.7, Mitigation Measures).

Instream Flow Rule Amendment

There are no construction activities proposed under this project and therefore no potential short-term impacts on fish or aquatic invertebrates.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements geared towards improving water quality and hatchery rearing conditions at the LNFH. Many of these activities would occur within the existing hatchery, although some in-water work would also be required. In general, construction of these elements has the potential to affect fish, depending on the specific location and type of disturbance.

Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential short-term impacts under the NEPA would be completed once the full scope of the project is determined. Similar to the construction activities described above, various authorizations are likely to be required that would ensure that potential impacts would be avoided, minimized, or compensated as noted in Section 4.7.7, Mitigation Measures.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek, as well as instream modifications to the Boulder Field near RM 5.6. This work would result in disturbances along the streambank and within Icicle Creek that could potentially affect fish and aquatic invertebrates.

Potential impacts include increased risk of disturbance or harm from construction activities such as installation of a cofferdam, increased potential for harm from noise and vibration, increased risks of water quality impacts adversely affecting aquatic habitat, and temporary loss of aquatic habitat during dewatering for in-water construction. Depending on the location and extent of these activities and the number and type of fish or aquatic invertebrates likely to be affected, short-term impacts could be significant.

These types of activities would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to address these impacts (Section 4.7.7, Mitigation Measures).

Fish Screen Compliance

This project involves replacing fish screens at three different diversions on lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws. This work would result in disturbances along the streambank and within Icicle Creek.

Potential impacts include increased risk of disturbance or harm from construction activities such as installation of a cofferdam, increased potential for harm from noise and vibration, increased risks of water quality impacts adversely affecting aquatic habitat, and temporary loss of aquatic habitat during dewatering for in-water construction. Depending on the location and extent of these activities and the number and type of fish or aquatic invertebrates likely to be affected, short-term impacts could be significant.

These types of activities would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to address these impacts (Section 4.7.7, Mitigation Measures).

Water Markets

There are no construction activities proposed under the Water Markets Project and therefore no potential short-term impacts on fish or aquatic invertebrates.

4.7.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from the affected lakes. Over the long-term the greatest potential for affecting fish and aquatic invertebrates would be related to changes in how the lakes are managed and the resulting changes in flows in lower Icicle Creek.

Under this project, the frequency in fluctuations in lake levels would increase compared to existing conditions because some portion of each lake would likely be drawn down every year instead of relying on draw down of only one or two lakes per year; however, the high and low lake water levels at the lakes would not change. Operation of the proposed project would also potentially result in less draw down at any one lake because releases would be spread across all lakes and releases would be optimized to meet instream and water supply needs in lower Icicle Creek. Lake level variation would largely remain within the same parameters as existing conditions.

Accumulation of organic inputs and nutrient cycles in the lakes that support the aquatic food web are not expected to substantially change as a result of re-operation of the lakes. Although lakes could be affected each year compared to every few years, the changes in lake levels (e.g., highs and lows) would be consistent with existing operations and the current seasonal pattern of change.

Additional flows released from these lakes would also be more evenly spread out across receiving streams that flow into Icicle Creek and eventually the Wenatchee River. With more efficient operation of the lakes, flow releases to lower Icicle Creek could be better targeted to the periods when they are needed. In general, this would mean that there would be lower contributions to flows early in the season and there would be higher contributions, estimated at up to 30 cfs over 92 days, when flows are low later in the summer (Skalicky et. al. 2013).

The potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates because flows would be returned to more natural conditions. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries. These benefits are generally anticipated to extend to any listed critical habitat and essential fish habitat within Icicle Creek and its tributaries and the Wenatchee River.

Rearing juvenile steelhead trout (*O. mykiss*) have been chosen to generally represent how flow changes are expected to affect aquatic habitat mainly because this species is present year-round when others are not and juvenile rainbow trout or steelhead have been observed in all reaches of Icicle Creek. Assuming that the full 30 cfs was achieved in late summer, the WUA per 1,000 linear feet of stream, a measure of aquatic habitat area, could increase by as much as 24 percent for juvenile steelhead in the historical channel (RM 3.9 to 2.7) compared to existing conditions (Skalicky et al., 2013). The historical channel currently experiences the lowest flows in Icicle Creek compared to other reaches downstream of RM 9 because of diversion of water from this reach for LNFH and irrigators, with an average of 63 cfs in September (IFC, 2016). Flow-habitat relationships have not been evaluated upstream of RM 9. Specific changes in the amount of available habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the late summer would correspond to increased aquatic habitat.

Because flow releases from the lakes would be better regulated in the spring and early summer months, it is not anticipated that additions from the lakes would exacerbate natural extreme high-flow conditions in spring and early summer. Instead of water from one or two lakes being released for the duration of the irrigation season and contributing to peak flows, releases would be controlled remotely and would occur only as needed to support continued irrigation withdrawals that might otherwise conflict with minimum instream flow targets intended to protect aquatic habitat.

Elevated flows in Icicle Creek are also expected to improve fish passage through obstructions in Icicle Creek during late summer and fall, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout (*S. confluentus*) by allowing access to high quality habitat in the upper reaches of Icicle Creek. Potential impacts associated with improved fish passage can result in increased genetic mixing and increased competition between different species or distinct populations of the same species. These impacts are described in greater detail under Section 4.7.2.2, Long-term Impacts, Fish Passage Improvements; however, improving fish passage is generally considered to be beneficial overall.

There remains uncertainty around how the proposed patterns of release would affect resident fish in receiving tributaries immediately downstream of the lakes but upstream of Icicle Creek. Compared to existing conditions, all of these streams would receive water released from the lakes each year instead of every few years; however, the releases would likely be more intermittent compared to a steady release.

Increasing instream flows in downstream tributaries, including Icicle Creek, over the summer and fall could also alter the hydrology in areas in which upstream-migrating salmon currently tend to gather, which may alter the distribution pattern of fish and affect fishing opportunities on a localized basis. There is uncertainty at this time whether increasing instream flow would cause fish to distribute themselves more broadly or in different areas than they currently do. Potential impacts would be addressed in part by efforts to be completed under the Tribal Fishery Preservation and Enhancement Project as described in greater detail in Chapter 2.

As part of the overall Icicle Strategy, the Guiding Principles require flows to be managed to benefit aquatic species and minimize adverse impacts. An example of a strategy under consideration is prioritizing the timing of releases relative to potential impacts on downstream aquatic habitat. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.7.7, Mitigation Measures.

IPID Irrigation Efficiencies

In the long-term, the IPID Irrigation Efficiencies Project would contribute an estimated 10 cfs to instream flows in Reaches 2 through 5 and in the Wenatchee River to the point of historical return flows (approximately RM 5). Improving irrigation system efficiency is intended to benefit all fish in Icicle Creek, including ESA-listed spring-run Chinook salmon (*O. tshawytscha*), steelhead, and bull trout, by allowing more water to remain in the creek downstream of the IPID and COIC irrigation diversions from May through September.

Rearing juvenile steelhead have been chosen to generally represent how flow changes are expected to affect aquatic habitat mainly because this species is present year-round when others are not and juvenile rainbow trout or steelhead have been observed in all reaches of Icicle Creek. With respect to the IPID Irrigation Efficiencies, the WUA for juvenile steelhead could increase by as much as 9 percent in the historical channel. Implementation could increase habitat area in September and expand the benefit earlier in the season in mid- to late July. Specific changes in availability of habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the later summer would correspond to increased habitat.

Elevated flows in Icicle Creek are also expected to improve fish passage through obstructions in Icicle Creek during summer, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek. Potential impacts associated with improved fish passage can result in increased genetic mixing and increased competition between different species or distinct populations of the same species. These potential impacts are described in greater detail under Section 4.7.2.2, Long-term Impacts, Fish Passage Improvements, but are generally considered to be beneficial overall.

As part of the overall Icicle Strategy, efforts to characterize the impacts of the managed flows on fish species are ongoing. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.7.7, Mitigation Measures.

COIC Irrigation Efficiencies and Pump Exchange

Under the COIC Irrigation Efficiencies and Pump Exchange Project, installing pipelines would occur in areas that have already been developed with irrigation infrastructure and would not result in long-term adverse impacts on fish from operation and maintenance activities. However, the COIC pump station would create a permanent change in the near-field hydraulics and levels of vibration on lower Icicle Creek or on the Wenatchee River, depending on where it is located. In addition, the new facilities would result in limited loss of riparian vegetation.

As noted in Section 4.8, Vegetation, compliance with applicable regulations would minimize the potential impacts on habitat and ecosystem functions and values associated with siting and operating the proposed facilities and would help reduce potential adverse impacts on fish and aquatic invertebrates. Overall, the new facilities are anticipated to represent a net benefit over the current facilities because they would be designed according to the current NMFS guidelines to ensure fish-friendly irrigation diversion operations, for example by providing intake screens that would be designed to prevent entrainment of juvenile fish.

Improving irrigation system efficiency and changing the location of the point of diversion is intended to benefit all fish in Icicle Creek, including ESA-listed spring-run Chinook salmon (*O. tshawytscha*), steelhead, and bull trout, by allowing more water to remain in the creek downstream of the current COIC irrigation diversions. In the long term, this project would contribute to beneficial increases in instream flows in Icicle Creek from RM 4.5 to its confluence with the Wenatchee River. Instream flow increases are expected to be between 8.0 cfs and 11.9 cfs.

Rearing juvenile steelhead have been chosen to generally represent how flow changes are expected to affect aquatic habitat mainly because this species is present year-round when others are not and juvenile rainbow trout or steelhead have been observed in all reaches of Icicle Creek. With respect to the COIC Irrigation Efficiencies and Pump Exchange Project, the WUA for juvenile steelhead could increase by as much as 17 percent in the historical channel. Specific changes in availability of habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the later summer would correspond to increased habitat.

Under existing conditions, water is diverted from Icicle Creek at the existing COIC/LNFH diversion at RM 4.5. Under average and low-flow conditions, withdrawals by COIC most typically result in an adverse impact on fish habitat. Extreme high-flow conditions that occur in spring and early summer may reduce habitat value for resident fish that must seek refuge from high velocity flows. An increase to instream flow during the early part of the irrigation season could contribute to a minor reduction in WUA of approximately 1 percent (Granger, 2017); however, this would present a negligible impact to fish that are already adapted to naturally elevated flow during this time of year.

Elevated flows in Icicle Creek are also expected to improve fish passage through obstructions in Icicle Creek during summer, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek. Potential impacts associated with improved fish passage can result in increased genetic mixing and increased competition between different species or distinct populations of the same species. These impacts are described in greater detail under Section 4.7.2.2, Long-term Impacts, Fish Passage Improvements, but are generally considered to be beneficial overall.

As part of the overall Icicle Strategy, efforts to characterize the impacts of the managed flows on fish species are ongoing. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.7.7, Mitigation Measures.

Domestic Conservation Efficiencies

The implementation of the Domestic Conservation Efficiencies Project for the City of Leavenworth and rural users in the Icicle Creek Subbasin would not have a direct impact on fish populations or aquatic resources within Icicle Creek or the Wenatchee River. Water made available through domestic conservation upgrades would go to new domestic uses. This increased efficiency could reduce return flows from the City of Leavenworth, which would decrease flows in the Wenatchee River downstream of the Leavenworth Wastewater Treatment Plant. However, this decreased flow is expected to be minimal.

Eightmile Lake Storage Restoration

This project would result in the restoration of Eightmile Lake Dam to allow for storage of water in Eightmile Lake to the original spillway elevation (4,671 feet) and construction of an inflow pipeline that would facilitate draw down of the lake. These changes would provide the ability to store and release more water, consistent with historical operations at the lake and the volume allowed by the IPID water right (2,500 acre-feet). While the changes in the maximum lake level would be consistent with historical operations, this would represent a change compared to existing conditions as discussed further below. Over the long term, the greatest potential for impacts affecting fish and aquatic invertebrates would be related to the relative changes in lake levels and the resulting changes in flows in lower Icicle Creek.

With this project, the lake would be able to reach the restored height of 4,671 feet, allowing for 4 additional feet of storage compared to existing conditions. This means the surface area of the lake would be restored to cover approximately 3.6 additional acres, which would last for about 1 month in the early summer before IPID begins to draw down the lake. Under this project, the lake would also be able to be drawn down by an additional 22.4 feet compared to current operations, occurring in the late summer or early fall before natural precipitation and runoff begin to recharge the lake.

Compared with existing conditions, re-operation of the lake area would result in an increase in habitat for resident fish in the early summer and a decrease in late summer. The extent of the decrease in aquatic habitat would depend on how far the lake is drawn down each year.

During draw down, shallow water areas would become disconnected from shorelines that have more vegetation and wood accumulation. This would reduce the area available for cover and foraging, although deeper water refugia towards the center of the lake would remain. As noted previously, productivity of the Alpine Lakes is low and the ability to support existing fish populations is also likely to be low. Over time, reductions in habitat area could further reduce the capacity of the lakes to support existing trout populations.

Restoration of the dam would also result in the ability to release up to 9.5 additional cfs from the lake relative to existing conditions. Increased flows would be released from the dam into Eightmile Creek, which flows into Icicle Creek. Increased flows would occur from the point of release at Eightmile Lake Dam down to the IPID diversion at RM 5.7.

The potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries.

Rearing juvenile steelhead have been chosen to generally represent how flow changes are expected to affect aquatic habitat mainly because this species is present year-round when others are not and juvenile rainbow trout or steelhead have been observed in all reaches of Icicle Creek. Assuming that a full 12.6 cfs is achieved in late summer, the WUA per 1,000 linear feet of stream could increase by as much as 9 percent for juvenile steelhead in the historical channel. Specific changes in availability of habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the later summer would correspond to increased habitat.

Elevated flows in Icicle Creek are also expected to improve fish passage through obstructions in Icicle Creek during late summer and fall, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek. Potential impacts associated with improved fish passage can result in increased genetic mixing and increased competition between different species or distinct populations of the same species. These impacts are described in greater detail under Section 4.7.2.2, Long-term Impacts, Fish Passage Improvements; however, improving fish passage is generally considered to be beneficial overall.

There remains uncertainty around how the proposed patterns of release would affect resident fish in receiving tributaries immediately downstream of the lakes but upstream of Icicle Creek. Compared to existing conditions, all of these streams would receive water released from the lakes each year instead of every few years; however, the releases would likely be more intermittent compared to a steady release.

Increasing instream flows in downstream tributaries, including Icicle Creek, over the summer and fall could also alter the hydrology in areas in which upstream-migrating salmon currently tend to gather, which may alter the distribution pattern of fish and affect fishing opportunities on a localized basis. There is uncertainty at this time whether increasing instream flow would cause fish to distribute themselves more broadly or in different areas than they currently do. Potential impacts would be addressed in part by efforts to be completed under the Tribal Fishery Preservation and Enhancement Project as described in greater detail in Chapter 2.

As part of the overall Icicle Strategy, the Guiding Principles require flows to be managed to benefit aquatic species and minimize adverse impacts. An example of a strategy under consideration is prioritizing the timing of releases relative to potential impacts on downstream aquatic habitat. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.7.7, Mitigation Measures.

Tribal Fishery Preservation and Enhancement

The intent of the Tribal Fishery Preservation and Enhancement Project is to ensure that other projects implemented as part of the Icicle Strategy do not have negative effects on tribal fisheries and tribal treaty and federally protected harvest rights. As noted in Section 3.23, Indian Trust Assets and Fishing Harvest, tribal harvest targets unlisted Carson-stock spring-run Chinook salmon and coho salmon (*O. kisutch*) returning to LNFH, with Usual and Accustomed fishing areas adjacent to and downstream of LNFH. Currently, the plunge pool immediately downstream of the LNFH Hatchery Channel spillway is a popular harvest area where fish returning to LNFH tend to collect. Hatchery-reared salmon find refuge in the deep scour pool and turbulent conditions created by large volumes of water spilling out of the Hatchery Channel.

Over the long term, this project would result in long-term benefits to fish and fish habitat that are primarily related to restoration actions to ensure that overall fish populations or fishing conditions are not adversely affected by the Icicle Strategy. These improvements are likely to increase the useable area for all fishes in the affected areas, improving conditions for LNFH-reared salmon that are targeted in fisheries, as well as leading to increases in the numbers of other native fish.

Habitat Protection and Enhancement

As noted previously, this project is intended to result in long-term improvements in habitat and ecosystem functions and values that would be beneficial to fish and aquatic invertebrates. As noted above, any work within sensitive areas would require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts, such as compensating for the permanent loss of any sensitive areas (Section 4.7.7, Mitigation Measures). These requirements would be developed once project-specific details are available.

Instream Flow Rule Amendment

Under the Instream Flow Rule Amendment Project, the Icicle Creek Reserve established under Chapter 173-545 WAC would be increased by 0.4 cfs. Over the long term, this amendment would ultimately result in the removal of 0.4 cfs from Icicle Creek annually, which could adversely affect water quantity and quality in portions of Icicle Creek and thus could adversely affect dependent fish and aquatic invertebrates. No instream flow reduction would occur in the Wenatchee River because this project would move 0.4 cfs out of the Wenatchee River Reserve.

Potential impacts associated with the Instream Flow Rule Amendment are anticipated to be offset by the implementation of required instream flow and habitat restoration actions under this Program Alternative, as well as several other projects associated with Alternative 1.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

Over the long term, LNFH Conservation and Water Quality improvements are intended to benefit fish reared at LNFH and resident fish that use Icicle Creek. A BiOp was issued by NMFS in 2015 and included recommendations that would improve the sustainability of LNFH to support production of spring-run Chinook salmon and protect wild salmon and trout listed under the ESA, including Wenatchee stock spring-run Chinook salmon, Wenatchee stock summer-run steelhead, and bull trout. This project would bring LNFH in compliance with guidelines established in the 2015 BiOp to protect wild and hatchery fish in Icicle Creek. These improvements would likely occur under the No-action Alternative; however, inclusion of this project within the Icicle Strategy would allow for coordination of LNFH projects with other IWG projects, maximizing and potentially expediting the benefits for fish in Icicle Creek.

Salmon reared in the LNFH would benefit from more reliable operations and upgraded facilities. Resident and migratory fish that use Icicle Creek would experience habitat benefits related to improvements in water quality from effluent treatment actions and in-water quantity from water use efficiency actions.

It is estimated that water use efficiency improvements could conserve up to 20 cfs depending on the specific measures put in place. The amount conserved would remain in Icicle Creek and would contribute to increased instream flows between the LNFH diversion at RM 4.5 and the hatchery water return at RM 2.5.

Fish and aquatic invertebrates would generally benefit from these increases. Major focal fish that would be affected include adult steelhead spawning, adult and juvenile steelhead migration, bull trout migration, and lamprey migration. The historical channel may provide some incubation and rearing to steelhead; however, these activities are less common under the current condition. Other fish uses that could be affected after flow is increased in the historical channel are bull trout rearing; rainbow trout rearing; coho spawning; and spring-run Chinook salmon, summer-run Chinook salmon, mountain whitefish (*Prosopium williamsoni*), largescale sucker (*Catostomus macrocheilus*), and bridgelip sucker (*C. columbianus*) spawning and rearing. Specific changes in habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the later summer would correspond to increased habitat.

Because this facility is owned by Reclamation and operated by the USFWS, an evaluation of the potential impacts under NEPA would be completed once the full scope of the project is determined. Compliance with applicable local, state, and federal regulations would further address any potentially significant impacts on fish and aquatic invertebrates. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and no net loss of ecological functions and values (Section 4.7.7, Mitigation Measures).

Fish Passage Improvements

Although the details of the Fish Passage Improvements Project are not yet determined, in general, the intent is to improve fish passage to the upper reaches of Icicle Creek. As noted in Section 3.7, Fish, while fish passage above LNFH does occur under some flow conditions, it is generally considered to be limited, particularly above the Boulder Field at RM 5.6. Currently, low numbers of anadromous steelhead and Chinook salmon can pass through the Boulder Field; biologists recently observed two redds, and one juvenile anadromous Chinook salmon was observed upstream of the Boulder Field (WDFW, 2016). It is unlikely that coho salmon (*O. kisutch*) can ascend the Boulder Field.

Opening a large area (over 20 miles) of relatively high quality habitat upstream of these barriers is expected to result in overall benefits to native stocks of anadromous fish, including ESA-listed upper Columbia spring-run Chinook, upper Columbia summer-run steelhead, as well as unlisted summer-run Chinook and reintroduced coho salmon. The upper Icicle Creek is relatively productive. For example, the habitat supports approximately 480 resident rainbow trout per kilometer that are between 4 to 12 inches in size that grow well as juveniles (Gayeski, 2015). These observations and modeled habitat potential suggest that improving passage in upper and lower Icicle Creek would greatly increase the capacity of habitat to sustain greater numbers of anadromous fish and generally contribute to an increase in these populations.

In addition, anadromous adults returning farther upstream from the ocean would spawn, die, and decay in the upper watershed where they were previously not able to reach in large numbers. They would bring large amounts of marine-derived nutrients to this area, generally providing benefits that have been absent from this system. The delivery of marine-derived nutrients by salmon carcasses is a natural process that supports food-webs and enhances riparian forest growth in Pacific Northwest streams. However, this process would also increase the potential for water-borne pathogens to be brought upstream by spawning salmon and steelhead. Diseases transmitted by these fish could negatively affect other resident salmonids, including rainbow trout, westslope cutthroat trout (*O. clarki lewisi*), and bull trout, as well as fish at the LNFH.

If productivity in these upper reaches is limited by suitable spawning and rearing habitats, nutrients, and food availability, competition between anadromous and resident fish for resources may reduce productivity for resident populations, including rainbow trout and bull trout, while increasing productivity of anadromous stocks. In addition, large subadult and adult bull trout are known to be effective predators on juvenile fish. More abundant anadromous juvenile salmon and steelhead may benefit the bull trout that prey on them, but anadromous stocks attempting to recolonize the upper watershed may be limited by the resident bull trout population.

Mixing of resident fish with anadromous fish may also contribute to some hybridization. It is possible that previously isolated rainbow trout could spawn with migratory steelhead, changing the genetic makeup of *O. mykiss* groups in the upper watershed. Whether a change in genetic diversity would ultimately benefit *O. mykiss* or reduce their ability to adapt to diverse conditions in the upper watershed is unknown.

Depending on how Structures 2 and 5 near LNFH are operated, there is a potential for fish passage improvements at LNFH to adversely affect fish distribution that supports fishing, particularly tribal fishing that occurs at the LNFH plunge pool. This could occur because, depending on the timing of how fish passage near LNFH is managed, some additional fish could be allowed or encouraged to move into the historical channel away from the plunge pool. There are also concerns that changing flows as the result of changes in operation of Structure 2 may result in conditions where fish are no longer attracted to or congregate in the plunge pool.

Currently, passage through Structure 5 is limited in spring and early summer during periods of broodstock collection (mid-May through June) to capture and prevent passage of hatchery fish to areas farther upstream. If Structure 5 is opened after broodstock collection goals are met to improve overall fish passage, some later-arriving LNFH spring-run Chinook salmon may stray into the historical channel and into the upstream reaches, away from typical tribal harvest areas. USFWS coordinates with WDFW, NMFS, the Confederated Tribes and Bands of the Yakama Nation, and the Confederated Tribes of the Colville Reservation on the timing of the adjustments for broodstock collection to minimize potential impacts on tribal fishing. This would continue as part of the development of this project.

In addition, if adjustments are made at Structure 2 to redirect flows into the historical channel to restore habitat for fish, the resulting reduction in flow to the Hatchery Channel may reduce attraction flow to the plunge pool near the hatchery ladder compared to the existing operations. However, recently, when no adjustments were made to divert water to the Hatchery Channel at Structure 2, no significant straying of hatchery origin spring-run Chinook salmon into the historical channel was observed and no noticeable loss of fishing opportunities was observed (Anglin, 2013). Implementation of activities as part of the Tribal Fishery Preservation and Enhancement Project would further help to ensure there are no significant impacts on tribal fishing.

As noted previously, this project would require compliance with various local, state, and federal regulations, including CWA and ESA compliance. If needed, additional mitigation measures would be developed during project-level permitting to minimize potentially significant adverse impacts as discussed in Section 4.7.7, Mitigation Measures.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws.

Improvements to fish screens are intended to provide a long-term benefit to fish. Under existing conditions, juvenile steelhead, rainbow trout, and bull trout have been entrained at these locations. For example, from 2009 and 2013, the number of *O. mykiss* removed from the LNFH water intake system ranged from 30 to 63 per year (excluding winter and spring months because of ice and debris buildup) (Hall et al., 2014). From 2005 to 2013, a total of 31 subadult bull trout or bull trout/brook trout hybrids were entrained and sampled for genetic analysis. With this project, these impacts would be reduced and would likely benefit other native aquatic species that could become entrained.

Water Markets

The implementation of Water Markets would not have a direct impact on fish populations or aquatic resources within Icicle Creek or the Wenatchee River. Fish may benefit indirectly over time from more efficient allocation and better reliability of the water supply for agricultural uses and allowing for the protection of instream flows for fish.

4.7.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would also be included while the Alpine Lakes Optimization, Modernization, and Automation project would not. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Other projects proposed under this Alternative are discussed under Alternative 1. In addition, consistent with the Guiding Principles, the selection of projects under this Program Alternative would seek to meet minimum instream flow targets and generally improve aquatic habitat.

4.7.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction activities associated with this project include construction of new IPID Dryden Pump Exchange facilities. Short-term impacts that could adversely affect fish and aquatic invertebrates include direct disturbance associated with work near or in water and any associated temporary impacts on aquatic habitat.

Construction of these facilities would require in-water work along the Wenatchee River, which has the potential to adversely affect fish and aquatic invertebrates. Potential short-term impacts would occur mainly as a result of work in or within close proximity to water. Potential impacts include increased risk of disturbance or harm from construction activities, including exclusion of these species from in-water work areas, increased potential for harm from noise and vibration, increased risks of water quality impacts adversely affecting aquatic habitat, and temporary loss of aquatic habitat during dewatering for in-water construction. Depending on the location and extent of these activities and the number and type of fish or aquatic invertebrates likely to be affected, short-term impacts could be significant.

Work within waters of the United States or State, which includes the Wenatchee River, would require a CWA Section 404 Permit and associated Section 401 Water Quality Certification. Compliance with applicable local, state, and federal regulations would require implementation of BMPs and if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions (Section 4.7.7, Mitigation Measures.

4.7.3.2 Long-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project would create a permanent change in the near-field hydraulics and levels of noise and vibration on the Wenatchee River, depending on where the pump station is located. In addition, the new facilities would result in the loss of some riparian vegetation. However, as noted above, compliance with applicable regulations would minimize the potential impacts on habitat and ecosystem functions and values associated with siting and operating the proposed facilities. This would help to reduce potential adverse impacts on fish and aquatic invertebrates in the long term.

Generally speaking, the overall impacts associated with this project are expected to be beneficial because instream flows would increase between the current IPID diversion (RM 5.7) and the new pump station location on the Wenatchee River. The benefit could be as much as 25 cfs in the late summer compared to the existing condition.

This project is intended to benefit all fish in Icicle Creek, including ESA-listed spring-run Chinook salmon, steelhead, and bull trout, by replacing diversions from Icicle Creek with water pumped to irrigation canals from the Wenatchee River. Increased flows in Icicle Creek would likely improve fish passage through obstructions in Icicle Creek during summer, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek.

Rearing juvenile steelhead have been chosen to generally represent how flow changes are expected to affect aquatic habitat mainly because this species is present year-round when others are not. Assuming that a full 25 cfs is achieved in late summer, the WUA per 1,000 linear feet of stream could increase by approximately 29 percent in the historical channel. Specific changes in habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the later summer would correspond to increased habitat.

The IPID Dryden Pump Exchange Project would also allow more water to remain in Peshastin Creek, which is a smaller tributary to the Wenatchee River where late summer low flows impact fish passage and habitat below the PID Diversion below RM 2.4. The project would benefit native fish in Peshastin Creek with relatively small additional adverse impact to fish in the Wenatchee River.

Elevated flows in Icicle Creek are also expected to improve fish passage through obstructions in Icicle Creek during summer, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek. Potential impacts associated with improved fish passage could result in increased genetic mixing and increased competition between different species or distinct populations of the same species. These impacts are described in greater detail under Section 4.7.2.2, Long-term Impacts, Fish Passage Improvements, but are generally considered to be beneficial overall.

As part of the overall Icicle Strategy, efforts to characterize the impacts of the managed flows on fish species are ongoing. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.7.7, Mitigation Measures.

4.7.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 Project would also be included while the Eightmile Lake Storage Restoration Project would not. This section describes the specific short- and long-term impacts associated with the legislative change project. Other proposed projects under Alternative 3 can be reviewed in Alternative 1 and Alternative 2. Consistent with the Guiding Principles, the selection of projects under this Program Alternative would seek to meet minimum instream flow targets and generally improve aquatic habitat.

4.7.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts on fish or aquatic invertebrates.

4.7.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority Project were enacted to allow impacts on the Instream Flow Rule when out-of-time mitigation where not available, there could be potential conflicts with instream flow allocations that could adversely affect fish and aquatic invertebrates. Under the proposed changes, junior domestic water rights could be exercised even when the Instream Flow Rule is not met, resulting in potential adverse impacts on riparian vegetation and any associated wetlands because of low-flow conditions.

4.7.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1. The Eightmile Lake Storage Restoration Project would be replaced with the Eightmile Lake Storage Enhancement Project. The Upper Klonaqua and Upper and Lower Snow Lakes Storage Enhancement Projects would also be included. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative. In addition, consistent with the

Guiding Principles, the selection of projects under this Program Alternative would seek to meet minimum instream flow targets and generally improve aquatic habitat.

4.7.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

As noted previously, there are no native populations of fish in the Alpine Lakes; however, some remnant fish associated with past recreational stocking activities remain, most likely cutthroat trout, rainbow trout, and lake trout. Construction activities have the potential to adversely affect these species, depending on the extent of the activity.

Construction activities would occur primarily in the dry lake margins in the later summer when the lake is drawn down. As discussed in Section 4.5, Water Quality, construction is not anticipated to result in significant water quality impacts and would therefore not be expected to adversely affect fish or aquatic invertebrates. However, construction activities would result in increased noise that could affect these species, depending on the type of activity and whether these species were located in close proximity.

As noted in Section 4.14, Noise, the majority of construction activities would result in relatively minor noise increases and normal fish behavior such as foraging or use of refuge areas within the lakes is not likely to be adversely affected because fish would be able to move to other areas of the lake during construction. However, construction could involve some blasting. Blasting can directly harm fish and aquatic invertebrates from increased noise and vibration. Depending on the species that may be within close proximity when blasting occurs, there is a potential for those species to be affected.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions (Section 4.7.7, Mitigation Measures).

Upper Klonaqua Lake Storage Enhancement

The potential impacts on fish and aquatic invertebrates during construction would be similar to those that would occur related to the Eightmile Lake Storage Enhancement Project (Section 4.7.5.1, Short-term Impacts). As noted previously, there are no native populations of fish in the Alpine Lakes; however, some remnant fish associated with past recreational stocking activities remain, most likely cutthroat trout, rainbow trout, and lake trout. Construction activities have the potential to adversely affect these species, depending on the extent of the activity.

Construction activities would occur primarily in the dry lake margins in the later summer when the lake is drawn down. As discussed in Section 4.5, Water Quality, construction is not anticipated to result in significant water quality impacts and would therefore not be expected to adversely affect fish or aquatic invertebrates. However, construction activities would result in increased noise that could affect these species, depending on the type of activity and whether these species were located in close proximity.

As noted in Section 4.14, Noise, the majority of construction activities would result in relatively minor noise increases and normal fish behavior such as foraging or use of refuge areas within the lakes is not likely to be adversely affected because fish would be able to move to other areas of the lake. However, construction could involve some blasting. Blasting can directly harm fish and aquatic invertebrates from increased noise and vibration. Depending on the species that may be within close proximity when blasting occurs, there is a potential for those species to be affected.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions (Section 4.7.7, Mitigation Measures).

Upper and Lower Snow Lakes Storage Enhancement

The potential impacts on fish and aquatic invertebrates during construction would be similar to those that would occur related to the Eightmile Lake Storage Enhancement Project (Section 4.7.5.1, Short-term Impacts). There would be limited in-water work and no permanent loss of aquatic habitat.

Construction activities would occur primarily in the dry lake margins in the later summer when the lake is drawn down. As discussed in Section 4.5, Water Quality, potential short-term impacts on water quality would not be significant and are not expected to adversely affect fish or aquatic invertebrates in the short term. However, construction activities would also result in increased noise that could adversely affect fish and other aquatic species.

As noted in Section 4.14, Noise, the majority of construction activities would result in relatively minor noise increases and normal fish behavior such as foraging or use of refuge areas within the lakes is not likely to be adversely affected because fish would be able to move to other areas of the lake during construction. Construction could involve some blasting. Blasting can directly harm fish and aquatic invertebrates from increased noise and vibration. Depending on the species that may be within close proximity when blasting occurs, there is a potential for those species to be affected.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions (Section 4.7.7, Mitigation Measures).

4.7.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would involve demolition of the existing structure and construction of a taller dam at Eightmile Lake (spillway elevation of 4,682 feet), and construction of an inflow pipeline that would facilitate draw down of the lake. These changes would provide the ability to store and release more water (up to 3,500 acre-feet), which would represent an increase over the historical operation and the volume currently allowed by the IPID water right (up to 2,500 acre-feet). It would also represent a change compared to existing conditions and the No-action Alternative as discussed further below. Over the long term, the greatest potential for impacts affecting fish and aquatic invertebrates would be related to the relative changes in lake levels and the resulting changes in flows in lower Icicle Creek.

Under this project, the lake would be able to reach a new maximum height of 4,682 feet for 11 additional feet of storage compared to existing conditions. This means the surface area of the lake would be restored to cover approximately 13.6 additional acres, which would last for about 1 month in the early summer before IPID begins to draw down the lake. Under this project the lake would also be able to be drawn down by an additional 24.4 feet, occurring in the late summer or early fall before natural precipitation began to recharge the lake.

Compared with existing conditions, re-operation of the lake area would result in an increase in habitat for resident fish in the early summer and a decrease in late summer. The extent of the decrease in aquatic habitat would depend on how far the lake is drawn down each year.

During draw down, shallow water areas would become disconnected from shorelines that have more vegetation and wood accumulation. This would reduce the area available for cover and foraging, although deeper water refugia toward the center of the lake would remain. As noted previously, productivity of the Alpine Lakes is low and the ability to support existing fish populations is also likely to be low. Over time, reductions in habitat area could further reduce the capacity of lakes to support existing trout populations.

Restoration of the dam would also result in the ability to release up to an additional 17.9 cfs from the lake relative to existing conditions. Increased flows would be released from the dam into Eightmile Creek, which flows into Icicle Creek. Increased flows would occur from the point of release at Eightmile Lake Dam down to the IPID diversion at RM 5.7.

The potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries.

Specific changes in habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the later summer would correspond to increased aquatic habitat.

Elevated flows in Icicle Creek are also expected to improve fish passage through obstructions in Icicle Creek during late summer and fall, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek. Potential impacts associated with improved fish passage can result in increased genetic mixing and increased competition between different species or distinct populations of the same species. These impacts are described in greater detail under Section 4.7.2.2, Long-term Impacts, Fish Passage Improvements; however, improving fish passage is generally considered to be beneficial overall.

There remains uncertainty around how the proposed patterns of release would affect resident fish in receiving tributaries immediately downstream of the lakes but upstream of Icicle Creek. Compared to existing conditions, all of these streams would receive water released from the lakes each year instead of every few years; however, the releases would likely be more intermittent compared to a steady release.

Increasing instream flows in downstream tributaries, including Icicle Creek, over the summer and fall could also alter the hydrology in areas in which upstream-migrating salmon currently tend to gather, which could alter the distribution pattern of fish and affect fishing opportunities on a localized basis. There is uncertainty at this time whether increasing instream flow would cause fish to distribute themselves more broadly or in different areas than they currently do. Potential impacts would be addressed in part by efforts to be completed under the Tribal Fishery Preservation and Enhancement Project as described in greater detail in Chapter 2.

As part of the overall Icicle Strategy, the Guiding Principles require flows to be managed to benefit aquatic species and minimize adverse impacts. An example of a strategy under consideration is prioritizing the timing of releases relative to potential impacts on downstream aquatic habitat. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.7.7, Mitigation Measures.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project would result in similar long-term impacts on fish and aquatic invertebrate as the Eightmile Lake Storage Enhancement Project (4.7.5.2, Long-term Impacts). This would provide the ability to store and release additional flows from Upper Klonaqua Lake, which would represent a change compared to existing conditions and the No-action Alternative as discussed further below. Over the long term, the greatest potential for impacts affecting fish and aquatic invertebrates would be related to the relative changes in lake levels and the resulting changes in flows in lower Icicle Creek.

The new high lake level in Upper Klonaqua Lake would not change. The lake would still refill and outlet naturally through an existing channel to Lower Klonaqua Lake during most of the year. However, the new facilities would allow for the lake to be drawn down an additional 20 feet to allow for access to an additional 1,146 acre-feet of storage. The draw down would likely occur over a couple of months in the late summer.

Compared with existing conditions, this project would result in an increase in habitat for any resident fish in the Upper Lake in the early summer and a decrease in late summer. The extent of the decrease in aquatic habitat would depend on how far the lake is drawn down each year.

During draw down, shallow water areas would become disconnected from shorelines that have more vegetation and wood accumulation. This would reduce the area available for cover and foraging, although deeper water refugia towards the center of the lake would remain. As noted previously, productivity of the Alpine Lakes is low and the ability to support existing fish populations is also likely to be low. Over time, reductions in habitat area could further reduce the capacity of the lakes to support existing trout populations.

Modifications at Upper Klonaqua Lake would also result in the ability to release up to an additional 5 to 20 cfs from the lake. Increased flows would be released from the dam into downstream tributaries, which flow into Icicle Creek. Increased flows would occur from the point of release at Klonaqua Dam down to the IPID diversion at RM 5.7.

The potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries.

Specific changes in habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the later summer would correspond to increased aquatic habitat.

Elevated flows in Icicle Creek are also expected to improve fish passage through obstructions in Icicle Creek during late summer and fall, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek. Potential impacts associated with improved fish passage can result in increased genetic mixing and increased competition between different species or distinct populations of the same species. These impacts are described in greater detail under Section 4.7.2.2, Long-term Impacts, Fish Passage Improvements; however, improving fish passage is generally considered to be beneficial overall.

There remains uncertainty around how the proposed patterns of release would affect resident fish in receiving tributaries immediately downstream of the lakes but upstream of Icicle Creek. Compared to existing conditions, all of these streams would receive water released from the lakes each year instead of every few years; however, the releases would likely be more intermittent compared to a steady release.

Increasing instream flows in downstream tributaries, including Icicle Creek, over the summer and fall could also alter the hydrology in areas in which upstream-migrating salmon currently tend to gather, which could alter the distribution pattern of fish and affect fishing opportunities on a localized basis. There is uncertainty at this time whether increasing instream flow would cause fish to distribute themselves more broadly or in different areas than they currently do. Potential impacts would be addressed in part by efforts to be completed under the Tribal Fishery Preservation and Enhancement Project as described in greater detail in Chapter 2.

As part of the overall Icicle Strategy, the Guiding Principles require flows to be managed to benefit aquatic species and minimize adverse impacts. An example of a strategy under consideration is prioritizing the timing of releases relative to potential impacts on downstream aquatic habitat. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.7.7, Mitigation Measures.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project would result in similar long-term impacts on fish and aquatic invertebrates as the Eightmile Lake Storage Enhancement Project (4.7.5.2, Long-term Impacts). This project would provide the ability to store and release additional flows at the lake, which would represent a change compared to existing conditions and the No-action Alternative as discussed further below. Over the long term, the greatest potential for impacts affecting fish and aquatic invertebrates would be related to the relative changes in lake levels and the resulting changes in flows in lower Icicle Creek.

The proposed enhancement project would increase the high-water storage levels in both Upper and Lower Snow Lakes by 5 feet compared with existing high levels. This change would result in the inundation of some upland vegetation that has grown along the shoreline areas between the current and proposed high lake levels, and would most likely occur in the fall through the early summer when releases would be likely to begin. The project would also allow for the Lower Snow Lake to be drawn down 3 feet below the current lake level, which would result in the exposure of slightly more lake bed.

Compared with existing conditions, this project would result in an increase in habitat for resident fish in the early summer and a decrease in late summer. The extent of the decrease in aquatic habitat would depend on how far the lake is drawn down each year.

During draw down, shallow water areas would become disconnected from shorelines that have more vegetation and wood accumulation. This would reduce the area available for cover and foraging, although deeper water refugia towards the center of the lake would remain. As noted previously, productivity of the Alpine Lakes is low and the ability to support existing fish populations is also likely to be low. Over time, reductions in habitat area could further reduce the capacity of lakes to support existing trout populations.

Restoration of the dams at Upper and Lower Snow Lakes would result in the ability to release up to an additional 9 to 18 cfs from the lake. Increased flows would be released from the Lower Snow Lake Dam or from the Upper Snow Lake release valve through Nada Lake to Snow Creek, which flows into Icicle Creek. Increased flows would occur from the point of release down to the IPID diversion at RM 5.7.

The potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries.

Specific changes in habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the late summer would correspond to increased aquatic habitat.

Elevated flows in Icicle Creek are also expected to improve fish passage through obstructions in Icicle Creek during late summer and fall, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek. Potential impacts associated with improved fish passage can result in increased genetic mixing and increased competition between different species or distinct populations of the same species. These impacts are described in greater detail under Section 4.7.2.2, Long-term Impacts, Fish Passage Improvements; however, improving fish passage is generally considered to be beneficial overall.

There remains uncertainty around how the proposed patterns of release would affect resident fish in receiving tributaries immediately downstream of the lakes but upstream of Icicle Creek. Compared to existing conditions, all of these streams would receive water released from the lakes each year instead of every few years; however, the releases would likely be more intermittent compared to a steady release.

Increasing instream flows in downstream tributaries, including Icicle Creek, over the summer and fall could also alter the hydrology in areas in which upstream-migrating salmon currently tend to gather, which may alter the distribution pattern of fish and affect fishing opportunities on a localized basis. There is uncertainty at this time whether increasing instream flow would cause fish to distribute themselves more broadly or in different areas than they currently do. Potential impacts would be addressed in part by efforts to be completed under the Tribal Fishery Preservation and Enhancement Project as described in greater detail in Chapter 2.

As part of the overall Icicle Strategy, the Guiding Principles require flows to be managed to benefit aquatic species and minimize adverse impacts. An example of a strategy under consideration is prioritizing the timing of releases relative to potential impacts on downstream aquatic habitat. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.7.7, Mitigation Measures.

4.7.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Station Project would be included.

4.7.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

This IPID Full Piping and Pump Exchange project would involve fully converting the IPID delivery systems to pressurized pipelines, removing or abandoning the existing intakes on Icicle and Peshastin Creeks, and constructing three new pump stations and screened intakes on the Wenatchee River. Short-term impacts that could adversely affect fish and aquatic invertebrates include direct disturbance associated with work near or in water and any associated temporary impacts on aquatic habitat.

Work affecting the delivery system is unlikely to adversely affect fish because it would be done in the dry during the off-season when the irrigation canals are dry, and away from where these species may be found. As noted in Section 4.5, Water Quality, there would also be relatively limited potential for water quality impacts that could adversely affect aquatic habitat related to these activities.

Removal of the existing intake structures and construction of the pump stations and new intakes would require in-water work along lower Icicle and Peshastin Creeks and the Wenatchee River. These activities have a higher potential to adversely affect fish and aquatic invertebrates. Potential impacts associated with intake removal could include increased risk of disturbance, depending on the type of equipment and extent of the work along the shoreline or within the creeks. Construction of the new pump stations and associated facilities could also result in increased risk of disturbance or harm from construction activities such as from installation of a cofferdam, increased potential for harm from noise and vibration, increased risks of water quality impacts adversely affecting aquatic habitat, and temporary loss of aquatic habitat during dewatering for in water construction. Depending on the location and extent of these activities and the number and type of fish or aquatic invertebrates likely to be affected, short-term impacts could be significant.

Work within waters of the United States or State of Washington or within irrigation canals or spillways that reconnect to these waters would require a CWA Section 404 Permit and associated Section 401 Water Quality Certification; work in other portions of the irrigation system could require local review and authorization.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions (Section 4.7.7, Mitigation Measures).

4.7.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange Project

Under this project, installing pipelines would occur in areas that have already been developed with irrigation infrastructure and would not result in long-term adverse impacts on fish from operation and maintenance activities. However, the new pump stations and associated facilities would create a permanent change in the near-field hydraulics and levels of vibration on the Wenatchee River at the three proposed locations. In addition, the new facilities would result in limited loss of riparian vegetation.

Generally speaking, the overall impacts associated with this project are expected to be beneficial because instream flows would increase between the current IPID diversion (RM 5.7) and the new pump station locations on the Wenatchee River. The benefit could be as much as 117 cfs in the late summer compared to the existing condition.

This project is intended to benefit all fish in Icicle Creek, including ESA-listed spring-run Chinook salmon, steelhead, and bull trout, by replacing diversions from Icicle Creek with water pumped to irrigation canals from the Wenatchee River. Increased flows in Icicle Creek would likely improve fish passage through obstructions in Icicle Creek during summer, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek.

Rearing juvenile steelhead have been chosen to generally represent how flow changes are expected to affect aquatic habitat mainly because this species is present year-round when others are not. Assuming that a full 117 cfs is achieved in late summer, the WUA per 1,000 linear feet of stream could increase by approximately 32-percentpercentfor juvenile steelhead rearing in the historical channel. Specific changes in habitat resulting from this project would vary depending on the species, the month of the year, general flow conditions, and the affected stream reach; however, in general, increased flow in the later summer would correspond to increased habitat.

The IPID Full Piping and Pump Exchange Project would also allow more water to remain in Peshastin Creek, which is a smaller tributary to the Wenatchee River where late summer low flows impact fish passage and habitat below the PID Diversion below RM 2.4. The project would benefit native fish in Peshastin Creek with relatively small additional adverse impact to fish in the Wenatchee River.

As noted in Section 4.8, Vegetation, compliance with applicable regulations would minimize the potential impacts on habitat and ecosystem functions and values associated with siting and operating the proposed facilities and would help reduce potential adverse impacts on fish and aquatic invertebrates. Overall, the new facilities are anticipated to represent a net benefit over the current facilities because they would be designed according to the current NMFS guidelines to ensure fish-friendly irrigation diversion operations, for example by providing intake screens that would be designed to prevent entrainment of juvenile fish.

As part of the overall Icicle Strategy, efforts to characterize the impacts of the managed flows on fish species are ongoing. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.7.7, Mitigation Measures.

4.7.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.7.7.1 Short-term Impacts

Short-term impacts on fish and aquatic invertebrates would be mitigated by complying with the terms and conditions of local, state, and federal regulations and obtaining required project-specific permits and approvals, such as any Shoreline Management Act shoreline permits, Critical Areas Review, HPAs, CWA compliance, and Endangered Species Act compliance.

Common mitigation measures are likely to include pre-construction surveys, when deemed appropriate; conducting construction work in a manner to minimize disturbance of wildlife, including excluding sensitive species from work areas; ensuring no net loss of any important habitat or ecosystem functions or values; and possibly restricting the timing of some construction activities to avoid affecting particular species.

Specific mitigation measures would be developed as part of future project-level review and permitting. In addition to the measures identified in Section 4.8, Vegetation, implementation of the following measures would ensure short-term impacts would be less than significant.

- Contracts for construction projects would include language directing workers to protect fish during construction such as excluding sensitive species from work areas, rescuing entrained fish in areas that are dewatered, and working within seasonal fish windows to avoid impacts on special-status species during periods of migration, spawning, and incubation.

4.7.7.2 Long-term Impacts

As part of the overall Icicle Strategy, the Guiding Principles must be met. This requires ensuring that proposed projects benefit fish and fisheries, provide adequate stream flow for fish, enhance aquatic habitat, support a sustainable LNFH, protect treaty and non-treaty harvest rights, and comply with state and federal laws, such as the ESA. Efforts are ongoing to ensure that projects implemented as part of the Icicle Strategy meet these objectives. More specifically, the following measures would help to reduce potential adverse impacts that could occur over the long term.

- Develop a long-term management plan for releases from IPID at the Alpine Lakes. To support project-level permitting and optimization planning, continue to evaluate how flow changes might affect downstream habitat of Icicle Creek and its tributaries.

  Examples of measures under consideration to help minimize impacts include the following.

  - Ramp down lake releases gradually toward the end of the augmentation period to avoid stranding fish.
  - Limit releases from these lakes in September to avoid negatively affecting spawning bull trout.
- Minimize ice and debris build-up on fish screens at existing diversion points by sustaining or increasing the frequency of maintenance compared to current activities. Sequence projects implemented as part of the Icicle Strategy to ensure irrigation diversion screens are updated prior to improving passage for anadromous fish above hatchery barriers and the Boulder Field barrier.
- Continue monitoring and adaptive management of tribal and non-tribal fisheries to prevent overfishing and unintended adverse impacts to non-target fish species, including endangered and threatened salmon and bull trout.
- Ensure compliance with permits issued by NMFS and USFWS for the protection of endangered and threatened native salmon, steelhead, and bull trout.
- Continue monitoring and adaptive management of fish passage efficiency through Structures 2 and 5 in association with different hydraulic conditions and structure configurations.

4.8 Vegetation

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.8, Vegetation, from construction and operation related to the No-action Alternative and Program Alternatives.

4.8.1 No-action Alternative

4.8.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that could result in short-term impacts on vegetation and wetlands in the Icicle Creek Watershed project area. This is anticipated to entail construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability. Potential impacts would primarily be associated with projects that require construction and improvements to the seven Alpine Lakes. Impacts that could adversely affect vegetation and wetlands include direct disturbance from construction activity and increased potential for exposure to contaminated stormwater runoff. These impacts would be localized to specific areas of disturbance along the Wenatchee River, Icicle and Peshastin Creeks, and the seven Alpine Lakes.

The agencies or entities implementing projects under the No-action Alternative would be required to comply with applicable local, state, and federal environmental review requirements and permits as described in Section 5.2, Table 5-2. Applicable permits would require appropriate mitigation measures to reduce impacts on vegetation, such as revegetation of adversely affected areas and BMPs designed to reduce the potential for erosion and accidental spills of construction chemicals (Section 4.8.7, Mitigation Measures). For instance, Chelan County Code requires riparian buffer protection and mitigation with buffer widths determined based on Environment Designation and intensity of use as shown in Table 4-2.

Table 4-2
Chelan County Riparian Buffer Protection and Mitigation Requirements

Environment Classification	Buffer Width	
	High Intensity (feet)	Low Intensity (feet)
Natural	250	200
Conservancy	250	200
Rural	150	100
Urban	100	75

A habitat management and mitigation plan could be required to avoid degradation of the riparian habitat function, structure, and value. Therefore, short-term impacts under the No-action Alternative are not expected to be significant.

4.8.1.2 Long-term Impacts

Long-term impacts associated with the diversion and water efficiency projects are anticipated to be largely beneficial for vegetation around Icicle and Peshastin Creeks because project elements that would be implemented would seek to improve instream flows during the late summer, which would provide a benefit to riparian vegetation. However, implementation of the Eightmile Restoration Project means that some area of vegetation around that lake would be periodically inundated more frequently. In addition, because projects would not generally be coordinated with other activities in the Icicle project area, instream flow benefits are not anticipated to be as great as they would under the other Program Alternatives. Potential long-term benefits from such projects are also expected to be more localized, providing only minor overall benefits within the larger Icicle Creek Subbasin.

4.8.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in greater impacts on vegetation compared with the No-action Alternative because there would be higher likelihood that certain projects would be implemented and the scale of certain efforts would likely be greater. Compliance with the Guiding Principles addresses vegetation in general by enhancing Icicle Creek aquatic and riparian habitat. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.8.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction activities associated with this project would involve replacing existing gates and installing solar panels, flow monitors, and other new equipment. Most of the work would occur in upland areas. Some limited work would occur within the lake shorelines but within the dry when the lakes are drawn down at the end of the summer. Activities would have limited potential to affect surrounding vegetated or potential wetland areas.

Accessing the project sites, staging equipment, and providing for worker accommodations could temporarily disturb vegetation or wetlands mainly as the result of inadvertent trampling. Construction equipment and supplies would most likely be flown in by helicopter with the exception of possibly carrying some equipment up by hand to Eightmile Lake. Hiking would occur within existing trails and roadways and would therefore have limited potential to adversely affect adjacent vegetation or wetlands along the route. Although some small vegetated areas may be disturbed during staging of equipment and supplies, vegetation and wetland impacts would largely be avoided by limiting vegetation removal and limiting work within sensitive areas.

As noted in Section 4.5, Water Quality, construction activities would also slightly increase the potential for contaminated stormwater runoff or spills of construction chemicals that could adversely affect vegetation and wetlands. However, as discussed in Section 4.5, Water Quality, this risk would be very low because there would be limited use of powered equipment near water.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include limiting the extent of work within sensitive areas, requiring revegetation of disturbed sites, and compensating for any loss of important ecosystem functions and values (Section 4.8.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on vegetation and wetlands would be less than significant.

IPID Irrigation Efficiencies

Construction activities associated with the IPID Irrigation Efficiencies Project include the conversion of irrigation canals to pipelines, replacing or abandoning pipelines, and the lining of irrigation canals with concrete. Impacts that could adversely affect vegetation and wetlands include inadvertent trampling or disturbance during construction. Short-term impacts on vegetation would be limited because most of the work would occur within areas that are already disturbed, such as within rights-of-way and existing irrigation canal easements, and would occur during the off-season when the irrigation canals are dry. As noted in Section 4.5, Water Quality, there would also be limited potential for water quality impacts that could adversely affect vegetation or wetlands.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include limiting the extent of work within sensitive areas, requiring revegetation of disturbed sites, and compensating for any loss of important ecosystem functions and values (Section 4.8.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on vegetation and wetlands would be less than significant.

COIC Irrigation Efficiencies and Pump Exchange

Potential impacts on vegetation and wetlands associated with work affecting COIC canals would be similar to those described above. Construction of the COIC pump station would also require work along the streambank of lower Icicle Creek or the Wenatchee River, and depending on the location would likely result in the loss of riparian vegetation. Depending on the location and extent of these activities, there would also be a potential for wetlands to be adversely affected. Impacts that could adversely affect vegetation and wetlands include inadvertent trampling or disturbance during construction.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include limiting the extent of work within sensitive areas, requiring revegetation of disturbed sites, and compensating for any loss of important ecosystem functions and values (Section 4.8.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on vegetation and wetlands would be less than significant.

Domestic Conservation Efficiencies

Construction activities proposed under the Domestic Conservation Efficiencies Project include pipeline replacement and meter installation. These activities are unlikely to adversely affect vegetation because the work would be done in areas that are already developed.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project involves demolishing the existing dam, installing new piping, and constructing new impoundment and water control structures. Construction activity would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down, and in Eightmile Creek immediately downstream of the dam. While most construction equipment (potentially including a small tracked excavator) and materials would likely be flown into the project site via helicopter, IPID is considering the option of walking in a larger tracked excavator or a spider excavator. The trail to access the project site requires several stream crossings and parallels several potential wetlands (Figure 3-10).

Disturbance within these areas has the potential to adversely affect vegetation and wetlands through direct impact or through increased exposure to contaminated stormwater runoff. Direct impacts could occur as the result of general construction activity resulting in clearing or trampling of vegetation during earth movement and staging of equipment and materials. There would also be minor potential for contaminated runoff to adversely affect vegetation and wetlands by increased erosion or accidental spills of chemicals, such as fuels, cement, and solvents, used during construction.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include limiting the extent of work within sensitive areas, requiring revegetation of disturbed sites, and compensating for any loss of important ecosystem functions and values (Section 4.8.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on vegetation and wetlands would be less than significant.

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effects on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. The specifics of this project are not yet determined, but would involve elements of restoration along the Lower Icicle Creek that could result in localized construction disturbance and removal of vegetation. At this stage, the primary options under consideration include the construction of facilities such as a bubble curtain, sprayer, or other minor modifications to the Hatchery Channel spillway at LNFH to promote favorable fishing conditions in the pool at the bottom of the spillway.

Depending on the specific location of the activities, construction would affect vegetation and any wetlands as a result of direct disturbance or through exposure to contaminated stormwater as described previously. However, project activities with the potential to affect these resources would likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include limiting the extent of work within sensitive areas, requiring revegetation of disturbed sites, and compensating for any loss of important ecosystem functions and values (Section 4.8.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on vegetation and wetlands would be less than significant.

Habitat Protection and Enhancement

Habitat protection and enhancement proposed under this project could involve grading; planting and thinning vegetation; hauling and placing logs, rock, soil, and other materials; and some in-water work on lower Icicle Creek. These activities could affect vegetation and wetlands. Depending on the specific location of the activities, construction would affect vegetation and any wetlands as the result of direct disturbance or through exposure to contaminated stormwater as described previously. However, project activities with the potential to affect these resources would likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures may include limiting the extent of work within sensitive areas, requiring revegetation of disturbed sites, and compensating for any loss of important ecosystem functions and values (Section 4.8.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on vegetation and wetlands would be less than significant.

Instream Flow Rule Amendment

There are no construction activities proposed under this project and, therefore, no potential short-term impacts on vegetation or wetlands.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements geared toward improving water quality and hatchery rearing conditions at the LNFH. In general, construction of these elements has the potential to affect vegetation and wetlands, depending on the specific location and type of disturbance. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential short-term impacts under NEPA would be completed once the full scope of the project is determined.

Similar to the construction activities described above, various authorizations are likely to be required that would ensure that potential impacts would be avoided, minimized, or compensated as noted in Section 4.8.7, Mitigation Measures. Therefore, short-term impacts on vegetation and wetlands from construction work are expected to be less than significant.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek as well as instream modifications to the Boulder Field near RM 5.6. This work would result in disturbances along the streambank and within Icicle Creek that would be addressed in subsequent environmental review and permitting once project specifics are determined. This work would also likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would help to further address potential impacts on vegetation and wetlands. Therefore, short-term impacts on vegetation and wetlands from construction work are expected to be less than significant.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws. This work would result in disturbances along the streambank and within Icicle Creek that would be addressed once project specifics are determined. This work would also likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would help to further address potential impacts on vegetation and wetlands. Therefore, short-term impacts on vegetation and wetlands from construction work are expected to be less than significant.

Water Markets

There are no construction activities proposed under the Water Markets Project and therefore no potential short-term impacts on vegetation or wetlands.

4.8.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Under this project, the greatest potential for impacts on vegetation and wetlands over the long term could occur as the result of any disturbance during maintenance activities and any changes in operations with respect to how lake levels are managed.

Because the facilities would be newer and largely operated remotely by IPID, any trips to and from the lakes, or activities needed to maintain the facilities, are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, this project would result in increased frequency in fluctuations in lake levels compared to existing conditions and the No-action Alternative. This is because lake levels would be drawn down every year instead of rotating one or two lakes per year.

Although the lakes would be drawn down more frequently, the high and low lake levels would not change. The variation in lake levels would be consistent with the general pattern that currently occurs. Therefore, there would be no impacts on shoreline vegetation or wetlands.

Likewise, as discussed in Section 3.5, Water Quality, changes in flows in Icicle Creek would be within the natural variation already occurring within the system. The main changes would be beneficial increases in flows during times when water levels would otherwise be low. As noted in Section 3.18, Shorelines, flow changes on Icicle Creek would not occur at a level that would negatively affect the shoreline. For these reasons, this project is not anticipated to result in significant long-term impacts on vegetation or wetlands.

IPID Irrigation Efficiencies

The majority of the IPID Irrigation Efficiencies Project elements include pipelines or canal improvements that would occur in areas that have already been disturbed and would not result in long-term impacts on vegetation or wetlands. Over the long term, efficiencies gained would result in an increase in instream flows that would also be beneficial to riparian vegetation and wetlands.

COIC Irrigation Efficiencies and Pump Exchange

In general, the potential impacts associated with the COIC Irrigation Efficiencies and Pump Exchange Project would be similar to those described for the IPID Irrigation Efficiencies Project with the exception of the COIC pump station and intake facilities.

These facilities would result in the loss of a small area of riparian vegetation and, depending on the specific location, could potentially affect wetlands. Any adverse impacts would likely be minor because the amount of area converted from vegetation to the new facilities would be small and would be addressed as required by applicable local, state, and federal permits or approvals, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts, such as compensating for the permanent loss of any sensitive areas (Section 4.8.6, Mitigation Measures). Over the long term, this project would also contribute to beneficial increases in instream flows that would be beneficial to riparian vegetation and wetlands.

Domestic Conservation Efficiencies

Increased conservation and re-use associated with this project is expected to lead to decreased return flows, which could decrease flows in the Wenatchee River downstream of the Leavenworth Wastewater Treatment Plant; however, the long-term effects on streamflow and any associated changes to riparian vegetation are expected to be negligible.

Eightmile Lake Storage Restoration

Operation of the proposed facilities for the Eightmile Lake Storage Restoration Project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. The greatest potential for impacts on vegetation and wetlands over the long term would occur as the result of permanent conversion of any sensitive areas, disturbance during maintenance, and any changes in operations with respect to how lake levels are managed.

Because the facilities would be newer and largely operated remotely by IPID, any trips to and from the lakes, or activities needed to maintain the facilities, are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, restoration of the facilities and re-operation of the lake would result in the ability to maintain the lake at higher, historical levels compared to existing conditions and the No-action Alternative.

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is restored, the lake would be able to fill to the historical high level of 4,671 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,666 feet, which would be the crest elevation of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch early in the summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,671 feet, equal to the historical full water surface elevation. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline would be under water. These areas have been historically inundated, but have not been under water since deterioration of the embankment. This change in lake levels could result in some changes to the vegetative community along the fringes of the shoreline; however, this area is expected to be relatively small, on the order of 3.6 acres of shoreline area inundated.

The project would also allow for the lake to be drawn down below the existing low lake levels to an elevation of 4,621 feet, which is approximately 22.4 feet below the existing low. This change would result in the exposure of slightly more lake bed, mainly in the later summer months and early fall up to the point when the water would no longer be drawn down, generally around the end of September. The additional draw down is not expected to adversely affect vegetation or wetlands by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

Likewise, as discussed in Section 3.5, Water Quality, changes in flows in Icicle Creek would be within the natural variation already occurring within the system. The main changes would be beneficial increases in flows during times when water levels would otherwise be low. As noted in Section 3.18, Shorelines, flow changes on Icicle Creek would not occur at a level that would negatively affect the shoreline. For these reasons, this project is not anticipated to result in significant long-term impacts on vegetation or wetlands.

Tribal Fishery Preservation and Enhancement

The purpose of this project is to protect and enhance the tribal fishery, which, depending on the specific actions, could result in the loss of some small areas of vegetation and wetlands; however, these project elements are meant to preserve and enhance stream and riparian habitat, leading to improved vegetation and wetland quality and habitat functions. Additionally, work within sensitive areas would require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts affecting sensitive areas (Section 4.8.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Habitat Protection and Enhancement

The purpose of this project is to protect and enhance habitat within the lower Icicle Creek corridor, which could require work within riparian areas and wetlands. Although these activities could result in the loss of some small areas of these resources, overall, the purpose of this project is to preserve and enhance stream and riparian habitat, which would improve vegetation and wetland quality and habitat functions. Additionally, work within sensitive areas would require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts, such as compensating for the permanent loss of any sensitive areas (Section 4.8.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Instream Flow Rule Amendment

Under the Instream Flow Rule Amendment Project, the Icicle Creek Reserve established under Chapter 173-545 WAC would be increased by 0.4 cfs. Over the long term, this amendment would ultimately result in the removal of 0.4 cfs from Icicle Creek annually, which could adversely affect riparian vegetation and any associated wetland areas because there could be less water to support these areas. However, potential impacts on vegetation and wetlands would be offset by the implementation of required instream flow and habitat restoration actions under this Program Alternative, as well as several other projects associated with Alternative 1.

No instream flow reduction would occur in the Wenatchee River because this project would move 0.4 cfs out of the Wenatchee River Reserve.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The potential long-term adverse impacts on vegetation and wetlands under the LNFH Conservation and Water Quality Improvements Project would occur in areas where new facilities resulted in the conversion or loss of vegetation and possibly wetland areas. Potential adverse impacts would likely be minor because the potential permanent loss of vegetation is expected to affect a relatively small area. Additionally, work within sensitive areas would require compliance with various local, state, and federal regulations, including NEPA, which would address the need for mitigation to reduce potential long-term impacts affecting sensitive areas (Section 4.8.7, Mitigation Measures).

Fish Passage Improvements

Proposed Fish Passage Improvements Project elements occur entirely within Icicle Creek, therefore no long-term negative impacts to vegetation and wetlands would be expected.

Fish Screen Compliance

Long-term impacts associated with the Fish Screen Compliance Project would largely be beneficial; however, it is possible that some small areas of vegetation could be removed, depending on final design of the proposed project elements.

Any adverse impacts on vegetation would be likely minor because these impacts would be addressed as required by applicable local, state, and federal permits or approvals, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts, such as revegetating any disturbed areas and compensating for the permanent loss of any sensitive areas that could not otherwise be restored (Section 4.8.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Water Markets

Proposed Water Markets Project elements would result in changes in the water market with the intention of increasing flows in lower Icicle Creek. There would be no long-term negative impacts on vegetation and wetlands. Potential long-term impacts would be beneficial.

4.8.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would also be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. Compliance with the Guiding Principles addresses vegetation in general by enhancing Icicle Creek aquatic and riparian habitat. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Impacts of other project elements are described under Alternative 1

4.8.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction of a new pump station under this project would require both in-water and riverbank work on the Wenatchee River. Such activities could result in many of the same construction-related short-term impacts on vegetation and wetlands described for the COIC Irrigation Efficiencies and Pump Exchange Project, including clearing of vegetation along the bank of the Wenatchee River and along the delivery pipeline route. As long as construction activities comply with permit terms and conditions that would be required as discussed in Section 4.8.7, Mitigation Measures, potential short-term impacts would not be significant. Specific mitigation measures would be developed as part of future project-level review and permitting.

4.8.3.2 Long-term Impacts

IPID Dryden Pump Exchange

IPID Dryden Pump Exchange Project facilities would likely result in the loss of a small area of riparian vegetation for the pump station and intake facilities constructed along the right bank of the Wenatchee River and, depending on the specific location, could potentially affect wetlands. The project could also require clearing of vegetation along the delivery pipeline alignment, which would likely pass through existing agricultural properties and could impact orchard trees.

Any adverse impacts would likely be minor because the amount of area converted from vegetation to the new facilities would be small and would be addressed as required by applicable local, state, and federal permits or approvals, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts, such as compensating for the permanent loss of any sensitive areas (Section 4.8.6, Mitigation Measures).

Operational changes associated with relocating the pump exchange would result in increased flows within Icicle Creek from the point of the existing diversion (RM 5.7) to the new location. Increased flows within the creek would be beneficial.

4.8.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 would be included while the Eightmile Lake Storage Restoration Project would not. Compliance with the Guiding Principles addresses vegetation in general by enhancing Icicle Creek aquatic and riparian habitat. This section describes the specific short- and long-term impacts associated with the legislative change. The impacts of all other project elements are described under Alternative 1 and Alternative 2.

4.8.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts to vegetation or wetlands.

4.8.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority Project were enacted, there could be potential conflicts with instream flow allocations. Under the proposed changes, junior domestic water rights could be exercised even when the Instream Flow Rule is not met, resulting in potential adverse impacts on riparian vegetation and any associated wetlands as a result of low-flow conditions. Under Alternative 3, there would be flow improvement projects. However, the timing of flow improvement might not always provide for in-time mitigation for junior users.

4.8.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1. The Eightmile Lake Storage Restoration Project would be replaced with the Eightmile Lake Storage Enhancement Project. The Upper Klonaqua and Upper and Lower Snow Lakes Storage Enhancement Projects would also be included. Compliance with the Guiding Principles addresses vegetation in general by enhancing Icicle Creek aquatic and riparian habitat. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.8.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would involve demolishing the existing dam, installing new piping, and constructing new impoundment and water control structures that would allow for an increase in the accessible storage at Eightmile Lake to 3,500 acre-feet. The spillway elevation would be raised to allow for storage at a higher level than current or historical water storage levels and the project would allow for additional draw down of the lake.

Construction activity would occur along the banks and within the dry areas of the lake margins once the lake was drawn down. While most construction equipment (potentially including a small tracked excavator) and materials would likely be flown into the project site via helicopter; however, IPID is considering the option of walking in a larger tracked excavator or a spider excavator. The trail to access the project site requires several stream crossings and parallels several potential wetlands (Figure 3-10).

Disturbance within these areas has the potential to adversely affect vegetation and wetlands through direct impact or through increased exposure to contaminated stormwater runoff. Direct impacts could occur as the result of general construction activity resulting in clearing or trampling of vegetation during earth movement and staging of equipment and materials. There would also be minor potential for contaminated runoff to adversely affect vegetation and wetlands by increased erosion or accidental spills of chemicals used during construction.

This project would require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential impacts on vegetation and wetlands, such as requiring all in-water work to be performed in the dry with the lake level drawn down and implementing construction BMPs designed to reduce the potential for erosion and inadvertent contamination from vehicle fluids, uncured concrete, human waste, and other sources (Section 4.8.7, Mitigation Measures). As such, potential impacts on vegetation and wetlands would not be significant.

Upper Klonaqua Lake Storage Enhancement

Short-term impacts on vegetation and wetlands from the Upper Klonaqua Lake Storage Enhancement Project would primarily be associated with construction activities required to provide a low-level outlet from Upper Klonaqua Lake to Lower Klonaqua Lake using one of the three conceptual connection options discussed in Section 2.8. Construction activity would occur between the lakes and along the banks within the dry areas of the lake margins once the lakes were drawn down.

Disturbance within these areas has the potential to adversely affect vegetation and wetlands through direct impact or through increased exposure to contaminated stormwater runoff. Direct impacts could occur as the result of general construction activity resulting in clearing or trampling of vegetation during earth movement and storage of equipment. There would also be minor potential for contaminated runoff to adversely affect vegetation and wetlands by increased erosion or accidental spills of chemicals used during construction.

This project would require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential impacts on vegetation and wetlands, such as requiring all in-water work to be performed in the dry and implementing construction BMPs designed to reduce the potential for erosion and inadvertent contamination from vehicle fluids, uncured concrete, human waste, and other sources (Section 4.8.6, Mitigation Measures). As such, potential impacts on vegetation and wetlands would not be significant.

Upper and Lower Snow Lakes Storage Enhancement

Short-term impacts on vegetation and wetlands from this project would be primarily related to construction activities, and the impacts are similar in type and mechanism to those discussed in Sections 4.8.5.1, Short-term Impacts, Eightmile Lake Storage Enhancement and Upper Klonaqua Lake Storage Enhancement. Specific construction activities that could result in impacts include the transportation of construction equipment and materials to the project site; draw down of the lakes to isolate in-water work areas; demolition of the existing dams and water control structures; removal of vegetation, excavation, and fill placement to install new low-level outlet piping; and the placement of concrete and other materials to construct new dams. Impacts that could result from these activities include direct disturbance of vegetation or wetlands or increased potential for exposure of these resources to contaminated stormwater runoff.

The Upper and Lower Snow Lakes Storage Enhancement Project would require multiple local, state, and federal environmental reviews and permits as described in Section 4.8.7, Mitigation Measures. Permits issued by regulatory agencies would include requirements for the implementation of appropriate mitigation measures and construction BMPs to reduce impacts on water quality. As a result of these requirements, potential impacts on vegetation and wetlands would not be significant.

4.8.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Operation of the proposed facilities for the Eightmile Lake Storage Enhancement Project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. The greatest potential for impacts on vegetation and wetlands over the long term would occur as the result of permanent conversion of any sensitive areas, disturbance during maintenance, and any changes in operations with respect to how lake levels are managed.

As noted previously, compliance with applicable regulations, as discussed in Section 4.8.7, Mitigation Measures, would ensure there would be no net loss of important ecological functions that may be associated with impacts on any sensitive vegetative communities.

Because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, this project would result in the ability to maintain the lake at higher than historical levels compared to existing conditions and the No-action Alternative.

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is restored, the lake would be able to fill to a new high water surface of 4,682 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,677 feet to the height of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch in the early summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,682 feet. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline would be under water. Shoreline areas up to 4,671 feet have been historically inundated, but areas above 4,671 feet to 4,682 feet have not been inundated. The additional area would be under water for a little less than a month each summer. This change in lake levels could result in some changes to the vegetative community along the shoreline. The proposed project would inundate approximately 13.6 acres that are not currently inundated, which would not represent a substantial loss but rather a change in the mix of vegetation.

The project would also allow for the lake to be drawn down below existing lake levels to an elevation of 4,619 feet, which is approximately 24.4 feet lower than the existing low. This change would result in the exposure of slightly more lake bed, mainly in the later summer months and early fall up to the point when the water would no longer be drawn down, generally around the end of September. The additional draw down is not expected to adversely affect vegetation or wetlands by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity

Likewise, as discussed in Section 3.5, Water Quality, changes in flows in Icicle Creek would be within the natural variation already occurring within the system. The main changes would be beneficial increases in flows during times when water levels would otherwise be low. As noted in Section 3.18, Shorelines, flow changes on Icicle Creek would not occur at a level that would negatively affect the shoreline. Additionally, work within sensitive areas would likely require compliance with various local, state, and federal regulations, which would require appropriate mitigation measures to reduce potential long-term impacts affecting sensitive areas (Section 4.8.7, Mitigation Measures). For these reasons, this project is not anticipated to result in significant long-term impacts on vegetation or wetlands.

Upper Klonaqua Lake Storage Enhancement

Potential long-term impacts to vegetation and wetlands would be similar to those described under the Eightmile Lake Storage Enhancement Project (Section 4.8.5.2, Long-term Impacts). Potential benefits would mainly occur in Icicle Creek and would include an increased ability to augment stream flow in the late summer or during drought years, with flow augmentation primarily benefitting the section of Icicle Creek between Upper Klonaqua Lake and the IPID diversion.

As noted previously, compliance with applicable regulations, as discussed in Section 4.8.7, Mitigation Measures, would ensure there would be no net loss of important ecological functions that may be associated with impacts on any sensitive vegetative communities.

The frequency in fluctuations in lake levels in Upper Klonaqua Lake would increase compared to existing conditions and the No-action Alternative. Lake levels would also be drawn down further compared to existing conditions.

The high lake level in Upper Klonaqua Lake would not change. The lake would still refill and outlet naturally through an existing channel to Lower Klonaqua Lake during most of the year. However, the new facilities would allow for the lake to be drawn down an additional 20 feet to allow for access to an additional 1,146 acre-feet of storage. The draw down would likely occur over a couple of months in the late summer. The additional draw down is not expected to adversely affect vegetation or wetlands by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

Likewise, as discussed in Section 3.5, Water Quality, changes in flows in Icicle Creek resulting from this action would be within the natural variation already occurring within the system. The main changes would be beneficial increases in flows during times when water levels would otherwise be low. As noted in Section 3.18, Shorelines, flow changes on Icicle Creek would not occur at a level that would negatively affect the shoreline. Additionally, work within sensitive areas would likely require compliance with various local, state, and federal regulations, which would require appropriate mitigation measures to reduce potential long-term impacts affecting sensitive areas (Section 4.8.7, Mitigation Measures). For these reasons, this project is not anticipated to result in significant long-term impacts on vegetation or wetlands.

Upper and Lower Snow Lakes Storage Enhancement

Potential long-term impacts to vegetation and wetlands would be similar to those described under the Eightmile Lake Storage Enhancement Project (Section 4.8.5.2, Long-term Impacts). Potential benefits would mainly occur in Icicle Creek and would include an increased ability to augment stream flow in the late summer or during drought years, with flow augmentation primarily benefitting the section of Icicle Creek between Lower Snow Lake and the IPID diversion.

The proposed enhancement project would increase the high-water storage levels in both Upper and Lower Snow Lakes by 5 feet compared with existing high levels. This change would result in the inundation of some upland vegetation that has grown along the shoreline areas between the current and proposed high lake levels, most likely occurring in the fall through the early summer when releases would be likely to begin. This could result in some changes to the vegetative community along the shoreline.

The project would also allow for the Lower Snow Lake to be drawn down 3 feet below the current lake level, which would result in the exposure of slightly more lake bed. The additional draw down is not expected to adversely affect vegetation or wetlands by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

Overall, potential adverse impacts would likely be minor because the potential loss or conversion of vegetation is expected to affect a relatively small area. Additionally, work within sensitive areas would require compliance with various local, state, and federal regulations, including NEPA, which would address the need for mitigation to reduce potential long-term impacts affecting sensitive areas (Section 4.8.7, Mitigation Measures).

4.8.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange Project would be included.

4.8.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

This project would involve converting the IPID delivery systems to pressurized pipelines throughout the entire system, removing or abandoning the existing intakes on Icicle and Peshastin Creeks, and constructing three new pump stations and intakes on the Wenatchee River. Construction of the new pump stations and removal of existing diversion facilities under this project would require both in-water and riverbank work on the Wenatchee River, Icicle Creek, and Peshastin Creek. Such activities could result in construction-related short-term impacts on vegetation and wetlands, including clearing of vegetation along the bank of the Wenatchee River and along the extensive delivery pipeline route. As long as construction activities comply with permit terms and conditions that would be required as discussed in Section 4.8.7, Mitigation Measures, potential short-term impacts would not be significant. Specific mitigation measures would be developed as part of future project-level review and permitting.

4.8.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange Project

IPID Full Piping and Pump Exchange Project facilities would likely result in the loss of a small area of riparian vegetation where the pump stations are located along the Wenatchee River and, depending on the specific location, there could be could potentially a loss of wetlands. The project could also require clearing of vegetation along the entire delivery pipeline alignment, which would likely pass through existing agricultural properties and could impact orchard trees.

Permanent loss of vegetation is expected to be relatively small and would be compensated for as required by applicable local, state, and federal permits or approvals, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts, such as compensating for the permanent loss of any sensitive areas (Section 4.8.6, Mitigation Measures).

Operational changes associated with relocating the intakes from Icicle and Peshastin Creeks to the Wenatchee River would result in increased flows within Icicle and Peshastin Creeks. Increased flows would be beneficial to riparian vegetation and wetlands.

4.8.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.8.7.1 Short-term Impacts

Short-term impacts on vegetation and wetlands would be mitigated by complying with the terms and conditions of local, state, and federal regulations and project-specific permits and approvals, including local building, grading, and stormwater construction permits; state stormwater permits; Shoreline Management Act shoreline permits; HPAs; and CWA Section 404 permits and their associated Section 401 Water Quality Certifications, among others. Common permit conditions are likely to include conducting work in a manner to minimize potential disturbance of sensitive vegetation communities and possibly compensating for loss of any important habitat or ecosystem functions. For permits or approvals affecting any work near or within wetlands, refer to Section 4.5.7, [Water Quality] Mitigation Measures.

Specific mitigation measures would be developed as part of future project-level review and permitting. Implementation of the following additional measures would ensure impacts would be less than significant.

- Mark clearing or disturbance limits and protect vegetation outside those limits.
- Design and locate any permanent facilities to avoid, to the extent possible, potential impacts on sensitive vegetative communities, including the removal of trees or wetlands.
- Locate construction staging areas and any new access roads to avoid disturbing sensitive areas to the extent possible.
- Revegetate disturbed areas with native plant species as agreed upon by the appropriate regulatory agencies.

4.8.7.2 Long-term Impacts

Long-term impacts on vegetation and wetlands would be mitigated by complying with the terms and conditions of local, state, and federal regulations and project-specific permits and approvals, as described above.

Specific mitigation measures would be developed as part of future project-level review and permitting. Implementation of the following additional measures would ensure impacts would be less than significant.

- Monitor and continue to remove invasive species from any revegetated areas to ensure re-establishment of the desired vegetation communities and ecological function as agreed upon by the appropriate regulatory agency.

4.9 Wildlife

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.9, Wildlife, from construction and operation related to the No-action Alternative and Program Alternatives. Potential impacts on special-status species are addressed in Section 4.10, Threatened and Endangered Species.

4.9.1 No-action Alternative

4.9.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that could result in short-term impacts on wildlife in the Alpine Lakes Wilderness Area and in riparian areas along Icicle Creek and the Wenatchee River. This is anticipated to entail construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability. Potential impacts would be associated with projects that require construction. In the short term, construction activity could adversely affect wildlife by causing noise disturbance and adversely affecting habitat as described in Section 4.8, Vegetation.

The agencies or entities implementing projects under the No-action Alternative would be required to comply with applicable local, state, and federal environmental review requirements and permits as described in Section 5.2, Table 5-2. Applicable permits would require appropriate mitigation measures to reduce impacts on wildlife, such as including any necessary timing restrictions for construction work and ensuring no net loss of important habitat and ecological values and functions (Section 4.9.7, Mitigation Measures). Therefore, short-term impacts to wildlife under the No-action Alternative are not expected to be significant.

4.9.1.2 Long-term Impacts

Long-term impacts under the No-action Alternative are anticipated to be largely beneficial for wildlife, especially wildlife dependent on Icicle Creek, because many projects would seek to improve instream flows during the late summer and improve habitat overall although the benefit is not excepted to be as great without implementation of a coordinated strategy.

4.9.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in greater impacts on wildlife compared with the No Action Alternative because there would be higher likelihood that certain projects would be implemented and the scale of certain efforts would likely be greater. Compliance with the Guiding Principles addresses wildlife in general by enhancing Icicle Creek aquatic and riparian habitat. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.9.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Most of the work would occur in upland areas. Some limited work would occur within the lake shorelines but within the dry when the lakes are drawn down at the end of the summer. Construction would last for a period of a few days to a couple of weeks at each lake. Some equipment may be walked in via the Eightmile Lake Trail but most equipment and workers would be transported to the project site by helicopter.

Construction activity could disrupt the use of riparian and forested habitat by native wildlife species to breed, forage, rest, and overwinter. As discussed in Section 3.9, Wildlife, the lakes are used by many species, including large and small mammals, reptiles, amphibians, cavity nesting birds, raptors, waterfowl, and a variety of songbirds. Waterfowl species such as common loons nest along the lake shoreline. Aquatic species such as amphibians could also be present during construction.

Although some vegetated areas would be used to stage construction equipment and temporarily provide housing for workers, there would be no permanent loss of habitat and the activities would not block access to habitat areas. As discussed in Section 4.5, Surface Water Quality, risks of spills (e.g., fuel, chemicals, etc.) would be very low because there would be limited use of powered equipment near water.

Wildlife would be exposed to some increased noise during construction. Short-term increases in noise lasting a couple days to a couple of weeks are described in Section 4.14, Noise, and would include some helicopter trips. As noted, the majority of construction noise would be relatively minor. In general, in response to periodic increases in noise and activity, most wildlife species are expected to disperse to adjacent habitat areas to avoid impacts. However, particularly vulnerable species include special-status species, especially those that may be breeding during this time. These species are discussed in Section 4.10, Threatened and Endangered Species.

Compliance with applicable local, state, and federal regulations would further ensure that there were no significant impacts on wildlife. If needed, mitigation would be developed during project-level review, which may include measures such as implementing construction timing restrictions and no net loss of ecological functions and values (Section 4.9.7, Mitigation Measures).

IPID Irrigation Efficiencies

Construction activities associated with this project include the conversion of IPID canals to pipelines and lining of irrigation canals with concrete. Short-term impacts that could adversely affect wildlife include disturbance from increased construction activity and noise, and temporary disturbance of habitat. These impacts would be relatively limited because most of the work would occur within areas that are already disturbed, such as within rights-of-way and existing canal easements. As noted in Section 4.14, Noise, construction-related noise is anticipated to be relatively minimal. Species in the work area may temporarily relocate to other areas during periods of increased activity.

Compliance with applicable local, state, and federal regulations would further ensure that there were no significant impacts on wildlife. If needed, mitigation would be developed during project-level review, such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for wildlife habitat (Section 4.9.6, Mitigation Measures).

COIC Irrigation Efficiencies and Pump Exchange

Potential impacts on wildlife associated with work affecting COIC canals would be similar to those described for the IPID Irrigation Efficiencies Project (4.9.2.1, Short-term Impacts). Construction of the COIC pump station would also require work along the streambank of lower Icicle Creek or the Wenatchee River. Depending on the specific location, there could be a slightly greater potential for adverse construction-related impacts compared with canal-related work, particularly if construction disturbance occurred in an otherwise relatively undisturbed area.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include limiting the extent of work within sensitive areas, requiring revegetation of disturbed sites, and compensating for any loss of important ecosystem functions and values (Section 4.9.6, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on wildlife would be less than significant.

Domestic Conservation Efficiencies

Construction activities proposed under the Domestic Conservation Efficiencies Project include pipeline replacement and meter installation. These activities are unlikely to adversely affect wildlife because the work would be done in areas that are already developed.

Eightmile Lake Storage Restoration

This project involves demolishing the existing dam, installing new piping, and constructing new impoundment and water control structures. Construction activity would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down and in Eightmile Creek immediately downstream of the dam. While most construction equipment (potentially including a small tracked excavator) and materials would likely be flown into the project site via helicopter, IPID is considering the option of walking in a larger tracked excavator or a spider excavator. The trail to access the project site requires several stream crossings and parallels several potential wetlands (Figure 3-10.

Construction activity could disrupt the use of riparian and forested habitat by native wildlife species to breed, forage, rest, and overwinter. As discussed in Section 3.9, Wildlife, the lakes are used by many species, including large and small mammals, reptiles, amphibians, cavity nesting birds, raptors, waterfowl, and a variety of songbirds. Waterfowl species such as common loons nest along the lake shoreline. Aquatic species such as amphibians could also be present during construction.

Construction activity would be limited to the dry lake margins and the existing structure for a period of 2 to 3 months. Although some vegetated areas would be used to stage construction equipment and temporarily provide housing for workers, there would be no permanent loss of habitat and the activities would not block access to adjacent habitat. As discussed in Section 4.5, Water Quality, risks of spills (e.g., fuel, chemicals, etc.) would be very low because there would be limited use of powered equipment near water and work would occur in the dry after the lake was drawn down.

The greatest potential for short-term impacts on wildlife would occur as the result of increased noise during construction. Short-term increases in noise lasting 2 to 3 months are described in Section 4.14, Noise, and would include some helicopter trips and possibly blasting. As noted, the majority of construction noise would be relatively minor. In general, in response to periodic increases in noise and activity, most wildlife species are expected to disperse to adjacent habitat areas to avoid impacts. Potential noise disturbance would be most disruptive if it occurred during the spring months when many species are breeding However, the potential for overlap with construction is more limited because construction activities would occur in late summer or early fall when lake water levels can be drawn down to allow for construction. Particularly vulnerable species include special-status species discussed in Section 4.10, Threatened and Endangered Species.

Compliance with applicable local, state, and federal regulations would further ensure that there were no significant impacts on wildlife. If needed, mitigation would be developed during project-level review, which may include measures such as implementing construction timing restrictions and no net loss of ecological functions and values (Section 4.9.6, Mitigation Measures).

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effects on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. The specifics of this project are not yet determined, but would involve elements of restoration along the lower Icicle Creek that could result in localized construction-related noise and short-term disturbance to habitat. At this stage, the primary options under consideration include the construction of facilities such as a bubble curtain, sprayer, or other minor modifications to the LNFH to promote favorable fishing conditions in the pool at the bottom of the spillway.

Depending on the specific location of the activities, construction could result in short-term impacts on wildlife, primarily related to construction disturbance. Project activities with the potential to affect sensitive wildlife species would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to address these impacts (Section 4.9.7, Mitigation Measures).

Habitat Protection and Enhancement

Habitat protection and enhancement proposed under this project could involve grading; planting and thinning vegetation; hauling and placing logs, rock, soil, and other materials; and some in-water work on lower Icicle Creek. Depending on the specific location of the activities, construction could result in short-term impacts on wildlife, primarily associated with construction disturbance similar to those described above.

Project activities with the potential to affect sensitive wildlife species would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential impacts (Section 4.9.7, Mitigation Measures).

Instream Flow Rule Amendment

There are no construction activities proposed under this project and therefore no potential short-term impacts to wildlife or wildlife habitat.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements geared towards improving water quality and hatchery rearing conditions at the LNFH. In general, construction of these elements has the potential to affect wildlife, depending on the specific location and type of disturbance. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential short-term impacts under NEPA would be completed once the full scope of the project is determined.

Similar to the construction activities described above, various authorizations are likely to be required that would ensure that potential impacts would be avoided, minimized, or compensated as noted in Section 4.9.7, Mitigation Measures.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek, as well as instream modifications to the Boulder Field near RM 5.6. This work would result in disturbances along the streambank and within Icicle Creek that would be addressed in subsequent environmental review and permitting once project specifics are determined. This work would also likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would further help to address potential impacts on wildlife.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on Lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws. This work would result in disturbances along the streambank and within Icicle Creek that would be addressed once project specifics are determined. This work would also likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would help to further address potential impacts on wildlife.

Water Markets

There are no construction activities proposed under the Water Markets Project and therefore no potential short-term impacts to wildlife or wildlife habitat.

4.9.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from the affected lakes. Long-term impacts on wildlife could occur if there was a substantial loss of habitat or from long-term disturbance of species from maintenance activities or changes in how lake levels are managed.

As discussed above, there would be no permanent loss of habitat. Because the facilities would be newer and operated remotely by IPID and USFWS personnel, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less than would occur compared to existing conditions.

The frequency in fluctuations in lake levels would increase compared to existing conditions because lake levels would be drawn down every year instead of rotating one or two lakes per year; however, the high and low lake water levels would not change. This variation would be consistent with natural fluctuations in lake level changes and no impacts on shorelines or vegetation and wetlands are anticipated (Section 4.8, Vegetation, and Section 4.18, Shorelines). Similarly, no significant impacts on wildlife are expected.

As discussed in Section 4.5, Water Quality, changes in flows in Icicle Creek would be within the natural variation already occurring within the system. The main changes would be beneficial increases in flows during times when water levels would otherwise be low. As noted in Section 3.18, Shorelines, flow changes on Icicle Creek would not occur at a level that would negatively affect the shoreline. For these reasons, this project is not anticipated to result in significant long-term impacts on wildlife.

IPID Irrigation Efficiencies

The majority of the IPID Irrigation Efficiencies Project elements include pipelines or canal improvements that would occur in areas that have already been disturbed and would not result in long-term impacts on wildlife. Over the long-term, efficiencies gained would result in an increase in instream flows that would be beneficial to riparian habitat and associated wildlife species.

COIC Irrigation Efficiencies and Pump Exchange

In general, the potential impacts associated with the COIC Irrigation Efficiencies and Pump Exchange Project would be similar to those described for the IPID Irrigation Efficiencies Project (4.9.2.2, Long-term Impacts) with the exception of the COIC pump station and intake facilities. These facilities would result in the loss of a small area of riparian habitat. Any adverse impacts on wildlife would be likely minor because the amount of habitat lost would be small and would be addressed as required by applicable local, state, and federal permits or approvals, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts, such as compensating for the permanent loss of any sensitive areas (Section 4.9.7, Mitigation Measures). Over the long-term, this project would also contribute to beneficial increases in instream flows that would be beneficial to riparian habitat and associated wildlife species.

Domestic Conservation Efficiencies

Increased conservation and re-use associated with this project is expected to lead to decreased return flows, which could decrease flows in the Wenatchee River downstream of the Leavenworth Wastewater Treatment Plant; however, the long-term effects on streamflow and any associated changes to riparian vegetation and associated wildlife habitat are expected to be negligible.

Eightmile Lake Storage Restoration

Operation of the proposed facilities for the Eightmile Lake Storage Restoration Project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. Wildlife impacts could occur over the long term from any permanent conversion of wildlife habitat, disturbance during maintenance, or any changes in operations with respect to how lake levels are managed.

As discussed above, there would be no permanent loss of habitat. Because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions. However, restoration of the facilities and re-operation of the lake would result in the ability to maintain the lake at higher, historical levels compared to existing conditions.

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is restored, the lake would be able to fill to the historical high level of 4,671 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,666 feet, which would be the crest elevation of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch early in the summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,671 feet, equal to the historical full water surface elevation. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline would be under water. These areas have been historically inundated, but have not been under water since deterioration of the embankment. This change in lake levels could result in some changes to the vegetative community along the fringes of the shoreline; however, this area is expected to be relatively small, on the order 3.6 acres of shoreline area inundated, and would not represent a substantial loss of habitat that is anticipated to adversely affect wildlife.

The project would also allow for the lake to be drawn down below the existing low lake levels to an elevation of 4,621 feet, which is approximately 22.4 feet below the existing low. This change would result in the exposure of slightly more lake bed, mainly in the later summer months and early fall up to the point when the water would no longer be drawn down, generally around the end of September. The additional draw down is not expected to adversely affect wildlife habitat by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity or any other changes that would adversely affect wildlife.

As discussed in Section 3.5, Water Quality, changes in flows in Icicle Creek would be within the natural variation already occurring within the system. The main changes would be beneficial increases in flows during times when water levels would otherwise be low. As noted in Section 3.18, Shorelines, flow changes on Icicle Creek would not occur at a level that would negatively affect the shoreline. For these reasons, this project is not anticipated to result in significant long-term impacts on wildlife.

Tribal Fishery Preservation and Enhancement

The intent of the Tribal Fishery Preservation and Enhancement Project is to ensure that other projects implemented as part of the Icicle Strategy do not have negative effects on tribal fisheries, and tribal treaty and federally protected harvest rights. Depending on the specific actions, this could result in the loss of some small areas of vegetation and wetlands that provide wildlife habitat; however, these project elements are meant to preserve and enhance stream and riparian habitat in the system overall, leading to improved vegetation and wetland quality, improved habitat functions, and long-term benefits for wildlife.

Additionally, work within sensitive areas would require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts affecting sensitive areas (Section 4.9.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Habitat Protection and Enhancement

No long-term adverse impacts on wildlife and wildlife habitat are expected under the Habitat Protection and Enhancement Project. The purpose of this project is to improve the quality and functions of riparian and wetland habitats for wildlife. Improved water quality conditions would benefit wildlife species, including amphibians and stream invertebrates. In addition, work within sensitive areas would require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts, such as compensating for the permanent loss of any sensitive areas (Section 4.9.7, Mitigation Measures). These requirements would be developed once project-specific details are available.

Instream Flow Rule Amendment

Under the Instream Flow Rule Amendment Project, the Icicle Creek Reserve established under Chapter 173-545 WAC would be increased by 0.4 cfs. Over the long-term, this amendment would ultimately result in the removal of an additional 0.4 cfs from Icicle Creek only after habitat and flow restoration elements are implemented. This project could adversely affect water quantity and quality in portions of Icicle Creek and thus could adversely affect dependent wildlife.

Potential impacts associated with the Instream Flow Rule Amendment are anticipated to be offset by the implementation of required instream flow and habitat restoration actions under this Program Alternative as well as several other projects associated with Alternative 1. Depending on the instream conditions at the time this reserve is accessed, there could be potential conflicts with the beneficial uses, most likely those associated with fish and wildlife habitat uses, designated for Icicle Creek.

No instream flow reduction would occur in the Wenatchee River because this project would move 0.4 cfs out of the Wenatchee River Reserve.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

Over the long term, the water conservation and water quality improvement elements proposed at LNFH for this project are expected to benefit water quality and associated wildlife in Icicle Creek and the Wenatchee River. As part of this project, LNFH would be required to secure an updated National Pollutant Discharge Elimination System permit and state Water Quality Certification for the LNFH through the implementation of facility upgrades and operational improvements. These actions would require compliance with relevant total maximum daily loads for the Wenatchee River Watershed and would ultimately be designed to avoid additional water quality impacts in the basin.

In addition, most of the work included under this project is designed to improve water use efficiency at LNFH and to develop additional groundwater supplies such that less water would need to be diverted from Icicle Creek for hatchery operations. Such actions would potentially support higher flows in the system, especially during late summer, which would benefit wildlife present within and along the creek.

Fish Passage Improvements

Long-term impacts associated with the Fish Passage Improvements Project would largely be beneficial; however, it is possible that some small areas of vegetation may be removed that could affect wildlife. The extent of the impacts would depend on final design of the proposed project elements and whether the affected area is used by wildlife.

Any adverse impacts on vegetation would be likely less than significant because these impacts would be addressed as required by applicable local, state, and federal permits or approvals, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts, such as revegetating any disturbed areas and compensating for the permanent loss of any sensitive areas that could not otherwise be restored (Section 4.9.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens along Icicle Creek. The potential for any impacts related to loss of riparian habitat that could adversely affect wildlife would be addressed in project-level review. Long-term operations would be beneficial to fish and aquatic species and by extension to the larger ecosystem in general. Therefore, no adverse long-term wildlife impacts are expected.

Water Markets

As noted in Section 4.5, Water Quality, the long-term impacts of the Water Markets Project on water quality would be beneficial. Therefore, there are no adverse long-term wildlife impacts that are expected.

4.9.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would also be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. Compliance with the Guiding Principles addresses wildlife in general by enhancing Icicle Creek aquatic and riparian habitat. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Impacts of other projects considered under Alternative 2 are described under Alternative 1.

4.9.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction of a new IPID pump exchange would require both in-water and riverbank work on the Wenatchee River, including the placement and removal of instream cofferdams, removal of streamside vegetation, and excavation of the streambed and bank. Depending on the specific location of the activities, construction could result in short-term impacts on wildlife, primarily related to construction disturbance. Project activities with the potential to affect sensitive wildlife species would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a

CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to address these impacts (Section 4.9.7, Mitigation Measures). Specific mitigation measures would be developed as part of future project-level review and permitting.

4.9.3.2 Long-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange facilities would likely result in the loss of a small area of riparian vegetation for the pump exchange station and intake facilities constructed along the right bank of the Wenatchee River, which could potentially affect wildlife, depending on the specific location. The project could also require clearing of vegetation along the delivery pipeline alignment, which would likely pass through existing agricultural properties and could impact orchard trees.

Any adverse impacts would be likely less than significant because the amount of area converted from vegetation to the new facilities would be small and would be addressed as required by applicable local, state, and federal permits or approvals, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts such as compensating for the permanent loss of any sensitive areas (Section 4.9.7, Mitigation Measures).

Operational changes associated with relocating the pump exchange would result in increased flows within Icicle Creek from the point of the existing diversion (RM 5.7) to the new location. Increased flows within the creek would be beneficial.

4.9.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3would be included while the Eightmile Lake Storage Restoration project would not. Compliance with the Guiding Principles addresses wildlife in general by enhancing Icicle Creek aquatic and riparian habitat. This section describes the specific short- and long-term impacts associated with the legislative change. Impacts of other projects proposed under Alternative 3 are described in Alternative 1 and Alternative 2.

4.9.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts on wildlife or wildlife habitat are expected.

4.9.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority Project were enacted, there could be potential conflicts with instream flow allocations that could result in adverse impacts on wildlife and wildlife habitat. Under the proposed changes, junior domestic water rights could be exercised even when the Instream Flow Rule is not met, resulting in potential adverse impacts on water quality as a result of low-flow conditions. Under Alternative 3, flow improvement projects would be implemented. However, the timing of flow improvement might not always provide in-time mitigation for junior users.

4.9.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1 with the exception that the Eightmile Lake Storage Restoration project would be replaced with the Eightmile Lake Storage Enhancement project, and the Upper Klonaqua and Upper and Lower Snow Lakes Storage Enhancement Projects would also be included. Compliance with the Guiding Principles addresses wildlife in general by enhancing Icicle Creek aquatic and riparian habitat. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.9.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would involve demolishing the existing dam, installing new piping, and constructing new impoundment and water control structures that would allow for an increase in the accessible storage at Eightmile Lake to 3,500 acre-feet. The spillway elevation would be raised to allow for storage at a higher level than current or historical water storage levels and the project would allow for additional draw down of the lake.

Construction activity could disrupt the use of riparian and forested habitat by native wildlife species to breed, forage, rest, and overwinter. As discussed in Section 3.9, Wildlife, the lakes are used by many species, including large and small mammals, reptiles, amphibians, cavity nesting birds, raptors, waterfowl, and a variety of songbirds. Waterfowl species such as common loons nest along the lake shoreline. Aquatic species such as amphibians could also be present during construction.

Construction activity would be limited to the dry lake margins and the existing structure for a period of 4 to 6 months. Although some vegetated areas would be used to stage construction equipment and temporarily provide housing for workers, there would be no permanent loss of habitat and the activities would not block access to adjacent habitat. As discussed in Section 4.5, Water Quality, risks of spills (e.g., fuel, chemicals, etc.) would be very low because there would be limited use of powered equipment near water and work would occur in the dry after the lake was drawn down.

The greatest potential for short-term impacts on wildlife would occur as the result of increased noise during construction. Short-term increases in noise lasting approximately 4 to 6 months are described in Section 4.14, Noise, and would include some helicopter trips and possibly blasting. As noted, the majority of construction noise would be relatively minor and similar to noise levels that already occur under existing conditions related to ongoing operations and maintenance and recreational use. In general, in response to periodic increases in noise and activity, most wildlife species are expected to disperse to adjacent habitat areas to avoid impacts. However, particularly vulnerable species include special-status species, especially those that may be breeding during this time. These species are discussed in Section 4.10, Threatened and Endangered Species.

Compliance with applicable local, state, and federal regulations would further ensure that there were no significant impacts on wildlife. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and no net loss of ecological functions and values (Section 4.9.7, Mitigation Measures).

Upper Klonaqua Lake Storage Enhancement

Under the Upper Klonaqua Lake Storage Enhancement Project, wildlife could be adversely affected in the short-term from construction activity in a manner similar to what would occur as described above for the Eightmile Lake Storage Enhancement Project (4.9.5.1, Short-term Impacts).

Construction activity could disturb the use of riparian and forested habitat used by native wildlife species to breed, forage, rest, and overwinter. As discussed in Section 3.9, Wildlife, riparian areas are used by many species, including large and small mammals, reptiles, amphibians, cavity nesting birds, raptors, waterfowl, and a variety of songbirds. Waterfowl species such as common loons could be nesting along the lake shoreline. Aquatic species such as amphibians could be present where in-water work is proposed.

Construction activity would be limited to the dry lake margins and the existing structure. Although some vegetated areas would be used to stage construction equipment and provide temporary housing for workers, there would be no permanent loss of habitat and the activities would not block access to adjacent habitat. As discussed in Section 4.5, Water Quality, risks of spills (e.g., fuel, chemicals, etc.) would be very low because there would be limited use of powered equipment near water and work would occur in the dry after the lake was drawn down.

The greatest potential for short-term impacts on wildlife would occur as the result of increased noise during construction. Short-term increases are described in Section 4.14, Noise, and would include some helicopter trips and possibly blasting. As noted, the majority of construction noise would be relatively minor. In general, in response to periodic increases in noise and activity, most wildlife species are expected to disperse to adjacent habitat areas to avoid impacts. However, particularly vulnerable species include special-status species, especially those that may be breeding during this time. These species are discussed in Section 4.10, Threatened and Endangered Species.

Compliance with applicable local, state, and federal regulations would further ensure that there were no significant impacts on wildlife. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and no net loss of ecological functions and values (Section 4.9.6, Mitigation Measures).

Upper and Lower Snow Lakes Storage Enhancement

Wildlife could be adversely affected in the short-term from construction activity in a manner similar to what would occur as described above for the Eightmile Lake Storage Enhancement Project (4.9.5.1, Short-term Impacts).

Construction activity could disturb the use of riparian and forested habitat used by native wildlife species to breed, forage, rest, and overwinter. As discussed in Section 3.9, Wildlife, riparian areas are used by many species, including large and small mammals, reptiles, amphibians, cavity nesting birds, raptors, waterfowl, and a variety of songbirds. Waterfowl species such as common loons could be nesting along the lake shoreline. Aquatic species such as amphibians could be present where in-water work is proposed.

Construction activity would be limited to the dry lake margins and the existing structure. Although some vegetated areas would be used to stage construction equipment and provide temporary housing for workers, there would be no permanent loss of habitat and the activities would not block access to adjacent habitat. As discussed in Section 4.5, Water Quality, risks of spills (e.g., fuel, chemicals, etc.) would be very low because there would be limited use of powered equipment near water and work would occur in the dry after the lake was drawn down.

The greatest potential for short-term impacts on wildlife would occur as the result of increased noise during construction. Short-term increases are described in Section 4.14, Noise, and would include some helicopter trips and possibly blasting. As noted, the majority of construction noise would be relatively minor. In general, in response to periodic increases in noise and activity, most wildlife species are expected to disperse to adjacent habitat areas to avoid impacts. However, particularly vulnerable species include special-status species, especially those that may be breeding during this time. These species are discussed in Section 4.10, Threatened and Endangered Species.

Compliance with applicable local, state, and federal regulations would further ensure that there were no significant impacts on wildlife. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and no net loss of ecological functions and values (Section 4.9.7, Mitigation Measures).

4.9.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Operation of the proposed facilities for the Eightmile Lake Storage Enhancement Project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. Because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, this project would result in the ability to maintain the lake at higher than historical levels compared to existing conditions and the No-action Alternative.

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is restored and raised, the lake would be able to fill to a new high water surface of 4,682 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,677 feet to the height of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch early in the summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,682 feet. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline, approximately 13.6 acres, would be under water for a part of each year. Shoreline areas up to 4,671 feet have been historically inundated, but areas above 4,671 feet to 4,682 feet have not. This additional area would be under water for a little less than a month each summer. This change in lake levels could result in some changes to the vegetative community along the shoreline. However, because of the availability of habitat in the surrounding area and the fact that increased water levels would not represent a permanent increase in the lake height, it would not represent a substantial loss of habitat and is not anticipated to adversely affect wildlife.

The project would also allow for the lake to be drawn down below existing lake levels to an elevation of 4,619 feet, which is approximately 24.4 feet lower than the existing low. This change would result in the exposure of slightly more lake bed, mainly in the later summer months and early fall up to the point when the water would no longer be drawn down, generally around the end of September. The additional draw down is not expected to adversely affect wildlife by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity or any other changes that would adversely affect wildlife.

As discussed in Section 3.5, Water Quality, changes in flows in Icicle Creek would be within the natural variation already occurring within the system. The main changes would be beneficial increases in flows during times when water levels would otherwise be low.

As noted in Section 3.18, Shorelines, flow changes on Icicle Creek would not occur at a level that would negatively affect the shoreline. For these reasons, this project is not anticipated to result in significant long-term impacts on wildlife.

Upper Klonaqua Lake Storage Enhancement

Potential long-term impacts on wildlife would be similar to those described under the Eightmile Lake Storage Enhancement Project (see Section 4.9.5.2, Long-term Impacts). Potential benefits would mainly occur in Icicle Creek and would include an increased ability to augment stream flow in the late summer or during drought years, with flow augmentation primarily benefitting the section of Icicle Creek between Upper Klonaqua Lake and the IPID diversion.

As noted previously, compliance with applicable regulations, as discussed in Section 4.9.6, Mitigation Measures, would ensure there would be no net loss of important ecological functions that may be associated with impacts on any wildlife communities.

The frequency in fluctuations in lake levels in Upper Klonaqua Lake would increase compared to existing conditions and the No-action Alternative. Lake levels would also be drawn down further compared to existing conditions.

The high lake level in Upper Klonaqua Lake would not change. The lake would still refill and outlet naturally through an existing channel to Lower Klonaqua Lake during most of the year. However, the new facilities would allow for the lake to be drawn down an additional 20 feet to allow for access to an additional 1,146 acre-feet of storage. The draw down would likely occur over a couple of months in the late summer. The additional draw down is not expected to adversely affect wildlife habitat by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

As discussed in Section 3.5, Water Quality, changes in flows in Icicle Creek would be within the natural variation already occurring within the system. The main changes would be beneficial increases in flows during times when water levels would otherwise be low. As noted in Section 3.18, Shorelines, flow changes on Icicle Creek would not occur at a level that would negatively affect the shoreline. For these reasons, this project is not anticipated to result in significant long-term impacts on wildlife.

Upper and Lower Snow Lakes Storage Enhancement

Potential long-term impacts on wildlife would be similar to those described under the Eightmile Lake Storage Enhancement Project (Section 4.9.5.2, Long-term Impacts). Potential benefits would mainly occur in Icicle Creek and would include an increased ability to augment stream flow in the late summer or during drought years with flow augmentation primarily benefitting the section of Icicle Creek between Upper Klonaqua Lake and the IPID diversion.

As noted previously, compliance with applicable regulations, as discussed in Section 4.9.6, Mitigation Measures, would ensure there would be no net loss of important ecological functions that may be associated with impacts on any sensitive wildlife communities.

Because the facilities would be newer and operated remotely by USFWS, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less than would occur compared to existing conditions and the No-action Alternative. However, lake levels would also be able to reach higher or lower levels compared to both existing conditions and historical levels.

The proposed enhancement project would increase the high-water storage levels in both Upper and Lower Snow Lakes by 5 feet compared with existing high levels. This change would result in the inundation of some upland vegetation that has grown along the shoreline areas between the current and proposed high lake levels, most likely occurring in the fall through the early summer when releases would be likely to begin. This could result in some changes to the vegetative community along the shoreline, similar to those described for the other lakes under this Program Alternative. However, these changes would not likely result in significant impacts on wildlife for the reasons described previously.

The project would also allow for the Lower Snow Lake to be drawn down 3 feet below the current lake level, which would result in the exposure of slightly more lake bed. The additional draw down is not expected to adversely affect wildlife habitat by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

As discussed in Section 3.5, Water Quality, changes in flows in Icicle Creek would be within the natural variation already occurring within the system. The main changes would be beneficial increases in flows during times when water levels would otherwise be low. As noted in Section 3.18, Shorelines, flow changes on Icicle Creek would not occur at a level that would negatively affect the shoreline. For these reasons, this project is not anticipated to result in significant long-term impacts on wildlife.

Overall, potential adverse impacts would likely be less than significant because the potential loss or conversion of vegetation is expected to affect a relatively small area. Additionally, work within sensitive areas would require compliance with various local, state, and federal regulations, including NEPA, which would address the need for mitigation to reduce potential long-term impacts affecting wildlife (Section 4.9.7, Mitigation Measures).

4.9.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange Project would be included.

4.9.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

This project would involve fully converting the IPID delivery systems to pressurized pipelines, removing the existing intakes on Icicle and Peshastin Creeks, and constructing three new pump stations and intakes on the Wenatchee River. Construction disturbance required throughout the entire delivery system for conversion to pressurized pipelines could result in short-term impacts on wildlife related to increase noise and temporary disturbance to surrounding vegetation.

Construction of the pump stations would require both in-water and riverbank work on the Wenatchee River, and Icicle and Peshastin Creeks, which could include the placement and removal of instream cofferdams, removal of streamside vegetation, and excavation of the streambed and bank. Project activities with the potential to affect sensitive wildlife species would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to address these impacts (Section 4.9.7, Mitigation Measures). Specific mitigation measures would be developed as part of future project-level review and permitting IPID Full Piping and Pump Exchange Project

4.9.6.2 Long-term Impacts

The IPID Full Piping and Pump Exchange Project would likely result in the loss of a small area of riparian vegetation for the pump stations, which could potentially affect wildlife, depending on the specific location. The project could also require clearing of vegetation along the entire delivery pipeline alignment, which would likely pass through existing agricultural properties and could impact orchard trees or other wildlife habitat.

Any adverse impacts would be likely less than significant because the area converted from vegetation to the new facilities or cleared would be compensated and mitigated as required by applicable local, state, and federal permits or approvals, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts such as compensating for the permanent loss of any sensitive areas (Section 4.9.7, Mitigation Measures).

Operational changes associated with relocating the pump stations and removing the existing diversion facilities would result in increased flows within Icicle and Peshastin Creeks. Increased flows within the creek would be beneficial to wildlife to the extent that higher flows would support riparian vegetation and any associated wildlife habitat.

4.9.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.9.7.1 Short-term Impacts

Short-term impacts on wildlife would be mitigated by complying with the terms and conditions of local, state, and federal regulations and obtaining required project-specific permits and approvals, such as any Shoreline Management Act shoreline permits; Critical Areas Review; HPAs; and CWA and Endangered Species Act compliance.

Common mitigation measures are likely to include pre-construction surveys, when deemed appropriate, conducting construction work in a manner to minimize disturbance of wildlife, ensuring no net loss of any important habitat or ecosystem functions or values, and possibly restricting the timing of some construction activities to avoid affecting particular species.

Specific mitigation measures would be developed as part of future project-level review and permitting. Mitigation measures to address potential short-term impacts on wildlife and habitat are expected to be the same as those described for vegetation and wetlands in Section 4.8.7, Mitigation Measures.

4.9.7.2 Long-term Impacts

Long-term impacts on wildlife would be mitigated by complying with the terms and conditions of local, state, and federal regulations and project-specific permits and approvals, as described under Short-term Impacts.

Specific mitigation measures would be developed as part of future project-level review and permitting. Mitigation measures to address potential long-term impacts on wildlife and habitat are expected to be the same as those described for vegetation and wetlands in Section 4.8.7, Mitigation Measures.

4.10 Threatened and Endangered Species

This section describes the potential short- and long-term impacts that could affect the special-status plant, wildlife, and fish species identified in Section 3.10, Threatened and Endangered Species, from construction and operation related to the No-action Alternative and Program Alternatives. Impacts on fish, vegetation, and wildlife in general are addressed in Section 4.7, Fish; Section 4.8, Vegetation; and Section 4.9, Wildlife.

4.10.1 No-action Alternative

4.10.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions in the Alpine Lakes Wilderness Area and in riparian areas along Icicle Creek and the Wenatchee River. This is anticipated to entail construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability. Potential impacts would primarily be associated with projects that require construction. In the short term, construction activity could affect special-status species by causing noise disturbance and temporarily disturbing areas where habitat occurs as described in Section 4.8, Vegetation.

The agencies or entities implementing projects under the No-action Alternative would be required to comply with applicable local, state, and federal environmental review requirements, which would include compliance with the federal and state ESA, as described in Section 5.2, Table 5-2. In the event of any potential adverse impacts, project applicants would be required to implement appropriate mitigation measures to reduce impacts on special-status species, such as including any necessary timing restrictions for construction work and ensuring no net loss of important habitat and ecological values and functions (Section 4.10.7, Mitigation Measures). Additionally, federal agencies are required to ensure that their actions do not adversely affect listed critical habitat. Therefore, short-term impacts on special-status species under the No-action Alternative are not expected to be significant.

4.10.1.2 Long-term Impacts

Long-term impacts under the No-action Alternative are anticipated to be largely beneficial for fish and wildlife species, especially those dependent on Icicle Creek (including special-status species), because many projects would seek to improve instream flows during the late summer and improve habitat conditions overall. The restoration of the dam at Eightmile Lake and re-operation of the lake would result in the ability to maintain the lake at higher, historical levels compared to existing conditions. This change in lake levels could result in some changes to the vegetative community along the fringes of the shoreline; however, this area is expected to be relatively small, on the order 3.6 acres of shoreline area inundated, and would not represent a substantial loss of habitat that is anticipated to adversely affect special-status species. Because both instream flow and fish habitat enhancement projects would not generally be coordinated with other activities in the Icicle project area, benefits are not anticipated to be as great as they would under the other Program Alternatives. Potential long-term benefits from such projects are also expected to be more localized, providing only minor overall benefits within the larger Icicle Creek Subbasin.

4.10.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in greater impacts on special-status species compared with the No-action Alternative because there would be a higher likelihood that certain projects would be implemented and the scale of certain efforts would likely be greater. Compliance with the Guiding Principles addressed special-status species in general by ensuring compliance with applicable regulations, including the ESA. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.10.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Most of the work under the Alpine Lakes Optimization, Modernization, and Automation Project would occur in upland areas. Some limited work would occur within the lake shorelines but within the dry when the lakes are drawn down at the end of the summer. Construction activity would last for a period of 2 to 4 weeks at each lake. Some small equipment may be packed in via various trails, but it is likely that most equipment and construction personnel would be transported to the project site by helicopter. Construction activity could disturb any special-status species that may be present during construction.

Listed plant species with the greatest potential to occur within the project site include showy stickseed (*Hackelia venusta*) and Wenatchee Mountains checkermallow (*Sidalcea oregana var. calva*); however, these species would not likely be affected by construction because the proposed activities would occur within areas where these species are very unlikely to be found. If activities were to occur outside of these areas, compliance with existing regulations would require the implementation of mitigation measures to minimize potential impacts as noted in Section 4.10.7, Mitigation Measures.

Listed animal species that could occur at or near the project sites include northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratus*), yellow-billed cuckoo (*Coccyzus americanus*), Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), grizzly bear (*Ursus arctos horribilis*), and wolverine (*Gulo gulo*). As noted in Section 3.10, Threatened and Endangered Species, there are no special-status fish species located within these lakes.

Although some vegetated areas would be used to stage construction equipment and provide temporary housing for workers, there would be no permanent loss of habitat and the activities would not block access to adjacent habitat areas. As discussed in Section 4.5, Water Quality, construction is not anticipated to result in significant water quality impacts.

Construction activities would also result in an increase in noise above background conditions that could disturb any species that may be present. However, the levels would be similar to the noise that already occurs as the result of maintenance-related activities, including the use of helicopters, which have occurred and would continue regardless of this project. As noted in Section 3.15, Recreation, background noise includes regular recreational activity around each of the lakes, including hikers and overnight campers. If bothered by increased sound, generally speaking, special-status species would be able to temporarily relocate to other areas of similarly suitable habitat without significant impacts. This would be similar to what currently occurs related to operation and maintenance at the lakes.

There is a potential for more significant disturbance to occur if loud construction noise occurs during the breeding season. Special-status bird species are particularly vulnerable because nesting birds have been known to abandon their nests in response to sudden loud increases in noise; however, construction activity would occur in late summer, which is outside the breeding period for both marbled murrelet and northern spotted owl. Compliance with applicable local, state, and federal regulations would ensure that there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for important habitat (Section 4.10.7, Mitigation Measures).

IPID Irrigation Efficiencies

Construction activities associated with this project include the conversion of IPID canals to pipelines and lining of irrigation canals with concrete. Short-term impacts that could adversely affect special-status species include disturbance from increased construction activity and noise and temporary disturbance of habitat. As noted in Section 4.14, Noise, construction-related noise is anticipated to be relatively minimal. Species in the area may temporarily relocate to other areas during periods of increased activity. Short-term impacts would be relatively limited because most of the work would occur within areas that are already disturbed, such as within rights-of-way and existing canal easements, during the off-season when the irrigation canals are dry, and away from where special-status fish species may be found.

Compliance with applicable local, state, and federal regulations would further ensure that there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for important habitat (Section 4.10.7, Mitigation Measures).

COIC Irrigation Efficiencies and Pump Exchange

Potential impacts on special-status species associated with work affecting COIC canals would be similar to those described for the IPID Irrigation Efficiencies Project. This project would also involve construction of the COIC pump station, requiring in-water work along lower Icicle Creek or the Wenatchee River, which would result in a slightly higher potential to adversely affect special-status species, particularly any fish that might be present during construction. Potential impacts include increased risk of disturbance or harm from construction activities, such as from installation of a cofferdam, increased potential for harm from noise and vibration, increased risks of water quality impacts adversely affecting aquatic habitat, and temporary loss of aquatic habitat during dewatering for in-water construction.

Work within waters of the United States or State or within irrigation canals or spillways that reconnect to these waters would require a CWA Section 404 Permit and associated Section 401 Water Quality Certification; work in other portions of the irrigation system could require local review and authorization. Compliance with these and other applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions (Section 4.10.7, Mitigation Measures).

Domestic Conservation Efficiencies

Construction activities proposed under the Domestic Conservation Efficiencies Project include pipeline replacement and meter installation. These activities are unlikely to adversely affect special-status species because the work would be done in areas that are already developed that provide minimal to no habitat.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project involves demolishing an existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures to restore the maximum water storage level in the lake to an elevation of 4,671 feet and restore the accessible storage in the lake to the volume permitted by IPID’s water right (2,500 acre-feet). Construction activity would occur along the shorelines and within the dry areas of the lake margins once the lake has been drawn down and in Eightmile Creek immediately downstream of the dam. While most construction equipment (potentially including a small tracked excavator) and materials would likely be flown into the project site via helicopter, IPID is considering the option of walking in a larger tracked excavator or a spider excavator. The trail to access the project site requires several stream crossings and parallels several potential wetlands (Figure 3-10).

Listed plant species with the greatest potential to occur within the project site include showy stickseed and Wenatchee Mountains checkermallow; however, these species would not likely be affected by construction because the proposed activities would occur within dry lake margins or the existing structures where these species are very unlikely to be found. If activities were to occur outside of these areas, compliance with existing regulations would require the implementation of mitigation measures to minimize potential impacts as noted in Section 4.10.7, Mitigation Measures.

Listed animal species that could occur near the project site include northern spotted owl, marbled murrelet, yellow-billed cuckoo, Canada lynx, gray wolf, grizzly bear, and wolverine. There are no special-status fish species located at this lake.

Although some vegetated areas would be used to stage construction equipment and provide temporary housing for workers, there would be no permanent loss of habitat and the activities would not block access to adjacent habitat areas. As discussed in Section 4.5, Water Quality, potential impacts affecting water quality would be low.

Construction activities would also result in an increase in noise above background conditions that could disturb any species that may be present. However, most construction activities would result in noise levels similar to those that already occur and would continue for maintenance unrelated to this project. As noted in Section 3.15, Recreation, background noise includes regular recreational activity around the lake, including hikers and overnight campers. If bothered by increased sound, generally speaking, special-status species would be able to temporarily relocate to other areas of similarly suitable habitat without significant impacts. This would be similar to what currently occurs related to operation and maintenance at the lakes.

There is a potential for more significant disturbance to occur if loud construction noise occurs during the breeding season. Construction for this project could involve blasting. Special-status bird species are particularly vulnerable because nesting birds have been known to abandon their nests in response to sudden loud increases in noise; however, construction activity would occur in late summer, which is outside the breeding period for both marbled murrelet and northern spotted owl. Compliance with applicable local, state, and federal regulations would ensure there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for important habitat (Section 4.10.7, Mitigation Measures).

Tribal Fishery Preservation and Enhancement

The details of the Tribal Fishery Preservation and Enhancement Project and the specific impacts on fish and wildlife species are not known at this time but are expected to require ground disturbance and likely in-water work on lower Icicle Creek. Depending on the specific location of the activities, construction could result in short-term impacts on special-status species, similar to those described above. Compliance with applicable local, state, and federal regulations would ensure that there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for important habitat (Section 4.10.6, Mitigation Measures).

Habitat Protection and Enhancement

The details of the Habitat Protection and Enhancement Project and the specific impacts on fish and wildlife species are not known at this time, although construction is expected to involve grading; planting and thinning vegetation; hauling and placing logs, rock, soil, and other materials; and some in-water work on lower Icicle Creek. Depending on the specific location of the activities, construction could result in short-term impacts on special-status species, similar to those described above. Compliance with applicable local, state, and federal regulations would ensure there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for important habitat (Section 4.10.7, Mitigation Measures).

Instream Flow Rule Amendment

There are no construction activities proposed under the Instream Flow Rule Amendment Project and therefore no potential short-term impacts to special-status species.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements geared towards improving water quality and hatchery rearing conditions at the LNFH. In general, construction of these elements has the potential to affect special-status species, depending on the specific location and type of disturbance. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential short-term impacts under NEPA would be completed once the full scope of the project is determined.

Similar to the construction activities described above, various authorizations are likely to be required that would ensure potential impacts would be avoided, minimized, or compensated as noted in Section 4.10.7, Mitigation Measures.

Fish Passage Improvements

The details of the Fish Passage Improvements Project and the specific impacts on fish and wildlife species are not known at this time, although construction is expected to involve in-water work and some streambank alterations along lower Icicle Creek. Depending on the specific location of the activities, construction could result in short-term impacts on special-status species, similar to those described above. Compliance with applicable local, state, and federal regulations would ensure there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for important habitat (Section 4.10.7, Mitigation Measures).

Fish Screen Compliance

The details of the Fish Screen Compliance Project and the specific impacts on fish and wildlife species are not known at this time, although construction is expected to involve in-water work and some streambank alterations along lower Icicle Creek. Depending on the specific location of the activities, construction could result in short-term impacts on special-status species, similar to those described above. Project activities are expected to require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits and approvals issued by these agencies would require appropriate mitigation measures to address any significant impacts on special-status species (Section 4.10.7, Mitigation Measures). These measures would be developed to address any such impacts once project-level information is available.

Water Markets

There are no construction activities proposed under the Water Markets Project and therefore no potential short-term impacts to non-fish listed species and associated habitats.

4.10.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from the affected lakes. Over the long term, the greatest potential for affecting special-status species would be related to changes in how the lakes are managed and the resulting changes in flows in Lower Icicle Creek.

Under this project, the frequency in fluctuations in lake levels would increase compared to existing conditions because some portion of each lake would be drawn down every year instead of relying on only one or two lakes per year; however, the high and low lake water levels at the lakes would not change. Although total water withdrawn would increase, operation of the proposed project would also potentially result in less draw down at any one lake because releases would be spread across all lakes and releases would be optimized to meet instream and water supply needs in Icicle Creek. Lake level variation would largely remain within the same parameters as existing conditions.

As noted in Sections 4.5, Surface Water Quality; 4.7, Fish; 4.8, Vegetation; and 4.9, Wildlife, re-operation of the lakes is not anticipated to result in significant changes affecting aquatic or terrestrial species. This is because although lakes could be affected each year compared to every few years, the changes in lake levels (e.g., highs and lows) would be consistent with existing operations and the current seasonal pattern of change, and is not expected to result in significant changes in ecosystem processes.

Additional flows released from these lakes would also be more evenly spread out across receiving streams that flow into Icicle Creek and eventually the Wenatchee River. This is expected to result in conditions more similar to the natural flow regime of these lakes than otherwise would occur under existing conditions, benefiting special-status species in Icicle Creek, including ESA-listed spring-run Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), and bull trout. These benefits are generally anticipated to extend to any listed critical habitat and essential fish habitat within Icicle Creek and its tributaries and the Wenatchee River.

With more efficient operation of the lakes, flow releases to lower Icicle Creek could be better targeted to the periods when they are needed. In general, this would mean that there would be lower contributions to peak flows early in the season and there would be higher contributions, estimated at up to 30 cubic cfs, when flows are low later in the summer.

As part of the Guiding Principles, flows would also be managed to benefit these species and minimize adverse impacts. For example, lake releases would ramp down gradually toward the end of the augmentation period to avoid stranding fish, and releases from these lakes would be limited in September to avoid negative affects to spawning bull trout (*Salvelinus confluentus*).

As part of the overall Icicle Strategy, efforts to characterize the impacts of the managed flows on special-status species are ongoing and future monitoring is also planned to determine whether additional mitigation measures could be needed to address potential impacts. For example, studies have looked at how instream flow releases affect important characteristics of bull trout Critical Habitat in French and Leland Creeks, including potential impacts on the food base and groundwater connectivity. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.10.7, Mitigation Measures.

IPID Irrigation Efficiencies

The majority of the project elements include pipelines or canal improvements that would occur in areas that have already been developed and would not result in long-term adverse impacts on special-status species.

As noted in Section 4.7, Fish, in the long term, this project would also contribute to beneficial increases in instream flows downstream of the current IPID diversion in the lower 5.7 RMs of Icicle Creek and in the Wenatchee River downstream of Icicle Creek. Improving irrigation system efficiency is intended to benefit special-status species in Icicle Creek, including ESA-listed spring-run Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), and bull trout, by allowing more water to remain in the creek downstream of the IPID irrigation diversions from April through September.

COIC Irrigation Efficiencies and Pump Exchange

Replacing canal with piping would occur in areas that have already been developed and would not result in long-term adverse impacts on special-status species. A pump station near the confluence of Icicle Creek and the Wenatchee River would potentially result in long-term changes affecting habitat would be the construction of the new COIC pump station and intake facilities. As part of this project, a new pump station would be constructed on the Wenatchee River or Lower Icicle Creek. These facilities would result in the loss of a small area of riparian vegetation and, depending on the specific location, could affect special-status fish species.

Compliance with applicable regulations would be required to ensure there is no net loss of ecological functions or values associated with siting the pump station and that there would be no significant impacts affecting special-status species. Therefore, there would be no significant long-term adverse impacts on special-status species expected. The long-term impacts associated with this project would be beneficial with respect to fish and wildlife in general, including special-status species.

As noted in Section 4.7, Fish, in the long term, this project would also contribute to beneficial increases in instream flows downstream of the current COIC diversion in the lower 4.5 RMRMs of Icicle Creek and in the Wenatchee River downstream of Icicle Creek. Improving irrigation system efficiency is intended to benefit special-status species in Icicle Creek, including ESA-listed spring-run Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), and bull trout, by allowing more water to remain in the creek downstream of COIC irrigation diversions from May through September.

Domestic Conservation Efficiencies

As discussed in Section 4.7, Fish; Section 4.8, Vegetation; and Section 4.9, Wildlife, this project is not expected to result in adverse long-term impacts on threatened and endangered species. Over the long term, the impacts are expected to be beneficial as the result of improved instream flows, which would also provide benefits for special-status fish species.

Eightmile Lake Storage Restoration

Operation of the proposed facilities for the Eightmile Lake Storage Restoration Project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. Over the long term, the greatest potential for affecting special-status species would be related to changes in how the lakes are managed and the resulting changes in flows in lower Icicle Creek.

Because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions. However, this project would result in the ability to maintain the lake at historical levels compared to existing conditions.

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is restored, the lake would be able to fill to the historical high level of 4,671 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,666 feet, which would be the crest elevation of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch early in the summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,671 feet, equal to the historical full water surface elevation. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline would be under water. These areas have been historically inundated, but have not been under water since deterioration of the embankment. This change in lake levels could result in some changes to the vegetative community along the fringes of the shoreline; however, this area is expected to be relatively small, on the order of 3.6 acres of shoreline area inundated, and would not represent a substantial loss of habitat that is anticipated to adversely affect special-status species.

The project would also allow for the lake to be drawn down below the existing low lake levels to an elevation of 4,621 feet, which is approximately 22.4 feet below the existing low. This change would result in the exposure of slightly more lake bed, mainly late in the summer and early fall up to the point when the water would no longer be drawn down, generally around the end of September. The additional draw down is not expected to adversely affect vegetation or wetlands by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity or any other changes that would adversely affect special-status species.

Restoration of the dam would result in the ability to release up to 9.5 additional cfs from the lake relative to existing conditions. Increased flows would be released from the dam into Eightmile Creek, which flows into Icicle Creek. Increased flows would occur from the point of release at Eightmile Lake Dam down to the IPID diversion at RM 5.7.

As discussed in Section 4.7, Fish, the potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries, benefiting special-status species in Icicle Creek, including ESA-listed spring-run Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), and bull trout. However, there remains uncertainty around how increased flows might affect fish habitat within the study area or interaction within and between fish species, including any special-status fish that may be present. For additional information, see Section 4.7, Fish.

As part of the overall Icicle Strategy, the Guiding Principles require flows to be managed to benefit aquatic species and minimize adverse impacts. An example of a strategy under consideration is prioritizing the timing of releases relative to potential impacts on downstream aquatic habitat. Continued coordination on the development of the Icicle

Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.10.7, Mitigation Measures.

Tribal Fishery Preservation and Enhancement

The purpose of the Tribal Fishery Preservation and Enhancement Project is to protect and enhance the tribal fishery, which, depending on the specific actions, could result in the loss of some small areas of terrestrial or aquatic habitat used by special-status species; however, these project elements are meant to preserve and enhance stream and riparian habitat in the system overall, leading to improved habitat functions and long-term benefits for fish and wildlife in general, including special-status species.

Compliance with applicable local, state, and federal regulations would ensure that there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review (Section 4.10.7, Mitigation Measures).

Habitat Protection and Enhancement

As discussed in Sections 4.7, Fish; 4.8, Vegetation; and 4.9, Wildlife, the Habitat Protection and Enhancement Project is not expected to result in adverse long-term impacts on fish and wildlife, including special-status species. Over the long term, the impacts are expected to be beneficial by providing improved instream and riparian habitat conditions.

Compliance with applicable local, state, and federal regulations would ensure that there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review (Section 4.10.7, Mitigation Measures).

Instream Flow Rule Amendment

As provided for in the Wenatchee Instream Flow Rule (Chapter 173-545 WAC), this project would increase the Icicle Reserve after implementation of instream flow and habitat restoration actions. The Icicle Reserve increase would be 0.4 cfs and offset by an equal reserve reduction for the mainstem Wenatchee River. This would create a 0.4 cfs impact on Icicle Creek, which does not exist under current conditions. This impact is anticipated to be offset by the implementation of other projects that benefit streamflow under Alternative 1.

Depending on the instream conditions at the timing and location of this 0.4 cfs impact, there could be potential conflicts with the other uses, most likely those associated with fish and wildlife habitat uses designated for Icicle Creek, which could adversely affect special-status species on a localized basis.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

As discussed in Sections 4.7, Fish; 4.8, Vegetation; and 4.9, Wildlife, this project is not expected to result in adverse long-term impacts on fish and wildlife but rather, would improve water quantity and water quality, which would benefit fish and wildlife in general, including any special-status species. Most the work included under this project is designed to improve water use efficiency at LNFH and to develop additional groundwater supplies such that less water would need to be diverted from Icicle Creek for hatchery operations. Such actions would potentially support higher flows in the system, especially during late summer, which would benefit special-status species present within and along the creek.

Fish Passage

As discussed in Sections 4.7, Fish; 4.8, Vegetation; and 4.9, Wildlife, the long-term impacts on fish and wildlife under the Fish Passage Project are generally anticipated to be beneficial because of increased access to additional habitat for listed fish species and the associated general improvement in ecosystem function. As discussed in Section 4.7, Fish, the potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates and listed critical habitat. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries. However, there remains uncertainty around how increased flows might affect fish habitat or interaction within and between fish species, including any special-status fish that may be present within the study area. For additional information, see Section 4.7, Fish.

Potential long-term impacts on special-status species, particularly listed fish, would be addressed during project design. Compliance with applicable local, state, and federal regulations would ensure there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review (Section 4.10.7, Mitigation Measures).

Fish Screen Compliance

As discussed in Section 4.7, Fish, and Section 4.9, Wildlife, the long-term impacts on fish and wildlife, including special-status species, under the Fish Screen Compliance Project are generally anticipated to be beneficial because of increased protection and improved passage conditions for listed fish species and the associated general improvement in ecosystem function. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws. Improvements to fish screens are intended to provide a long-term benefit to fish.

Any adverse impacts associated with screen improvements would be likely less than significant because these impacts would be addressed as required by applicable local, state, and federal permits or approvals, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts such as revegetating any disturbed areas and compensating for the permanent loss of any sensitive areas that could not otherwise be restored (Section 4.10.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Water Markets

As discussed in Section 4.7, Fish, and Section 4.9, Wildlife, the long-term impacts on fish and wildlife, including special-status species, under the Water Markets Project are generally anticipated to be beneficial because of the potential to increase instream flows that would provide for improved ecological function and habitat values.

4.10.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. Compliance with the Guiding Principles addressed special-status species in general by ensuring compliance with applicable regulations, including the ESA. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Impacts of other projects proposed under Alternative 2 are described under Alternative 1.

4.10.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction of a new IPID pump exchange would require both in-water and riverbank work on the Wenatchee River, including the placement and removal of instream cofferdams, removal of streamside vegetation, and excavation of the streambed and bank. Depending on the specific location of the activities, construction could result in short-term impacts on special-status species, primarily related to construction disturbance. Project activities with the potential to affect these species would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to address these impacts (Section 4.10.7, Mitigation Measures). Specific mitigation measures would be developed as part of future project-level review and permitting.

4.10.3.2 Long-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project facilities would likely result in the loss of a small area of riparian vegetation for the pump exchange station and intake facilities constructed along the right bank of the Wenatchee River and, depending on the specific location, could potentially affect special-status species. The project could also require clearing of vegetation along the delivery pipeline alignment, which would likely pass through existing agricultural properties and could impact orchard trees. Depending on the specific location, long-term operation could affect special-status fish species.

Generally speaking, the overall impacts associated with this project are expected to be beneficial because instream flows would increase by approximately 25 cfs between the current IPID diversion (RM 5.7) and the new pump station location, yet to be determined, during late summer pump station operation. This project is intended to benefit special-status species in Icicle Creek, including ESA-listed spring-run Chinook salmon, steelhead, and bull trout, by replacing diversions from Icicle Creek with water pumped to irrigation canals from the Wenatchee River. Increased flows in Icicle Creek are likely to improve fish passage through obstructions in Icicle Creek during summer, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek.

Any adverse impacts on special-status species would be likely less than significant because the amount of area converted from vegetation to the new facilities would be small. Potential operational impacts affecting fish species would be addressed as required by applicable local, state, and federal permits or approvals.

4.10.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 1 and Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 project would be included while the Eightmile Lake Storage Restoration Project would not. Compliance with the Guiding Principles addressed special-status species in general by ensuring compliance with applicable regulations, including the ESA. This section describes the specific short- and long-term impacts associated with the Legislative Change Creating OCPI Authority for Alternative 3 Project. Impacts associated with other projects proposed under Alternative 3 are described in Alternative 1 and Alternative 2.

4.10.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts on special-status species.

4.10.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority for Alternative 3 Project were enacted, there could be potential conflicts with instream flow allocations that could result in adverse impacts on special-status species, primarily fish. Under the proposed changes, junior domestic water rights could be exercised even when the Instream Flow Rule is not met. This could result in potential adverse impacts on water quality as a result of low-flow conditions that could adversely affect special-status species, mainly fish. Under Alternative 3, there would be flow improvement projects implemented. However, the timing of flow improvements might not always provide in-time mitigation for junior users.

4.10.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1. The Eightmile Lake Storage Restoration Project would be replaced with the Eightmile Lake Storage Enhancement Project, and the Upper Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects would be included. Compliance with the Guiding Principles addressed special-status species in general by ensuring compliance with applicable regulations, including the ESA. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.10.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

This project would involve demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures that would allow for an increase in the accessible storage at Eightmile Lake to 3,500 acre-feet. The spillway elevation would be raised to allow for storage at a higher level than current or historical water storage levels and the project would allow for additional draw down of the lake.

Listed plant species with the greatest potential to occur within the project site include showy stickseed and Wenatchee Mountains checkermallow; however, these species would not likely be affected by construction because the proposed activities would occur within dry lake margins or the existing structures where these species are very unlikely to be found. If activities were to occur outside of the work areas, compliance with existing regulations would require the implementation of mitigation measures to minimize potential impacts as noted in Section 4.10.7, Mitigation Measures.

Listed animal species with the greatest potential to occur near the project site include northern spotted owl, marbled murrelet, yellow-billed cuckoo, Canada lynx, gray wolf, grizzly bear, and wolverine. There are no special-status fish species located at this lake.

Although some vegetated areas would be used to stage construction equipment and provide temporary housing for workers, there would be no permanent loss of habitat and the activities would not block access to adjacent habitat areas. As discussed in Section 4.5, Water Quality, potential impacts affecting water quality would be low.

Construction activities would also result in an increase in noise above background conditions that could disturb any species that may be present. However, most construction activities would result in noise levels similar to those that already occur and would continue for maintenance unrelated to this project. As noted in Section 3.15, Recreation, background noise includes regular recreational activity around the lake, including hikers and overnight campers. If bothered by increased sound, generally speaking, special-status species would be able to temporarily relocate to other areas of similarly suitable habitat without significant impacts. This would be similar to what currently occurs related to operation and maintenance at the lake.

There is a potential for more significant disturbance to occur if loud construction noise occurs during the breeding season. Construction for this project could involve blasting. Special-status bird species are particularly vulnerable because nesting birds have been known to abandon their nests in response to sudden loud increases in noise; however, construction activity would occur in late summer, which is outside the breeding period for both marbled murrelet and northern spotted owl. Compliance with applicable local, state, and federal regulations would ensure there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for important habitat (Section 4.10.6, Mitigation Measures).

Upper Klonaqua Lake Storage Enhancement

Special-status species could be adversely affected in the short-term from construction activity in a manner similar to what would occur as described above for the Eightmile Lake Storage Enhancement Project (Section 4.10.5.1, Short-term Impacts). The same special-status species have the potential to occur at this project site.

Construction activity would mainly occur in the dry lake margins in the late summer when the lake is drawn down. Although some vegetated areas would be used to stage construction equipment and provide temporary housing for workers, there would be no permanent loss of habitat and the activities would not block access to adjacent habitat. As discussed in Section 4.5, Water Quality, risks of spills (e.g., fuel, chemicals, etc.) would be very low because there would be limited use of powered equipment near water and work would occur in the dry after the lake was drawn down.

Construction activities would also result in an increase in noise above background conditions that could disturb any species that may be present. However, most construction activities would result in noise levels similar to those that already occur and would continue for maintenance unrelated to this project. As noted in Section 3.15, Recreation, background noise includes regular recreational activity around the lakes, including hikers and overnight campers. If bothered by increased sound, generally speaking, special-status species would be able to temporarily relocate to other areas of similarly suitable habitat without significant impacts. This would be similar to what currently occurs related to operation and maintenance at the lakes.

There is a potential for more significant disturbance to occur if loud construction noise occurs during the breeding season. Construction for this project could involve blasting. Special-status bird species are particularly vulnerable because nesting birds have been known to abandon their nests in response to sudden loud increases in noise; however, construction activity would occur in late summer, which is outside the breeding period for both marbled murrelet and northern spotted owl. Compliance with applicable local, state, and federal regulations would ensure there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for important habitat (Section 4.10.7, Mitigation Measures).

Upper and Lower Snow Lakes Storage Enhancement

Special-status species could be adversely affected in the short-term from construction activity in a manner similar to what would occur as described above for the Eightmile Lake Storage Enhancement Project (4.10.5.1, Short-term Impacts). The same special-status species have the potential to occur at this project site.

Construction activity would occur primarily in the dry lake margins in the late summer when the lake is drawn down. Although some vegetated areas would be used to stage construction equipment and temporarily provide housing for workers, there would be no permanent loss of habitat and the activities would not block access to adjacent habitat. As discussed in Section 4.5, Water Quality, risks of spills (e.g., fuel, chemicals, etc.) would be very low because there would be limited use of powered equipment near water and work would occur in the dry after the lake was drawn down.

Construction activities would also result in an increase in noise above background conditions that could disturb any species that may be present. However, most construction activities would result in noise levels similar to those that already occur and would continue for maintenance unrelated to this project. As noted in Section 3.15, Recreation, background noise includes regular recreational activity around each of the lakes, including hikers and overnight campers. If bothered by increased sound, generally speaking, special-status species would be able to temporarily relocate to other areas of similarly suitable habitat without significant impacts. This would be similar to what currently occurs related to operation and maintenance at the lakes.

There is a potential for more significant disturbance to occur if loud construction noise occurs during the breeding season. Construction for this project could involve blasting. Special-status bird species are particularly vulnerable because nesting birds have been known to abandon their nests in response to sudden loud increases in noise; however, construction activity would occur in late summer, which is outside the breeding period for both marbled murrelet and northern spotted owl. Compliance with applicable local, state, and federal regulations would ensure there were no significant impacts on special-status species. If needed, mitigation would be developed during project-level review, which could include measures such as implementing construction timing restrictions and ensuring no net loss of ecological functions and values for important habitat (Section 4.10.7, Mitigation Measures).

4.10.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. Over the long term, the greatest potential for affecting special-status species would be related to changes in how the lakes are managed and the resulting changes in flows in lower Icicle Creek.

Because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, this project would result in the ability to maintain the lake at higher than historical levels compared to existing conditions and the No-action Alternative.

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is restored, the lake would be able to fill to a new high water surface of 4,682 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,677 feet to the height of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch early in the summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,682 feet. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water. These changes would increase the accessible storage to 3,500 acre-feet, which is 1,000 acre-feet more than currently permitted by IPID’s water right.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline, approximately 13.6 acres, would be under water for a part of each year. Shoreline areas up to 4,671 feet have been historically inundated, but areas above 4,671 feet to 4,682 feet have not. This additional area would be under water for a little less than a month each summer. This change in lake levels could result in some changes to the vegetative community along the shoreline. However, because of the availability of habitat in the surrounding area and the fact that increased water levels would not represent a permanent increase in the lake height, it would not represent a substantial loss of habitat that is anticipated to adversely affect special-status species.

The project would also allow for the lake to be drawn down below existing lake levels to an elevation of 4,619 feet, which is approximately 24.4 feet lower than the existing low. This change would result in the exposure of slightly more lake bed, mainly in the later summer months and early fall up to the point when the water would no longer be drawn down, generally around the end of September. The additional draw down is not expected to adversely affect vegetation or wetlands by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity or any other changes that would adversely affect special-status species.

As discussed in Section 4.7, Fish, the potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries. However, there remains uncertainty around how increased flows might affect fish habitat within Eightmile Creek or interaction within and between fish species, including special-status fish. For additional information, see Section 4.7, Fish.

As part of the overall Icicle Strategy, the Guiding Principles require flows to be managed to benefit aquatic species and minimize adverse impacts. An example of a strategy under consideration is prioritizing the timing of releases relative to potential impacts on downstream aquatic habitat. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.10.7, Mitigation Measures.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project would provide the ability to store and release additional flows from Upper Klonaqua Lake, which would represent a change compared to existing conditions and the No-action Alternative as discussed further below. Over the long term, the greatest potential for impacts affecting fish and aquatic invertebrates would be related to the relative changes in lake levels and the resulting changes in flows in lower Icicle Creek.

The frequency in fluctuations in lake levels in Upper Klonaqua Lake would increase compared to existing conditions and the No-action Alternative. Lake levels would also be drawn down further compared to existing conditions.

The high lake level in Upper Klonaqua Lake would not change. The lake would still refill and outlet naturally through an existing channel to Lower Klonaqua Lake during most of the year. However, the new facilities would allow for the lake to be drawn down an additional 20 feet to allow for access to an additional 1,146 acre-feet of storage. The draw down would likely occur over a couple of months in the late summer. The additional draw down is not expected to adversely affect special-status species, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

Modifications at Upper Klonaqua Lake would also result in the ability to release up to an additional 5 to 20 cfs from the lake. Increased flows would be released from the dam into a downstream tributary, which flows into Icicle Creek. Increased flows would occur from the point of release at Klonaqua Dam down to the IPID diversion at RM 5.7.

As discussed in Section 4.7, Fish, the potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries. However, there remains uncertainty around how increased flows might affect fish habitat immediately downstream of the lake or interaction within and between fish species, including special-status fish. For additional information, see Section 4.7, Fish.

As part of the overall Icicle Strategy, the Guiding Principles require flows to be managed to benefit aquatic species and minimize adverse impacts. An Example of a strategy under consideration is prioritizing the timing of releases relative to potential impacts on downstream aquatic habitat. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.10.7, Mitigation Measures.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project would provide the ability to store and release additional flows at the lake, which would represent a change compared to existing conditions and the No-action Alternative as discussed further below. Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from the lakes. Long-term impacts on special-status species could occur if there were any lasting impacts on critical habitat or long-term disturbance to these species from maintenance activities or changes in how lake levels are managed.

As discussed above, there would be no permanent loss of habitat, which would include designated critical habitat. Because the facilities would be newer and remotely operated by USFWS, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less than would occur compared to existing conditions and the No-action Alternative. However, lake levels would also be able to reach higher or lower levels compared to both existing conditions and historical levels.

The proposed enhancement project would increase the high-water storage levels in both Upper and Lower Snow Lakes by 5 feet compared with existing high levels. This change would result in the inundation of some upland vegetation that has grown along the shoreline areas between the current and proposed high lake levels, most likely occurring in the fall through the early summer when releases would be likely to begin. This could result in some changes to the vegetative community along the shoreline, similar to those described for the other lakes under this Program Alternative. However, these changes would not likely result in significant impacts on special-status species for the reasons described previously.

The project would also allow for Lower Snow Lake to be drawn down 3 feet below the current lake level, which would result in the exposure of slightly more lake bed. The additional draw down is not expected to adversely affect vegetation or wetlands by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

As discussed in Section 4.7, Fish, the potential impacts associated with increased flows would generally be beneficial with respect to fish and aquatic invertebrates. The benefits are mainly associated with increasing aquatic habitat in lower Icicle Creek in the later summer months and improving fish passage to the upper reaches (above the Boulder Field at RM 5.6) of Icicle Creek and its tributaries. However, there remains uncertainty around how increased flows might affect fish habitat immediately downstream of the lakes or interaction within and between fish species, including special-status fish. For additional information, see Section 4.7, Fish.

As part of the overall Icicle Strategy, the Guiding Principles require flows to be managed to benefit aquatic species and minimize adverse impacts. An example of a strategy under consideration is prioritizing the timing of releases relative to potential impacts on downstream aquatic habitat. Continued coordination on the development of the Icicle Strategy along with compliance with applicable regulatory requirements would help to address potential impacts on special-status species as noted in Section 4.10.7, Mitigation Measures.

4.10.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange would be included.

4.10.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

This project would involve fully converting the IPID delivery systems to pressurized pipelines, removing the existing intakes on Icicle and Peshastin Creeks, and constructing three new pump stations and intakes on the Wenatchee River. Construction disturbance required throughout the entire delivery system for conversion to pressurized pipelines could result in short-term disturbance of special-status from increased noise and short-term impacts on vegetation.

Construction of the IPID Full Piping and Pump Exchange Project would require both in-water and riverbank work on the Wenatchee River and Icicle and Peshastin Creeks, including the placement and removal of instream cofferdams, removal of streamside vegetation, and excavation of the streambed and bank. Construction disturbance required throughout the entire delivery system for conversion to pressurized pipelines could result in short-term impacts on any special-status species that may be found within these areas as discussed further in Section 4.7.

Project activities with the potential to affect these species would require authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to address these impacts (Section 4.10.7, Mitigation Measures). Specific mitigation measures would be developed as part of future project-level review and permitting. Such measures could include limiting in-water work, excluding aquatic species from in-water work areas, and implementing construction timing restrictions.

4.10.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange Project

The project would likely result in the loss of a small area of riparian vegetation for the new pump stations and intake facilities constructed along the Wenatchee River and, depending on the specific location, could potentially affect special-status species. The project could also require clearing of vegetation along the delivery pipeline alignment, which would likely pass through existing agricultural properties and could impact orchard trees. Depending on the specific location, long-term operation could affect special-status fish species.

Generally speaking, the overall impacts associated with this project are expected to be beneficial because instream flows would in Icicle and Peshastin Creeks during late summer pump station operation. This project is intended to benefit special-status species in Icicle Creek, including ESA-listed spring-run Chinook salmon, steelhead, and bull trout, by replacing diversions from Icicle Creek and Peshastin Creek with water pumped to irrigation canals from the Wenatchee River. Increased flows in Icicle Creek are likely to improve fish passage through obstructions in Icicle Creek during summer, particularly benefiting anadromous and migratory salmon, steelhead, and bull trout by allowing access to high-quality habitat in the upper reaches of Icicle Creek.

Any adverse impacts would be likely less than significant because the area converted from vegetation to the new facilities or cleared would be compensated and mitigated. Potential operational impacts affecting fish species would be addressed as required by applicable local, state, and federal permits or approvals.

4.10.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.10.7.1 Short-term Impacts

Short-term impacts on special-status species would be mitigated by complying with the terms and conditions of local, state, and federal regulations and obtaining required project-specific permits and approvals, such as any Shoreline Management Act shoreline permits, Critical Areas Review, HPAs, CWA compliance, and ESA compliance.

Common mitigation measures are likely to include pre-construction surveys, when deemed appropriate, conducting construction work in a manner to minimize disturbance of special-status species, ensuring no net loss of any important habitat or ecosystem functions or values, and possibly restricting the timing of some construction activities to avoid affecting particular special-status fish and wildlife species, in particular during critical life stages (i.e., breeding or mating).

Specific mitigation measures would be developed as part of future project-level review and permitting. As long as any blasting occurs outside sensitive breeding periods for special-status species with a high potential to be in the project vicinity, mitigation measures to address potential short-term impacts on special-status species are expected to be the same as those described for vegetation and wetlands in Section 4.8.7, Mitigation Measures.

4.10.7.2 Long-term Impacts

Long-term impacts on special-status species would be mitigated by complying with the terms and conditions of local, state, and federal regulations and project-specific permits and approvals, as described above under Short-term Impacts.

Specific mitigation measures to address any potential long-term impacts would be developed as part of any future project-level review and permitting. Mitigation measures to address potential long-term impacts on special-status species and their habitat are expected to be similar to those described for vegetation and wetlands in Section 4.8.7, Mitigation Measures, but may also include subsequent monitoring activities.

4.11 Aesthetics

This section describes the potential short- and long-term environmental impacts that could affect the resources identified in Section 3.11, Aesthetics, from construction and operation related to the No-action Alternative and Program Alternatives.

To assess the potential impacts, key viewpoints within the Icicle Creek Watershed project area were selected based in part on a GIS viewshed analysis, refined through field observations. Key viewpoints are specific locations where sensitive viewer groups would be able to see aesthetic changes. Sensitive viewer groups represent multiple user groups who are more sensitive to aesthetic changes because their underlying activity relies in part on the aesthetic setting. The magnitude of an impact depends on, among other factors, the number of individuals exposed to a change and their collective sensitivity to the change.

Once the Icicle project area was defined, the GIS viewshed analysis involved identifying specific locations from which important aesthetic resources (e.g., scenic views, landscape features) can be seen. When available, information about how people use the Icicle project area (e.g., recreational use data) was overlaid to show where there is a concentrated area of potentially sensitive viewers. For a general example, a trailhead that opens onto a panoramic overlook could represent a key viewpoint within a study area. Places where project changes are planned, such as a newly proposed facility, are also identified. A GIS analysis is then conducted to determine the visibility of project changes for sensitive viewers at each key viewpoint. The location of key viewpoints and representative views at these locations are presented in the discussion of Program Alternatives below.

4.11.1 No-action Alternative

4.11.1.1 Short-term Impacts

Under the No-action Alternative, various agencies and other entities would continue to undertake individual actions to restore and enhance fish and aquatic resources in the Icicle project area and maintain existing infrastructure, but those actions would not be part of a coordinated program implemented with the support of the Icicle Work Group. Actions implemented by individual agencies and entities to restore and enhance fish and aquatic resources could include upgrading irrigation infrastructure at the Alpine Lakes and constructing diversion improvements, irrigation system upgrades, LNFH improvements, and fish passage work.

Under the No-action Alternative, short-term impacts on aesthetics would primarily occur as the result of construction-related activities. Visual changes resulting from these activities could include short-term dewatering of stream segments and increased activity, including the transport of construction materials, and the operation of construction equipment. In some cases, construction may require vegetation removal, grading, and stockpiling soil. Depending on the specific location of these activities, there is a potential for aesthetic changes to be disruptive in the short-term; however, most of these changes would be temporary (i.e., lasting only for the duration of the construction activity) and would, therefore, not be likely to be significant.

In addition, as noted in Section 4.8, Vegetation, any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. For instance, Chelan County Code requires riparian buffer protection and mitigation, with buffer widths determined based on Environment Designation and intensity of use as shown in Table 4-2 in Section 4.8, Vegetation.

A habitat management and mitigation plan may be required to avoid degradation of the riparian habitat function, structure, and value. Mitigation requirements would also provide aesthetic benefits.

4.11.1.2 Long-term Impacts

Long-term impacts under the No-action Alternative are anticipated to be largely beneficial for aesthetics because the projects likely to be implemented are expected to improve habitat and upgrade aging and degraded infrastructure. However, there would be no coordinated and integrated effort to ensure that the projects move forward in a well-planned manner, and thus these benefits are not anticipated to be as great as they would under the other Program Alternatives. In addition, project proponents may have less input or coordination with other stakeholders on the visual impact of a specific project that moves forward under the No-action Alternative. For example, if the Alpine Lakes Optimization, Modernization, and Automation project or the Eightmile Lake Storage Restoration project were to move forward as individual projects without input from a coordinated IWG, there might be less emphasis placed on making sure the infrastructure blends in aesthetically with the environment. Potential long-term benefits from such projects are also expected to be more localized, providing only minor overall benefits within the larger Icicle Creek Subbasin.

4.11.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in greater impacts on aesthetics compared with the No-action Alternative because there would be higher likelihood that certain projects would be implemented and the scale of certain efforts would likely be greater. The following sections describe existing viewpoints and the short- and long-term impacts that would occur under Alternative 1.

4.11.2.1 Short-term Impacts

This section addresses the potential for short-term impacts on aesthetics anticipated with implementation of individual projects under Alternative 1.

Alpine Lakes Optimization, Modernization, and Automation

The Alpine Lakes Optimization, Modernization, and Automation Project would improve management and releases of stored water at five lakes in the upper Icicle Creek Subbasin to meet agricultural needs. It would also increase instream flows for fish and improve reliability for agricultural use.

The sensitive viewers for this project are predominately recreation users (e.g., hikers and campers) who visit the Alpine Lakes as discussed in greater detail in Section 3.15, Recreation. Impacts on recreational use are described in greater detail in Section 4.15, Recreation.

The areas from which it would be possible to see proposed project changes are presented in orange in Figures 4-1 through 4-5 at each lake. This viewshed analysis is based on topographic relief and does not take into account obstructions that may limit views, such as vegetation, and is therefore a conservative representation. Viewpoints within these areas were selected as representative because these are locations from which the most recreational users are likely to be able to see project changes.

Figure 4-1. Colchuck Lake Viewshed

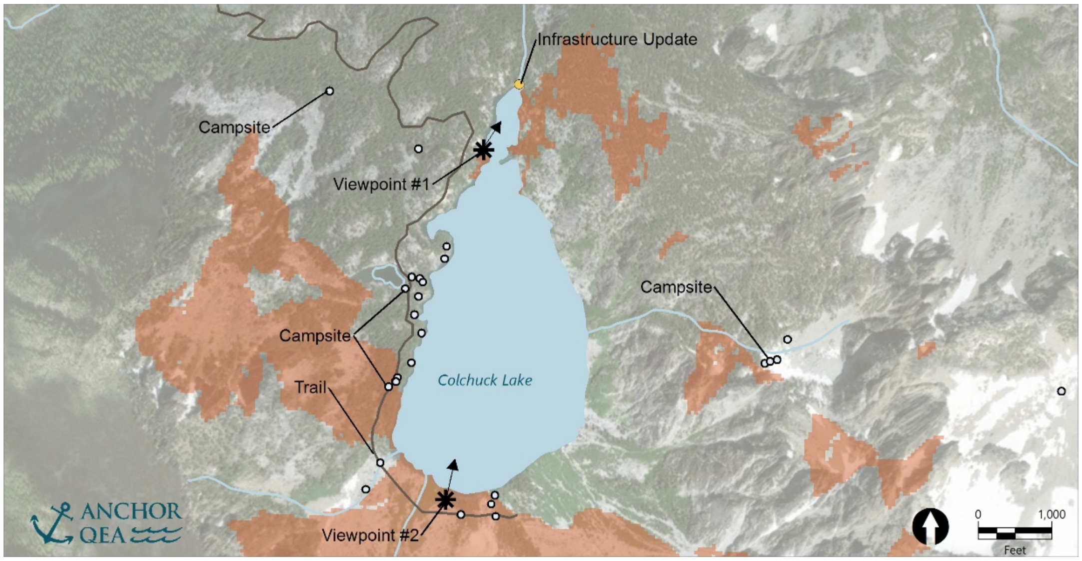


Figure 4-2. Eightmile Lake Viewshed

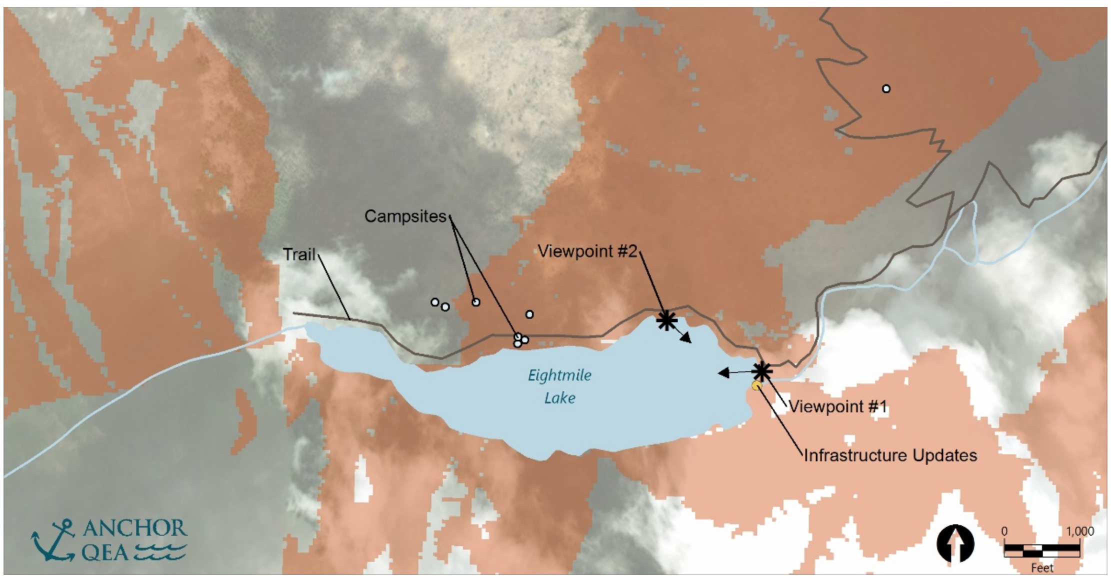


Figure 4-3. Upper and Lower Klonaqua Lakes Viewshed

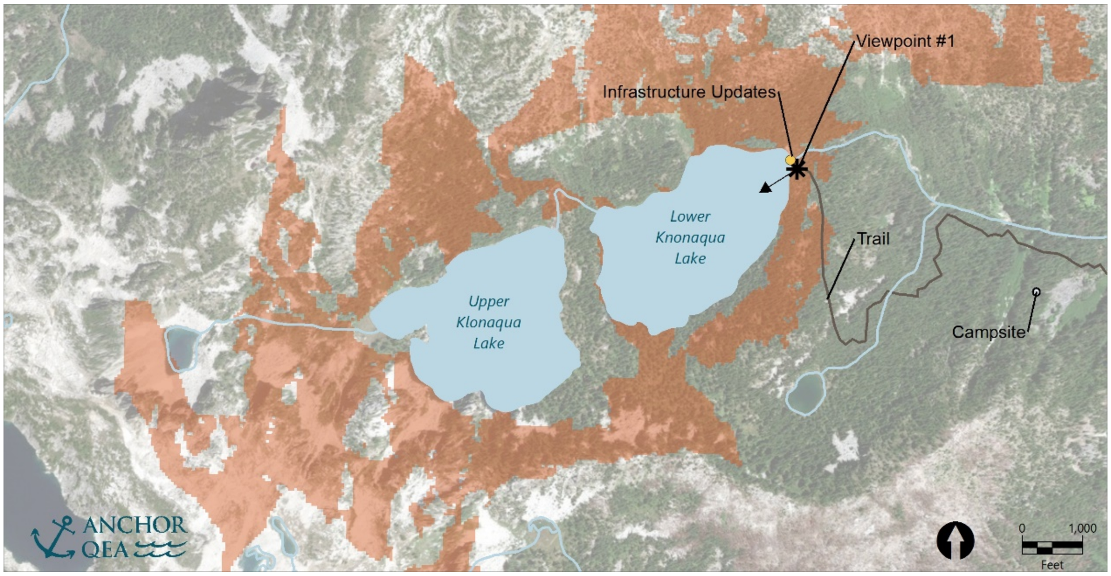


Figure 4.4 Snow Lake Viewshed

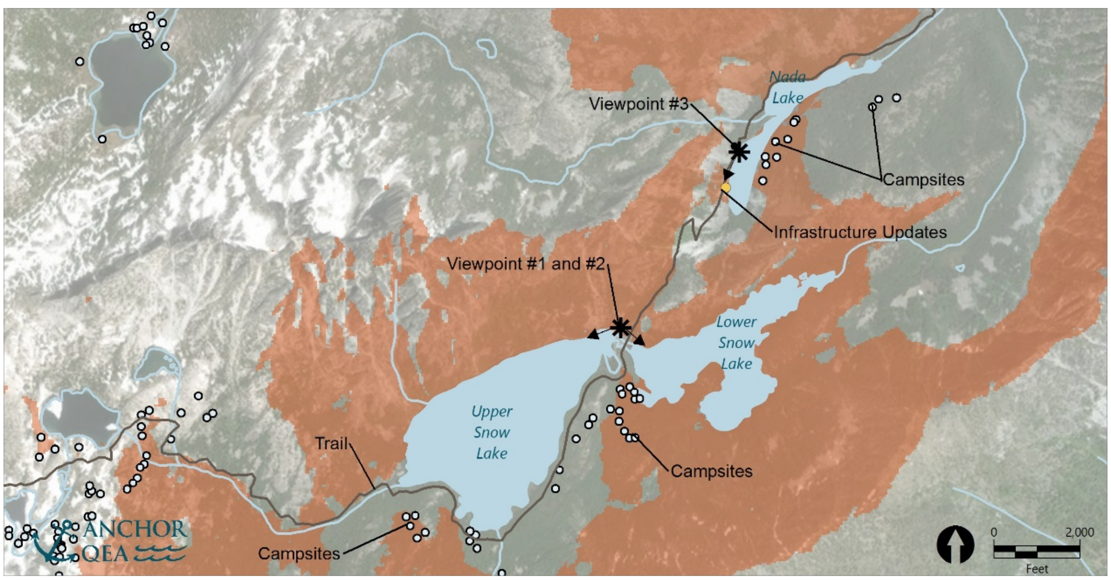
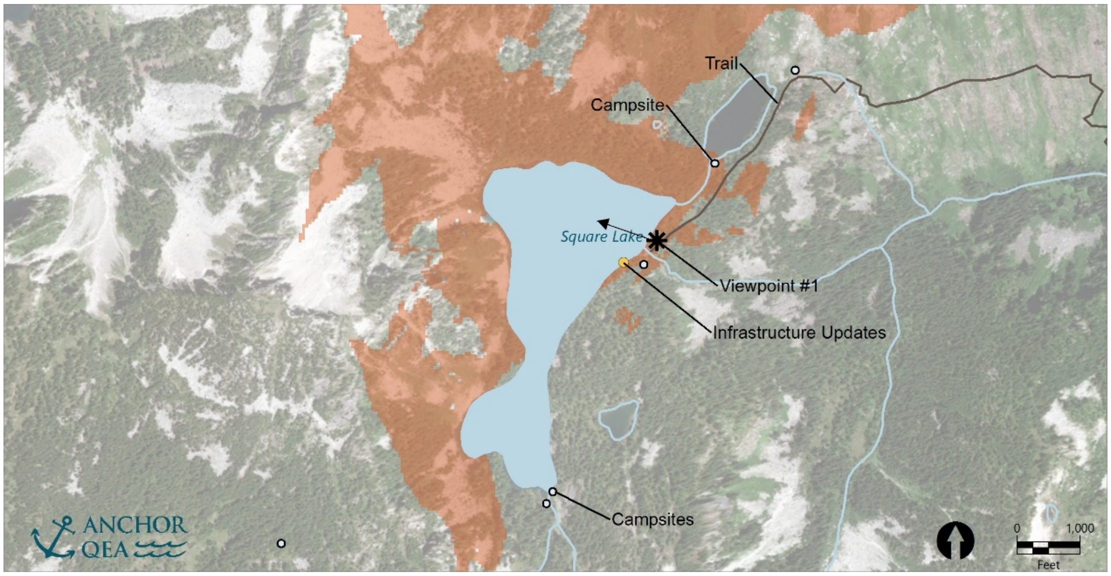


Figure 4-5. Square Lake Viewshed



Representative views from the selected viewpoints at each lake are presented in Figures 4-6 through 4-14. In general, the aesthetic setting around the lakes where proposed changes would take place consist of views of the lakes and surrounding forested areas and in some cases contain mountain views. For the most part, the views are relatively open and consist of largely intact views of undeveloped wilderness.

Figure 4-6. Colchuck Lake Viewpoint 1: Looking Northeast (August)

Viewpoint 1 at Colchuck Lake is along the trail north of the Lake. This location has views of conifers, snags, a large boulder, and the lake shoreline in the foreground; the lake, dam, large wood material in the lake, and forested shoreline in the midground; and further forested slopes and the sky in the background.

Figure 4-7. Colchuck Lake Viewpoint 2: Looking North (August)

Viewpoint 2 at Colchuck Lake occurs along the southern shoreline near camping sites. This location includes views of boulders and the lake shoreline in the foreground, forested slopes on either side of the lake in the midground, and further peaks and the sky in the background.

Figure 4-8. Eightmile Lake Viewpoint 1: Looking West (August)

Viewpoint 1 at Eightmile Lake is located along the berm of the existing dam east of the lake. This location includes views of boulders, large wood material, dam infrastructure and the lake edge in the foreground; the lake and forested slopes in the midground; and further forested and alpine peaks as well as sky in the background.

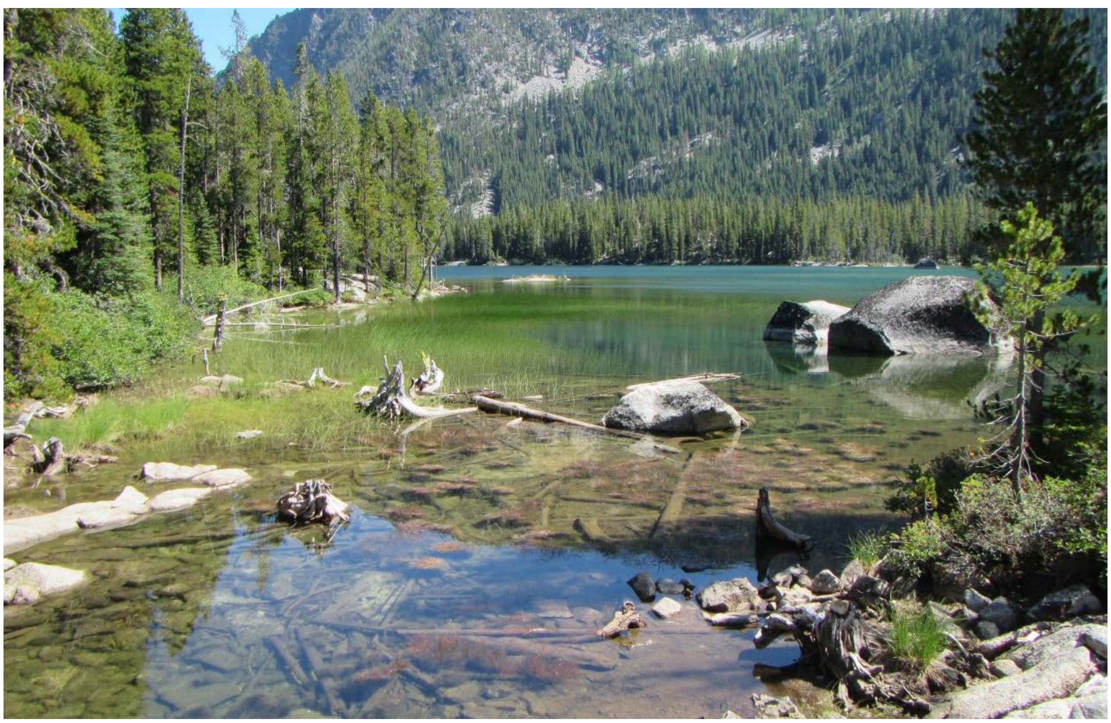
Figure 4-9. Eightmile Lake Viewpoint 2: Looking Southeast (July)

Viewpoint 2 at Eightmile Lake is located near the trail running along the north side of the lake. This location includes views of the lake in the foreground; the lake, lake edge, and dam infrastructure in the midground; and forested and rock slopes in the background.

Figure 4-10. Klonaqua Lake Viewpoint 1: Looking Southwest (July)

Viewpoint 1 at Klonaqua Lake is located at the terminus of the trail to the lake. The location includes views of conifers and snags in the foreground, the lake and forested slope in the midground, and alpine peaks and the sky in the background.

Figure 4-11. Snow Lake Viewpoint 1: Looking East (August)



Viewpoint 1 at Snow Lake is located along the trail in between Upper and Lower Snow Lakes. This location includes views of groundcover and small conifers, cobbles, boulders, shallow water, and large wood material in the foreground; the lake, aquatic vegetation, and a conifer forest in the midground; and a sloped conifer forest in the background.

Figure 4-12. Upper Snow Lake Viewpoint 2: Looking West (August)

Viewpoint 2 at Snow Lake is located at the northeast corner of Upper Snow Lake. This location features views of driftwood and the bare shoreline bank in the foreground; the lake, snags, and conifers in the midground; and forested edge of the lake, further peaks, and sky in the background.

Figure 4-13. Snow Lake Viewpoint 3 (Nada Lake): Looking Southwest

Viewpoint 3 at Snow Lake/Nada Lake is found along the trail west of Nada Lake. This location features views of boulders, the existing gatehouse, and outlet.

Figure 4-14. Square Lake Viewpoint 1: Looking West (September)

Viewpoint 1 at Square Lake is located at the terminus of the trail to the lake. The location includes views of the tops of conifer trees in the foreground, the lake and forested edge of the lake in the midground, and alpine slopes in the background.

In the short term, construction activities would result in some aesthetic changes visible to recreationalists who may be present at the time of construction. Construction activities associated with this project would involve replacing existing gates and installing solar panels, flow monitors, and motorized actuators at each of the lakes. Visual changes would include increased activity and the presence of hand-held construction tools, materials, and temporary worker housing near each dam. Most of the work would occur in upland areas with limited work occurring within the dry shorelines when the lakes are drawn down at the end of the summer.

- Depending on the specific location of these activities, there is a potential for aesthetic changes to be disruptive in the short term; however, construction activity would not be easily seen from many representative viewpoint locations as discussed further below. This is because in these locations, project changes are either obstructed by topography or vegetation or are too far away to be very noticeable.
- Colchuck Lake: construction activities would be visible from Viewpoint 1, but not from Viewpoint 2.
- Eightmile Lake: construction activities would be visible from Viewpoint 1, but not from Viewpoint 2.
- Lower Klonaqua Lake: construction activities would not be visible from the viewpoint.
- Snow Lake: construction activities would be visible from Viewpoint 3 only.
- Square Lake: construction activities would not be visible from the viewpoint.

Even when project activity may occur in areas where recreationalists would be located in close proximity, such as would be the case at Eightmile Lake, disturbance and associated aesthetic changes would be temporary (i.e., lasting only for the duration of the construction activity or about 2 to 4 weeks at each lake) and would not differ in duration or magnitude of change from the existing maintenance activities currently taking place or that would continue under the No-action Alternative. For these reasons, short-term aesthetic impacts are not likely to be significant.

IPID Irrigation Efficiencies

The IPID Irrigation Efficiencies Project involves improving irrigation delivery and on-farm efficiencies. Construction activities associated with this project could include lining and piping irrigation canals throughout the IPID service area. These activities would require the use of excavators, compactors, and other heavy equipment, such as dump trucks that would represent short-term changes to the aesthetic surroundings. However, construction activities would be occurring in areas that are already developed and in agricultural use. As a result, it is expected that there would be limited sensitivity of viewers to short-term changes and the potential impacts would not be significant. As noted previously, any vegetation removal would be mitigated through compliance with local, state, and federal requirements. If additional mitigation is required, it would be developed through project-level review as discussed in greater detail in Section 4.11.7, Mitigation Measures.

COIC Irrigation Efficiencies and Pump Exchange

The potential aesthetic impacts associated with the COIC Irrigation Efficiencies and Pump Exchange Project would largely be similar to those described above except that this project would also include construction of a new COIC pump station along the right bank of the Wenatchee River somewhere near its confluence with Icicle Creek or along the left bank of Icicle Creek near its confluence with the Wenatchee River. Depending on the site that is selected, construction could result in short-term aesthetic impacts associated with vegetation clearing, grading, soil stockpiling, and general construction activity.

Representative viewpoints where sensitive viewers would be able to see aesthetic changes are presented for the Wenatchee River (Figure 4-15). The areas from which it would be possible to see proposed project changes are presented in orange. These viewpoints were selected because of their proximity to potential pump station locations and their accessibility for recreationalists using hand-boat launch facilities (Icicle Creek Viewpoint 1) and the creek or river for boating (all viewpoints). Views from each of these viewpoints are presented in Figures 4-16 through 4-18.

Figure 4-15. Wenatchee River Viewshed: Viewpoints 1 through 3

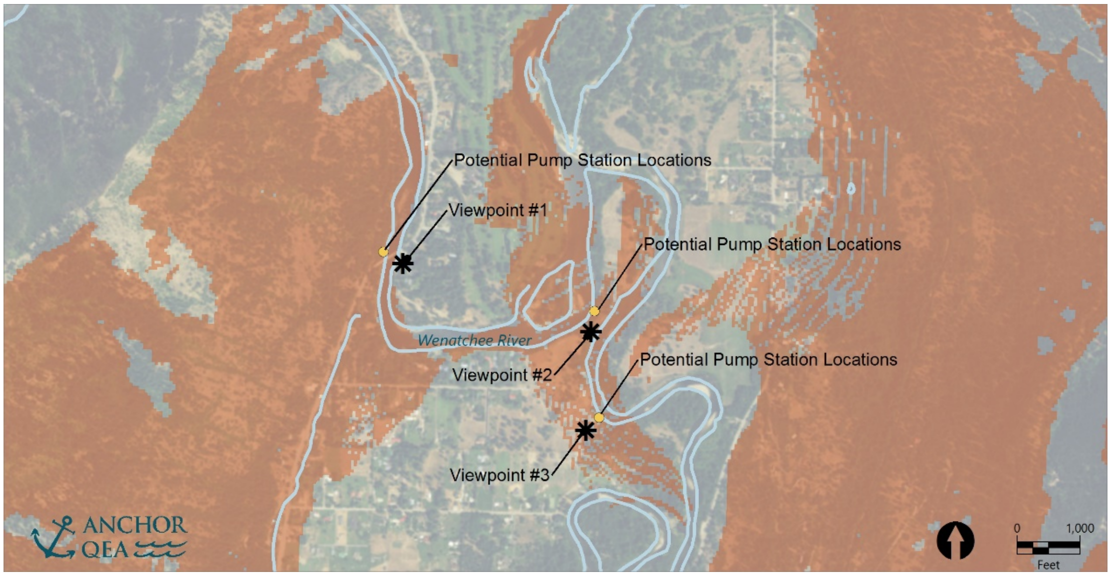


Figure 4-16. Wenatchee River Viewpoint 1: Looking Northwest (September)

This viewpoint is found near a public water access point along the river. The location includes views of the creek; the gravel, cobble, and boulder bank in the foreground; and the creek, bridge, armored bank, and upland and riparian vegetation in the midground.

Figure 4-17. Wenatchee Viewpoint 2: Looking Northeast (September)

This viewpoint is found at the water's edge accessible from upland private properties. The location features views of the river and gravel/cobble bank in the foreground, the creek and deciduous riparian vegetation in the midground, and conifer slopes and sky in the background.

Figure 4-18. Wenatchee Viewpoint 3: Looking Northeast (September)

This viewpoint is found along the shoreline slope accessible from upland private properties. The location features views of the gravel bank and herbaceous vegetation in the foreground; the creek, vegetated gravel bar, and riparian vegetation in the midground; and further riparian vegetation and upland forest slope and sky in the background.

Visual changes resulting from project activities could include short-term dewatering of stream segments through cofferdam construction and increased construction activity overall, including the transport of construction materials and the operation of construction equipment. In some cases, construction may require vegetation removal, grading, and stockpiling soil. Depending on the specific location of these activities, there is a potential for aesthetic changes to be disruptive in the short term; however, most of these changes would be temporary (i.e., lasting only for the duration of the construction activity) and would therefore not be likely to be significant.

In addition, any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits. If additional mitigation is required, it would be developed through project-level review as discussed in greater detail in Section 4.11.7, Mitigation Measures.

Domestic Conservation Efficiencies

The Domestic Conservation Efficiencies Project focuses on conservation projects in the City of Leavenworth and Chelan County and implements municipal and rural water efficiency projects such as leak detection and repair, meter installation, and implementation of water conservation measures to improve domestic supply. Any construction activities proposed under this project would occur in areas that are already developed and would be minimal. Therefore, potential short-term impacts on aesthetics would be less than significant.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would involve rebuilding the dam and outlet facilities to allow for restoration of water storage levels and useable storage volumes to their historical levels. The existing dam and embankment structure has eroded, which has limited the volume of water that can be stored in Eightmile Lake. This would help to increase the amount of water available in lower Icicle Creek, primarily in the late summer and fall.

The sensitive viewers for this project are predominately recreation users (e.g., hikers and campers) who would be visiting Eightmile Lake during construction activities. However, recreational access is currently limited due to damage caused by the Jack Creek fire that burned to lakeshore at Eightmile Lake during the summer of 2017. The subsequent emergency declarations made by IPID and local emergency response officials have resulted in USFS limiting access to Eightmile Lake. Impacts on recreational use are described in greater detail in Section 4.15, Recreation.

The locations where it would be possible to see proposed project changes, including construction-related disturbance in the short term, are presented in orange in Figure 4-2. This viewshed analysis is based on topographic relief and does not take into account obstructions that may limit views such as vegetation. Viewpoints 1 and 2 were selected as representative for this project because these are locations from which the most recreational users are likely to be able to see the areas where project changes are proposed.

This project involves demolishing the existing dam, installing new piping, and constructing new impoundment and water control structures. Construction activity would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down. Short-term impacts on aesthetics would be moderate because while most of the work and staging would occur within areas that are already disturbed and developed, the construction work would require flying in or “walking in” an excavator and other equipment, clearing vegetation, and blasting or rock-hammering the existing structure and bedrock. Specifically, replacement of the low-level outlet pipe below the dam would require excavation and movement of rock to a depth of as much as 10 to 15 feet below the existing ground surface. Construction of a 99-foot-long spillway northeast of the dam face, and a 75-foot-long spillway south of the existing dam would require the removal of some natural vegetation, placement of concrete, and moving and placing earth and rock.

These changes would be highly visible from Viewpoint 1, which is adjacent to the main construction activity. The work would also be visible from Viewpoint 2, although it would occur about 0.25 mile away from this location. Overall, short-term aesthetic impacts would be moderate.

Any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits.

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effects on tribal fishing as a result of implementing other projects as part of the overall Icicle Creek Strategy. Although the specific activities are not yet defined, there are some elements under consideration, including the construction of facilities such as new plumbing to create a bubble curtain, sprayer, or other minor modifications near the spillway in front of the LNFH to promote favorable fishing conditions.

Project activities are anticipated to largely occur along lower Icicle Creek. Depending on the specific location of the activities, construction activities could be visible to recreational users. For any project elements occurring near LNFH, some aesthetic changes could be visible to trail users near LNFH or kayakers in Icicle Creek.

A representative viewpoint where potentially sensitive viewers would be able to see aesthetic changes is shown in Figure 4-19 and a representative view in Figure 4-20. This viewpoint was selected because of its proximity to potential project changes and its accessibility for recreationalists visiting the LNFH.

Figure 4-19. Icicle Creek Viewpoint 1

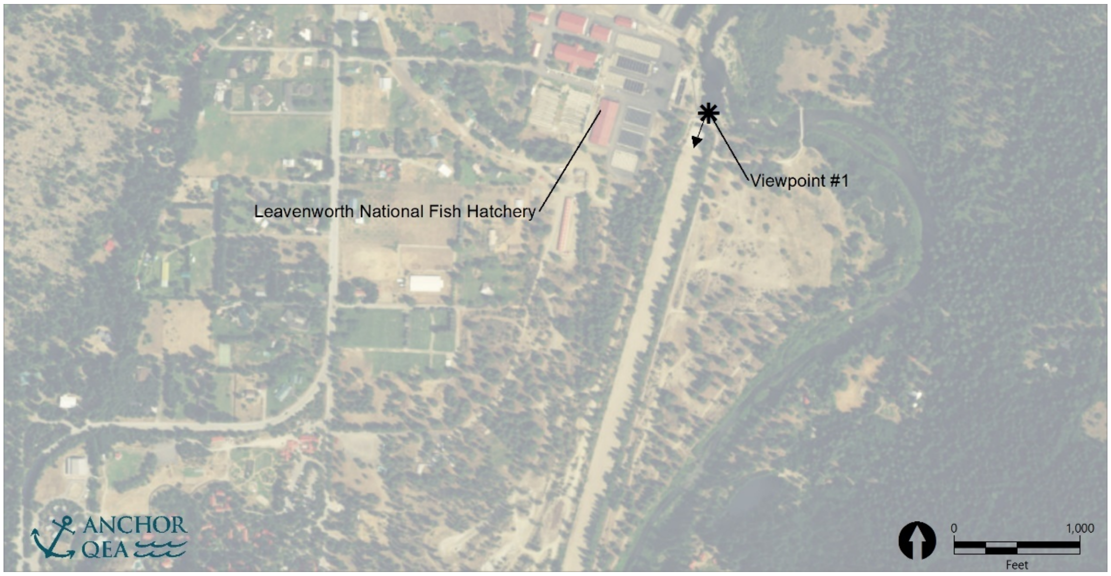


Figure 4-20. Icicle Creek Viewpoint 1: Looking Southwest

This viewpoint is located along the spillway structure of the LNFH. The location features views of the spillway and conifer vegetation in the foreground; the creek, shoreline edge, and coniferous riparian vegetation in the midground; and conifer slopes and sky in the background.

In the short term, project activities would likely include staging equipment, grading, and vegetation removal. Even though some activities may result in short-term aesthetic changes, these activities would be temporary and changes would be consistent with the developed character of the surrounding landscape and are therefore not anticipated to be significant.

In addition, any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits. If additional mitigation is required, it would be developed through project-level review as discussed in greater detail in Section 4.11.7, Mitigation Measures.

Habitat Protection and Enhancement

Habitat protection and enhancement proposed under this project could involve grading; planting and thinning vegetation; hauling and placing logs, rock, soil, and other materials; and some in-water work on lower Icicle Creek. These activities could temporarily impact natural areas for clearing and grading activities; however, enhancement would, over time, benefit aesthetics. Therefore, even though some activities could result in short-term aesthetic changes, these impacts would be temporary. Therefore, it is not anticipated that they would be significant.

In addition, any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits. If additional mitigation is required, it would be developed through project-level review as discussed in greater detail in Section 4.11.7, Mitigation Measures.

Instream Flow Rule Amendment

No short-term aesthetic impacts are anticipated from this project because no construction would be required.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements geared towards improving water quality and hatchery rearing conditions at the LNFH. In general, construction of these elements has the potential to affect natural areas and views in the short term, depending on the specific location and type of disturbance. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential short-term impacts under NEPA would be completed once the full scope of the project is determined, which would address in greater detail the potential for aesthetic impacts.

In general, while the magnitude of potential aesthetic impacts would depend on the scale of the proposed construction activities, these changes would occur within an already developed landscape and are anticipated to be less than significant. In addition, any impacts would be further addressed through implementation of mitigation measures as described in Section 4.11.7, Mitigation Measures.

Fish Passage Improvements

The specifics of the Fish Passage Improvements Project are not yet determined; however, it is anticipated that some improvements would be made at three locations on lower Icicle Creek: existing LNFH instream structures and the Boulder Field near RM 5.6. This work would require the use of excavators, dump trucks, and possibly a crane and would result in some disturbance in the short term that would alter existing views along lower Icicle Creek.

The sensitive viewers for this project are predominately recreation users (e.g., hikers and campers) who would be accessing the Snow Lake Trailhead, which passes over the Boulder Field, or recreation users on the trails at the LNFH during construction activities. The viewshed for this project is shown in Figure 4-21 with areas from which it would be possible to see proposed project changes presented in orange. This includes select viewpoints where individuals would be able to see aesthetic changes related to this project. Representative viewpoints were chosen because these are the locations where a relatively high number of individuals are likely to be able to see potential project activities. Figures 4-22 through 4-24 provide representative views from all three viewpoints.

Figure 4-21. Icicle Creek Fish Passage Improvements Viewshed

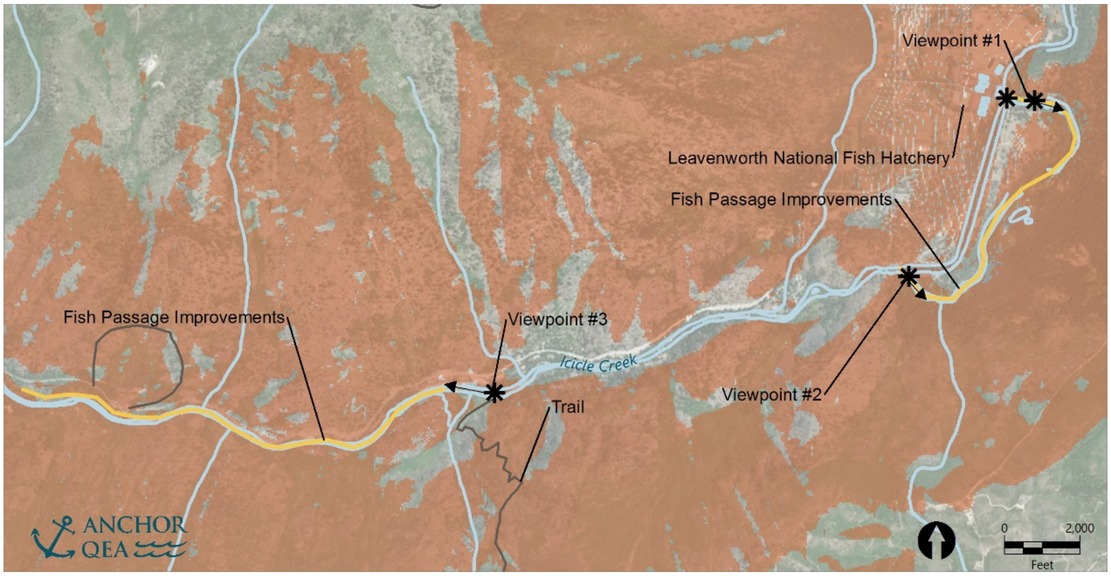


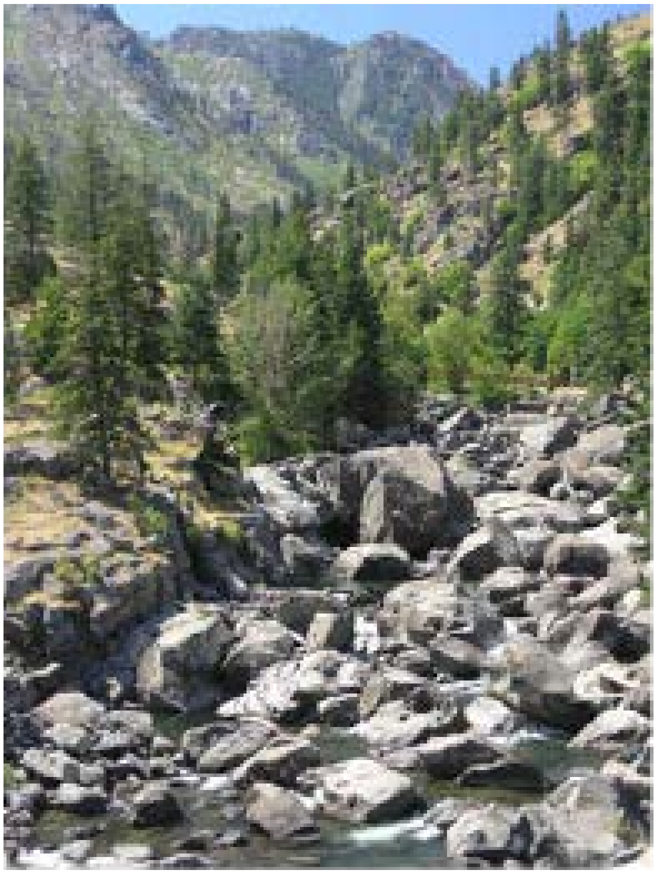
Figure 4-22. Icicle Creek Viewpoint 1: From Structure 5 Looking Upstream (Mid-water, 450 cubic feet per second [cfs])

Viewpoint 1 is accessible from trails within the LNFH. This location includes views of Icicle Creek in the foreground; shrub and herbaceous vegetation along an island and sides of banks as well as conifer forest in the midground; and sloped conifer forest and sky in the background.

Figure 4-23. Icicle Creek Viewpoint 2: From Structure 2 Looking Downstream (Mid-water, 390 cfs)

Viewpoint 2 is accessible from trails within the LNFH. This location includes views of Icicle Creek, Structure 2 infrastructure, and willows and conifers in the foreground; the creek, herbaceous and shrub riparian plants, and the edge of upland forest in the midground; and conifer forested slopes in the background.

Figure 4-24. Icicle Creek Viewpoint 3: From Boulder Field Looking Upstream (Low-water, 85 cfs)



Viewpoint 3 is located at the pedestrian bridge of the Snow Lake Trailhead. This location includes views of channel boulders and the creek in the foreground; boulders, herbaceous vegetation, and conifers in the midground; and vegetated slopes and talus in the background.

Depending on the specific location of the activities, construction activities are likely to be most visible to those who are recreating or fishing along this corridor. For any project elements occurring near LNFH, some aesthetic changes may be visible to trail users and fishers near LNFH or kayakers in Icicle Creek.

In the short-term, project activities would likely include staging equipment, grading, and vegetation removal, which would temporarily change the existing aesthetic character of each work site. Even though some activities could result in short-term aesthetic changes to typical views along lower Icicle Creek (Figures 4-22 through 4-24), these activities would be temporary and not anticipated be significant.

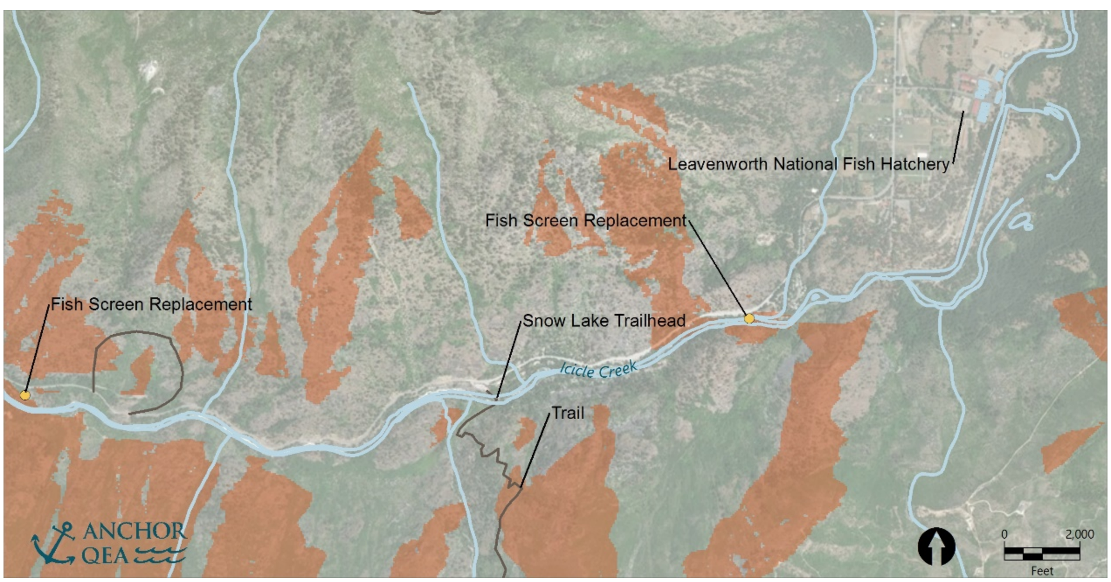
In addition, any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits. If additional mitigation is required, it would be developed through project-level review as discussed in greater detail in Section 4.11.7, Mitigation Measures.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws. These activities would involve the use of excavators, dump trucks, compaction equipment, concrete mixers, and other equipment as needed to move earth and other equipment materials. Although there would be some minor impacts to surrounding areas during construction because of removal and replacement of screens as well as inadvertent vegetation trampling, these impacts are anticipated to be less than significant.

In the short term, project activities would likely include staging equipment, grading, and vegetation removal, which would temporarily change the existing aesthetic character of each work site. Even though some activities could result in short-term aesthetic changes to typical views along lower Icicle Creek, these locations are not as visible from key areas used most by recreationalists, such as the trailhead to Upper and Lower Snow Lakes, private resorts, and recreation parking areas (Figure 4-25). Even if these activities are visible, they would not result in extensive changes and would be temporary. For these reasons, they are not anticipated to be significant.

Figure 4-25. Icicle Creek Viewshed



In addition, any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits. If additional mitigation is required, it would be developed through project-level review as discussed in greater detail in Section 4.11.7, Mitigation Measures.

Water Markets

No short-term aesthetic impacts are anticipated from the Water Markets Project because no construction would be required.

4.11.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

The greatest potential for aesthetic impacts over the long term could occur as the result of any permanent changes to the existing aesthetic character as the result of introducing new elements into the viewshed and changes with respect to how lake levels are managed.

This project would result in updates to the existing infrastructure that are not expected to be substantially noticeable in the long term. The proposed updates would include replacing existing mechanical actuators with similar-looking motorized actuators. Power would be supplied by tree- or pole-mounted solar panels and antennas (Figure 4-26), and stamped concrete and plastic boulder utility covers would be used to enclose and protect the actuators and control (Figures 4-27 and 4-28). Because these elements would be incorporated to minimize long-term aesthetic changes and to match the natural character at each lake, infrastructure upgrades are not anticipated to result in significant long-term impacts on aesthetics.

Figure 4-26. Representative Photo: Solar-panel Associated with Existing Trees

Photo credit: ell brown via VisualHunt / CC BY

Figure 4-27. Representative Photo: Actuator

Figure 28 – Representative Photo: Utility Cover

Photo credit: fekaylius via Visual hunt / CC BY-SA

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from the affected lakes. Because the facilities would be newer and largely operated remotely by IPID, any trips to and from the lakes, or activities needed to maintain the facilities, are expected to be less frequent and extensive than what would occur compared to existing conditions.

However, this project would result in increased frequency in fluctuations in lake levels compared to existing conditions. This is because lake levels would be drawn down every year instead of rotating one or two lakes per year.

Although the lakes would be drawn down more frequently, the high and low lake levels would not change. The variation in lake levels would be consistent with the general pattern that currently occurs and would continue to occur under the No-action Alternative:

- Highest water levels would continue to occur following spring thaw from April to July.
- Draw down to lower levels would still occur beginning in July or August with the lowest levels reached by early October.
- Autumn precipitation would contribute to lake levels rising slightly until the winter freeze occurs beginning in October or November.

Representative high- and low-water views for all five of the Alpine Lakes are presented below (Figures 4-29 through 4-42). As noted previously, these views would not be altered in terms of an individual's ability to view the lake and surrounding area; however, there would be a greater chance of encountering lower water conditions and greatest amount of shoreline (as shown in the representative low water figures below) during the later summer or early fall.

Specifically, automating the lake infrastructure would involve installed controls and telemetry that would allow for IPID and the USFWS to remotely control releases from the lakes. With better control, IPID and the USFWS would be able to optimize releases to meet water supply needs and help achieve instream flow targets in Icicle Creek. Automation would likely result in more frequent, targeted, controlled releases. However, a majority of the water would still be needed at the same time of year (late summer) to meet water supply and instream flow needs. Overall, the impact to aesthetics in the Alpine Lakes would be less than significant for this project.

Figure 4-29. Colchuck Lake Viewpoint 1: Looking Northeast, High Water

Timing: Water is typically high May to early July.

Figure 4-30. Colchuck Viewpoint 1: Looking Northeast, Low Water

Timing: Water is typically low late September to early October.

Figure 4-31. Colchuck Lake Viewpoint 2: Looking North, High Water

Timing: Water is typically high May to early July.

Figure 4-32. Colchuck Lake Viewpoint 2: Looking North, Low Water

Timing: Water is typically low late September to early October.

Figure 4-33. Eightmile Lake Viewpoint 1: Looking West, High Water

Timing: Water is typically high May to early July.

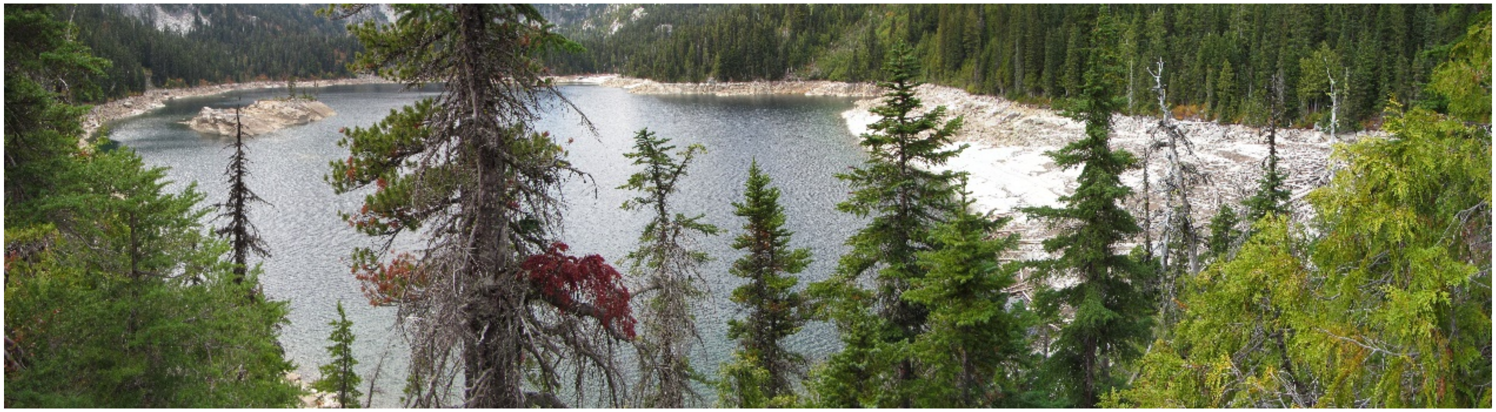
Figure 4-34. Eightmile Lake Viewpoint 1: Looking West, Low Water

Timing: Water is typically low late September to early October.

Figure 4-35. Lower Klonaqua Lake Viewpoint 1: Looking Southwest, High Water

Timing: Water is typically high May to early July.

Figure 4-36. Lower Klonaqua Viewpoint 1: Looking Southwest, Low Water



Timing: Water is typically low late September to early October.

Figure 4-37. Lower Snow Lake Viewpoint 1: Looking East, High Water

Timing: Water is typically high May to early July.

Figure 4-38. Lower Snow Viewpoint 1: Looking East, Low Water

Timing: Water is typically low late September to early October.

Figure 4-39. Upper Snow Viewpoint 2: Looking West, High Water

Timing: Water is typically high May to early July.

Figure 4-40. Upper Snow Viewpoint 2: Looking West, Low Water

Timing: Water is typically low late September to early October.

Figure 4-41. Square Viewpoint 1: Looking West

Timing: Water is typically high May to early July.

Figure 4-42. Square Viewpoint 1: Looking West

Timing: Water is typically low late September to early October.

Likewise, as discussed in Section 3.3, Surface Water Resources, changes in flows in Icicle Creek would be within the natural variation already occurring within the system. Views of high- and low-water flows that currently occur within at the representative viewpoints are shown in Figures 4-43 through 4-48. With implementation of this project, seasonal flows would remain within this same level of natural variation.

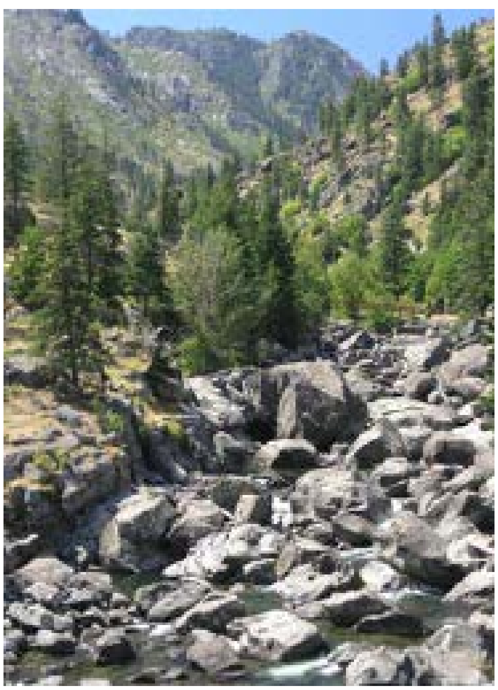
The goal of the proposed project would be to make additional water available to meet Icicle Creek instream flow goals outlined in the Guiding Principles of 100 cfs during normal and wet years and 60 cfs during drought years.

Compared with existing conditions, this would result in additional flows in the later summer and early fall. Overall, the impact to aesthetics on Icicle Creek would be less than significant for this project.

Figure 4-43. Icicle Creek Viewpoint 3: From Boulder Field Looking Upstream, High Water

Timing: High flows in Icicle Creek typically occur from April to June.

Figure 4-44. Icicle Creek Viewpoint 3: From Boulder Field Looking Upstream, Low Water



Timing: Low Flows in Icicle Creek typically occur from August to early October.

Figure 4-45. Icicle Creek Viewpoint 2: From Structure 2 Looking Downstream, High Water

Timing: High flows in Icicle Creek typically occur from April to June.

Figure 4-46. Icicle Creek Viewpoint 2: From Structure 2 Looking Downstream, Low Water

Timing: Low Flows in Icicle Creek typically occur from August to early October.

Figure 4-47. Icicle Creek Viewpoint 1: From Structure 5 Looking Upstream, High Water

Timing: High flows in Icicle Creek typically occur from April to June.

Figure 4-48. Icicle Creek Viewpoint 1: From Structure 5 Looking Upstream, Low Water

Timing: Low Flows in Icicle Creek typically occur from August to early October.

IPID Irrigation Efficiencies

The majority of the IPID Irrigation Efficiencies Project elements include pipelines or canal improvements that would occur in areas that have already been disturbed and would not result in long-term impacts on aesthetics. Over the long term, efficiencies gained would also result in increases in instream flows along lower Icicle Creek downstream of the IPID Diversion at RM 2.4, mainly during late summer and early fall, compared to existing conditions and the No-action Alternative. The potential long-term impacts associated with flow changes on Icicle Creek would result in similar types of impacts to those described as the result of the Alpine Lakes Optimization, Modernization, and Automation Project in this section.

COIC Irrigation Efficiencies and Pump Exchange

In general, the potential impacts associated with the COIC Irrigation Efficiencies and Pump Exchange Project would be similar to those described above. The project would involve replacing an existing ditch that has some aesthetic benefit to those who live near it, with buried pipelines. However, the ditch cover would be restored to a more natural state, which could be viewed as an overall benefit to the general aesthetic of the ditch. In addition, the project would result in construction of a new COIC pump station and intake facilities along the right bank of the Wenatchee River near its confluence with Icicle Creek, or along the left bank of Icicle Creek near its confluence with the Wenatchee River. These facilities would result in the loss of a small area of riparian vegetation and result in a permanent aesthetic change as the result of a new pump station facility similar to the one shown in Figure 4-49. However, the proposed pump station would likely be close to residences and would include a building (Figure 4-50) over the pumps to mitigate for noise and aesthetic impact.

Figure 4-49. Representative Photo: Pump Station Intake Features and Armored Bank

Figure 4-50. Representative Photo: Pump Station Building (Prior to Revegetation)

Depending on the location of the COIC pump station, there is a potential that the new facility would represent a moderate level of contrast between the surrounding natural or pastoral view and the new structure. In addition to a building, additional treatment would likely be included, such as screening with vegetation or fencing. Representative views of areas under consideration are shown in Figures 4-16 through 4-18.

Depending on which location is selected by COIC, the pump station could likely not be very visible to sensitive viewers, except from certain viewpoints on the river. For example, a pump station at Wenatchee River Viewpoint 1 (Figure 4-16) would only be far below the roadway and would likely only be visible from the public river access or residences across the river. A pump station at Wenatchee River Viewpoint 2 (Figure 4-17) would also be visible from the river and residences near the river, but could be hidden by preserving or enhancing riparian vegetation. A pump station near Icicle Creek Viewpoint 3 (Figure 4-18) would be located in a forested area along Icicle Creek and would not likely be visible from any residences. It would only be visible from the creek. Additionally, with a pump station building around the facility, the views would be consistent with the surrounding rural and residential development that currently exists.

Over the long term, relocation of the COIC diversion and efficiencies gained by replacing the delivery system would also result in increases in instream flows along lower Icicle Creek, mainly during late summer and early fall, compared to existing conditions and the No-action Alternative. The potential long-term impacts associated with flow changes on Icicle Creek would result in similar types of impacts to those described as the result of the Alpine Lakes Optimization, Modernization, and Automation Project in this section.

Domestic Conservation Efficiencies

Increased conservation and re-use associated with this project is expected to lead to decreased return flows, which could decrease flows in the Wenatchee River downstream of the Leavenworth Wastewater Treatment Plant; however, the long-term effects on streamflow and any associated aesthetic changes are expected to be negligible.

Eightmile Lake Storage Restoration

The greatest potential for impacts on aesthetics over the long term would occur as the result of replacing the existing dam structure and low-level outlet pipeline at Eightmile Lake with a new dam and spillway facilities, low-level outlet pipeline, and controls. The project would likely decrease maintenance and allow for remote operations with respect to how the lake level is managed. The project would be managed, with the other Alpine Lakes, to meet water supply and instream flow needs in lower Icicle Creek instead of for agricultural purposes alone.

Sensitive viewers for this project are predominately recreation users (e.g., hikers and campers) who would be visiting Eightmile Lake, as discussed in greater detail in Section 3.15, Recreation. Impacts on recreational use are described in greater detail in Section 4.15, Recreation.

The areas from which it is possible to see proposed project changes are presented in orange in Figure 4-2. Viewpoints 1 and 2 (existing views shown in Figures 4-8 and 4-9) were selected as representative because these are the locations from which the most recreational users are likely to be able to see the proposed project changes.

For this project, the existing dam would be rebuilt with new facilities that would restore IPID’s ability to store water to the historical spillway elevation. The dam and embankment have been eroded, which has reduced the elevation to which water can be stored and the volume of storage available for release to enhance water supply. The new dam would have a primary spillway elevation equal to the existing dam, but the spillway facilities would be larger and the top of the dam would be higher in order to meet current dam safety design requirements for spillway facilities and freeboard. The facilities would be constructed with concrete, native rock, and native earth in a manner to minimize contrast with the natural surroundings. As such the new dam facility is expected to result in a less than significant impact to aesthetics because the height of the dam would be similar to existing conditions, degraded elements of the existing dam (e.g. metal debris) would be removed, enhancing the appearance of the feature, and natural materials would be used to the extent feasible in constructing the facility. Additionally, with time, surrounding vegetation and the weathering properties of the lake and weather would further integrate this feature into the surrounding landscape.

Because the facilities would be newer and largely operated remotely by IPID, any trips to and from the lakes, or activities needed to maintain the facilities, are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, restoration of the facilities and re-operation of the lake would result in the ability to fill the lake to the levels at which water was historically stored, and lower lake levels below the existing low-level outlet would provide access to the useable storage allowed by IPID's water right. These represent changes in lake level compared to existing conditions and the No-action Alternative.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline would be under water mainly in the late spring and early summer, when IPID is trying to capture the last bit of snowmelt runoff. These areas have been historically inundated, but have not been under water since deterioration of the embankment. This change in lake level would result in minimal changes in the vegetative community along the fringes of the shoreline, but otherwise there would be very limited changes to aesthetics from existing high water views.

Under current conditions, pumping or siphoning is occasionally used to draw the lake level down below the existing low level outlet; however, in most cases, the low lake levels do not extend below the existing outlet. The project would also result in the potential to expose about 3.6 acres more of lake bed when fully drawn down, compared to these more typical low-water conditions. Draw down would occur mainly in the later summer and early fall, with the lowest lake levels occurring at the end of the release period, generally around the end of September. Figure 4-51 illustrates existing and proposed low- and high-water levels.

Figures 4-52 and 4-53 show existing and simulated views of the lake. Figure 4-52 compares existing and proposed views from Viewpoint 2 under higher lake levels. in Figure 4-53 shows existing and simulated conditions from Viewpoint 1. Although an additional area of lakeshore would be inundated compared to existing conditions, as shown in the simulations of the proposed conditions, these changes mostly occur in the midground to background and are not easily discernible.

Figure 4-54 shows how views would differ when the lake is drawn down. Although foreground views would change because there would be a greater area of exposed lakebed, views during this time already include exposed shoreline. In addition, midground and background views would still provide a natural view of the lake. For these reasons, long-term aesthetic impacts associated with lake level changes are considered to be moderate but not significant.

Figure 4-51. Eightmile Lake Water Levels

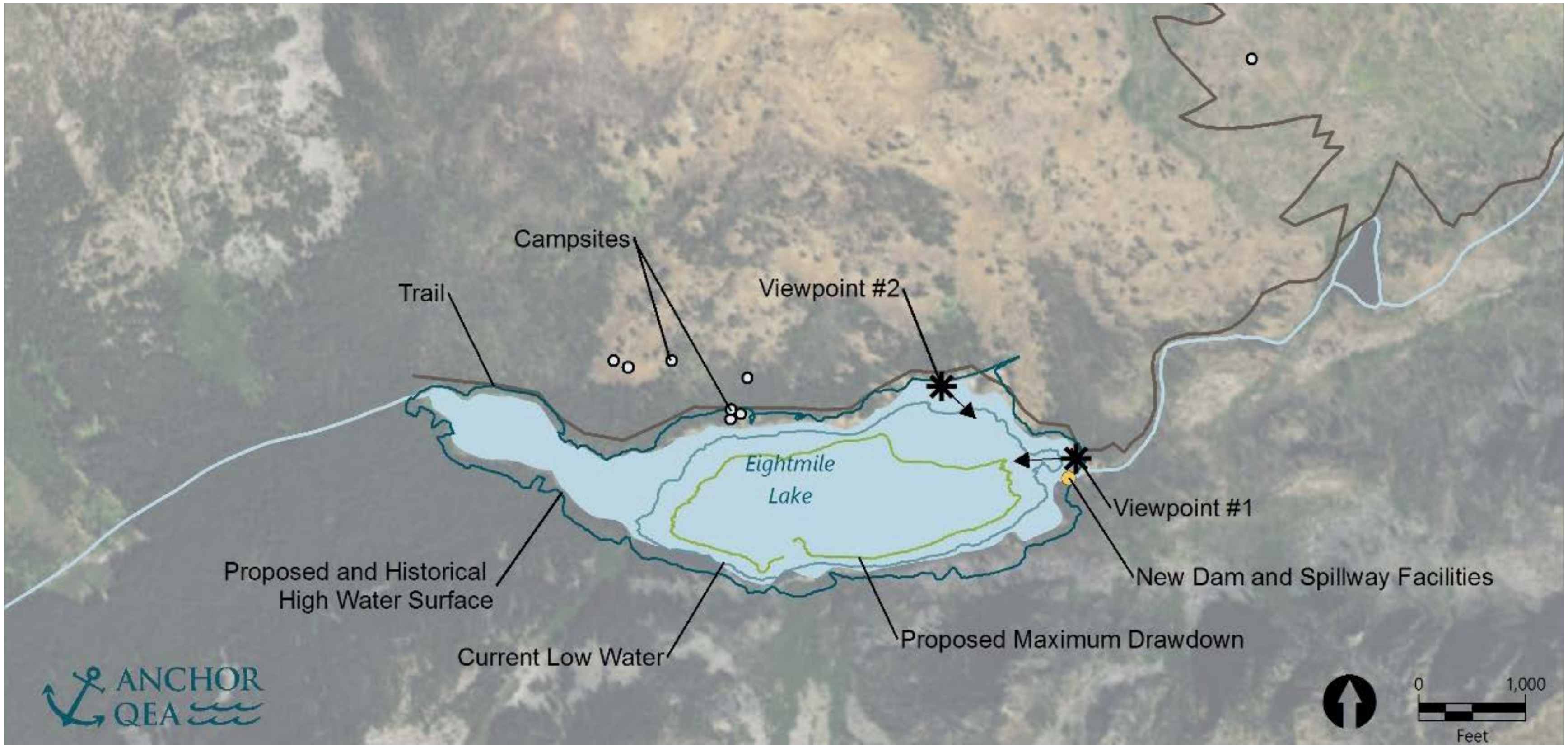


Figure 4-52. Eightmile Lake Viewpoint 2: Eightmile Lake Dam, Existing and Simulated Views

Figure 4-53. Eightmile Lake Viewpoint 1: High Lake Conditions, Existing and Simulated Views

Figure 4-54. Eightmile Lake Viewpoint 1: Low Lake Level, Existing and Simulated Views

Over the long term, this project would also result in increases in instream flows along lower Icicle Creek, mainly during late summer and early fall, compared to existing conditions and the No-action Alternative. The potential long-term impacts associated with flow changes on Icicle Creek would result in similar types of impacts to those described as the result of the Alpine Lakes Optimization, Modernization, and Automation Project in this section.

Tribal Fishery Preservation and Enhancement

The purpose of this project is to protect and enhance the tribal fishery, which, depending on the specific actions, could result in the loss of some small areas of vegetation and possibly the construction of some minor new facilities; however, these project elements are meant to preserve and enhance stream and riparian habitat and would most likely result in long-term beneficial changes to aesthetic resources. Additionally, work within sensitive areas would require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts affecting sensitive areas (Section 4.11.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Habitat Protection and Enhancement

The purpose of Habitat Protection and Enhancement Project is to protect and enhance habitat within the lower Icicle Creek corridor, which could require work along the natural shoreline project sites. Although these activities could affect small areas of native vegetation, the purpose of this project is to preserve and enhance stream and riparian habitat, which would likely lead to improvement of natural views over time.

Compliance with applicable local, state, and federal regulations would require implementation of BMPs and, if needed, additional mitigation would be developed during project-level review to address potentially significant impacts. Such measures could include generally incorporating improvements into the landscape to minimize contrast between project elements and the surrounding view (Section 4.11.7, Mitigation Measures). With implementation of BMPs and any required mitigation measures, the short-term impacts on aesthetics would be less than significant.

Instream Flow Rule Amendment

Under the Instream Flow Rule Amendment Project, the Icicle Reserve established under Chapter 137-545 WAC would be increased to support future domestic water supply demands projected through 2050. Over the long term, this amendment would ultimately result in the removal of an additional 0.4 cfs water from Icicle Creek after habitat and instream flow restoration elements are implemented. Additional water withdrawals could result in reduced instream flows in Icicle Creek, which could impact natural areas along the shoreline bank because there could be less water to support vegetation. However, potential impacts would be offset by the implementation of required instream flow and habitat restoration actions under Alternative 1. Changes in flows in Icicle Creek would be within the natural variation already occurring within the system and illustrated in Section 4.11.2.2, Long-term Impacts, Irrigation Efficiencies.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The potential long-term adverse impacts on natural shoreline areas would occur in areas where new facilities resulted in the conversion or loss of vegetation. Potential adverse impacts would likely be minor because the potential permanent loss of vegetation is expected to affect a relatively small area. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential aesthetic impacts under NEPA would be completed once the full scope of the project is determined.

Fish Passage Improvements

Although the specifics of the Fish Passage Improvements Project have not yet been determined, it is expected that long-term aesthetic changes would occur mainly at the Boulder Field (Figure 4-24) where the existing conditions would be altered to improve fish passage. Other potential project elements under consideration mainly include operational changes at Structures 2 and 5. To improve passage at the Boulder Field, it is anticipated that alteration to the stream channel would be required to create improved conditions for fish passage. Long-term impacts are not anticipated to be significant because the design does not include the introduction of any new elements or facilities but rather would maintain the overall natural conditions at this location.

Fish Screen Compliance

No impacts on aesthetics are anticipated from the Fish Screen Compliance Project over the long term because the project would replace degraded fish screens with updated models.

Depending on the location of the proposed new facilities, this project could result in the loss of some small areas of vegetation and possibly the construction of some minor new facilities; however, these project elements would be similar to the existing facilities and are not anticipated to result in a substantial change to the surrounding environment.

Additionally, work within sensitive areas would require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential long-term impacts affecting sensitive areas (Section 4.11.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Water Markets

Proposed Water Markets Project elements would result in increased flows in lower Icicle Creek, especially in years when mitigation water is not required for interruptible water users. Over the long term, efficiencies gained would also result in increases in instream flows along lower Icicle Creek, mainly during late summer and early fall, compared to existing conditions and the No-action Alternative. The potential long-term impacts associated with flow changes on Icicle Creek would result in similar types of impacts to those described as the result of the Alpine Lakes Optimization, Modernization, and Automation Project in this section.

4.11.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would also be included while the Alpine Lakes Optimization, Modernization, and Automation project would not. Compliance with the Guiding Principles addresses aesthetic views in general by enhancing Icicle Creek aquatic and riparian habitat. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Potential impacts associated with other projects proposed under Alternative 2 are discussed under Alternative 1.

4.11.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction of a new pump station under this project would require both in-water and riverbank work on the Wenatchee River. Such activities could result in many of the same construction-related short-term impacts on aesthetics described for the COIC Irrigation Efficiencies and Pump Exchange Project (4.11.2.1, Short-term Impacts), including clearing of vegetation along the bank of the Wenatchee River and along the delivery pipeline route.

4.11.3.2 Long-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project would result in the loss of a small area of riparian vegetation and the construction of a new pump exchange and associated intake facilities. Although the specific location is not yet determined, it is planned to be constructed along the banks of the Wenatchee River. A viewshed map is presented in Figure 4-55 with the areas from which it would be possible to see proposed project changes presented in orange and a representative view is shown in Figure 4-56. Representative photographs of what these facilities would likely look like are presented in Figures 4-49 and 4-50.

Figure 4-56 shows the view near the Highway 2 bridge at Dryden. This location includes views of an armored slope and willow trees and grasses in the foreground; the river, building debris, and a shoreline structure and upland vegetation in the midground; and the bend of the river and forested slope in the background.

Figure 4-55. Wenatchee River Viewshed: Viewpoint 4

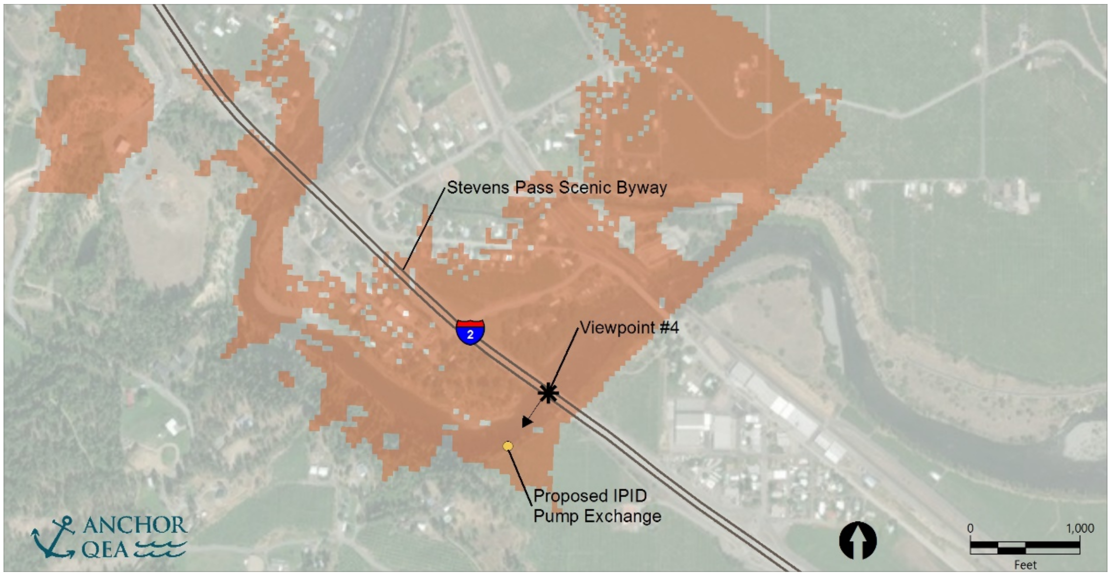


Figure 4-56. Wenatchee Viewpoint 4: Looking Southwest (July)

Sensitive viewers for this project could include recreationalists (e.g., walkers, kayakers) using public access points along the Wenatchee River during construction activities. Drivers along the Stevens Pass Scenic Byway could also be able to see the new facilities.

Representative photos of the pump station infrastructure are provided through the COIC Efficiencies Project (Figures 4-49 and 4-50). Viewers may notice a moderate level of contrast between the surrounding pastoral view and the new structure; however, the project site includes an existing degraded structure already affecting this view and the view from the Dryden bridge is accessed predominately by vehicular drivers limiting the amount of time this infrastructure could be noticed.

Over the long term, efficiencies gained would also result in increases in instream flows along lower Icicle Creek, mainly during late summer and early fall, compared to existing conditions and the No-action Alternative. The potential impacts would be similar to those described as the result of the Alpine Lakes Optimization, Modernization, and Automation Project (Section 4.11.2.2, Long-term Impacts).

4.11.4 Alternative 3

The potential impacts associated with Alternative 3 are similar to those discussed above with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 would be implemented and the Alpine Lakes Optimization, Modernization, and Automation Project would not.

4.11.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

No short-term aesthetic impacts are anticipated from this project because no construction would be required.

4.11.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority Project for Alternative 3 were enacted, there could be potential conflicts with instream flow allocations. Under the proposed changes, junior domestic water rights could be exercised even when the instream flow rule is not met, resulting in the potential for lower instream flows and associated aesthetic changes.

4.11.5 Alternative 4

The potential impacts associated with Alternative 4 are similar to those discussed for Alternative 1 with the exception that the Eightmile Lake Storage, Upper Klonaqua Lake Storage, and Upper and Lower Snow Lakes Storage Enhancement Projects are included. The potential aesthetic impacts associated with these projects are described below.

4.11.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would involve demolishing the existing dam, installing new piping, and constructing new impoundment and water control structures that would allow for an increase in the accessible storage at Eightmile Lake to 3,500 acre-feet. The new dam structure would increase the normal high operating water surface elevation by 11 feet to 4,682 feet to allow for storage at a higher level than current or historical water storage levels and the project would also allow for additional draw down of the lake.

Construction activity would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down. Short-term impacts on aesthetics would be limited because most of the work would occur within areas that are already disturbed and developed. However, a 100-foot-long spillway northeast of the dam face and a 75-foot-long spillway south of the existing dam would disturb natural vegetation.

As noted in Section 4.8, Vegetation, any potentially significant impacts related to the removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits. With implementation of required mitigation measures, the short-term impacts on aesthetics would be less than significant.

Upper Klonaqua Lake Storage Enhancement

Short-term impacts on aesthetics from this project would primarily be associated with construction activities required to provide a low-level outlet from Upper Klonaqua Lake to Lower Klonaqua Lake using one of the three conceptual connection options discussed in Chapter 2. Construction activity would occur between the lakes and along the banks within the dry areas of the lake margins once the lakes had been drawn down.

As noted in Section 4.8, Vegetation, any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits. With implementation of required mitigation measures, the short-term impacts on aesthetics would be less than significant.

Upper and Lower Snow Lakes Storage Enhancement

Short-term impacts on aesthetics from the Upper and Lower Snow Lakes Storage Enhancement Project would be primarily related to construction activities, and the impacts are similar in type and mechanism to those discussed in Sections 4.11.5.1, Short-term Impacts, Eightmile Lake Storage Enhancement and Upper Klonaqua Lake Storage Enhancement. Specific construction activities that could result in impacts include the transportation of construction equipment and materials to the project site; draw down of the lakes to isolate in-water work areas; demolition of the existing dams and water control structures; removal of vegetation, excavation, and fill placement to install new low-level outlet piping; and the placement of concrete and other materials to construct new dams.

As noted in Section 4.8, Vegetation, any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits. With implementation of required mitigation measures, the short-term impacts on aesthetics would be less than significant.

4.11.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Operation of the proposed facilities for the Eightmile Lake Storage Enhancement Project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. The greatest potential for impacts on aesthetics over the long term would occur as the result of permanent conversion of any natural areas, disturbance during maintenance, and any changes in operations with respect to how lake levels are managed.

The sensitive viewers for this project, representative viewpoints, and viewsheds are the same as under Alternative 2 Eightmile Lake Storage Restoration (Section 4.11.2.2).

Because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, this project would result in the ability to maintain the lake at higher than historical levels compared to existing conditions and the No-action Alternative.

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is restored, the lake would be able to fill to a new high water surface of 4,682 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,677 feet to the height of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch in the early summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,682 feet. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline would be under water. Shoreline areas up to 4,671 feet have been historically inundated, but areas above 4,671 feet to 4,682 feet have not been inundated. The additional area would be under water for a little less than a month each summer. This change in lake levels could result in some changes to the vegetative community at the water's edge but would otherwise represent limited changes to aesthetics from existing high water views.

The project would also allow for the lake to be drawn down below existing lake levels to an elevation of 4,620 feet, which is approximately 25 feet lower than the existing low. This change would result in the exposure of 13.6 acres of additional lake bed, mainly in the later summer month and early fall up to the point when the water would no longer be drawn down, generally around the end of September.

The dam infrastructure updates would have a temporary impact on views as a result of vegetation removal and impacts because of earthwork and clearing associated with construction of the primary and secondary spillways. The new dam facility would represent a moderate impact to aesthetics because the height of the dam would be increased, requiring additional earthwork (compared to Eightmile Lake Storage Restoration) and greater impact to surrounding vegetation. As with the Eightmile Lake Storage Restoration Project, degraded elements of the existing dam (e.g., metal debris) would be removed, enhancing the appearance of the area. Additionally, with time the surrounding vegetation and the weathering properties of the lake and weather would further integrate this feature into the surrounding landscape.

These draw down surface water-level changes represent moderate impacts to aesthetics through the change between existing and proposed views. However, the draw down conditions would still provide a natural view of the lake, but with a greater proportion of rock and sediment exposed compared to the existing view. The higher surface water changes represent a less than significant impact to aesthetics. The higher water would affect vegetation at portions of the shoreline; however, existing conditions include snags and ample large wood in the lake supplied by the forested slopes.

Simulations of the high water and dam infrastructure updates are provided below in Figures 4-57 and 4-58. Draw down conditions are similar to those shown in Alternative 2 Eightmile Lake Storage Restoration, but the lowest draw down level would include an additional 2 feet (Figure 4-59).

Figure 4-57. Eightmile Lake Storage Enhancement: Dam, Existing and Simulated Views

Figure 4-58. Eightmile Lake Storage Enhancement: Higher Lake Level, Existing and Simulated Views

Figure 4-59. Eightmile Lake Storage Enhancement: Low Lake Level, Existing and Proposed Conditions

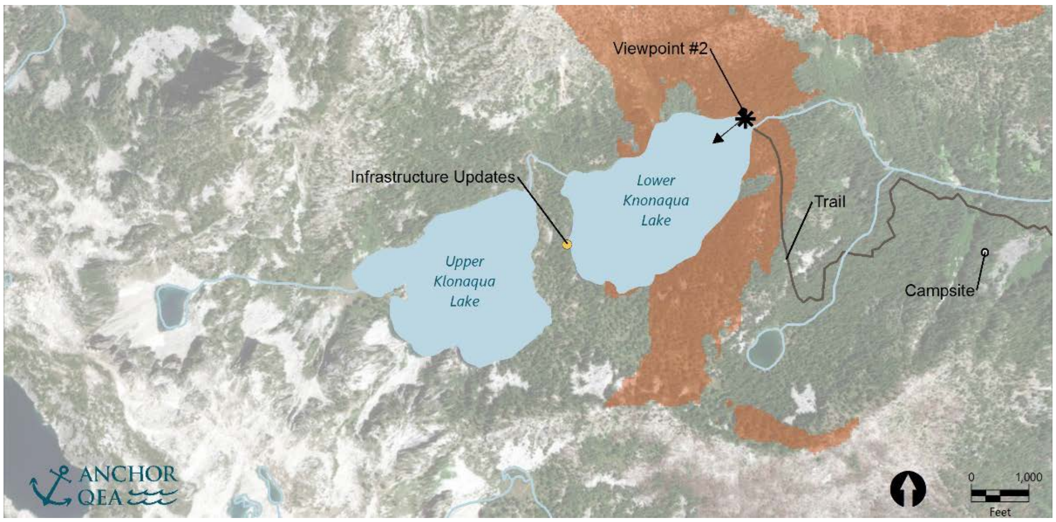
Changes in flows in Icicle Creek would be within the natural variation already occurring within the system and illustrated in Section 4.11.2.2, Long-term Impacts, IPID Irrigation Efficiencies. The main changes would be beneficial from increased flows during times when water levels would otherwise be low.

Any potentially significant impacts related to removal of riparian vegetation or other vegetation types that constitute important habitat would be addressed prior to construction by compliance with applicable local, state, and federal permits and approvals. This would include riparian vegetation, with potential mitigation requirements providing aesthetic benefits. Additional mitigation measures may include stamping or facing infrastructure with natural materials, screening with vegetation, and generally incorporating facilities into the landscape to minimize contrast between project elements and the surrounding view (Section 4.11.7, Mitigation Measures).

Upper Klonaqua Lake Storage Enhancement

The sensitive viewers for this project are predominately recreation users (e.g. hikers and campers) who would be visiting Upper Klonaqua Lake. Representative viewpoints where recreation users would see aesthetic changes are presented and described below. Figure 4-60 provides viewshed results with the locations of the representative viewpoint and the areas from which it would be possible to see proposed project changes presented in orange.

Figure 4-60. Upper Klonaqua Lake Storage Enhancement Viewshed



Potential long-term impacts to aesthetics would be similar to those described under the Eightmile Lake Storage Enhancement Project (Section 4.11.5.2, Long-term Impacts). Potential benefits would mainly occur in Icicle Creek and would include an increased ability to augment stream flow in the late summer or during drought years, with flow augmentation primarily benefitting the section of Icicle Creek between Upper Klonaqua Lake and the IPID diversion. Simulations of this project condition with the outlet structure are provided in Figure 4-61 below.

Figure 4-61. Viewpoint 2: Upper Klonaqua Lake Outlet Visible from Lower Klonaqua Lake, Existing and Proposed Conditions

The outlet structure and water flows would change the existing view as shown in the simulation; however, the view change would occur far from sensitive viewers who might be hiking on the surrounding trails and camping nearby. Additionally, the changes would largely look natural and would not introduce any new manmade elements into the viewshed that would conflict with the natural feel of the view. Further, changes to water levels would be limited to Upper Klonaqua Lake and would not be visible to sensitive viewers. Therefore, this project is not expected to result in significant aesthetic impacts in the long term at the lakes.

Over the long term, this project would also result in increases in instream flows along lower Icicle Creek, mainly during late summer and early fall, compared to existing conditions and the No-action Alternative. The potential long-term impacts associated with flow changes on Icicle Creek would result in similar types of impacts to those described as the result of the Alpine Lakes Optimization, Modernization, and Automation Project in this section.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project would result in the construction of new facilities that would allow for an increase in the high-water storage levels at both Upper and Lower Snow Lakes by 5 feet compared with existing conditions. The project would also allow for Lower Snow Lake to be drawn down 3 feet below the current lake level, which would result in the exposure of slightly more lake bed. The infrastructure changes for this project would not be visible to recreationalists at Upper and Lower Snow Lake as they would be located within a currently existing gatehouse. Changes in water pressure from the existing outlet would likewise be indistinguishable from existing conditions (Figure 4-13). Simulations of the water-level changes associated with the project are provided below in Figures 4-62 through 4-65.

Figure 4-62. Viewpoint 1: Lower Snow Lake High Water, Existing and Proposed Conditions

Figure 4-63. Viewpoint 1: Lower Snow Lake Low Water, Existing and Proposed Conditions

Figure 4-64. Viewpoint 2: Upper Snow Lake High Water, Existing and Proposed Conditions

Figure 4-65. Viewpoint 2: Upper Snow Lake Low Water, Existing and Proposed Conditions

The draw down and high water levels would change the existing view during a portion of the peak recreation time period. More specifically, those accessing the lakes in late summer are more likely to experience lower lake levels (Figures 4-62 and 4-64); however, the view would largely remain intact and have the same natural character. This would be consistent with the surrounding landscape. Therefore, it is expected that this project would not result in significant aesthetic impacts over the long term.

Over the long term, this project would also result in increases in instream flows along lower Icicle Creek, mainly during late summer and early fall, compared to existing conditions and the No-action Alternative. The potential long-term impacts associated with flow changes on Icicle Creek would result in similar types of impacts to those described as the result of the Alpine Lakes Optimization, Modernization, and Automation Project in this section.

4.11.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange Project would be included.

4.11.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

This project would involve converting the IPID delivery systems to pressurized pipelines, removing the existing intakes on Icicle and Peshastin Creeks, and constructing three new pump stations and intakes on the Wenatchee River. Conversion of the IPID delivery systems and removal of the existing intakes would require the use of excavators, compactors, and other heavy equipment, such as dump trucks that would represent short-term changes to the aesthetic surroundings. However, construction activities would be occurring in areas that are already developed and in agricultural use. As a result, it is expected that there would be limited sensitivity of viewers to short-term changes and the potential impacts would not be significant.

Construction of the three new pump stations and associated facilities would require both in-water and riverbank work on the Wenatchee River. Such activities could result in many of the same construction-related short-term impacts on aesthetics described for the COIC Irrigation Efficiencies Project (4.11.2.1, Short-term Impacts), including clearing of vegetation along the bank of the Wenatchee River and along the delivery pipeline route. As noted previously, any vegetation removal would be mitigated through compliance with local, state, and federal requirements. If additional mitigation is required, it would be developed through project-level review as discussed in greater detail in Section 4.11.7, Mitigation Measures.

4.11.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange Project

Conversion of the existing delivery systems would likely mean that canals and flumes would be abandoned in place or removed. New sections of pipelines would be buried. Therefore, it is expected that there would be limited sensitivity of viewers to long-term changes and the potential impacts would not be significant.

The Full IPID Full Piping and Pump Exchange Project would also result in the loss of a small area of riparian vegetation associated with the pump exchanges and intake facilities.

Potential impacts associated with one of the three pump stations would be the same as those described for the IPID Full Piping and Pump Exchange Project (Viewpoint 4) in Figure 4-56. The likely location of the two additional pump stations are shown in Figure 4-66 with representative views of the current conditions at those locations shown in Figure 4-67 and Figure 4-68.

Figure 4-66. Wenatchee River Viewshed: Viewpoints 5 and 6

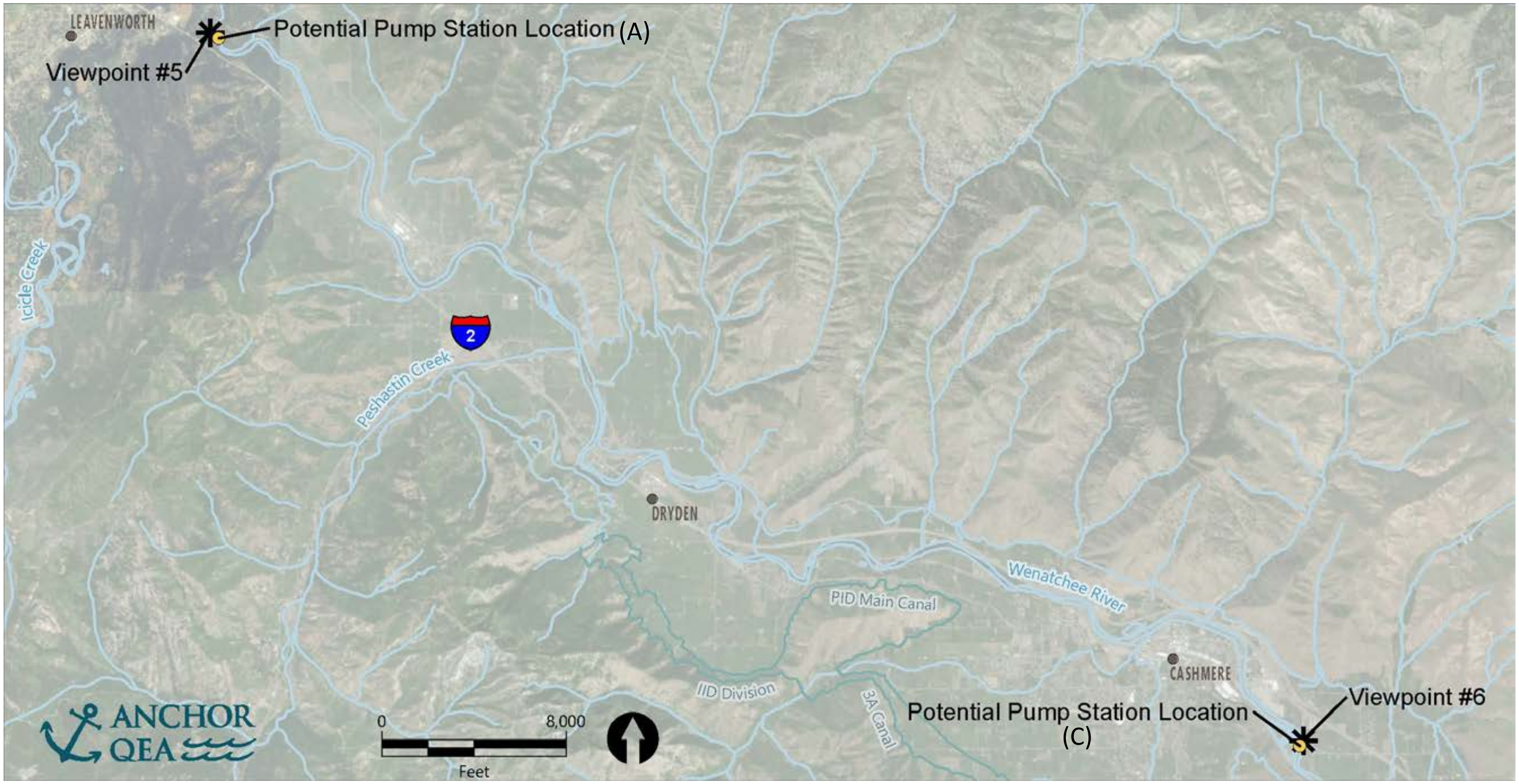


Figure 4-67. Wenatchee Viewpoint 5: Looking Southwest

Figure 4-68. Wenatchee Viewpoint 6: Looking Southwest

Sensitive viewers at the two additional pump station locations (Viewpoints 5 and 6) could include recreationalists (e.g., walkers, kayakers) using public access points along the Wenatchee River. Drivers along the Stevens Pass Scenic Byway could also be able to see the new facilities near Viewpoint 5 but not at Viewpoint 6.

Viewers from these locations may notice a low to moderate level of contrast between the surrounding view and the new pump station or intake, depending on the specific location. Representative photographs of what these facilities would likely look like are presented in Figures 4-49 and 4-50. From Viewpoint 5, there is an existing degraded structure already affecting this view and the view from the Dryden bridge is accessed predominately by vehicular drivers limiting the amount of time this infrastructure could be noticed. Viewpoint 6 represent views from a private property where the surroundings include other manmade structures. Because the new facilities would represent less of a change to the aesthetics at that location and are not easily accessible to the public, changes to this location would represent less of an aesthetic change.

Over the long term, efficiencies gained through relocation intakes on Icicle and Peshastin Creeks would also result in increases in instream flows up to the new diversion points, mainly during late summer and early fall, compared to existing conditions and the No-action Alternative. The potential long-term impacts associated with flow changes on Icicle Creek would result in similar types of impacts to those described as the result of the Alpine Lakes Optimization, Modernization, and Automation Project in this section.

4.11.7 Mitigation Measures

This section describes the BMPs that would be required and would help to mitigate the potential environmental impacts identified above.

4.11.7.1 Short-term Impacts

Short-term aesthetic impacts are often largely addressed through the implementation of BMPs that are typically required by local, state, and federal regulations and project-specific permits and approvals. Common BMPs include conducting work in a manner to minimize potential disturbance of native vegetation, minimizing dust, implementing thorough site cleanup activities, and possibly compensating for loss of any important habitat, which indirectly affects aesthetics.

If deemed necessary, specific mitigation measures would be developed as part of future project-level review and permitting. Mitigation measures to address potential short-term impacts on aesthetics are expected to be the same as those described for vegetation and wetlands in Section 4.8.6, Mitigation Measures.

4.11.7.2 Long-term Impacts

Long-term impacts on aesthetics would be mitigated in part by complying with the terms and conditions of local, state, and federal regulations and project-specific permits and approvals to restore or compensate for the loss of sensitive vegetative areas. However, specific mitigation measures would be developed as part of future project-level review and permitting if needed. Implementation of the following additional measures would ensure impacts would be less than significant.

- Design and locate to the extent feasible permanent facilities outside of publicly accessible viewpoints and avoid or minimize to the extent possible the permanent removal of native vegetative communities.
- Minimize the aesthetic impacts of new facilities by designing them to visually fit into the surrounding landscape by:
  - Selecting materials to blend into surrounding views. Avoid the use of reflective coatings or paints.
  - Painting grouped infrastructure the same color to reduce contrast and visual complexity.
  - Siting infrastructure away from ridgelines such that views of the new facilities would not have high contrast against the sky.
  - Minimize the need for nighttime lighting. Use motion detectors to minimize the need for lights to be on continually.
  - Use natural topography and vegetation to screen infrastructure from publicly accessible vantage points where possible.

4.12 Air Quality

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.12, Air Quality, from construction and operation related to the No-action Alternative and Program Alternatives.

4.12.1 No-action Alternative

4.12.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that could result in short-term impacts on air quality in the Icicle Creek Watershed project area. construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability.

Short-term impacts on air quality would primarily occur as the result of construction-related activities. Emissions would result from the transport of construction materials and the operation of construction equipment. In addition, fugitive dust as a result of the exposure or transport of soil during construction may also contribute to short-term air quality impacts. In general, short-term construction emissions are expected to be less than significant because any emissions would be temporary and minimal. Further, the majority of construction activities would be anticipated to be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110). In addition, incorporation of the standard BMPs outlined in Section 4.12.7, Mitigation Measures, would help to further reduce emissions.

4.12.1.2 Long-term Impacts

Under the No-action Alternative, individual project implementation would result in increased air emissions compared to existing conditions. Emissions from any new stationary sources, (e.g., a diesel-powered backup generators for pumping), would have the potential to result in long-term air quality impacts if the emissions exceed the applicable regulatory standards described in Section 3.12, Air Quality. However, compliance with the applicable regulatory processes described in Section 5.2, Table 5-2, would ensure any new sources of emissions would remain within acceptable thresholds.

In general, small-scale water resources projects would most likely either not result in longer-term sources of emissions or would likely fall below WAC stationary source permit requirements (WAC 173-400-110); however, if permitting was required, individual projects would be required to incorporate additional emissions controls as described in Section 4.12.7, Mitigation Measures. Therefore, the No-action Alternative is not anticipated to result in significant long-term air quality impacts.

4.12.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in an increase in emissions compared with the No-action Alternative because there would be greater likelihood that certain projects would be implemented and the scale of certain efforts would likely be greater.

4.12.2.1 Short-term Impacts

This section addresses the potential for short-term impacts on air quality anticipated with implementation of individual projects under Alternative 1.

Alpine Lakes Optimization, Modernization, and Automation

Construction activities associated with this project would result in minor short-term increases in air emissions from transporting workers and equipment to the five lakes and possibly operating a generator to power hand tools. No heavy equipment would be used related to this project. Transportation would involve helicopter trips to and from the lakes and related construction activity over a brief (likely just a few days) period at each lake. No campfires are allowed at the lakes and no other burning activities are planned related to this project.

Although there would be some minor increases in air emissions during construction, anticipated levels would be considered minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110).

IPID Irrigation Efficiencies

Construction activities associated with the IPID Irrigation Efficiencies Project include the conversion of IPID canals to pipelines and lining of irrigation canals with concrete. These activities could require the use of excavators, compactors, and other heavy equipment, such as dump trucks. Although there would be some minor increases in air emissions in the short term, anticipated levels would be considered minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110).

COIC Irrigation Efficiencies and Pump Exchange

Construction activities associated with COIC Irrigation Efficiencies and Pump Exchange Project would include piping canals and installation of a pump station, and would also be considered exempt per WAC 173-400-110. Short-term impacts on air quality would not be significant.

Domestic Conservation Efficiencies

Certain components of the Domestic Conservation Efficiencies Project, such as evaluating conservation-oriented rate structures and expanding conservation education, xeriscape, and rebate programs, would not result in air emissions; however, the construction-related activities associated with this project, such as replacing leaky water mains and residential meters, could result in some minor, short-term increases in air emissions related to the use of generators to power tools and operation of heavy equipment, including trucks, as needed. Although there would be some minor increases in air emissions during construction, anticipated levels would be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110).

Eightmile Lake Storage Restoration

Construction activities associated with the Eightmile Lake Storage Restoration Project would result in minor short-term increases in air emissions from transporting workers and equipment to Eightmile Lake and general construction activity, including operating an excavator and a generator to power hand tools and dewatering equipment. Transportation would involve periodic helicopter trips to and from the lake during the construction period, which is anticipated to last approximately 2 to 3 months. An excavator, which would be required for construction, may also be walked in along the Eightmile Lake Trail or transported by helicopter, which would also result in some short-term emissions.

Although there would be some minor increases in air emissions during construction, anticipated levels would be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110). If burning activities are required, they would be conducted in compliance with the appropriate regulations or permit conditions, as discussed in Section 4.12.7, Mitigation Measures, to ensure that potential impacts on air quality would remain minimal.

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effects on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. The specifics of this project are not yet determined, but would likely involve the operation of construction equipment, resulting in some minor short-term emissions. At this stage, the primary options under consideration include the construction of facilities, such as a pipeline, bubble curtain, or sprayer, near the spillway in front of the LNFH to promote favorable fishing conditions. Most construction activities are expected to be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110). Any new sources of emissions would be subjected to regulation as discussed in greater detail in Section 4.12.7, Mitigation Measures, which would ensure emissions would not exceed applicable thresholds.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project could involve grading; planting and thinning vegetation; hauling and placing logs, rock, soil, and other materials; and some in-water work on lower Icicle Creek. These activities would require construction equipment, including trucks, excavators, and hand-held equipment, the use of which would result in minor air emissions. Most construction activities are expected to be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110). Any new sources of emissions would be subjected to regulation as discussed in greater detail in Section 4.12.7, Mitigation Measures, which would ensure emissions would not exceed applicable thresholds.

Instream Flow Rule Amendment

No short-term air quality impacts are anticipated from this project because no construction would be required.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements geared towards improving water quality and hatchery rearing conditions at the LNFH. In general, construction of these elements would result in some increase in short-term air emissions. Because this facility is owned by Reclamation and operated by the USFWS, an evaluation of the potential air quality impacts under NEPA would be completed once the full scope of the project is determined. In general, while the magnitude of potential air quality impacts would depend on the scale of the proposed construction activities, it is anticipated that construction-related emissions for this project would be similar in nature to those described above and would be addressed through implementation of BMPs similar to those described in Section 4.12.7, Mitigation Measures.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek, as well as instream modifications to the Boulder Field near RM 5.6. This work would require the use of excavators, dump trucks, and possibly a crane. Although there would be some minor increases in air emissions during construction, anticipated levels would be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110).

Fish Screen Compliance

This project involves replacing fish screens at three different diversions on lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws. These activities would involve the use of excavators, dump trucks, compaction equipment, concrete mixers, and other equipment as needed to move earth and other equipment materials. Although there would be some minor increases in air emissions during construction, anticipated levels would be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110)

Water Markets

No short-term air quality impacts are anticipated from the Water Markets Project because no construction would be required.

4.12.2.2 Long-term Impacts

This section addresses the potential for long-term impacts on air quality anticipated with implementation of individual projects under Alternative 1.

Alpine Lakes Optimization, Modernization, and Automation

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from the affected lakes. Because the facilities would be operated largely by desktop and would rely in part on solar energy, the greatest potential for impact to air emissions over the long term would occur as the result of maintenance trips to and from the lakes, which are anticipated to likely be less frequent than would occur under the No-action Alternative. For this reason, this project is not anticipated to result in significant long-term impacts on air quality.

IPID Irrigation Efficiencies

The IPID Irrigation Efficiencies Project does not involve new emission-generating facilities or changes in operation of the existing facilities and therefore would not result in any significant long-term increases in air emissions.

COIC Irrigation Efficiencies and Pump Exchange

The long-term impacts of the COIC Irrigation Efficiencies and Pump Exchange Project on air quality would be similar to those described for the IPID Irrigation Efficiencies

Project with the exception of those associated with the new COIC pump station. As a new facility, the pump station would be required to comply with applicable regulations described in Section 3.12, Air Quality, which would ensure any new sources of emissions would remain within acceptable thresholds.

Domestic Conservation Efficiencies

No long-term impacts are anticipated from this project because no new emissions would be generated.

Eightmile Lake Storage Restoration

Operation of the proposed facilities for the Eightmile Lake Storage Restoration Project would result in the ability to store and withdraw additional water consistent with historical levels at Eightmile Lake. Because the facilities would be operated largely by desktop at the IPID offices and would rely in part on solar energy, the greatest potential for increased air emissions over the long term would occur as the result of maintenance trips to and from the lakes, which are anticipated to be less than would occur under the No-action Alternative. For this reason, this project is not anticipated to result in significant long-term impacts on air quality.

Tribal Fishery Preservation and Enhancement

No impacts on air quality are anticipated from this project over the long term because no new emissions-generating facilities are proposed.

Habitat Protection and Enhancement

No impacts on air quality are anticipated from this project over the long term because no new emissions-generating facilities are proposed.

Instream Flow Rule Amendment

No impacts on air quality are anticipated from this project over the long term because no new emissions-generating facilities are proposed.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

Operation of the LNFH over the long term has the potential to result in changes in air emissions compared to the No-action Alternative. The extent of the changes depends on the specifics of the proposed project; however, in general, it is anticipated that long-term impacts would be minor because any proposed facilities would be required to operate consistent with applicable local, state, and federal air quality regulations, as noted in Section 4.12.7, Mitigation Measures. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential air quality impacts under NEPA would be completed once the full scope of the project is determined.

Fish Passage Improvements

No impacts on air quality are anticipated from this project over the long term because no new emissions-generating facilities are proposed.

Fish Screen Compliance

No impacts on air quality are anticipated from this project over the long term because no new emissions-generating facilities are proposed.

Water Markets

No impacts on air quality are anticipated from this project over the long term because no new emissions-generating facilities are proposed.

4.12.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project compared to Alternative 1 and the No-action Alternative.

4.12.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction of the IPID Dryden Pump Exchange Project would require the use of excavators, compactors, and other heavy equipment, such as dump trucks, which would result in short-term increases in air emissions. Construction is anticipated to last up to 3 months. Although there would be some minor increases in air emissions associated with this activity, anticipated levels would be considered minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110).

4.12.3.2 Long-term Impacts

IPID Dryden Pump Exchange

Long-term operation of the IPID Dryden Pump Exchange Project would result in some increased emissions primarily associated with powering the pump. As a new facility, the pump exchange would be required to comply with the applicable regulatory processes described in Section 4.12.7, Mitigation Measures. This would ensure any new sources of emissions would remain within acceptable thresholds.

4.12.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 1 and Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 Project would be included while the Eightmile Lake Storage Restoration Project would not. This section describes the specific short- and long-term impacts associated with the Legislative Change Creating OCPI Authority for Alternative 3 Project.

4.12.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

No impacts on air quality are anticipated from this project in the short term because no new emissions-generating activities are proposed.

4.12.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

No impacts on air quality are anticipated from this project over the long term because no new emissions-generating activities are proposed.

4.12.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1 with the exception that the Eightmile Lake, Upper Klonaqua Lake, and Upper and Lower Snow Lakes Enhancement Projects would be included. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.12.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

Construction activities associated with the Eightmile Lake Storage Enhancement Project would result in minor short-term increases in air emissions from transporting workers and equipment to Eightmile Lake and general construction activity, including operating an excavator and a generator to power hand tools and dewatering equipment. Transportation would involve periodic helicopter trips to and from the lake during the construction period, which is anticipated to last approximately 2 to 3 months. An excavator may also be walked in along the Eightmile Lake Trail or transported by helicopter, which would also result in some short-term emissions.

Although there would be some minor increases in air emissions during construction, anticipated levels would be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110). If burning activities are required, they would be conducted in compliance with the appropriate regulations or permit conditions, as discussed in Section 4.12.7, Mitigation Measures, to ensure that potential impacts on air quality would remain minimal.

Upper Klonaqua Lake Storage Enhancement

Construction activities associated with this project would result in minor short-term increases in air emissions from transporting workers and equipment to the lake and general construction activity, including operating an excavator and a generator to power hand tools and dewatering equipment. Transportation would involve periodic helicopter trips to and from the lake during the construction period.

Although there would be some minor increases in air emissions during construction, anticipated levels would be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110). If burning activities are required, they would be conducted in compliance with the appropriate regulations or permit conditions, as discussed in Section 4.12.7, Mitigation Measures, to ensure that potential impacts on air quality would remain minimal.

Upper and Lower Snow Lakes Storage Enhancement

Construction activities associated with this project would result in minor short-term increases in air emissions from transporting workers and equipment to the lake and general construction activity, including operating an excavator and a generator to power hand tools and dewatering equipment. Transportation would involve periodic helicopter trips to and from the lakes during the construction period.

Although there would be some minor increases in air emissions during construction, anticipated levels would be minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110). If burning activities are required, they would be conducted in compliance with the appropriate regulations or permit conditions, as discussed in Section 4.12.7, Mitigation Measures, to ensure that potential impacts on air quality would remain minimal.

4.12.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Operation of the proposed facilities for the Eightmile Lake Storage Enhancement Project would result in the ability to store and withdraw additional water at Eightmile Lake. Because the facilities would be operated largely by desktop at the IPID offices and would rely in part on solar energy, the greatest potential for increased air emissions over the long term would occur as the result of maintenance trips to and from the lake, which are anticipated to be the same as or less than would occur under the No-action Alternative. For this reason, this project is not anticipated to result in significant long-term impacts on air quality.

Upper Klonaqua Lake Storage Enhancement

Operation of the proposed facilities for the Upper Klonaqua Lake Storage Enhancement Project would result in the ability to store and withdraw additional water at Klonaqua Lake. Because the facilities would be operated largely by desktop at the IPID offices and would rely in part on solar energy, the greatest potential for increased air emissions over the long term would occur as the result of any maintenance trips to and from the lake. Because these facilities would be new and require less maintenance, and because travel to and from the site would largely be done on foot, the potential long-term impacts are anticipated to be minimal. For this reason, this project is not anticipated to result in significant long-term impacts on air quality.

Upper and Lower Snow Lakes Storage Enhancement

Operation of the proposed facilities for the Upper and Lower Snow Lakes Storage Enhancement Project would result in the ability to store and withdraw additional water from Upper and Lower Snow Lakes. The facilities would be operated remotely by USFWS personnel at the LNFH. Releases from the lakes would be automated, with electronic actuators that would rely on solar energy. The greatest potential for increased air emissions over the long term would occur as the result of maintenance trips to and from the lakes, which are anticipated to be the same as or less than would occur under the No-action Alternative. For this reason, this project is not anticipated to result in significant long-term impacts on air quality.

4.12.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange project would be included.

4.12.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

Construction of the IPID Full Piping and Pump Exchange Project would require the use of excavators, compactors, and other heavy equipment, such as dump trucks, which would result in short-term increases in air emissions. Construction is anticipated to be phased over several years. Although there would be some minor increases in air emissions associated with this activity, anticipated levels would be considered minimal such that they would not trigger the need for a notice of construction permit from Ecology (WAC 173-400-110).

Construction activities specifically associated with installing the pressurized pump delivery system would also be considered exempt per WAC 173-400-110. Short-term impacts on air quality would not be significant.

4.12.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

Long-term operation of the IPID Full Piping and Pump Exchange Project would result in some increased emissions primarily associated with powering the pumps. As new facilities, the pump stations would be required to comply with the applicable regulatory processes described in Section 4.12.7, Mitigation Measures. This would ensure any new sources of emissions would remain within acceptable thresholds.

4.12.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.12.7.1 Short-term Impacts

Air quality regulations are set forth in Chapter 173-400 WAC. Construction permits for activities that are not otherwise exempt per WAC 173-400-110 are required to comply with the standards set forth in Chapter 173-400 WAC to ensure that air quality levels do not exceed acceptable thresholds.

Even though the construction activities associated with the Program Alternatives are expected to be minimal and otherwise exempt from regulation, implementation of the following BMPs would ensure that emissions were further reduced.

- Ensure all equipment is in good repair to minimize potential emissions.
- Minimize unnecessary idling of emission-generating equipment.
- Cover any areas of bare stockpiled soil when not in use.
- Limit any burn piles to an area of 10 feet by 10 feet and follow any other applicable limitations set forth by Washington Department of Natural Resources, Chelan County, and Ecology.

4.12.7.2 Long-term Impacts

New sources of emissions are also required to comply with the requirements set forth in Chapter 173-400 WAC. Compliance with required permit conditions would ensure that any long-term air emissions do not exceed acceptable thresholds.

4.13 Climate Change

This section describes the potential short- and long-term impacts of climate change on the proposed projects. Additionally, it describes any possible effects of the projects on climate change. Effects on climate change are assumed to primarily occur during construction activities and are discussed in the short-term impacts section. The impacts are related to emissions from construction equipment. The amount of carbon emissions resulting from construction projects depend on the type, quantity, and duration of heavy equipment use. None of the projects’ construction plans are developed enough to calculate carbon emissions. Ecology guidance suggests that increased carbon emissions of less than 25,000 metric tons per year are presumed not to be significant (Ecology, 2011).

Effects of climate change on projects are discussed in the long-term impacts sections. Many of the impacts of climate change on streamflow, as discussed in Section 3.13, are expected to be reduced if Program Alternatives are implemented. Table 4-3 indicates if the instream flow goal of 100 cfs is met by the various Program Alternatives under low, medium, and high climate change scenarios in 2080. These climate change scenarios are related to modeled changes based on the amount of future greenhouse gas releases. More detail regarding the difference climate change scenarios is available in Changing Streamflow in Icicle, Peshastin, and Mission Creeks (UW CIG, 2017) in Appendix F.

Table 4-3
Ability to Maintain Minimum Flow Target of 100 cfs Under 2080 Climate Change Conditions?

	Present	Low Change	Medium Change	High Change
Alternative 0	No	No	No	No
Alternative 1	Yes	Yes	Yes	Yes
Alternative 2	Yes	Yes	Yes	Yes
Alternative 3	Yes	No	No	No
Alternative 4	Yes	Yes	Yes	Yes
Alternative 5	Yes	Yes	Yes	Yes

Note: If guiding principles could be met both in drought and non-drought years per climate change scenario, yes. If guiding principles are not expected to be met in either drought or non-drought years per climate change scenario, no.

4.13.1 No-action Alternative

4.13.1.1 Short-term Impacts

Under the No-action Alternative, various agencies and other entities would continue to undertake individual actions to restore and enhance fish and aquatic resources in the Icicle Creek Watershed project area, but those actions would not be part of a coordinated program implemented with the support of the IWG. Actions implemented by individual agencies and entities could include construction of diversion improvements, irrigation system upgrades, LNFH improvements, and fish passage work.

Short-term impacts to climate change would result from increased greenhouse gas emissions during the construction of ongoing projects. At this point in the planning process, it is not possible to calculate the greenhouse gas emissions resulting from projects built under the No-action Alternative. However, it is assumed that the No-action Alternative would result in the lowest level of greenhouse gas emissions because the fewer projects would be constructed compared to the Program Alternatives.

4.13.1.2 Long-term Impacts

As discussed in Section 3.13, climate change is expected to have significant impacts on the timing of the hydrograph, with peak flows occurring earlier in the season and having a lower magnitude as well as lower summer and early fall flows. These changes in the hydrograph would likely have significant negative consequences for aquatic species and water availability for out-of-stream uses. Without an integrated water resource management strategy, individual project efficacy could reduce the potential to address these issues.

Several projects will likely proceed under the No-action Alternative that will help secure supplies of out-of-stream use. These include improvements at points of diversions, efficiency/conservation upgrades, and continued maintenance and operation of storage facilities. While these projects might continue under the No-action Alternative, the focus of these projects would likely be focused on out-of-stream beneficiaries and not on streamflow.

Long-term impacts to climate change resulting from this project that would have increased energy demands, such as the COIC pump station, could include increases in greenhouse gas emissions. However, Chelan PUD, which generates power primarily through hydroelectric projects, will provide the electricity for this project, so greenhouse gas emissions are expected to be relatively low. Significant increases in greenhouse gas emissions are not expected to result from implementation of the No-action Alternative.

4.13.2 Alternative 1 (Base Package)

As discussed in Section 3.13, research on climate change indicates there will likely be significant changes in the magnitude and timing of the hydrograph in Icicle Creek over time. Implementation of Alternative 1 has the potential partially to offset the impacts associated with increased variability in water flows, and increase adaptable water management strategies in response to changing climatic conditions. Appendix F provides graphs of modeled streamflow under low, medium, and high climate change scenarios, with additional flows provided by Alternative 1 augmenting the climate change base flow. These models were built from data available in the University of Washington Climate Impacts Group report on Icicle Creek streamflow under various greenhouse gas scenarios and climate change models (CIG, 2017). These graphs use an average of models to predict stream flow based on low greenhouse gas release scenarios. Based on these analyses, Alternative 1 would meet the instream flow targets established in the Guiding Principles in 2080 under the low, medium and high climate change scenarios.

There is also the potential for greenhouse gas releases in association with construction activities.

4.13.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction activities associated with the Alpine Lakes Optimization, Modernization, and Automation Project would involve replacing existing gates and installing solar panels, actuators, flow monitoring equipment, and other new equipment. Some of these activities could require the use of gasoline/diesel powered equipment, which could be flown in via helicopter during normal maintenance trips. The use of heavy equipment for construction would likely be limited for this project. As discussed in Section 4.12.2.1 emissions from construction equipment would be considered minimal. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

IPID Irrigation Efficiencies

Construction activities associated with the IPID Irrigation Efficiencies Project include the conversion of irrigation canals to pipelines, lining of irrigation canals with concrete, and installation of on-farm efficiency upgrades. These construction activities would require the use of gasoline/diesel powered heavy equipment. As discussed in Section 4.12.2.1 emissions from construction equipment would be considered minimal. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

COIC Irrigation Efficiencies and Pump Exchange

Construction activities associated with the COIC Irrigation Efficiencies and Pump Exchange Project include the conversion of irrigation canals to pipelines and construction of a new surface water intake and pump station on the Wenatchee River. These construction activities would require the use of gasoline/diesel powered heavy equipment. As discussed in Section 4.12.2.1 emissions from construction equipment would be minimal. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

Domestic Conservation Efficiencies

Construction activities under the Domestic Conservation Efficiencies Project would likely be associated with upgrading leaky infrastructure, such as replacing watermains and installing meters. These construction activities would require the use of gasoline/diesel powered heavy equipment, but as discussed in Section 4.12.2.1 emissions from construction equipment would be considered minimal. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would involve demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures. These construction activities would likely require the use of gasoline/diesel powered heavy equipment, but as discussed in Section 4.12.2.1 emissions from construction equipment would be considered minimal. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effects on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. At this stage, the primary options under consideration include the construction of facilities, such as plumbing to create a bubble curtain, a sprayer, or other minor modifications to the Hatchery Channel spillway at LNFH to promote favorable fishing conditions in the pool at the bottom of the spillway. These construction activities would require the use of gasoline/diesel powered equipment, but as discussed in Section 4.12.2.1 emissions from construction equipment would be considered minimal. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project includes planting vegetation, grading, and installing logs, rocks, and other materials. These construction activities would require the use of gasoline/diesel powered equipment, but as discussed in Section 4.12.2.1 emissions from construction equipment would be considered minimal. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

Instream Flow Rule Amendment

There are no construction activities associated with this project, and no potential for greenhouse gas emissions.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements that would require the use of gasoline/diesel powered equipment during construction, including the installation of circular tanks, implementation of effluent pump-back, and groundwater augmentation. These construction activities would result in some increase in short-term greenhouse gas emissions. Because this facility is owned by the Reclamation and operated by the USFWS, an evaluation of the potential air quality impacts under NEPA would be completed once the full scope of the project is determined. In general, while the magnitude of potential greenhouse gas emissions would depend on the scale of the proposed construction activities, it is anticipated that construction-related emissions for this project would be similar in nature to other projects described in this section.

Fish Passage Improvements

The Fish Passage Improvements Project would involve modification of existing LNFH instream structures in Icicle Creek as well as instream modifications to the Boulder Field near RM 5.6. These construction activities would require the use of gasoline/diesel powered heavy equipment, but as discussed in Section 4.12.2.1 emissions from construction equipment would be considered minimal. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

Fish Screen Compliance

The Fish Screen Compliance Project involves installing fish screens at three different diversions on Icicle Creek. These construction activities would require the use of gasoline/diesel powered equipment, but as discussed in Section 4.12.2.1 emissions from construction equipment would be considered minimal. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

Water Markets

There are no construction activities associated with this project, and no potential for greenhouse gas emissions.

4.13.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

As discussed in Section 3.13, climate change is predicated to impact the timing of the hydrograph, leading to increased streamflow in the winter and decreased streamflow in the summer, over time. The Alpine Lakes Optimization, Modernization, and Automation Project is designed to release up to 30 cfs to augment low flows in Icicle Creek. This project would be expected to help offset the impacts of climate change and provide the flexibility for adaptive management of water resources within the basin, reducing impacts on fish and out-of-stream users.

Under climate change scenarios, the likelihood that lakes will still be able to fully recharge remains relatively unchanged or improves in 2030 across model types. However, the timing of when runoff from rain or snowmelt occurs changes, which leads to increased recharge in the winter and spring, and decreased runoff to the lakes during the summer months (CIG, 2017).

Long-term impacts to climate change resulting from greenhouse gas emission is not expected from this project. The project would be operated via solar power and gravity works.

IPID Irrigation Efficiencies

The IPID Irrigation Efficiencies Project would reduce IPID's diversion on Icicle Creek by approximately 10 cfs in summer months through canal piping and lining, and on-farm efficiency upgrades. This would have positive effects on stream flow, which climate change models indicate would decrease in the summer months. These decreased flows are not anticipated to have impacts on the project's operation or viability. Long-term demand forecasting predicts that agriculture demand could decrease overall in the Wenatchee River Watershed, with peak use shifting to earlier in the season (WSU, 2016), meaning climate change may not have long-term impacts on the efficacy of this project. This change in demand is based on changes in crop type.

The IPID diversion and canal is a gravity system. This project is not anticipated to contribute to greenhouse gas emission through its operation. Long-term changes in greenhouse gas emissions are not expected to result from this project.

COIC Irrigation Efficiencies and Pump Exchange

The COIC Irrigation Efficiencies and Pump Exchange Project involves piping the system and replacing the gravity feed point of diversion on Icicle Creek with a pump station on the Wenatchee River. This project is anticipated to provide 8.0 to 11.9 cfs in Icicle Creek during summer months when climate change models predict lower flows. These decreased flows are not anticipated to have impacts on the project's operation or viability. Long-term demand forecasting predicts that agricultural demand may decrease overall in the Wenatchee River Watershed, with peak use shifting to earlier in the season (WSU, 2016), meaning climate change may not have long-term impacts on the efficacy of this project. This change in demand is based on changes in crop type.

Long-term impacts to climate change resulting from this project could include increases in greenhouse gas emissions. However, Chelan PUD, which generates power primarily through hydroelectric projects, will provide the electricity for this project, so greenhouse gas emissions are expected to be relatively low. Long-term changes in greenhouse gas emissions are not expected to result from this project. This project is currently undergoing pre-design and feasibility, which will help inform how many tons of carbon per year may result from this project.

Domestic Conservation Efficiencies

The Domestic Conservation Efficiencies Project involves upgrading meters, increased leak detection, replacing leaking infrastructure, and providing incentives to reduce water use such as conservation education, conservation rebate programs, and conservation-oriented rate structures. It is not anticipated that climate change would impact the project's operation, viability, or efficacy. Additionally, this project is not anticipated to increase greenhouse gas emissions.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project is designed to release up to 12.6 cfs and 900 acre-feet of additional storage (2,500 acre-feet total). This additional water would go to instream flows and improved domestic supply, but if the City of Leavenworth is able to withdraw the additional water from the Wenatchee River well field, the project would provide an additional 12.6 cfs to Icicle Creek in all reaches of the creek. This project would be expected to help ameliorate the impacts of climate change and provide the flexibility for adaptive management of water resources within the basin, reducing impacts on fish and out-of-stream users.

Under low, medium, and high climate change scenarios, the likelihood for lake recharge remains relatively unchanged or increases. However, the timing of runoff changes, which leads to increased recharge in the winter and spring, and decreased inflow during the summer months (Aspect, 2015).

Long-term impacts to climate change resulting from this project could include increases in greenhouse gas emissions. However, Chelan PUD, which generates power primarily through hydroelectric projects, will provide the electricity for the municipal/domestic component of this project, via increased pumping from City wells, so greenhouse gas emissions are expected to be relatively low.

Gate operations at the dam would be powered by solar panels, allowing for the automated releases of water for increased instream flows. Long-term changes in greenhouse gas emissions are not expected to result from this project.

Tribal Fishery Preservation and Enhancement

This project would include measures to minimize the impacts of other projects implemented through the Icicle Strategy on tribal, as well as non-tribal, fisheries. It is expected that climate change will result in increased variability of water flows and temperatures, which can make water use reliability more tenuous and fish habitat lower quality. This project, by definition will help address potential adverse impacts of the Program on fisheries, which will in part offset adverse climate change impacts. As flow conditions change in response to climate change, the effectiveness of project elements may change. The efficacy of projects would require long-term monitoring based on changing flow conditions.

A long-term increase in greenhouse gas emissions from project operations is not anticipated.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project includes riparian plantings, installation of woody debris and rocks, reconnection and protection of the flood plain, and conserving upland forested habitat. While climate change may impact riparian areas and vegetation dynamics, it is believed this project would still be viable and effective.

The project has the potential to reduce the carbon in the atmosphere by conserving forest lands and planting riparian vegetation. There would be no long-term greenhouse gas emissions resulting from this project.

Instream Flow Rule Amendment

This project involves amending the Instream Flow Rule. Climate change is predicted to create even more variabilities in flows and increase periods when the instream flow rule is not met. Increasing the reserve has the potential to exacerbate this issue. However, as noted in Section 4.7.2, Fish, other flow and habitat restoration project under Alterative 1 are meant to collectively address this problem.

This project could result in additional greenhouse gas emissions resulting from increased pumping. However, the power source for any additional pumping from the City's well field would likely be provided by Chelan PUD, which supplies hydropower throughout Chelan County. Long-term changes in greenhouse gas emissions are not expected to result from this project.

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Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

Operation of the LNFH over the long-term has the potential to result in changes in greenhouse gas emissions. The extent of the changes depends on the specifics of the proposed project; however, in general, it is anticipated that long-term impacts would be minor because any proposed facilities would be required to operate consistent with applicable local, state, and federal air quality regulations. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential greenhouse gas emissions under NEPA would be completed once the full scope of the project is determined.

Fish Passage Improvements

The Fish Passage Improvements Project involves improving fish passage in Icicle Creek. There are no long-term greenhouse gas emissions associated with the project. Reduced summer flows resulting from climate change could impact the efficacy of this project. However, with the instream flow improvements proposed under Alternative 1, these impacts to efficacy are unlikely. Long-term changes in greenhouse gas emissions are not expected to result from this project.

Fish Screen Compliance

The Fish Screen Compliance Project involves upgrading the IPID, City of Leavenworth, and the LNFH/COIC fish screens. The operation of this project is not expected to result in long-term increases of greenhouse gas emissions. The efficacy of this project is not expected to be impacted by climate change. Long-term changes in greenhouse gas emissions are not expected to result from this project.

Water Markets

The Water Markets Project would provide mitigation to interruptible water users. This project is expected to provide instream flow benefit in several Icicle Creek and Wenatchee River reaches in drought years and benefit in all reaches in non-drought years. The instream flow benefit would be 3.4 cfs during the summer months when stream flow is expected to be at its lowest. Long-term demand forecasting predicts that agricultural demand could decrease overall in the Wenatchee River Watershed, with peak use shifting to earlier in the season (WSU, 2016), meaning climate change may not have long-term impacts on the efficacy of this project.

Long-term changes in greenhouse gas emissions are not expected to result from this project.

4.13.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would also be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. Implementation of Alternative 2 has the potential to offset some of the impacts of climate change on stream flow and increase adaptable water management strategies in response to changing conditions. Appendix F provides graphs of modeled streamflow under low, medium, and high climate change scenarios, with additional flows provided by Alternative 2 augmenting the climate change base flow. Based on this analysis, Alternative 2 would meet the instream flow targets established in the Guiding Principles in 2080 under the low and medium climate change scenario, but not under the high climate change scenario.

4.13.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction activities associated with the IPID Dryden Pump Exchange Project includes construction of a new surface water intake and pump station on the Wenatchee River. These construction activities would require the use of gasoline/diesel powered equipment. However, greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change.

4.13.3.2 Long-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project involves piping the system and replacing the gravity feed point of diversion on Icicle Creek with a pump station on the Wenatchee River. This project is anticipated to provide 8.0 to 11.9 cfs in Icicle Creek during summer months when climate change models predict lower flows. These decreased flows are not anticipated to have impacts on the project's operation or viability. Long-term demand forecasting predicts that agricultural demand could decrease overall in the Wenatchee River Watershed, with peak use shifting to earlier in the season (WSU, 2016), meaning climate change may not have long-term impacts on the efficacy of this project. This change in demand is based on changes in crop type.

Long-term impacts to climate change resulting from this project could include increases in greenhouse gas emissions. However, Chelan PUD, which generates power primarily through hydroelectric projects, will provide the electricity for this project, so greenhouse gas emissions are expected to be relatively low. This project is currently undergoing pre-design and feasibility, which will help inform how many tons of carbon per year may result from this project. However, it is not anticipated to have significant impacts on climate change.

4.13.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 Project would also be included while the Eightmile Lake Storage Restoration Project would not. Implementation of Alternative 3 has the potential to offset some of the impacts of climate change on streamflow and water resource management, and increase adaptable water management strategies in response to changing conditions. However, under Alternative 3, the flow targets established in the Guiding Principles would not be obtainable in 2080 under low, medium, and high climate change scenarios. Appendix F provides graphs of modeled streamflow under low, medium, and high climate change scenarios, with additional flows provided by Alternative 3 augmenting the climate change base flow.

4.13.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities associated with this project, and no potential for greenhouse gas emissions. This project will not have significate short-term climate change impacts.

4.13.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

This project involves a legislative change to provide for domestic water use when the Instream Flow Rule is not met. This is because the timing of instream flow improvement projects may not be timed perfectly to match domestic demand, making it difficult to provide in-time mitigation to impacts on the Instream Flow Rule. This project could result in additional greenhouse gas emissions resulting from increased pumping. Calculating these impacts is not possible at this time. However, the power source will likely be hydropower provided by Chelan PUD, which would minimize greenhouse gas emissions. This project is not anticipated to have significate long-term climate change impacts.

4.13.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1. The Eightmile Lake Storage Restoration Project would be replaced with the Eightmile Lake Storage Enhancement Project, and the Upper Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects would be included. Implementation of Alternative 4 has the potential to offset some of the impacts of climate change on stream flow and increase adaptable water management strategies in response to changing conditions. Appendix F provides graphs of modeled streamflow under low, medium, and high climate change scenarios, with additional flows provided by Alternative 4 augmenting the climate change base flow. Based on this analysis, Alternative 4 would meet the instream flow targets established in the Guiding Principles in 2080 under the low, medium, and high climate change scenarios.

4.13.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would involve demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures that would allow for an increase in the accessible storage at Eightmile Lake. These construction activities would require the use of gasoline/diesel powered equipment. Greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change. Overall, the project is a not anticipated to result in significant short-term climate change impacts.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project would involve installing a conveyance system between Upper Klonaqua Lake and Lower Klonaqua Lake to allow draw down of Upper Klonaqua Lake. Construction activities have not been determined, but would require the use of gasoline/diesel powered equipment. Greenhouse gas emissions would be limited to the construction period and are not expected to cause appreciable impacts to climate change. Overall, the project is a not anticipated to result in significant short-term climate change impacts.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project would require altering the dam at Snow Lake and the outlet structure to increase accessible storage. Construction activities have not been determined, but would require the use of gasoline/diesel powered equipment. Greenhouse gas emissions would be limited to the construction period and are not expected to cause appreciable impacts to climate change. Overall, the project is a not anticipated to result in significant short-term climate change impacts.

4.13.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project is designed to release up to 17.9 cfs and 1,000 acre-feet of additional storage (2,500 acre-feet total). This additional water would go to instream flows and improved domestic supply, but if the City of Leavenworth is able to withdraw the additional water from the Wenatchee River well field, the project would provide an additional 17.9 cfs to Icicle Creek in all reaches of the creek. This project would be expected to help ameliorate the impacts of climate change and provide the flexibility for adaptive management of water resources within the basin, reducing impacts on fish and out-of-stream users.

Long-term greenhouse gas emissions from project operations could occur if the additional domestic supply is provided via the Wenatchee River well field rather than the Icicle Creek diversion, because power use would increase. These increased emissions are discussed under the Eightmile Lake Storage Restoration project. Gate operations at the dam would be powered by solar panels. Overall, the project is a not anticipated to result in significant long-term climate change impacts.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project is designed to release up to 20 cfs and 2,448 acre-feet of additional storage. This additional water would go to instream flows and improved domestic supply. This project would be expected to help ameliorate the impacts of climate change and provide the flexibility for adaptive management of water resources within the basin, reducing impacts on fish and out-of-stream users.

Gate operations at the dam would be powered by solar panels. Overall, the project is a not anticipated to result in significant long-term climate change impacts.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project is designed to release up to 18 cfs and 1,079 acre-feet. This additional water would go to instream flows and improved domestic supply. This project would be expected to help ameliorate the impacts of climate change and provide the flexibility for adaptive management of water resources within the basin, reducing impacts on fish and out-of-stream users.

Gate operations at the dam would be powered by solar panels. Overall, the project is a not anticipated to result in significant long-term climate change impacts.

4.13.6 Alternative 5

Alternative 5 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Full Piping and Pump Exchange Project would replace the IPID Irrigation Efficiencies Project. Implementation of Alternative 5 has the potential to offset some of the impacts of climate change on stream flow and increase adaptable water management strategies in response to changing conditions. Appendix XF provides graphs of modeled streamflow under low, medium, and high climate change scenarios, with additional flows provided by Alternative 5 augmenting the climate change base flow. Based on this analysis, Alternative 5 would meet the instream flow targets established in the Guiding Principles in 2080 under the low, medium, and high climate change scenario.

4.13.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

Construction activities associated with the IPID Full Piping and Pump Exchange Project includes construction of a new surface water intakes and pump stations on the Wenatchee River. These construction activities would require the use of gasoline/diesel powered equipment. However, greenhouse gas emissions would be limited to the construction window and are not expected to cause appreciable impacts on climate change. Overall, the project is a not anticipated to result in significant short-term climate change impacts.

4.13.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

The IPID Dryden Pump Exchange Project involves piping the system and replacing the gravity feed point of diversion on Icicle Creek with three pump stations on the Wenatchee River. This project is anticipated to provide up to 117 cfs in Icicle Creek during summer months when climate change models predict lower flows. These decreased flows are not anticipated to have impacts on the project's operation or viability. Long-term demand forecasting predicts that agricultural demand could decrease overall in the Wenatchee River Watershed, with peak use shifting to earlier in the season (WSU, 2016), meaning climate change may not have long-term impacts on the efficacy of this project. This predicted change in demand is based on anticipated changes in crop type.

Long-term impacts to climate change resulting from this project could include increases in greenhouse gas emissions. However, the primary power supply for the pump stations would be Chelan PUD, which generates power primarily through hydroelectric projects, so greenhouse gas emissions are expected to be relatively low. This project is currently undergoing pre-design and feasibility, which will help inform how many tons of carbon per year may result from this project. Overall, the project is a not anticipated to result in significant long-term climate change impacts.

4.13.7 Mitigation Measures

This section describes mitigation measures to minimize the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.13.7.1 Short-term Impacts

While construction activities are not expected to have a significant effect on global climate change, construction-related greenhouse gas emissions should be reduced by the following BMPs.

- Ensure all equipment is in good repair to minimize potential emissions.
- Minimize unnecessary idling of emission-generating equipment.
- Minimize the number of trips to/from construction sites and use local materials when possible.

4.13.7.2 Long-term Impacts

As discussed in Section 3.13, climate change is anticipated to impact stream flow and, consequently, water resource management in the Icicle Creek Subbasin. There may be increases in greenhouse gas emissions associated with the implementation of some projects, which BMPs relating to equipment maintenance can help minimize. The expected increase in greenhouse gas emissions is considered less than significant.

4.14 Noise

This section describes potential short- and long-term impacts that could affect the resources identified in Section 3.14, Noise, from construction and operations related to the No-action Alternative and the Program Alternatives.

4.14.1 No-action Alternative

4.14.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that could result in short-term noise impacts in short-term impacts in the Alpine Lakes Wilderness Area and in riparian areas along Icicle Creek and the Wenatchee River. Short-term noise impacts would largely result from operating mechanized construction equipment but may also include blasting related to maintenance activities at the existing irrigation structures at the Alpine Lakes. Table 4-4 presents noise levels associated with typical mechanized construction activities. The magnitude of short-term construction impacts in each case would depend on specific types of equipment used, the distance between construction activities and the nearest noise-sensitive receptor, and existing background noise levels.

Table 4-4
Typical Construction Noise Levels

Construction Activity	Equipment	Maximum Noise Level (dBA)[1]
Construction Preparation	Air compressors, power plants, pickup trucks, tractor trailers	55 to 85
Clearing and Grading	Air compressors, backhoe, blasting, dozer, excavator, forklifts, dump trucks, frontend loader, pumps, power plants, pickup trucks, rock drill, tractor trailers	55 to 94
Structure Construction	Air compressors, auger drill rig, backhoe, crane, excavator, forklifts, dump trucks, frontend loader, pumps, power plants, pickup trucks, tractor trailers, vibratory pile driver	55 to 95
Planting/Revegetation	Backhoe, dump trucks, frontend loader, pickup trucks, tractor trailers	55 to 84
Demobilization	Air compressors, backhoe, excavator, forklifts, dump trucks, loader, pumps, power plants, pickup trucks, tractor trailers	55 to 85

Source: Federal Highway Administration Construction Noise Handbook (FHWA 2006)
1) Noise is measured as A-weighted decibels (dBA) at 50 feet from the source.

In general, construction noise limited activities occurring between 7 a.m. and 10 p.m. (daytime hours) are exempt from regulations per WAC 173-60-050 and Chelan County Code Title 7. Any construction activities that may occur at the Alpine Lakes associated with upgrading the existing irrigation infrastructure are considered allowable uses consistent with the Wilderness Act as discussed further in Section 4.17.

4.14.1.2 Long-term Impacts

Under the No-action Alternative, most of the anticipated projects would not result in the creation of facilities that would generate ongoing sources of noise; however, any projects involving ongoing use of equipment, such as pumps or compressors would result in potential increases in long-term noise.

As discussed further in Section 4.14.7, Mitigation Measures, the state imposes limits on the allowable environmental noise levels from a variety of sources as described in Chapter 173-60 WAC. If permitting is required, individual projects would be required to incorporate additional controls consistent with those regulations. Therefore, the No-action Alternative is not anticipated to result in significant long-term noise impacts.

4.14.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in greater noise impacts compared with the No-action Alternative because there would be a higher likelihood that certain projects would be implemented and the scale of certain efforts would likely be greater. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.14.2.1 Short-term Impacts

This section describes the potential for short-term increases in noise anticipated with implementation of Alternative 1.

Alpine Lakes Optimization, Modernization, and Automation

Construction activities associated with this project would result in less than significant short-term increases in noise from transporting workers and equipment to the five lakes and from general construction activity, including operation of a generator to power hand tools. No heavy equipment would be used related to this project. Transportation would involve helicopter trips to and from the lakes over a brief period (likely a few days to a couple of weeks) at each lake. Noise levels associated with typical construction activities at 50 feet from the source are presented in Table 4-4.

Background noise levels at the project sites are generally quiet and mainly include sounds associated with the natural environment. Although there are no permanently occupied residences, recreationalists are granted access to camp and hike within and around the project sites based on a lottery system managed by the USFS. For additional information about recreational use, refer to Section 3.15, Recreation.

Depending on the location of recreationalists relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Although most camping sites are located farther than 50 feet from the proposed construction activities, anticipated noise levels could be a nuisance to recreationalists in the general vicinity. However, the increases in noise would not represent a permanent increase. Rather, nuisance noise would occur intermittently over a period of 2 to 4 weeks at each lake. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. As discussed in Section 4.17, the proposed project is an allowed use consistent with the Wilderness Act. Therefore, increased noise from construction is not anticipated to be significant.

IPID Irrigation Efficiencies

Construction activities associated with the IPID Irrigation Efficiencies Project include the conversion of IPID canals to pipelines and lining of irrigation canals with concrete. These activities could require the use of excavators, compactors, and other heavy equipment, such as dump trucks. Noise levels associated with typical construction activities at 50 feet from the source are presented in Table 4-4.

Construction activities are anticipated to occur within rural agricultural areas, but could also occur in more developed urban settings. Background noise levels would vary but are generally anticipated to be representative of noise levels associated with agricultural and urban development. Sensitive noise receptors that could be affected by these activities are likely to include agricultural workers, residents, and other workers or individuals present at the time of construction.

Depending on the location of noise-sensitive receptors relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Anticipated noise levels could be a nuisance but would not represent a permanent increase. Rather, nuisance noise would occur intermittently during construction activities. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, increased noise from construction is not anticipated to be significant.

COIC Irrigation Efficiencies and Pump Exchange

Construction activities associated with COIC Irrigation Efficiencies and Pump Exchange Project would be similar to those described above for the IPID Irrigation Efficiencies Project and are not anticipated to be significant.

Domestic Conservation Efficiencies

Certain components of the Domestic Conservation Efficiencies Project, such as evaluating conservation-oriented rate structures and expanding conservation education, xeriscape, and rebate programs, would not result in increased noise; however, construction-related activities associated with this project, such as replacing leaky water mains and residential meters, could result in some minor, short-term increases in noise.

These activities include the use of generators to power tools and operation of heavy equipment, including trucks, as needed.

Construction activities are anticipated to occur within already developed residential settings. Background noise levels would vary but are generally anticipated to be representative of noise levels associated with urban development and general residential activity. Sensitive noise receptors that could be affected are likely to include residents or workers present at the time of construction.

Depending on the location of noise-sensitive receptors relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Anticipated noise levels could be a nuisance but would not represent a permanent increase. Rather, nuisance noise would occur intermittently during construction activities. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, increased noise from construction is not anticipated to be significant.

Eightmile Lake Storage Restoration

Construction activities associated with the Eightmile Lake Storage Restoration Project would result in increases in noise from transporting workers and equipment to Eightmile Lake and general construction activity, including operating an excavator and a generator to power hand tools. Transportation would involve periodic helicopter trips to and from the lakes during the construction period, which is anticipated to last approximately 2 to 3 months. An excavator could also be walked in along the Eightmile Lake Trail, which would also result in brief activity and associated noise along the trail.

Noise levels associated with typical construction activities at 50 feet from the source are presented in Table 4-4. In addition, some blasting could be required to break up rock at the site. Prior to any blasting, IPID would develop a blasting plan, as described in Section 4.14.7, Mitigation Measures, and in conjunction with USFS, which would establish notification procedures so the public is informed that blasting might occur.

Background noise levels at the project site are generally quiet and mainly include sounds associated with the natural environment. Although there are no permanently occupied residences, recreationalists are granted access to camp and hike within and around the project site based on a lottery system managed by the USFS. For additional information about recreational use, refer to Section 3.15, Recreation.

Depending on the location of recreationalists relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4 related to the majority of construction activity. Although most camping sites are located farther than 50 feet from the proposed construction activities, anticipated noise levels could be a nuisance to recreationalists in the general vicinity, particularly if any blasting were to occur. Implementation of the blasting plan described in Section 4.14.7, Mitigation Measures, would help to minimize these impacts.

Increases in noise would not be permanent. Rather, nuisance noise would occur intermittently over a period of 2 to 4 weeks at the lake. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. As discussed in Section 4.17, the proposed project is an allowed uses consistent with the Wilderness Act. Therefore, with incorporation of the measures identified in Section 4.14.7, Mitigation Measures, increased noise from construction is not anticipated to be significant.

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effects on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. The specifics of this project are not yet determined, but would involve elements of restoration along lower Icicle Creek that could result in localized construction-related noise. At this stage, the primary options under consideration include the construction of facilities such as a bubble curtain, sprayer, or other minor modifications near the spillway in front of the LNFH to promote favorable fishing conditions.

Construction activities are anticipated to occur along the lower Icicle Creek. Background noise levels would vary, but are generally anticipated to be representative of noise levels associated with natural sounds near the creek edge and some urban development. Sensitive noise receptors that could be affected are likely to include any residents who may live nearby, workers, or other individuals, including recreationalists, present at the time of construction.

Depending on the location of noise-sensitive receptors relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Anticipated noise levels could be a nuisance but would not represent a permanent increase. Rather, nuisance noise would occur intermittently during construction activities. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, increased noise from construction is not anticipated to be significant.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project could involve grading; planting and thinning vegetation; hauling and placing logs, rock, soil, and other materials; and some in-water work on lower Icicle Creek. These activities would require construction equipment, including trucks, excavators, and hand-held equipment, the use of which would result in increased noise. Construction activities are anticipated to occur along the lower Icicle Creek. Background noise levels would vary but are generally anticipated to be representative of levels associated with natural sounds near the creek edge and some urban development. Sensitive noise receptors that could be affected are likely to include any residents that may live nearby, workers, or other individuals, including recreationalists, present at the time of construction.

Depending on the location of noise-sensitive receptors relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Anticipated noise levels could be a nuisance but would not represent a permanent increase. Rather, nuisance noise would occur intermittently during construction activities. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, increased noise from construction is not anticipated to be significant.

Instream Flow Rule Amendment

No short-term noise impacts are anticipated from this project because no construction would be required.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements geared toward improving water quality and hatchery rearing conditions at the LNFH. In general, construction of these elements would result in some increase in short-term noise. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential short-term noise impacts under NEPA would be completed once the full scope of the project is determined.

Background noise levels are generally representative of levels associated with natural sounds near the creek edge and some urban development. Sensitive noise receptors that could be affected are likely to include workers or other individuals, including recreationalists, present at the time of construction.

Depending on the location of noise-sensitive receptors relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Anticipated noise levels could be a nuisance but would not represent a permanent increase. Rather, nuisance noise would occur intermittently during construction activities. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, increased noise from construction is not anticipated to be significant.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek as well as instream modifications to the Boulder Field near RM 5.6. This work would require the use of excavators, dump trucks, and possibly a crane.

Background noise levels are generally representative of levels associated with natural sounds near the creek edge and some urban development. Sensitive noise receptors that could be affected are likely to include workers or other individuals, including recreationalists, present at the time of construction.

Depending on the location of noise-sensitive receptors relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Anticipated noise levels could be a nuisance but would not represent a permanent increase. Rather, nuisance noise would occur intermittently during construction activities. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, increased noise from construction is not anticipated to be significant.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws. These activities would involve the use of excavators, dump trucks, compaction equipment, concrete mixers, and other equipment as needed to move earth and other equipment materials.

Background noise levels are generally representative of levels associated with natural sounds near the creek edge and some urban development. Sensitive noise receptors that could be affected are likely to include workers or other individuals, including recreationalists, present at the time of construction.

Depending on the location of noise-sensitive receptors relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Anticipated noise levels could be a nuisance but would not represent a permanent increase. Rather, nuisance noise would occur intermittently during construction activities. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, increased noise from construction is not anticipated to be significant.

Water Markets

No short-term noise impacts are anticipated from this project because no construction would be required.

4.14.2.2 Long-term Impacts

This section addresses the potential for long-term noise impacts anticipated with implementation of individual projects under Alternative 1.

Alpine Lakes Optimization, Modernization, and Automation

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from the affected lakes. Because the facilities would be largely operated remotely by IPID and would rely in part on solar energy, the greatest potential for increased noise over the long term would occur as the result of maintenance trips to and from the lakes. For this reason, this project is not anticipated to result in significant long-term noise impacts.

IPID Irrigation Efficiencies

The IPID Irrigation Efficiencies Project does not involve new emission-generating facilities or changes in operation of the existing facilities and would therefore, not result in any significant long-term increases in noise.

COIC Irrigation Efficiencies and Pump Exchange

Under the COIC Irrigation Efficiencies and Pump Exchange Project, the long-term impacts from noise would be similar to those described above for the IPID Irrigation Efficiencies Project with the exception of the new COIC pump station. Because the pump station would generate additional noise over the long-term, the design would incorporate features to reduce noise, including the use of variable frequency drives, which reduce the mechanical noise of the pumps, and placement within an insulated building.

In addition, as discussed in Section 3.14, Noise, the state imposes limits on the allowable environmental noise levels from a variety of sources consistent with Chapter 173-60 WAC. As such, individual projects, including the COIC pump station, would be required to incorporate additional controls consistent with those regulations. Therefore, this project is not anticipated to result in significant long-term noise impacts.

Domestic Conservation Efficiencies

No long-term noise impacts are anticipated from this project because no new noise-generating facilities or activities would occur.

Eightmile Lake Storage Restoration

Operation of the proposed facilities for the Eightmile Lake Storage Restoration Project would result in the ability to store and withdraw additional water consistent with historical levels at Eightmile Lake. Because the facilities would be largely operated remotely by IPID and would rely in part on solar energy, there would be potential for an overall reduction in noise impacts over the long term that would occur as the result of maintenance trips to and from the lakes, which are anticipated to be less than would occur under the No-action Alternative. For this reason, this project is not anticipated to result in significant noise impacts.

Tribal Fishery Preservation and Enhancement

The only potential noise impact that may occur as part of this project could be some minor from a bubbler or other equipment designed to create conditions that attract and keep fish in the pool near the hatchery spillway. No other long-term noise impacts are anticipated from this project because no new noise-generating facilities or activities would occur.

Habitat Protection and Enhancement

No long-term noise impacts are anticipated from this project because no new noise-generating facilities or activities would occur.

Instream Flow Rule Amendment

No long-term noise impacts are anticipated from this project because no new noise-generating facilities or activities would occur.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

Operation of the LNFH over the long term has the potential to result in changes in noise levels compared to the No-action Alternative. The extent of the changes depends on the specifics of the proposed project; however, in general, it is anticipated that long-term impacts would be less than significant because any proposed facilities would be required to operate consistent with applicable local, state, and federal noise regulations, as described in Section 3.14, Noise. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential noise impacts under NEPA would be completed once the full scope of the project is determined.

Fish Passage Improvements

No long-term noise impacts are anticipated from this project over the long term because no noise-generating facilities or activities would occur.

Fish Screen Compliance

No long-term noise impacts are anticipated from this project over the long term because no new noise-generating facilities or activities would occur.

Water Markets

No long-term noise impacts are anticipated from this project over the long term because no new noise-generating facilities or activities would occur.

4.14.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included while the Alpine Lakes Optimization, Modernization, and Automation project would not. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Impacts associated with other projects proposed under Alternative 2 are discussed under Alternative 1.

4.14.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction of the IPID Dryden Pump Exchange Project would require the use of excavators, compactors, and other heavy equipment, such as dump trucks, which would result in short-term increases in noise. Construction is anticipated to last up to 3 months.

Construction activities would occur along the bank of the Wenatchee River. Background noise levels would vary but are generally anticipated to be representative of levels associated with natural sounds near the creek edge and some urban development.

Sensitive noise receptors that could be affected by these activities are likely to include agricultural workers, residents, and other workers or individuals, including recreationalists, present at the time of construction.

Depending on the location of noise-sensitive receptors relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Anticipated noise levels could be a nuisance but would not represent a permanent increase. Rather, nuisance noise would occur intermittently during construction activities. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, increased noise from construction is not anticipated to be significant.

4.14.3.2 Long-term Impacts

IPID Dryden Pump Exchange

Under the IPID Dryden Pump Exchange Project, the operation of a new IPID pump station could result in increased noise emissions compared to existing conditions and the No-action Alternative. Increased noise would occur as the result of operating the pump station during the irrigation season. The pumps would operate with variable frequency drives, which would reduce the mechanical noise from the pumps. The pumps would also be enclosed in an insulated structure, which would help to further reduce noise, resulting in levels anticipated to be similar to other urban utility pump stations in the Icicle Creek area.

In addition, as discussed further in Section 4.14.7, Mitigation Measures, the state imposes limits on the allowable environmental noise levels from a variety of sources as described in Chapter 173-60 WAC. As such, individual projects, including the pump station, would be required to incorporate additional controls consistent with those regulations. Therefore, this project is not anticipated to result in significant long-term noise impacts.

4.14.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 Project would also be included while the Eightmile Lake Storage Restoration Project would not. This section describes the specific short- and long-term impacts associated with the Legislative Change Creating OCPI Authority for Alternative 3 Project. Impacts associated with other projects proposed under Alternative 3 are discussed under Alternative 1 and Alternative 2.

4.14.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

No noise impacts are anticipated from this project in the short-term because no new noise-generating facilities or activities would occur.

4.14.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

No noise impacts are anticipated from this project in the short-term because no new noise-generating facilities or activities would occur.

4.14.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1. The Eightmile Lake Storage Restoration Project would be replaced with the Eightmile Lake Storage Enhancement Project, and the Upper Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects would be included. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.14.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

Construction activities associated with the Eightmile Lake Storage Enhancement Project would result in less than significant short-term increases in noise from transporting workers and equipment to Eightmile Lake and from general construction activity, including operating an excavator and a generator to power hand tools. Transportation would involve periodic helicopter trips to and from the lake during the construction period, which is anticipated to last approximately 2 to 3 months. An excavator may also be walked in along the Eightmile Lake Trail, which would also result in some increased activity and associated noise along the Eightmile Trail.

Noise levels associated with typical construction activities at 50 feet from the source are presented in Table 4-4. In addition, some blasting may be required to break up rock at the site. Prior to any blasting, IPID would develop a blasting plan, as described in Section 4.14.6, Mitigation Measures, and in conjunction with the USFS, which would establish notification procedures so the public is informed that blasting might occur.

Background noise levels at the project site are generally quiet and mainly include sounds associated with the natural environment. Although there are no permanently occupied residences, recreationalists are granted access to camp and hike within and around the project site based on a lottery system managed by the USFS. For additional information about recreational use, refer to Section 3.15, Recreation.

Depending on the location of recreationalists relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4 related to the majority of construction activity. Although most camping sites are located farther than 50 feet from the proposed construction activities, anticipated noise levels could be a nuisance to recreationalists in the general vicinity, particularly if any blasting were to occur. Implementation of the blasting plan described in Section 4.14.6, Mitigation Measures, would help to minimize these impacts.

Increases in noise would not be permanent. Rather, nuisance noise would occur intermittently during construction. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, with incorporation of the measures identified in Section 4.14.7, Mitigation Measures, increased noise from construction is not anticipated to be significant.

Upper Klonaqua Lake Storage Enhancement

Construction activities associated with the Upper Klonaqua Lake Storage Enhancement Project would result in less than significant short-term increases in noise from transporting workers and equipment to the project site and operating an excavator and a generator to power hand tools. Transportation would involve periodic helicopter trips to and from the lake during the construction period.

Noise levels associated with typical construction activities at 50 feet from the source are presented in Table 4-4. In addition, some blasting may be required to break up rock at the site. Prior to any blasting, IPID would develop a blasting plan, as described in Section 4.14.7, Mitigation Measures, and in conjunction with USFS, which would establish notification procedures so the public is informed that blasting might occur.

Background noise levels at the project site are generally quiet and mainly include sounds associated with the natural environment. Although there are no permanently occupied residences, recreationalists are granted access to camp and hike within and around the project site based on a lottery system managed by the USFS. For additional information about recreational use, refer to Section 3.15, Recreation.

Depending on the location of recreationalists relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4 related to the majority of construction activity. Although most camping sites are located farther than 50 feet from the proposed construction activities, anticipated noise levels could be a nuisance to recreationalists in the general vicinity, particularly if any blasting were to occur. Implementation of the blasting plan described in Section 4.14.7, Mitigation Measures, would help to minimize these impacts.

Increases in noise would not be permanent. Rather, nuisance noise would occur intermittently during construction. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, with incorporation of the measures identified in Section 4.14.7, Mitigation Measures, increased noise from construction is not anticipated to be significant.

Upper and Lower Snow Lakes Storage Enhancement

Construction activities associated with the Upper and Lower Snow Lakes Storage Enhancement Project would result in less than significant short-term increases in noise from transporting workers and equipment to the lakes and general construction activity, including operating an excavator and a generator to power hand tools. Transportation would involve periodic helicopter trips to and from the lakes during the construction period.

Noise levels associated with typical construction activities at 50 feet from the source are presented in Table 4-4. In addition, some blasting may be required to break up rock at the site. Prior to any blasting, USFWS would develop a blasting plan, as described in Section 4.14.7, Mitigation Measures, and in conjunction with USFS, which would establish notification procedures so the public is informed that blasting might occur.

Background noise levels at the project site are generally quiet and mainly include sounds associated with the natural environment. Although there are no permanently occupied residences, recreationalists are granted access to camp and hike within and around the project site based on a lottery system managed by the USFS. For additional information about recreational use, refer to Section 3.15, Recreation.

Depending on the location of recreationalists relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4 related to the majority of construction activity. Although most camping sites are located farther than 50 feet from the proposed construction activities, anticipated noise levels could be a nuisance to recreationalists in the general vicinity, particularly if any blasting were to occur. Implementation of the blasting plan described in Section 4.14.6, Mitigation Measures, would help to minimize these impacts.

Increases in noise would not be permanent. Rather, nuisance noise would occur intermittently during construction. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, with incorporation of the measures identified in Section 4.14.7, Mitigation Measures, increased noise from construction is not anticipated to be significant.

4.14.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Operation of the proposed facilities for the Eightmile Lake Storage Enhancement Project would result in the ability to store and withdraw additional water at the lake. Because the facilities would be largely operated remotely by IPID and would rely in part on solar energy, the greatest potential for increased noise over the long term would occur as the result of maintenance trips to and from the lakes, which are anticipated to be less than would occur under the No-action Alternative. For this reason, this project is not anticipated to result in significant noise impacts.

Upper Klonaqua Lake Storage Enhancement

Operation of the proposed facilities for the Upper Klonaqua Lake Storage Enhancement Project would result in the ability to store and withdraw additional water at the lake. Because the facilities would be largely operated remotely by IPID and would rely in part on solar energy, the greatest potential for increased noise over the long term would occur as the result of maintenance trips to and from the lakes. Because these facilities would be new, requiring less maintenance, and because travel to and from the site would largely be done on foot, the potential long-term impacts are anticipated to be minimal. For this reason, this project is not anticipated to result in significant noise impacts.

Upper and Lower Snow Lakes Storage Enhancement

Operation of the proposed facilities for the Upper and Lower Snow Lakes Storage Enhancement Project would result in the ability to store and withdraw additional water from Upper and Lower Snow Lakes. The facilities would be operated remotely by USFWS personnel at LNFH. Releases from the lakes would be automated, with electronic actuators that would rely on solar energy. The greatest potential for increased noise over the long term would occur as the result of maintenance trips to and from the lakes, which are anticipated to be less than would occur under the No-action Alternative. For this reason, this project is not anticipated to result in significant noise impacts.

4.14.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange project would be included.

4.14.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

Construction of the IPID Full Piping and Pump Exchange Project would require the use of excavators, compactors, and other heavy equipment, such as dump trucks, which would result in short-term increases in noise. Construction is anticipated to be completed in phases over several years.

Construction activities would occur throughout the IPID service area for piping the entire conveyance system and at specific locations on Icicle and Peshastin Creeks and the Wenatchee River. Background noise levels would vary but are generally anticipated to be representative of levels associated with natural sounds near the creek edge and some urban development. Sensitive noise receptors that could be affected by these activities are likely to include agricultural workers, residents, and other workers or individuals, including recreationalists, present at the time of construction.

Depending on the location of noise-sensitive receptors relative to construction activity, they could be exposed to increased noise similar to the levels shown in Table 4-4. Anticipated noise levels could be a nuisance but would not represent a permanent increase. Rather, nuisance noise would occur intermittently during construction activities. In addition, construction activity occurring between the hours of 7:00 a.m. to 10:00 p.m. is exempt from local regulation. Therefore, increased noise from construction is not anticipated to be significant.

4.14.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange Project

Under the IPID Full Piping and Pump Exchange Project, the operation of three new IPID pump stations could result in increased noise emissions compared to existing conditions and the No-action Alternative. Increased noise would occur as the result of operating the pump stations during the irrigation season. The pumps would operate with variable frequency drives, which would reduce the mechanical noise from the pumps. The pumps would also be enclosed in an insulated structure, which would help to further reduce noise, resulting in levels anticipated to be similar to other urban utility pump stations in the Icicle Creek area.

In addition, as discussed further in Section 4.14.7, Mitigation Measures, the state imposes limits on the allowable environmental noise levels from a variety of sources as described in Chapter 173-60 WAC. As such, individual projects, including the pump station, would be required to incorporate additional controls consistent with those regulations. Therefore, this project is not anticipated to result in significant long-term noise impacts.

4.14.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.14.7.1 Short-term Impacts

Noise regulations are set forth in Chapter 173-60 WAC and rules applicable to blasting are set forth in Chapter 296-52 WAC. Construction activities are generally exempt but otherwise are required to comply with the standards set forth in this chapter of the WAC to ensure noise levels do not exceed acceptable thresholds.

Even though the majority of construction activities associated with the Program Alternatives are expected to be minimal and otherwise exempt from regulation, implementation of the following BMPs would ensure that noise levels were further reduced.

- Ensure all equipment is in good repair to minimize noise.
- Minimize unnecessary idling of emission-generating equipment.

In addition, compliance with applicable state and federal blasting regulations would ensure blasting was completed in a manner to reduce potential impacts. Implementation of the following measure would help to further reduce the potential noise impacts.

- Develop a blasting plan in coordination with USFS to ensure that recreationalists within affected areas are informed of the potential for blasting.

4.14.7.2 Long-term Impacts

New noise sources are also required to comply with the requirements set forth in Chapter 173-60 WAC. Compliance with required permit conditions would ensure that any long-term noise levels do not exceed acceptable thresholds.

- Insulated pump houses.
- Use of solar panels in the Wilderness Areas.
- Use of lower noise producing pumps (i.e. variable speed pumps).

4.15 Recreation

The recreational activities most likely to be affected by the projects in the Program Alternatives are those that are water-dependent. Alterations to lake levels in the four IPID-managed Alpine Lakes and the USFWS-managed Snow Lakes system, and to instream flows in Icicle Creek and the mainstem Wenatchee River, could affect fishing, rafting, kayaking, and other water-based recreation. Additionally, portions of existing trails and campsites surrounding Eightmile Lake, Upper Klonaqua Lake, and Upper and Lower Snow Lakes could be affected by inundation.

Short-term recreation impacts are those things that could temporarily alter the ability to use the recreational resource. For example, if construction activities block access to a trailhead, this would be considered a short-term impact until access is restored. Long-term recreation impacts are those things that could permanently alter the ability to use the recreational resource. For example, if water level of a lake is raised such that an existing campsite is permanently inundated, that would be considered a long-term impact.

4.15.1 No-action Alternative

4.15.1.1 Short-term Impacts

Under the No-action Alternative, various agencies and other entities would continue to undertake individual actions to restore and enhance fish and aquatic resources in the Icicle Creek Watershed project area, but those actions would not be part of a coordinated program implemented with the support of the IWG. Actions implemented by individual agencies and entities could include construction of diversion improvements, irrigation system upgrades, LNFH improvements, and fish passage work.

Short-term impacts to recreational opportunities would result from construction related activities, including maintenance at the alpine lakes, reconstruction of Eightmile Lake Dam, irrigation efficiency and domestic conservation work, upgrades at LNFH, and implementing improvements at points of diversions.

Construction-related activity in the Alpine Lakes area could result in short-term disruption to recreational users near the individual lakes outlets while work is ongoing.

Any in- or near-water projects would have associated construction-related activities could disrupt water based recreation. Staging of heavy equipment and supplies near access points to Icicle Creek could result in temporary disruption to water-dependent recreational activities such as recreational fishing, kayaking, and tubing. Many instream construction projects would occur at low flow, which would minimize impacts on some of these activities.

4.15.1.2 Long-term Impacts

Under the No-action Alternative, long-term impacts to recreation could result from implementation of certain projects.

If IPID restored Eightmile Lake Dam to its original height, existing trails, campsites, and lakeshore access routes would largely remain unchanged as a result of this project. Long-term operational impacts could change the timing and duration of water releases from the lake, with increased draw down levels. No significant long-term impacts to existing recreational opportunities in or around Eightmile Lake, such as hiking, horseback riding, and overnight camping, are expected.

Improvements at LNFH that would likely occur under the No-action Alternative could have minor long-term impacts on recreation. Installation of wells and an infiltration gallery on Hatchery Island could have impacts on current hiking and skiing trails. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential recreation impacts under NEPA would be completed once the full scope of the project is determined.

4.15.2 Alternative 1 (Base Package)

The expected impacts of implementing Alternative 1 involve short-term construction-related impacts that are generally temporary, and long-term impacts resulting from the operation of proposed projects. Potential short-term impacts include temporary limited access to trails based on construction activities and impacts to water-based recreation resulting from in-stream work. The long-term impacts of implementing Alternative 1 are associated with stream flow increases, which are expected to improve water-based recreation in Icicle Creek.

4.15.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction-related activity to upgrade existing outlet infrastructure may result in short-term, temporary limited access at the construction sites at each lake. Construction activity at each outlet could result in short-term disruption to recreational users near the individual lakes outlets while work is ongoing. Recreational use in the vicinity of construction sites includes day use (e.g., hiking, horseback riding, and recreational fishing) and overnight camping.

IPID currently performs regular maintenance activities on the outlet structures at each of the four managed reservoir lakes and these activities have some related equipment and helicopter traffic. New delivery of construction-related supplies and equipment by helicopter would be consistent with existing operations. Helicopter trips would utilize existing landing areas and are not expected to result in obstruction of trails or camping sites. As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

IPID Irrigation Efficiencies

Under IPID Irrigation Efficiencies Project, IPID would update its Comprehensive Water Conservation Plan to control the volume, frequency, and rate of water for efficient irrigation. This plan update is currently underway. This is an administrative action that would have no short-term impacts to existing recreational opportunities.

Conservation projects with construction-related activities could include some canal to pipeline conversion, canal lining, and on-farm efficiencies. These actions would all occur in upland areas on private lands and easements. Any temporary disturbance within these areas would not affect existing recreational opportunities or access to public lands. As noted in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

COIC Irrigation Efficiencies and Pump Exchange

COIC is considering relocating their point of diversion from Icicle Creek to a location on the Wenatchee River. Construction-related activities would include installing a new diversionary structure near or on the Wenatchee River, installing conveyance piping, and decommissioning COIC-specific diversionary works on Icicle Creek. Most of this work would occur in upland areas on private lands and easements, and any temporary disturbance within these areas would not affect existing recreational opportunities. It is expected that any in- or near-water construction would occur within a small physical footprint required for pumps and conveyance infrastructure. Construction would likely occur during the late summer and fall when water levels are low and less recreational use is occurring. A cofferdam would also be installed during construction of intake facilities to separate the river and the work area.

Water-dependent activities that may be temporarily affected by construction activities along the shoreline of the Wenatchee River could include recreational fishing, kayaking, rafting, and tubing. Impacts from work at the existing COIC diversion on Icicle Creek would be limited to kayaking and fishing. Based upon the small footprint of these projects and the temporary nature of the disturbance, meaningful impacts to existing water-dependent recreational activities are unlikely.

As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

Domestic Conservation Efficiencies

Under the Domestic Conservation Efficiencies Project, the City of Leavenworth and rural areas of the Icicle Creek Watershed would upgrade conveyance infrastructure and promote water-use conservation practices among municipal and domestic users. This work would be limited primarily to administrative and maintenance actions, and could include limited installation or replacement of pipes and meters. This work would all occur within existing easements and rights-of-way and would not result in short-term impacts to existing recreational opportunities.

As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

Eightmile Lake Storage Restoration

Under the Eightmile Lake Storage Restoration Project, construction-related activity to replace Eightmile Lake Dam would result in short-term, temporary limited access at the construction sites at the lake. Construction activity at the lake outlet could result in short-term disruption to recreational users near the lake outlet while work is ongoing. The lake will likely be drawn down for construction and a temporary cofferdam may be used to separate the lake from the work area. Recreational use in the vicinity of construction sites includes day use (e.g., hiking and horseback riding) and overnight camping.

IPID currently performs regular maintenance activities at Eightmile Lake and these activities have some related equipment and helicopter traffic. Delivery of construction-related supplies and equipment by helicopter would be consistent with existing operations. Helicopter trips would utilize an existing landing area and are not expected to result in obstruction of trails or camping sites. As noted in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

Tribal Fishery Preservation and Enhancement

Under the Tribal Fishery Preservation and Enhancement Project, the IWG would evaluate actions to preserve and enhance tribal treaty harvest rights and recreational fishing on Icicle Creek. Some construction activities near the plunge pool may occur, such as installation of a sprayer. However, construction activities are likely to occur outside the prime fishing window. Specific impacts to recreational use will be identified in environmental review and permitting once project details are known, but are expected to be related to on-water recreation, such as tubing.

While no specific improvements are suggested for the recreational fishery, protecting the recreational fishery is one of the IWG's Guiding Principles. Mitigation measures, including construction when the recreational fishery is closed, would be employed to minimize any potential impact to the recreational fishery.

Habitat Protection and Enhancement

Under the Habitat Protection and Enhancement Project, the IWG is working with Chelan County and the USFWS to implement recommended habitat improvement actions and land acquisition projects throughout Icicle Creek. All habitat enhancement projects are located along lower Icicle Creek, between RM 0.0 and 4.3.

Construction-related activities associated with habitat protection and enhancement could result in temporary restrictions to public access and passage through lower Icicle Creek as a result of staging of heavy equipment and supplies or active in-water work. Depending upon the timing and duration of the individual projects, construction could result in short-term effects to tubing or stand-up paddle boarding (SUP); construction would be timed not to conflict with recreational fishing.

As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

Instream Flow Rule Amendment

Amending the Wenatchee Instream Flow Rule is an administrative action that would have no short-term impacts to existing recreational opportunities.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The IWG has identified several high-priority water-quality and conservation improvement projects for LNFH that would be implemented over the next 10 years. Many of these projects are limited in scope to upgrading existing fish-rearing systems within the hatchery itself (e.g., water-quality treatment, circular tanks) and would have no effect on existing recreational opportunities. Actions with associated construction-related activities may include installation of new wells and conveyance piping. This work would occur in upland areas within and adjacent to the existing LNFH complex and may result in short-term disruption to recreational opportunities in the immediate vicinity of LNFH, such as wildlife viewing, walking trails, tubing, recreational fishing, and SUP activities. Impacts on Nordic skiing, which is a popular winter activity in the area, are not expected because of the timing of construction. Construction would also be timed not to conflict with recreational fishing. Other specific recreational impacts will be identified during the NEPA process when project details are known.

Fish Passage Improvements

Fish passage improvements are proposed at LNFH and in upper Icicle Creek to include improving or replacing Structure 2 and improving passage through the Boulder Field. These projects would include in- and near-water construction.

Improvements to Structure 2 would occur completely within the LNFH complex and are not expected to conflict with existing recreational opportunities, although staging of heavy equipment and supplies could temporarily block access for wildlife viewing and walking trails. Passage improvement activities in the Boulder Field could result in short-term impacts with fishing, although mitigation measures such as construction timing will be utilized to minimize any potential impacts on recreational fishing; this area is generally not utilized by kayakers and is above/upstream of the area suitable for tubing and SUP activities.

As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

Fish Screen Compliance

Upgrading fish screens to meet current requirements is planned for three existing diversions on Icicle Creek. These actions are expected to occur within the existing physical footprint of the structure. Construction-related activity is not expected to alter or impact adjacent areas utilized for water-dependent recreational activities such as fishing, and to a lesser extent, kayaking.

As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

Water Markets

Creation of a voluntary Icicle Water Market is an administrative action that would have no short-term impacts to existing recreational opportunities.

4.15.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Upgrades to existing infrastructure at Colchuck, Eightmile, Square, and Klonaqua Lakes would not alter lake levels. Existing trails, campsites, and lakeshore access routes would remain unchanged as a result of this project. Long-term operational impacts could change the timing and duration of water releases from each lake, but would not change the range of water levels that currently occurs. Hiking, horseback riding, overnight camping, and other recreational uses would still be possible under modified release scenarios. Therefore, no significant long-term impacts to existing recreational opportunities in and around the Alpine Lakes are expected.

Improved water management of the Alpine Lakes reservoir lakes is expected to increase stream flow in Icicle Creek, especially during the late season. In comparison to existing conditions, this is expected to result in benefits to kayaking, tubing and SUP activities, and fishing in Icicle Creek by increasing the length of time during which flows for those respective activities are suitable.

IPID Irrigation Efficiencies

Improved water management through on-farm practices and conveyance infrastructure is expected to increase stream flow in Icicle Creek and the Wenatchee River. In comparison to existing conditions, this is expected to result in benefits to kayaking, rafting, tubing and SUP activities, and fishing in both water bodies by increasing the length of time during which flows for those respective activities are suitable.

COIC Irrigation Efficiencies and Pump Exchange

Under the COIC Irrigation Efficiencies and Pump Exchange project, relocating the COIC point of diversion would increase streamflow in Icicle Creek. In comparison to existing conditions, this is expected to result in benefits to late-season water-dependent activities such as tubing and SUP by increasing the length of time during which flows for those respective activities are suitable. This project may also benefit the recreational fishery.

Domestic Conservation Efficiencies

Improved water management through domestic and municipal upgrades and practices is expected to have no impact on recreation in Icicle Creek and the Wenatchee River, with water saving going towards expanded domestic use. No long-term impacts are anticipated.

Eightmile Lake Storage Restoration

Under the Eightmile Lake Storage Restoration Project, upgrades to existing infrastructure at Eightmile Lake would restore lake levels to authorized, historical levels. Existing trails, campsites, and lakeshore access routes would largely remain unchanged as a result of this project. Long-term operational impacts could change the timing and duration of water releases from the lake, with increased draw down levels. No significant long-term impacts to existing recreational opportunities in or around Eightmile Lake, such as hiking, horseback riding, and overnight camping, are expected. To the extent possible, new infrastructure improvements would be designed to fit into the surrounding landscape and minimize impacts to recreational users' visual experience.

Improved water management of the Eightmile Lake reservoir is expected to increase stream flow in Icicle Creek, especially during the late season. In comparison to existing conditions, this is expected to result in benefits to kayaking, tubing and SUP activities, and fishing in Icicle Creek by increasing the length of time during which flows for those respective activities are suitable.

Tribal Fishery Preservation and Enhancement

Promoting tribal fishery preservation and enhancement is expected to improve long-term fishing opportunities in Icicle Creek. Long-term operation of this project is not expected to limit access for recreational opportunities. No significant impacts are expected to result from this project.

While no specific improvements are suggested for the recreational fishery, protecting the recreational fishery is one of the IWG's Guiding Principles. No significant impacts are expected to result from this project.

Habitat Protection and Enhancement

Improvements to instream and floodplain habitat is expected to improve the overall ecological value of Icicle Creek. In comparison to existing conditions, this is expected to result in benefits to the quality of recreational fishing and wildlife viewing activities, and to the aesthetic experience for those participating in tubing and SUP activities.

Instream Flow Rule Amendment

Amending the Instream Flow Rule to increase the Icicle Creek reserve would have small impacts on stream flow (approximately 0.4 cfs). However, it is not anticipated that this process would significantly impact water recreation in Icicle Creek. Additionally, stream flow impacts would be offset by instream flow benefits from other projects.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

Improved water quality and conservation at LNFH is expected to improve the instream habitat and ecological value of Icicle Creek. In comparison to existing conditions, this is expected to result in benefits to fishing in both Icicle Creek and the Wenatchee River, and would improve wildlife viewing and the aesthetic experience for those participating in tubing and SUP activities. However, the installation of wells and an infiltration gallery could have impacts on current hiking and skiing trails located on hatchery island. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential recreation impacts under NEPA would be completed once the full scope of the project is determined.

Fish Passage Improvements

Improved fish passage in lower and upper Icicle Creek would promote long-term health and recovery of multiple fisheries. In comparison to existing conditions, this is expected to result in long-term benefits to fishing in both Icicle Creek and the Wenatchee River through improved quality and duration of sport/recreational fishing opportunities and reduced limitations/regulations.

Fish Screen Compliance

Improved fish screens would improve the ecological health of juvenile fish in Icicle Creek. In comparison to existing conditions, this is expected to result in long-term benefits to fishing in both Icicle Creek and the Wenatchee River through improved quality and duration of sport fishing opportunities and reduced limitations/regulations.

Water Markets

Improved water management through use of water markets is expected to increase stream flow in Icicle Creek and the Wenatchee River. In comparison to existing conditions, this is expected to result in benefits to kayaking, rafting, tubing and SUP activities, and fishing in both water bodies by increasing the length of time during which flows for those respective activities are suitable.

4.15.3 Alternative 2

The expected impacts of implementing Alternative 2 are similar to those identified for Alternative 1 because of the commonality of project, with the exception of the IPID Dryden Pump Exchange and the removal of the Alpine Lakes Optimization, Modernization, and Automation project. Potential short-term impacts include impacts to land use related to access during construction. There are no anticipated long-term impacts associated with the IPID Dryden Pump Exchange Project.

4.15.3.1 Short-term Impacts

IPID Dryden Pump Exchange

IPID is considering locating a pump station on the right bank of the Wenatchee River near Dryden as an alternative to the existing IPID diversion on Peshastin Creek. Relocating their point of diversion would involve construction of a new pump station and installation of new pipeline and associated conveyance infrastructure. Most of this work would occur in upland areas on private lands and easements, and any temporary disturbance within these areas would not affect existing recreational opportunities. It is expected that any in- or near-water construction would occur within a small physical footprint required for pumps and conveyance infrastructure.

Water-dependent activities that could be temporarily affected by construction activities along the shoreline of the Wenatchee River could include fishing, kayaking, and rafting. Based upon the small footprint of the project and the temporary nature of the disturbance, meaningful impacts to existing water-dependent recreational activities are unlikely.

As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

4.15.3.2 Long-term Impacts

IPID Dryden Pump Exchange

Relocating the IPID point of diversion to the Wenatchee River would increase streamflow in Icicle Creek and the Wenatchee River. In comparison to existing conditions, this is expected to result in benefits to late-season water-dependent activities such as tubing and SUP by increasing the length of time during which flows for those respective activities are suitable. There would also be instream flow benefit in Peshastin Creek resulting from this project.

4.15.4 Alternative 3

This alternative includes the same project actions as Alternative 2, with the exception that the Eightmile Lake Restoration project actions are removed and the OCPI Legislative Change project action is added. The discussion of short- and long-term impacts focuses on impacts associated with changes from Alternatives 1 and 2.

4.15.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

Amending the OCPI determination is an administrative action that would have no short-term impacts to existing recreational opportunities.

4.15.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

Legislative change to OCPI to allow the Instream Flow Rule to be impaired by domestic use when instream flow targets adopted in Chapter 173-545 WAC are not met would lead to decreased stream flow during low flow periods. This has the potential to impact water-based recreation, such as kayaking, rafting, tubing and SUP activities, and fishing in Icicle Creek. However, impacts are expected to be very minor when considering the flow and habitat improvements proposed under Alternative 3.

4.15.5 Alternative 4

This alternative includes all the project actions as the base package of Alternative 1, but calls for increasing storage at Eightmile Lake to above the historic high water mark and enhancing storage and release at Upper Klonaqua and Upper Snow Lakes. The discussion of short- and long-term impacts focuses on impacts associated with these changes similar to those listed in Alternative 1.

4.15.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

Under the Eightmile Lake Storage Enhancement Project, storage capacity in Eightmile Lake would be increased by increasing both the height of the existing dam and draw down level. This would be accomplished by rebuilding the existing dam to a higher overflow elevation and installing a low-level siphon.

Construction-related activity to upgrade and replace existing outlet infrastructure at Eightmile Lake could result in short-term, temporary limited access at the construction sites at the lake. Construction activity at the lake outlet could result in short-term disruption to recreational users near the lake outlet while work is ongoing. The lake will likely be drawn down for construction and a temporary cofferdam may be used to separate the lake from the work area. Recreational use in the vicinity of construction sites includes day use (e.g., hiking, fishing, and horseback riding) and overnight camping.

IPID currently performs regular maintenance activities at Eightmile Lake and these activities have some related equipment and helicopter traffic. Delivery of construction-related supplies and equipment by helicopter would be consistent with existing operations. Helicopter trips would utilize an existing landing area and are not expected to result in obstruction of trails or camping sites. As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

Upper Klonaqua Lake Storage Enhancement

Upper Klonaqua Lake is currently used by IPID to augment water supply. The Upper Klonaqua Lake Storage Enhancement Project would increase the ability to draw down Upper Klonaqua Lake by installing new conveyance infrastructure to siphon, pump, or drain water into Lower Klonaqua Lake.

Construction-related activity to release more water from Upper Klonaqua Lake could result in short-term, temporary limited access to the construction site on the lake. Construction activities at the lake outlet could result in short-term disruption to recreational users near the lake outlet while work is ongoing. Upper Klonaqua Lake is not believed to be a popular recreational use location. However, types of uses that may occur at Upper Klonaqua Lake are hiking and overnight camping.

As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

Upper and Lower Snow Lakes Storage Enhancement

Under this project, existing infrastructure at Upper and Lower Snow Lakes would be improved to provide additional storage capacity. This would be accomplished by rebuilding the two existing Snow Lakes dams and installing new, lower-level outlets and gates at each structure.

Construction-related activity to upgrade and replace existing outlet infrastructure at Upper and Lower Snow Lakes could result in short-term, temporary limited access at the construction sites at the lakes. Construction activity at the lake outlet could result in short-term disruption to recreational users near the lake outlet while work is ongoing. Recreational use in the vicinity of construction sites includes hiking and overnight camping.

USFWS currently performs regular maintenance activities at Upper and Lower Snow Lake and these activities have some related equipment and helicopter traffic. New delivery of construction-related supplies and equipment by helicopter would be consistent with existing operations. Helicopter trips would utilize an existing landing area and are not expected to result in obstruction of trails or camping sites. As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

4.15.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Upgrades to existing infrastructure at Eightmile Lake would increase lake levels above historical levels. Existing trails, campsites, and lakeshore access routes could experience some limited seasonal inundation as a result of this project. In comparison to existing conditions, long-term operational impacts could change the timing and duration of water releases from the lake and would result in an increased range of water levels. Therefore, some long-term impacts to existing recreational opportunities in and around Eightmile Lake are expected. To the extent possible, new infrastructure improvements would be designed to fit into the surrounding landscape and minimize impacts to recreational users' visual experience.

Improved water management of the Eightmile Lake reservoir is expected to increase stream flow in Icicle Creek, especially during the late season. In comparison to existing conditions, this is expected to result in benefits to kayaking, tubing and SUP activities, and fishing in Icicle Creek by increasing the length of time during which flows for those respective activities are suitable.

Upper Klonaqua Lake Storage Enhancement

Upgrades to existing infrastructure at Upper Klonaqua Lake would draw lake levels down below historical levels. Additionally, changes to storage capacity could result in some limited seasonal inundation of existing trails, campsites, and lakeshore access routes when storage is at maximum capacity. In comparison to existing conditions, long-term operational impacts could change the timing and duration of water releases from the lake and would result in an increased range of water levels. Therefore, some long-term impacts to existing recreational opportunities in and around Upper Klonaqua Lake are expected.

Improved water management of Upper Klonaqua Lake is expected to increase stream flow in Icicle Creek, especially during the late season. In comparison to existing conditions, this is expected to result in benefits to kayaking, tubing and SUP activities, and fishing in Icicle Creek by increasing the length of time during which flows for those respective activities are suitable.

Upper and Lower Snow Lakes Storage Enhancement

Upgrades to existing infrastructure at Upper and Lower Snows Lakes would draw lake levels down below historical levels. Additionally, changes to storage capacity could result in some limited seasonal inundation of existing trails, campsites, and lakeshore access routes when storage is at maximum capacity. In comparison to existing conditions, long-term operational impacts could change the timing and duration of water releases from the lake and would result in an increased range of water levels. Therefore, some long-term impacts to existing recreational opportunities in and around Upper and Lower Snow Lakes are expected.

Improved water management of Upper and Lower Snows lakes is expected to increase stream flow in Icicle Creek, especially during the late season. In comparison to existing conditions, this is expected to result in benefits to kayaking, tubing and SUP activities, and fishing in Icicle Creek by increasing the length of time during which flows for those respective activities are suitable.

4.15.6 Alternative 5

The expected impacts of implementing Alternative 5 are similar to those identified for Alternative 1 because of the commonality of project, with the exception that IPID Full Piping and Pump Exchange would replace the IPID Irrigation Efficiencies project. Potential short-term impacts include impacts to land use related to access during construction. There are no anticipated long-term impacts associated with the IPID Full Piping and Pump Exchange project.

4.15.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

This project would involve replacing the IPID diversion on Icicle and Peshastin Creeks with three pump stations located on the Wenatchee River near Leavenworth, Dryden, and Cashmere. Relocating their point of diversion would involve construction of a new pump station and installation of new pipeline and associated conveyance infrastructure. Most of this work would occur in upland areas on private lands and easements, and any temporary disturbance within these areas would not affect existing recreational opportunities. It is expected that any in- or near-water construction would occur within a small physical footprint required for pumps and conveyance infrastructure.

Water-dependent activities that could be temporarily affected by construction activities along the shoreline of the Wenatchee River could include fishing, kayaking, and rafting. Based upon the small footprint of the project and the temporary nature of the disturbance, meaningful impacts to existing water-dependent recreational activities are unlikely.

As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

4.15.7 Mitigation Measures

4.15.7.1 Short-term Impacts

Construction-related mitigation measures to minimize and protect against impacts to recreation would include timing work windows to avoid certain recreational activities and communicating with user groups months ahead of construction, so trips can be scheduled outside of construction windows, which would be particularly important to backcountry uses in the Alpine Lakes Wilderness Area. Phased project construction at back country sites would also help minimize impacts. For example, installing automated gates and solar panels at different lakes during different years would allow for users to plan trips around construction activities.

For in-water work, approved work windows are expected to occur during the late season (summer/fall) when flows are low. This time frame generally coincides with the period when water-dependent activities include tubing and SUP activities; kayaking and rafting generally occur during early season, high-flow periods. Some overlap between work windows and fishing seasons in the Wenatchee River could occur, but are expected to be limited in physical footprint to localized areas of the river shoreline.

4.15.7.2 Long-term Impacts

Operational mitigation measures to minimize and protect against impacts to recreation would include relocating those portions of trails and campsites that would be inundated by increased lake levels. In regard to recreation, the majority of projects are expected to have positive long-term impacts on water-dependent recreation opportunities in Icicle Creek and the Wenatchee River.

4.16 Land Use

This section describes the potential short- and long-term impacts affecting land use, described in Section 3.16 Land Use, from the No-action Alternative and Program Alternatives. Consistency with the Wilderness Act and related land uses is addressed in Section 4.17, Wilderness Area.

4.16.1 No-action Alternative

4.16.1.1 Short-term Impacts

Under the No-action Alternative, various agencies and other entities would continue to undertake individual actions to restore and enhance fish and aquatic resources in the Icicle Creek Watershed project area, but those actions would not be part of a coordinated program implemented with the support of the IWG. Actions implemented by individual agencies and entities could include construction of diversion improvements, irrigation system upgrades, LNFH improvements, and fish passage work.

Under the No-action Alternative, short-term land use impacts could occur during project construction. For work near water, such as improving points of diversions and habitat and fish passage work, construction-related activities could temporarily impact public access at construction locations because staging of heavy equipment and supplies, or active in-water work.

All construction-related activities would adhere to applicable federal, state, and local land use regulations and permitting, as well as BMPs to minimize any impacts. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of projects, including compliance with CAO and SMP.

4.16.1.2 Long-term Impacts

The long-term impacts under the No-action Alternative would likely result from operation of several of the projects.

For projects that require the use of riparian lands, such as the COIC Irrigation Efficiencies and Pump Exchange and Pump Exchange Project and potential habitat projects, easements could be required. If these projects require the acquisition of land or easements, appropriate compensation would be required in accordance with applicable federal or state regulations.

Water made available through the Domestic Conservation Efficiencies Project would benefit improved domestic supply. This could lead to further population growth and urbanization of lands within the urban growth boundary. It could also lead to increased water availability for rural domestic growth if reserve accounting finds more water available in the reserve based on rural domestic conservation. However, long-term domestic supply projections through 2050 would likely not be met.

Any land use conversion that may result from increased domestic supply would comply with all federal, state, and local land use regulations and zoning restrictions.

4.16.2 Alternative 1 (Base Package)

Short-term land use impacts would primarily be related to temporary access restrictions. The overall expected long-term land use impacts associated with Alternative 1 include increased residential development as a result of increased water available for domestic growth. Additionally, there would be an increase in public land ownership in the uplands of the Icicle Creek Subbasin as a result of protection efforts associated with the Habitat Enhancement projects. All Program Alternatives would be required to comply with land use regulations, local zoning, and permitting. Consistency with applicable land use planning would occur at project level review or permitting.

4.16.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction-related activity to upgrade or replace existing outlet infrastructure could result in short-term, temporary obstruction of recreational access as described in Section 4.15, Recreation. Construction activities would need to comply with Chelan Counties Critical Area Ordinance (CAO) and Shoreline Master Plan (SMP). Consultation with Chelan County Community Development Department would be required to determine if this project would fall under the maintenance exemption provided in County Code 14.10(B)(2).

IPID Irrigation Efficiencies

Conservation projects with construction-related activities could include some canal to pipeline conversion, canal lining, and on-farm efficiencies. These actions are not expected to impact short-term land use. The construction zones would not likely be within the critical area or covered under the SMP. However, consultation with Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project.

COIC Irrigation Efficiencies and Pump Exchange

Under the COIC Irrigation Efficiencies and Pump Exchange Project, construction-related activities would include installing a new diversionary structure on the Wenatchee River and installing conveyance piping within the current canal’s right-of-way. Installing a new pump station on the Wenatchee River could temporarily impact public access of the Wenatchee River, depending on site location and equipment staging needs.

All construction-related activities would adhere to applicable federal, state, and local land use regulations and permitting, as well as BMPs to minimize any impacts. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

There are no anticipated construction-related impacts to land use associated with installing new conveyance piping within the current canal's right-of-way.

Domestic Conservation Efficiencies

The City of Leavenworth and Chelan County are proposing implementing a municipal and rural water efficiency project that includes project elements such as pipe replacements, meter installation, and water use conservation to improve the domestic supply. Construction-related activities are not expected to have any substantial impact on land use.

Eightmile Lake Storage Restoration

Construction-related activity related to upgrading infrastructure at Eightmile Lake may result in short-term, temporary obstruction of recreational access to the lake for equipment transportation, storage, and staging. To minimize access impacts, construction activities could occur in the fall after peak use. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

Tribal Fishery Preservation and Enhancement

Proposed activities under the Tribal Fishery Preservation and Enhancement Project would ensure that no negative effects occur to the tribal, as well as non-tribal, fishery on Icicle Creek. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

Habitat Protection and Enhancement

The IWG is working with Chelan County and the USFWS to implement recommended habitat improvement actions and land acquisition projects throughout Icicle Creek. All habitat enhancement projects are located along lower Icicle Creek, between RM 0.0 and 4.3.

Construction-related activities associated with habitat protection and enhancement could result in temporary restrictions to public access and passage through lower Icicle Creek because of staging of heavy equipment and supplies, or active in-water work. All construction-related activities would adhere to applicable federal, state, and local land use regulations and permitting as well as BMPs to minimize any impacts. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

Instream Flow Rule Amendment

This is an administrative action and no construction-related impacts to land use are expected.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

While much of the construction related to this project is anticipated to occur in the uplands, some of the construction projects could include work in and near streams, and in the floodplain on hatchery-owned lands. All construction-related activities would adhere to applicable federal, state, and local land use regulations and permitting as well as BMPs to minimize any impacts. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

Fish Passage Improvements

Construction-related activities associated with fish passage could result in temporary restrictions to public access and passage through lower Icicle Creek because of staging of heavy equipment and supplies or active in-water work. All construction-related activities would adhere to applicable federal, state, and local land use regulations and permitting as well as BMPs to minimize any impacts. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP. More detail on the impacts to shorelines is discussed in Section 4.18, Shorelines.

Fish Screen Compliance

Construction-related activities associated with upgrading fish screens could result in temporary restrictions to public access and passage through lower Icicle Creek because of staging of heavy equipment and supplies or active in-water work. All construction-related activities would adhere to applicable federal, state, and local land use regulations and permitting as well as BMPs to minimize any impacts. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

Water Markets

There are not construction components to this proposal, therefore no short-term land use impacts are anticipated.

4.16.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

There are no anticipated long-term changes to land use associated with the Alpine Lakes Optimization, Modernization, and Automation Project. As discussed in Section 3.17, Wilderness Area, IPID has easements to operate and maintain their dams on these lakes, and use would remain consistent with current operation. The only difference would be how often the lakes are drawn down. All water made available through this project would benefit instream flow.

IPID Irrigation Efficiencies

There are no anticipated long-term impacts to land use associated with the IPID Irrigation Efficiencies Project. All water made available through this project would benefit instream flow.

COIC Irrigation Efficiencies and Pump Exchange

There are no anticipated long-term impacts to land use associated with the COIC Irrigation Efficiencies and Pump Exchange Project. All water made available through this project would benefit instream flow.

Easements could be required for the pump station site. If this project requires the acquisition of land or easements, appropriate compensation would be required in accordance with applicable federal or state regulations.

Domestic Conservation Efficiencies

Water made available through the Domestic Conservation Efficiencies Project would benefit improved domestic supply. This could lead to further population growth and urbanization of lands within the urban growth boundary. It could also lead to increased water availability for rural domestic growth if reserve accounting finds more water available in the reserve based on rural domestic conservation.

Any land use conversion that may result from increased domestic supply would comply with all federal, state, and local land use regulations and zoning restrictions.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would make 900 acre-feet of domestic water available for projected future growth. This could lead to further population growth and urbanization of lands within the urban growth boundary. It could also lead to increased rural domestic growth. Any land use conversion that may result from increased domestic supply would comply with all federal, state, and local land use regulations, and zoning restrictions.

Tribal Fishery Preservation and Enhancement

There would be no long-term land use impacts associated with tribal fishery protections and enhancements.

Habitat Protection and Enhancement

As part of the Habitat Protection and Enhancement Project, the IWG would seek to acquire conservation lands in the uplands of the watershed. This would increase the amount of public land in the Icicle Creek Subbasin. A likely source of land acquisition would be private timber land. This would reduce the acres of working forest lands in the watershed. Use would likely pivot to recreation and habitat conservation.

Some instream and riparian habitat projects could have impacts on the function and extent of the floodplain, which could have long-term land use impacts.

All land use changes would comply with federal, state, and local land use regulations and zoning restrictions. Easements and/or property purchases could be required for conservation lands. If this project requires the acquisition of land or easements, appropriate compensation would be required in accordance with applicable federal or state regulations.

Instream Flow Rule Amendment

The Instream Flow Rule Amendment Project would make an additional 0.4 cfs from the Wenatchee Reserve available for projected future growth in the Icicle Creek Subbasin. This could lead to increased rural domestic growth. Any land use conversion that may result from increased domestic supply would comply with all federal, state, and local land use regulations and zoning restrictions.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

There are no long-term effects from the LNFH Conservation and Water Quality Improvements Project on land use. Water made available through this project would benefit instream flows.

Fish Passage Improvements

The Fish Passage Project would not have any long-term effect on land use in the Icicle project area.

Fish Screen Compliance

There would be no long-term land use impacts associated with the fish screen improvements.

Water Markets

Under the Water Markets Project, irrigation water rights would be retired in the Icicle Creek Subbasin to mitigate interruptible users when the Instream Flow Rule is not met. This would change land use within the watershed by moving some land use away from irrigated agriculture to other uses. The lands that would be mitigated through the Water Markets Project are already in agricultural use. Any land use conversion that may result from this project would comply with all federal, state, and local land use regulations and zoning restrictions.

4.16.3 Alternative 2

The expected impacts of implementing Alternative 2 involve short-term construction-related impacts that are temporary, and long-term impacts resulting from the operation of proposed projects. These impacts are similar to those identified in Alternative 1 because of the commonality of projects, with the exception of the inclusion of the IPID Dryden Pump Exchange Project and the removal of the Alpine Lakes Optimization, Modernization, and Automation Project. Potential short-term impacts include impacts to land use related to access during construction. There are no anticipated long-term impacts associated with the IPID Dryden Pump Exchange Project.

4.16.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction-related activities would include installing a new diversionary structure on the Wenatchee River. Installing a new pump station on the Wenatchee River could temporarily impact public access of the Wenatchee River, depending on site location and equipment staging needs. All construction-related activities would adhere to applicable federal, state, and local land use regulations and permitting as well as BMPs to minimize any impacts. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

4.16.3.2 Long-term Impacts

IPID Dryden Pump Exchange

There are no anticipated long-term impacts to land use associated with the IPID Dryden Pump Exchange Project. All water made available through this project would benefit instream flow.

Easements could be required for the pump station site. If this project requires the acquisition of land or easements, appropriate compensation would be required in accordance with applicable federal or state regulations.

4.16.4 Alternative 3

The expected impacts of implementing Alternative 3 are similar to those identified in Alternative 2 because of the commonality of projects, with the exception of the inclusion of the Legislative Change Creating OCPI Authority for Alternative 3 Project and the removal of the Eightmile Lake Storage Restoration Project. Potential short-term impacts include impacts to land use related to access during construction. Potential long-term impacts include domestic growth resulting from more water being available for domestic use.

4.16.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

This is an administrative action with no construction activities, therefore no short-term impacts to land use are anticipated.

4.16.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

The Legislative Change Creating OCPI Authority for Alternative 3 Project would allow for new domestic use in the Icicle Creek Subbasin at times when the Instream Flow Rule is not met. This is because instream flow improvement and mitigation projects would not perfectly align when the highest instream and out-of-stream demand occurs. This project could result in increases to population growth and urbanization of lands within the urban growth boundary. It could also lead to increased rural domestic growth. Any land use conversion that may result from increased domestic supply would comply with all federal, state, and local land use regulations and zoning restrictions.

4.16.5 Alternative 4

Alternative 4 includes all the projects proposed in Alternative 1 with the exception of the Eightmile Lake Storage Restoration Project, which is replaced with the Eightmile Lake Storage Enhancement Project, and the addition of the Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects. The anticipated short-term land use impacts are related to restricted access during construction. The anticipated long-term impacts are related to increased domestic growth resulting from water availability.

4.16.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project differs from the Eightmile Lake Storage Restoration Project in that it calls for increasing the useable storage by approximately 1,000 acre-feet. This would be accomplished by rebuilding the dam and raising the crest, and increasing available draw down. The short-term impacts would be to the result of construction of the dam and would primarily affect recreational land use, as detailed in Section 4.15, Recreation. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

Upper Klonaqua Storage Enhancement

The Upper Klonaqua Storage Enhancement Project takes advantage of the potential storage in Upper Klonaqua Lake by installing infrastructure to facilitate draw down. It is in the conceptual stages, but short-term impacts would primarily be to recreational land use as a result of construction. For details on recreational land use refer to Section 4.15, Recreation. These impacts are related to transporting, storing, and staging construction equipment. To minimize access impacts, construction activities could occur in the fall after peak use. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project would raise the dam on Upper Snow Lake to increase its storage capacity by 1,079 acre-feet. The short-term land use impacts would primarily affect recreational land use as a result of dam construction. These impacts are further detailed in Section 4.15.5.2, Short-term Impacts, Recreation. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

4.16.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would raise the level of Eightmile Lake and increase the draw down, impacting its shoreline used primarily for recreation, as discussed in Sections 4.15.5.2, Long-term Impacts, Recreation, and 4.18.5.2, Long-term Impacts, Shorelines.

This project would make water available for instream uses and projected future municipal/domestic demand. This could lead to further population growth and urbanization of lands within the urban growth boundary. It could also lead to increased rural domestic growth. Any land use conversion that may result from increased domestic supply would comply with all federal, state, and local land use regulations and zoning restrictions.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project would draw down Upper Klonaqua Lake, impacting its shoreline used primarily for recreation, as discussed in sections 4.15 and 4.18.

This project would make water available for instream uses and projected future municipal/domestic demand. This could lead to further population growth and urbanization of lands within the urban growth boundary. It could also lead to increased rural domestic growth. Any land use conversion that may result from increased domestic supply would comply with all federal, state, and local land use regulations and zoning restrictions.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project would raise the level of Upper Snow Lake and increase draw down, impacting its shoreline used primarily for recreation, as discussed in Sections 4.15.5.2, Long-term Impacts, Recreation, and 4.18.5.2, Long-term Impacts, Shorelines.

This project would make water available for instream uses and projected future municipal/domestic demand. This could lead to further population growth and urbanization of lands within the urban growth boundary. It could also lead to increased rural domestic growth. Any land use conversion that may result from increased domestic supply would comply with all federal, state, and local land use regulations and zoning restrictions.

4.16.6 Alternative 5

The expected impacts of implementing Alternative 5 involve short-term construction-related impacts that are temporary, and long-term impacts resulting from the operation of proposed projects. These impacts are similar to those identified in Alternative 1 because of the commonality of projects, with the exception of the IPID Irrigation Efficiencies project would be replaced by the IPID Full Piping and Pump Exchange. Potential short-term impacts include impacts to land use related to access during construction. There are no anticipated long-term impacts associated with the IPID Dryden Pump Exchange Project.

4.16.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

Construction-related activities would include installing three new diversionary structures on the Wenatchee River. Installing new pump stations on the Wenatchee River could temporarily impact public access of the Wenatchee River, depending on site location and equipment staging needs. All construction-related activities would adhere to applicable federal, state, and local land use regulations and permitting as well as BMPs to minimize any impacts. Consultation with Chelan County Community Development Department would confirm land use regulations pertaining to construction of this project, including compliance with CAO and SMP.

4.16.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

There are no anticipated long-term impacts to land use associated with the IPID Full Piping and Pump Exchange Project. All water made available through this project would benefit instream flow.

Easements could be required for the pump station site. If this project requires the acquisition of land or easements, appropriate compensation would be required in accordance with applicable federal or state regulations.

4.16.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.16.7.1 Short-term Impacts

The primary short-term impact to land use is related to access during construction. Property impacts would mainly be public, although some private lands could be impacted. To the extent possible, alternate access routes would be provided or projects would be timed to minimize access issues.

There would also be impacts related to in-water and near-water work. All work would comply with applicable permits and BMPs. This is discussed in more detail in Section 4.18, Shorelines.

4.16.7.2 Long-term Impacts

The primary long-term impact of the above described projects is increased water availability for domestic use. This could lead to land use changes related to increased domestic/residential use. Any land use conversion that may result from increased domestic supply would comply with all federal, state, and local land use regulations and zoning restrictions.

Some projects would require land acquisition or easements. Appropriate compensation would be required in accordance with applicable federal or state regulations.

4.17 Wilderness Area

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.17, from construction and operation related to the No-action Alternative and Program Alternatives.

4.17.1 No-action Alternative

4.17.1.1 Short-term Impacts

Under the No-action Alternative, various agencies and other entities would continue to undertake individual actions to restore and enhance fish and aquatic resources in the Icicle Creek Watershed project area, but those actions would not be part of a coordinated program implemented with the support of the IWG. Actions implemented by individual agencies and entities could include construction of diversion improvements, irrigation system upgrades, LNFH improvements, and fish passage work.

IPID and USFWS would likely pursue some construction and maintenance activities at their dam sites in the ALWA. Especially those in need of reconstruction and repair. Potential short-term impacts affecting wilderness would be associated with projects that require construction. Construction can affect wilderness characteristics such as solitude in the short-term. As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

As discussed in Section 3.17, these construction activities are permissible in the ALWA per easements granted by the USFS to IPID.

4.17.1.2 Long-term Impacts

Long-term impacts under the No-action Alternative to the Wilderness Area are anticipated to be largely the same as current conditions. Under the No-action Alternative, seasonal maintenance and water release operations of the seven lakes located within the Alpine Lakes Wilderness would continue. This includes use of helicopters to access dam sites, as studied in the USFS Environmental Assessment on IPID helicopter use (USFS, 1981), and allowed for in the land exchanges agreement. This requires multiple trips by IPID staff every year to both open impoundment release controls during the summer and close them in the fall, respectively. These activities impact the Wilderness Area’s untrammeled state and the sense of solitude to wilderness users. However, it would not pose a significant change from current conditions.

4.17.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in different impacts on the Wilderness Area compared with the No-action Alternative. There is a higher likelihood that certain projects would be implemented and the scale of certain efforts would likely be greater. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.17.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction activities associated with this project would involve replacing existing gates and installing solar panels, actuators, flow monitoring equipment, and other new equipment to improved management and release of stored water at the lakes in the Icicle Creek Subbasin.

The short-term impact to the Wilderness Area is primarily related to accessing the project sites, staging equipment, and providing for worker accommodations because these activities could temporarily disturb the wilderness characteristics of natural, solitude, undeveloped, and untrammeled experienced by users at these sites. As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

To minimize user impacts, construction work could occur after peak use, and construction could be phased so not all lakes are impacted at the same time. Notices would be posted so wilderness users would be aware of potential impacts before planning a trip to the Wilderness Area.

As discussed in Section 3.17, these construction activities are permissible in the ALWA per easements granted by the USFS to IPID. The easement for Eightmile, Klonaqua, and Colchuck Lake provides the following:

> *"Excepting and reserving the right to overflow and inundate the bed and shore; water rights granted; perpetual easement across, through, along, and upon the property for maintenance, repair, operation, modification, upgrading, and replacement of all facilities presently located in and upon the property. IPID may exercise the rights by any means reasonable... including... motorized transport and equipment or aircraft. These rights include... regulating water level. Grantor will not without the prior written consent of the Forest Service, which consent shall not unreasonably be withheld, materially increase the size or scope of the facilities."*

Colchuck also has an agricultural and Irrigation Livestock Watering System Easement because the lakes outlet and dam is located on land note subject to the IPID, USFS land exchange discussed in Section 3.17. Square Lake also operates under this type of permit. These permits authorize right-of-way and water conveyance systems and operation and maintenance of facilities with consultation and concurrence from USFS. Modernizing and automating releases from these lakes fall under the facility maintenance, and would require USFS concurrence.

Upper and Lower Snow Lake are owned by USFWS. As ownership of the lakes, USFWS has the right to upgrade and maintain storage facilities on their property.

IPID Irrigation Efficiencies

The proposed IPID Irrigation Efficiencies improvements are downstream from the Alpine Lakes Wilderness and do not present any short-term impacts to the Wilderness Area.

COIC Irrigation Efficiencies and Pump Exchange

The proposed COIC Irrigation Efficiencies and Pump Exchange improvements are downstream from the Alpine Lakes Wilderness and do not present any short-term impacts to the Wilderness Area.

Domestic Conservation Efficiencies

The proposed Domestic Conservation Efficiencies improvements are downstream from the Alpine Lakes Wilderness and do not present any short-term impacts to the Wilderness Area

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would involve demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures. Construction activities would occur along the lake shore. Short-term impacts to wilderness characteristics are expected as a result of construction. To minimize user impacts, construction work could occur after peak use and notices would be posted so wilderness users would be aware of potential impacts before planning a trip to the Wilderness Area. As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term wilderness impacts are not expected to be significant.

As discussed above, IPID reserved rights to maintenance, repair, operation, modification, upgrading, and replacement of all facilities at Eightmile Lake. With prior written consent of the Forest Service, which consent shall not unreasonably be withheld, IPID can increase the size of Eightmile Lake.

Tribal Fishery Preservation and Enhancement

All proposed tribal fishery improvements are downstream from the Wilderness Area, and thus no short-term impacts are associated with these actions.

Habitat Protection and Enhancement

All proposed Habitat Protection and Enhancement Project construction activities are downstream from the Wilderness Area, and thus there are no potential impacts associated with these actions.

Instream Flow Rule Amendment

There are no proposed construction activities associated with this project and therefore no potential short-term impacts on the Wilderness character.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

There are no construction activities proposed under this project and therefore no potential short-term impacts on the Wilderness character.

Fish Passage Improvements

As all currently proposed Fish Passage Improvements are downstream from the Wilderness Area, there are no potential impacts associated with these actions.

Fish Screen Compliance

As all proposed Fish Screen Compliance improvements are downstream from the Wilderness Area, there are no potential impacts associated with these actions.

Water Markets

There are no construction activities proposed under the Water Markets Project and therefore no potential short-term impacts on the Wilderness character.

4.17.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from the lakes. This has several potential long-term impacts. Reservoir automation would significantly reduce seasonal reservoir maintenance and service visits, which are currently all done by hikes and helicopter visits to the lakes. Instead, stored water would be released via remote telemetry. Additionally, construction of the proposed facilities, such as antenna, solar panels, and equipment enclosures, could be designed to have an undeveloped, aesthetically appropriate look and feel so to appear unobtrusive on the natural wilderness character of the area.

As lake levels would be drawn down every year instead of rotating one or two lakes per year, stream and lake water levels would be changed in portions of the Wilderness Area. As the resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system, downstream impacts are expected to beneficially increase flows in the Wilderness Areas in the summer months.

As it relates to wilderness character as described in the Wilderness Act, drawing down the lake levels from their current artificially impounded levels could have beneficial long-term impacts to the wilderness character by returning the lakes to their “natural,” pre-1920s reservoir construction levels.

IPID Irrigation Efficiencies

The proposed IPID Irrigation Efficiencies improvements are downstream from the Alpine Lakes Wilderness and do not present any long-term impacts to the wilderness character.

COIC Irrigation Efficiencies and Pump Exchange

The proposed COIC Irrigation Efficiencies and Pump Exchange improvements are downstream from the Alpine Lakes Wilderness and do not present any long-term impacts to the wilderness character.

Eightmile Lake Storage Restoration

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. However, a larger inundated area and bigger draw down would likely impact the wilderness experience of users. However, the inundation area was experienced for decades prior to the partial erosion on of the dam, including at the time of wilderness designation. Draw down could be managed to minimize these impacts during peak use.

Additionally, a larger dam would impact the wilderness characteristics that users experience (natural, undeveloped, untrammeled). As discussed in Section 4.11, Aesthetics, visual impacts of this project could be minimized by dam design that would incorporate architectural components to make the dam feel more natural and less modern.

Tribal Fishery Preservation and Enhancement

All proposed tribal fishery improvements are downstream from the Wilderness Area, thus there are no potential impacts associated with these actions.

Habitat Protection and Enhancement

The purpose of the Habitat Protection and Enhancement Project is to protect and enhance habitat within the Lower Icicle Creek corridor. There are also plans to obtain upland habitat for conservation purposes under this project. This would create additional public lands adjacent to the Wilderness Area, which would likely increase the feeling of a natural and undeveloped area to users.

Instream Flow Rule Amendment

There are no construction activities proposed under the Instream Flow Rule Amendment Project. Long term, this proposal would result in removal of water from Icicle Creek at the City of Leavenworth's diversion. Because this diversion is downstream of the Wilderness Area, no potential long-term impacts are anticipated to the Wilderness Area.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

All proposed LNFH improvements are downstream from the Wilderness Area, thus there are no potential long-term impacts associated with these actions.

Fish Passage Improvements

All proposed Fish Passage Improvements are downstream from the Wilderness Area, thus there are no potential long-term impacts associated with these actions.

Fish Screen Compliance

All proposed Fish Screen Compliance improvements are downstream from the Wilderness Area, thus there are no potential long-term impacts associated with these actions.

Water Markets

All proposed Water Markets Project improvements are downstream from the Wilderness Area, thus there are no potential long-term impacts associated with these actions.

4.17.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would also be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project.

4.17.3.1 Short-term Impacts

IPID Dryden Pump Exchange

All proposed improvements are downstream from the Wilderness Area, thus there are no potential long-term impacts associated with these actions.

4.17.3.2 Long-term Impacts

IPID Dryden Pump Exchange

All proposed improvements are downstream from the Wilderness Area, thus there are no potential long-term impacts associated with these actions.

4.17.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange and the Legislative Change Creating OCPI Authority for Alternative 3 Projects would also be included while the Alpine Lakes Optimization, Modernization, and Automation and Eightmile Lake Storage Restoration Projects would not. This section describes the specific short- and long-term impacts associated with the Legislative Change Creating OCPI Authority for Alternative 3 Project. The impacts of the IPID Dryden Pump Exchange Project are discussed in Section 4.17.3.

4.17.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts with the potential to affect the Wilderness Area.

4.17.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

This project relates to domestic water use in the Icicle Creek Subbasin and instream flows as measured at the Ecology gage on lower Icicle Creek, all of which are downstream of the Wilderness Area. There are no anticipated impacts to wilderness character from this project.

4.17.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1. The Eightmile Lake Storage Restoration project would be replaced with the Eightmile Lake Storage Enhancement Project, and the Upper Klonaqua and Upper and Lower Snow Lakes Storage Enhancement Projects would also be included. This section describes the specific short- and long-term impacts associated with these projects.

4.17.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

This project would involve demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures that would allow for an increase in the accessible storage at Eightmile Lake by 1,000 acre-feet.

The short-term impacts to the Wilderness Area is primarily related to accessing the project sites, staging equipment, and providing for worker accommodations. These impacts would temporarily disturb the wilderness characteristics of solitude, natural, undeveloped, and untrammeled. As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

To minimize user impacts, construction work could occur after peak use, and notices would be posted so wilderness users would be aware of potential impacts before planning a trip to the Wilderness Area.

As discussed above, IPID reserved rights to maintenance, repair, operation, modification, upgrading, and replacement of all facilities at Eightmile Lake. With prior written consent of the Forest Service, which consent shall not unreasonably be withheld, IPID can increase the size of Eightmile Lake.

Upper Klonaqua Lake Storage Enhancement

Short-term impacts on the Wilderness Area from this project would primarily be associated with construction activities required to provide a low-level outlet from Upper Klonaqua Lake to Lower Klonaqua Lake using one of the three conceptual connection options discussed in Chapter 2. The construction activity would be similar in nature to that described for the Eightmile Lake Storage Enhancement Project in 4.17.5.1 above, as would the short-term impacts. As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term recreational impacts are not expected to be significant.

To minimize user impacts, construction work could occur after peak use, and notices would be posted so wilderness users would be aware of potential impacts before planning a trip to the Wilderness Area.

As discussed in Section 3.17, IPID reserved several right at Upper and Lower Klonaqua Lakes, including the right to increase the size and scope of the facilities with USFS written consent and the right to regulate water levels.

Upper and Lower Snow Lakes Storage Enhancement

Short-term impacts on wilderness from this project would be primarily related to construction activities and are similar in type and mechanism to those discussed in Sections 4.17.5.1, Short-term Impacts, Eightmile Lake Storage Enhancement, and 4.17.5.1, Short-term Impacts, Upper Klonaqua Lake Storage Enhancement. As notes in Sections 4.11, Aesthetics, and 4.14, Noise, while construction activities would result in short-term visual changes and increased noise, the extent of these changes would be similar to operational and maintenance activities that currently occur, temporary, and relatively minimal. Therefore, short-term wilderness impacts are not expected to be significant.

To minimize user impacts, construction work could occur after peak use, and notices would be posted so wilderness users would be aware of potential impacts before planning a trip to the Wilderness Area.

As discussed in Section 3.17, USFWS owns easement to the Upper and Lower Snow Lake beds, and land adjacent to these lakes. Because USFWS owns these lands, this project would have to undergo a NEPA review.

4.17.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

The greatest potential for impacts on the Wilderness Area over the long term would occur as a result of increased inundated areas and larger draw downs. These changes would impact the wilderness characteristics of natural, undeveloped, and untrammeled. Additionally, a larger dam could also impact these wilderness characteristics. Wilderness impacts and whether the action is permissible under the Wilderness Act and IPID easements would be addressed during project level environmental review.

As discussed in Section 4.11, Aesthetics, to minimize these impacts, dam design could incorporate architectural components to make the dam feel more natural and less modern. Additionally, draw down could be managed to minimize these impacts during peak use.

Upper Klonaqua Lake Storage Enhancement

Under the Upper Klonaqua Lake Storage Enhancement Project, the high water mark would remain unchanged and the lake would still refill and outlet naturally through an existing channel to Lower Klonaqua Lake during most of the year. However, the new facilities would allow for the lake to be drawn down an additional 10 to 50 feet to allow for access to additional storage. The draw down would likely occur over a couple of months in the late summer. Modifications at Upper Klonaqua Lake would also result in the ability to release up to an additional 5 to 20 cfs from the lake.

Similar to the Eightmile Lake Storage Enhancement Project, these changes would impact the wilderness characteristics of natural, undeveloped, and untrammeled. With this project in the conceptual stage, exact impacts and mitigation measures are unclear. Wilderness impacts and whether the action is permissible under the Wilderness Act and IPID easements would be addressed during project level environmental review should this project proceed.

Upper and Lower Snow Lakes Storage Enhancement

Similar to the Eightmile Lake Storage Enhancement Project, wilderness character would be impacted by a larger dam, greater area of inundation, and larger draw downs.

To minimize these impacts, dam design would incorporate architectural components to make the dam feel more natural and less modern, and draw down could be managed to minimize these impacts during peak use. Wilderness impacts and whether the action is permissible under the Wilderness Act and IPID easements would be addressed during project level environmental review should this project proceed.

4.17.6 Alternative 5

Alternative 5 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Irrigation Efficiencies project would be replaced by the IPID Full Piping and Pump Exchange project. This section describes the specific short- and long-term impacts associated with the IPID Full Piping and Pump Exchange Project.

4.17.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

All proposed improvements are downstream from the Wilderness Area, thus there are no potential long-term impacts associated with these actions.

4.17.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

All proposed improvements are downstream from the Wilderness Area, thus there are no potential long-term impacts associated with these actions.

4.17.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential wilderness character impacts identified above. Additional mitigation measures are also identified as appropriate.

4.17.7.1 Short-term Impacts

Short-term impacts related to temporary construction on the Wilderness Area's feeling of solitude, naturalness, undeveloped, and untrammeled that users experience. To minimize the impacts of construction on these wilderness characters, notice would be provided, construction activities would occur outside of peak use when possible, and construction activities at lake sites would be staggered to allow for unimpacted wilderness experiences at some of the lakes during construction activities.

4.17.7.2 Long-term Impacts

Long-term impacts on the wilderness character could result from the increased frequency, and for some projects, increased level of draw down associated with proposals at the

Alpine Lakes. To help minimize these impacts, releases could be managed to occur only when critical low flows are occurring in lower Icicle Creek. As a result, draw down might not occur in wet years when there is sufficient stream flow. Additionally, for storage restoration and enhancement projects some draw down could be managed outside of peak visitation windows.

Additional impacts to wilderness character could result from installation of equipment to allow for remote operation of control gates. This would include antenna, solar panels, and equipment enclosures. To minimize the impacts of this equipment, they would be made to blend into the natural environment to allow for the feeling of an untrammeled wilderness.

For storage enhancement projects discussed in Alternative 4, larger dams would also impact the wilderness experience. To minimize this impact, dam design would incorporate architectural components to make the dam feel more natural and less modern. Increased areas of inundation pose a potential significant impact, which would be examined in more detail during project level environmental review.

4.18 Shorelines

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.18, Shorelines, from construction and operation related to the No-action Alternative and Program Alternatives. Potential shoreline impacts affecting aquatic and terrestrial habitat are addressed in Section 4.7, Fish, and Section 4.9, Wildlife.

4.18.1 No-action Alternative

4.18.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that could result in short-term impacts on shorelines around the seven Alpine Lakes, Icicle and Peshastin Creeks, and the Wenatchee River. This is anticipated to entail construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability. Potential short-term impacts affecting shorelines would be associated with projects that require construction. Construction could adversely affect shorelines in the short-term by resulting in ground disturbance that could increase shoreline erosion. An increase in the potential for shoreline erosion and flooding could also occur as the result of more permanent changes and are addressed under long-term impacts.

The agencies or entities implementing projects under the No-action Alternative would be required to comply with applicable local, state, and federal environmental review requirements and permits as described in Section 1.9, Related Permits, Actions, and Laws. Applicable permits would require appropriate mitigation measures to reduce impacts on shorelines, such as revegetation of adversely affected areas and BMPs designed to reduce the potential for erosion (Section 4.18.7, Mitigation Measures). Therefore, short-term impacts under the No-action Alternative are not expected to be significant.

4.18.1.2 Long-term Impacts

Long-term impacts under the No-action Alternative are anticipated to be largely beneficial for shorelines because many projects would seek to restore riparian habitat and improve instream flows. However, because both instream flow and fish habitat enhancement projects would not generally be coordinated with other activities in the Icicle project area, these benefits are not anticipated to be as great as they would under the other Program Alternatives. Potential long-term benefits from such projects are also expected to be more localized, providing only minor overall benefits within the larger Icicle Creek Subbasin.

Depending on the extent of changes affecting the shoreline or the flow regime, there could also be some minor and localized increases in flooding and erosion potential over the long term, mainly along Icicle Creek but also at the Alpine Lakes. Changes to the shorelines or stream flows could result in increased potential for erosion of the streambank. Minor changes are anticipated at the Alpine Lakes compared to existing conditions because management of lake levels would remain similar to existing conditions. Although the frequency at which any given lake might be drawn down could increase, the timing and extent of draw down would generally be similar to existing conditions.

Any alterations of streambanks or the placement of new structures within the floodplain could also reduce the flood storage capacity of the adjacent floodplain; however, as noted previously, compliance with applicable regulations would require minimizing these risks. More specifically, work within shorelines of the state is regulated by the Shoreline Master Plan (SMP) and any development within the shoreline would require review by the local jurisdiction for consistency with SMP regulations and policies (Section 4.18.7, Mitigation Measures, for additional information).

4.18.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in greater impacts on shorelines compared with the No-action Alternative because there would be higher likelihood that certain projects would be implemented and the scale of certain efforts would likely be greater. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.18.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction activities associated with this project would involve replacing existing gates and installing solar panels, actuators, flow monitoring equipment, and other new equipment. Most of the work would occur in upland areas. Some limited work would occur within the lake shorelines but within the dry when the lakes are drawn down at the end of the summer. There would be limited potential to affect flooding and erosion potential along the shorelines in the short term.

Accessing the project sites, staging equipment, and providing for worker accommodations could temporarily disturb shoreline vegetation mainly as the result of inadvertent trampling; however, no permanent changes or placement of additional structures are proposed.

As noted in Section 4.5, Water Quality, the potential for these activities to increase erosion would be low because work along the lake margins would occur after the lake was drawn down. In addition, this work would also likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would help to further address potential impacts on shorelines.

IPID Irrigation Efficiencies

Construction activities associated with this project include the conversion of IPID canals to pipelines and lining of irrigation canals with concrete. Short-term impacts on shorelines would be limited because most of the work would occur within areas that are already developed, such as within rights-of-way and existing irrigation canal easements, and would occur during the off-season when the irrigation canals are dry.

Compliance with applicable permits and approvals would include appropriate mitigation measures to reduce impacts on shorelines, such as implementing BMPs designed to reduce the potential for erosion (Section 4.18.7, Mitigation Measures). Therefore, short-term impacts on shorelines from construction work are expected to be less than significant.

COIC Irrigation Efficiencies and Pump Exchange

Construction activities associated with COIC Irrigation Efficiencies and Pump Exchange would be similar to those described above for IPID Irrigation Efficiencies with the exception of a new COIC pump station to be constructed along the shoreline of Icicle Creek or the Wenatchee River. Depending on the specific location and the extent of the disturbance, these activities could result in short-term shoreline impacts, including minor localized potential for increased flooding and erosion, mainly related to vegetation clearing for the new facilities.

This work would likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would help to further address potential impacts on shorelines. Compliance with applicable permits and approvals would include appropriate mitigation measures to reduce impacts on shorelines, such as implementing BMPs designed to reduce the potential for erosion (Section 4.18.7, Mitigation Measures). Therefore, short-term impacts on shorelines from construction work are expected to be less than significant.

Domestic Conservation Efficiencies

Construction activities proposed under the Domestic Conservation Efficiencies Project include pipeline replacement and meter installation. These activities are unlikely to adversely affect shorelines because the work would be done in areas that are already developed away from waterways.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would involve demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures. Construction activities would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down. As a result, the potential for increased erosion and flooding would be low.

This work would likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would require BMPs to ensure that potential impacts would be less than significant.

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effects on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. The specifics of this project are not yet determined, but would involve elements of restoration along the lower Icicle Creek that could result in localized shoreline disturbance, including vegetation removal and grading. At this stage, the primary options under consideration include the construction of facilities such as a plumbing to create a bubble curtain, a sprayer, or other minor modifications to the Hatchery Channel spillway at LNFH to promote favorable fishing conditions in the pool at the bottom of the spillway. Depending on the extent of the disturbance, there is the potential for some short-term increase in shoreline erosion and to a lesser extent flooding. However, as noted in Section 4.18.7, Mitigation Measures, work within the shoreline of Icicle Creek would require compliance with applicable local, state, and federal regulations, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would ensure that potential impacts would be less than significant.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project could involve grading; planting and thinning vegetation; and hauling and placing logs, rock, soil, and other materials. These activities could increase the potential for shoreline erosion and flooding in the short-term. However, project activities with the potential to affect these resources would likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would help to further address potential impacts on shorelines. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce potential impacts on shorelines, such as requiring revegetation of adversely affected areas and BMPs designed to reduce the potential for erosion and minimize potential shoreline impacts (Section 4.18.7, Mitigation Measures).

Instream Flow Rule Amendment

There are no construction activities proposed under this project and therefore no potential short-term impacts on shorelines.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

This project includes various elements geared towards improving water quality and hatchery rearing conditions at the LNFH. In general, construction of these elements has the potential to affect shorelines, depending on the specific location and type of disturbance. Because this facility is owned by Reclamation and operated by the USFWS, an evaluation of the potential short-term impacts under NEPA would be completed once the full scope of the project is determined.

Similar to the construction activities described above, this work would also likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would help to ensure that potential impacts would be avoided, minimized, or compensated as noted in Section 4.18.7, Mitigation Measures.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek as well as instream modifications to the Boulder Field near RM 5.6. This work would result in disturbances along the streambank and within Icicle Creek that would be addressed in subsequent environmental review and permitting once project specifics are determined. This work would also likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would help to further address potential impacts on shorelines.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Under this project, screens and associated infrastructure would be improved to bring all three intakes up to compliance with state and federal laws. This work would result in disturbances along the streambank and within Icicle Creek that would be addressed once project specifics are determined. This work would also likely require multiple authorizations from local, state, and federal regulatory agencies, including a shoreline permit, HPA, and a CWA Section 404 Permit and Section 401 Water Quality Certification, which would help to further address potential impacts on shorelines.

Water Markets

There are no construction activities proposed under this project and therefore no potential short-term impacts on shorelines.

4.18.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Operation of the proposed facilities for this project would involve a more efficient and flexible system for releasing flows from the lakes. The greatest potential for long-term impacts on shorelines could occur as a result of disturbance during maintenance activities or from changes in operations with respect to how lake levels are managed. Because the facilities would be newer and largely operated remotely by IPID, any trips to and from the lakes, or activities needed to maintain the facilities, are expected to be less frequent and extensive than what would occur compared to existing conditions. In addition, there would be no new structures that would contribute to increased potential for flooding at the lakes.

However, the project would result in some changes in how lake levels are managed. Lake levels would be drawn down every year instead of rotating one or two lakes per year. Although the lakes would be drawn down more frequently, the high and low lake levels and the general pattern of releases would not change. As noted in Section 3.5, Water Quality, these changes are not expected to result in a significant increase in the potential for erosion that would adversely affect shorelines.

Likewise, the resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months.

IPID Irrigation Efficiencies

This project would not result in the construction of any new facilities and therefore would not result in long-term impacts on shorelines.

COIC Irrigation Efficiencies and Pump Exchange

Of the elements proposed as part of this project, the new COIC pump station and intake facilities would have the potential to change instream flow dynamics that could contribute to increased potential for shoreline erosion. In addition, placement of these facilities along the shoreline could contribute to increased flooding. As noted in Section 3.18, Shorelines, the 100-year floodplain includes a fairly narrow area that extends along Icicle Creek and the Wenatchee River. The floodplain extends further upland from the shoreline in broader valley areas near the Cities of Leavenworth and Wenatchee. The proposed intake and pump station structure would be constructed in and adjacent to the river or creek channel and 100-year floodplain.

Any adverse impacts would be likely minor because compliance with applicable local, state, and federal permits or approvals would require appropriate mitigation measures to reduce any potentially significant long-term impacts, such as ensuring that stream channel morphology and floodplain storage capacity were not adversely affected (Section 4.18.7, Mitigation Measures) and the flood levels were not impacted. In addition, relocation of the pump station farther downstream would result in increased flows between the point of the old diversion (RM 5.7) and the new location. This would represent a restoration of increased flows along this segment of the creek, which would be beneficial to shorelines.

Domestic Conservation Efficiencies

Increased conservation and re-use associated with the Domestic Conservation Efficiencies Project is expected to lead to decreased return flows, which could decrease flows in the Wenatchee River downstream of the Leavenworth Wastewater Treatment Plant; however, the long-term effects on stream flow and any associated impacts on shorelines are expected to be negligible.

Eightmile Lake Storage Restoration

Operation of the proposed facilities for the Eightmile Lake Storage Restoration Project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. The greatest potential for impacts on shorelines over the long term would occur as the result of increased shoreline disturbance during maintenance and any changes in operations with respect to how lake levels are managed.

Because the facilities would be newer and largely operated remotely by IPID, any trips to and from the lakes, or activities needed to maintain the facilities, are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, restoration of the facilities and re-operation of the lake would result in the ability to maintain the lake at higher levels compared to existing conditions and the No-action Alternative due erosion of the dam over time.

Under existing conditions, the lake fills to a maximum elevation of approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is restored, the lake would be able to fill to the historical high level of 4,671 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,666 feet, which would be the crest elevation of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch early in the summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,671 feet, equal to the historical full water surface elevation. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water.

The project would also allow for the lake to be drawn down below the existing low lake levels to an elevation of 4,621 feet, which is approximately 22.4 feet below the existing low. These changes would restore the maximum storage available for release from the lake to 2,500 acre-feet, which is the maximum volume permitted for release by IPID's water right, and would not result in shoreline impacts because lake levels would be within the range of previously inundated shorelines.

The additional height and draw down are not expected to result in significant increases in erosion because draw down of the lake would occur over a period of several months each year. Potential changes to shoreline vegetation are addressed in Section 4.8, Vegetation.

Likewise, the resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months. As noted in Section 4.7, Fish, during high-flow years, there could also be a potential for this project to result in a reduced contribution by the lakes to peak flows that might otherwise contribute to increased erosion and flooding.

Tribal Fishery Preservation and Enhancement

The purpose of this project is to protect and enhance the tribal fishery, which, depending on the specific actions, could result in long-term changes to shorelines that could increase the potential for erosion and flooding; however, these project elements are meant to preserve and enhance stream and riparian habitat, leading to a general improvement in ecosystem quality and functions. Additionally, work within the shoreline would require multiple authorizations from local, state, and federal regulatory agencies. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce any potentially significant long-term impacts affecting shorelines (Section 4.18.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Habitat Protection and Enhancement

The purpose of the Habitat Protection and Enhancement Project is to protect and enhance habitat within the lower Icicle Creek corridor, which could require work within the shoreline. Projects would likely include placement of large woody debris and placement of other materials to enhance habitat and reduce bank and shoreline downcutting and erosion. The purpose of this project is to preserve and enhance stream and riparian habitat and would require multiple authorizations from local, state, and federal regulatory agencies. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce any potentially significant long-term impacts (Section 4.18.6, Mitigation

Measures). These requirements would be developed once project-specific details were available.

Instream Flow Rule Amendment

Under the Instream Flow Rule Amendment Project, the Icicle Reserve, established under Chapter 137-545 WAC, would be increased by 0.4 cfs. Over the long term, this amendment would ultimately result in the removal of an additional 0.4 cfs from Icicle Creek only after habitat and flow restoration elements are implemented. Additional water withdrawals could result in reduced instream flows, which could adversely affect the shoreline primarily through impacts on riparian vegetation because there could be less water to support these areas. However, potential impacts on shorelines would be offset by the implementation of required instream flow and habitat restoration actions under this Program Alternative, as well as several other projects associated with Alternative 1.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The potential long-term adverse impacts on shorelines would occur in areas where new facilities were constructed within the shoreline. Potential adverse impacts would likely be minor because work within the shoreline would require compliance with various local, state, and federal regulations, including NEPA, which would address the need for mitigation to reduce potential long-term impacts (Section 4.18.7, Mitigation Measures).

Fish Passage Improvements

Although the details of the Fish Passage Improvements Project are not yet known, it would involve modification potentially affecting the shoreline at three locations on lower Icicle Creek. Depending on the extent of alteration to the shoreline, there could be increased potential for flooding and erosion along the shoreline. Work within the shoreline would require multiple authorizations from local, state, and federal regulatory agencies. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce any potentially significant long-term impacts affecting shorelines (Section 4.18.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Fish Screen Compliance

Although the details of the Fish Screen Compliance Project are not yet known, it would involve modification of intake screen facilities potentially affecting the shoreline at three locations on lower Icicle Creek. Depending on the extent of alteration to the shoreline, there could be increased potential for flooding and erosion along the shoreline. Work within the shoreline would require multiple authorizations from local, state, and federal regulatory agencies. Applicable permits issued by these agencies would require appropriate mitigation measures to reduce any potentially significant long-term impacts affecting shorelines (Section 4.18.7, Mitigation Measures). These requirements would be developed once project-specific details were available.

Water Markets

Proposed Water Markets Project elements would result in changes in the water market with the intention of increasing flows in lower Icicle Creek. Any increases would be consistent with the natural flow regime within the system and is not expected to result in significant adverse impacts, although in peak years, increased flows within Icicle Creek could contribute to increased flooding risks.

4.18.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Impacts associated with other project elements are discussed in Alternative 1.

4.18.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction of a new pump station under this project would require work along the shorelines of the Wenatchee River. Such activities could result in many of the same construction-related short-term impacts described above, including the increased potential for erosion. As long as construction activities comply with required permit terms and conditions that would be required as discussed in Section 4.18.7, Mitigation Measures, potential impacts would not be significant. Specific mitigation measures would be developed as part of future project-level review and permitting.

4.18.3.2 Long-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project would result in new pump exchange and intake facilities constructed along the right bank of the Wenatchee River and, depending on the specific location, could potentially affect shorelines by increasing the potential for shoreline erosion and flooding over the long term.

Any adverse impacts would likely be minor because compliance with applicable local, state, and federal permits or approvals would require appropriate mitigation measures to reduce any potentially significant long-term impacts, such as ensuring that stream channel morphology and floodplain storage capacity are not adversely affected (Section 4.18.7, Mitigation Measures) and that no increase in flood elevations result from the proposed project.

4.18.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 would be included while the Eightmile Lake Storage Restoration Project would not. This section describes the specific short- and long-term impacts associated with the Legislative Change Creating OCPI Authority for Alternative 3 Project. Impacts associated with other projects are discussed in Alternative 1 and Alternative 2.

4.18.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts with the potential to affect shorelines.

4.18.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority for Alternative 3 Project were enacted, there could be potential conflicts with instream flow allocations. Under the proposed changes, junior domestic water rights could be exercised even when the Instream Flow Rule is not met, resulting in potential adverse impacts on riparian vegetation as a result of low-flow conditions. Although these changes would be generally adverse for shorelines, they would not contribute to an increased potential for flooding or erosion.

4.18.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1. The Eightmile Lake Storage Restoration Project would be replaced with the Eightmile Lake Storage Enhancement project, and the Upper Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects would also be included. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.18.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would involve demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures that would allow for an increase in the accessible storage at Eightmile Lake to 3,500 acre-feet. Construction activities would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down. As a result, the potential for increased erosion and flooding would be low.

In addition, as noted in Section 4.18.7, Mitigation Measures, work within and around the lakes would require compliance with applicable local, state, and federal regulations, which would require BMPs to ensure that potential impacts would be less than significant.

Upper Klonaqua Lake Storage Enhancement

Short-term impacts on shorelines from the Upper Klonaqua Lake Storage Enhancement Project would primarily be associated with construction activities required to provide a low-level outlet from Upper Klonaqua Lake to Lower Klonaqua Lake using one of the three conceptual connection options discussed in the project description in Section 2.8.3, Upper Klonaqua Lake Storage Enhancement. Construction activity would occur between the lakes and along the banks within the dry areas of the lake margins once the lakes had been drawn down.

In addition, as noted in Section 4.18.7, Mitigation Measures, work within and around the lakes would require compliance with applicable local, state, and federal regulations, which would require BMPs to ensure that potential impacts would be less than significant.

Upper and Lower Snow Lakes Storage Enhancement

Short-term impacts on shorelines from the Upper and Lower Snow Lakes Storage Enhancement Project would be primarily related to construction activities and are similar in type and mechanism to those discussed in Sections 4.8.5.1, Short-term Impacts, Eightmile Lake Storage Enhancement and Upper Klonaqua Lake Storage Enhancement. Construction activities would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down. As a result, the potential for increased erosion and flooding would be low.

In addition, as noted in Section 4.18.7, Mitigation Measures, work within and around the lakes would require compliance with applicable local, state, and federal regulations, which would require BMPs to ensure that potential impacts would be less than significant.

4.18.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Operation of the proposed facilities for the Eightmile Lake Storage Enhancement Project would involve a more efficient and flexible system for releasing flows from Eightmile Lake. The greatest potential for impacts on shorelines over the long term would occur as the result of permanent conversion of any sensitive areas, disturbance during maintenance, and any changes in operations with respect to how lake levels are managed.

Because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative. However, this project would result in the ability to maintain the lake at higher than historical levels compared to existing conditions and the No-action Alternative.

Under existing conditions, the maximum fill height of the lake is approximately 4,667 feet because the embankment portion of the dam has deteriorated. After the dam is restored, the lake would be able to fill to a new high water surface of 4,682 feet. Under this project, lake levels would be managed to rise beginning in the late fall and would continue to approximately 4,677 feet to the height of a notch in the proposed dam. The lake would remain at this height until stop logs are placed in the notch in the early summer. Placement of the stop logs would allow the lake level to continue to rise to the spillway elevation of 4,682 feet. The lake would stay at this level for less than a month in the early summer, after which time IPID would begin drawing down the lake by releasing water. These changes would increase the accessible storage to 3,500 acre-feet, which is 1,000 acre-feet more than currently permitted by IPID's water right.

Compared with existing conditions and the No-action Alternative, this means that an additional area of shoreline would be under water. Shoreline areas up to 4,671 feet have been historically inundated, but areas above 4,671 feet to 4,682 feet have not been inundated. The additional area would be under water for a little less than a month each summer. This change in lake levels could result in some changes to the vegetative community along the shoreline. The proposed project would inundate approximately 13.6 acres that are not currently inundated, which would not represent a substantial loss but rather a change in the mix of shoreline vegetation.

The project would also allow for the lake to be drawn down below existing lake levels to an elevation of 4,619 feet, which is approximately 24.4 feet lower than the existing low. This change would result in the exposure of slightly more lake bed, mainly in the later summer months and early fall up to the point when the water would no longer be drawn down, generally around the end of September. The additional draw down is not expected to adversely affect shorelines by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity

Likewise, the resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months.

Upper Klonaqua Lake Storage Enhancement

Under the Upper Klonaqua Lake Storage Enhancement Project, potential long-term impacts to shorelines would be similar to those described under the Eightmile Lake Storage Enhancement Project (Section 4.18.5.2, Long-term Impacts). Potential benefits would mainly occur in Icicle Creek and would include an increased ability to augment stream flow in the late summer or during drought years, with flow augmentation primarily benefitting the section of Icicle Creek between Upper Klonaqua Lake and the IPID diversion.

The frequency in fluctuations in lake levels in Upper Klonaqua Lake would increase compared to existing conditions and the No-action Alternative. Lake levels would also be drawn down further compared to existing conditions.

The new high lake level in Upper Klonaqua Lake would not change. The lake would still refill and outlet naturally through an existing channel to Lower Klonaqua Lake during most of the year. However, the new facilities would allow for the lake to be drawn down an additional 20 feet to allow for access to an additional 1,146 acre-feet of storage. The draw down would likely occur over a couple of months in the late summer. The additional draw down is not expected to adversely affect shorelines by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

Modifications at Upper Klonaqua Lake would also result in the ability to release up to an additional 5 to 20 cfs from the lake. Increased flows would be released from the dam into a downstream tributary, which flows into Icicle Creek. Increased flows would occur from the point of release at Klonaqua Dam down to the IPID diversion at RM 5.7.

The resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months.

Upper and Lower Snow Lakes Storage Enhancement

Potential long-term impacts to shorelines under the Upper and Lower Snow Lakes Storage Enhancement Project would be similar to those described under the Eightmile Lake Storage Enhancement Project (Section 4.8.5.2, Long-term Impacts). Potential benefits would mainly occur in Icicle Creek and would include an increased ability to augment stream flow in the late summer or during drought years, with flow augmentation primarily benefitting the section of Icicle Creek between lower Snow Lake and the IPID diversion.

The proposed enhancement project would increase the high-water storage levels in both Upper and Lower Snow Lakes by 5 feet compared with existing high levels. This change would result in the inundation of some upland vegetation that has grown along the shoreline areas between the current and proposed high lake levels, most likely occurring in the fall through the early summer when releases would be likely to begin. This could result in some changes to the vegetative community along the shoreline.

The project would also allow for the Lower Snow Lake to be drawn down 3 feet below the current lake level, which would result in the exposure of slightly more lake bed. The additional draw down is not expected to adversely affect the shorelines by comparison, particularly because draw down of the lake would occur over a period of a couple of months and would not result in substantial increases in turbidity.

The resulting downstream changes in flows in Icicle Creek would be within the natural variation already occurring within the system. In most years, the main change would be a beneficial increase in flows during the summer months.

4.18.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange project would be included.

4.18.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

Construction of three new pump stations under this project would require work along the shorelines of the Wenatchee River. Removal of existing diversion facilities would also require work along Icicle and Peshastin Creeks. Ground disturbance would occur along the entire existing IPID delivery system as the canal system is replaced with a pressurized pipeline. Such activities could result in many of the same construction-related short-term impacts described above, including the increased potential for erosion. As long as construction activities comply with required permit terms and conditions that would be required as discussed in Section 4.18.7, Mitigation Measures, potential impacts would not be significant. Specific mitigation measures would be developed as part of future project-level review and permitting. Therefore, short-term impacts on shorelines from construction work are expected to be less than significant.

4.18.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange Project

The IPID Full Piping and Pump Exchange Project would result in new pump stations and intake facilities at three locations on the Wenatchee River. Depending on the specific location, these new facilities could potentially affect shorelines by increasing the potential for shoreline erosion and flooding over the long term.

Any adverse impacts would likely be minor because compliance with applicable local, state, and federal permits or approvals would require appropriate mitigation measures to reduce any potentially significant long-term impacts, such as ensuring that stream channel morphology and floodplain storage capacity are not adversely affected (Section 4.18.7 Mitigation Measures) and that no increase in flood elevations result from the proposed project.

As noted in Section 3.18, Shorelines, the 100-year floodplain includes a fairly narrow area that extends along Icicle Creek and the Wenatchee River. The floodplain extends further upland from the shoreline in broader valley areas near the Cities of Leavenworth and Wenatchee. The proposed intake and pump station structures would be constructed in and adjacent to the river or creek channel and 100-year floodplain.

4.18.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.18.7.1 Short-term Impacts

Short-term impacts on shorelines related to increasing the potential for shoreline erosion would be mitigated by complying with the terms and conditions of local, state, and federal regulations and project-specific permits and approvals, including local building, grading, and stormwater construction permits; state stormwater permits; Shoreline Management Act shoreline permits; HPAs; and CWA Section 404 permits and their associated Section 401 Water Quality Certifications, among others. Common permit conditions are likely to include conducting work in a manner to minimize potential disturbance of sensitive shoreline vegetation communities, minimizing soil disturbance, and implementing BMPs to control and minimize erosion.

Specific mitigation measures would be developed as part of future project-level review and permitting. In addition to those measures identified in Sections 4.5.7, Water Quality, and Section 4.8.7, Vegetation, implementation of the following measures would ensure impacts would be less than significant.

- Where project elements may be permanently located in or substantially alter the floodplain, conduct a study to assess the potential for the project activities to adversely affect floodplain storage capacity and flood levels.
- Where project elements may be permanently located in the stream channel, ensure that the project is designed in a manner that does not result in long-term changes in sediment transport of the affected water way.

4.18.7.2 Long-term Impacts

Long-term impacts on shorelines would be mitigated by complying with the terms and conditions of local, state, and federal regulations and project-specific permits and approvals, as described above.

4.19 Utilities

The primary utility types to be impacted by the alternatives discussed in this document are related to municipal water service and irrigation districts. Short-term impacts would be reductions or disturbances in service related to project construction. Impacts are considered minor if the impact is short or can be scheduled to minimize impacts. Long-term impacts are related to increased demand on a utility. Impacts are considered minor if the increases would not affect regional supplies.

In addition to water utilities, potential impacts on power utilities are discussed.

4.19.1 No-action Alternative

4.19.1.1 Short-term Impacts

Under the No-action Alternative, various agencies and other entities would continue to undertake individual actions to restore and enhance fish and aquatic resources in the Icicle Creek Watershed project area, but those actions would not be part of a coordinated program implemented with the support of the IWG. Actions implemented by individual agencies and entities could include construction of diversion improvements, irrigation system upgrades, LNFH improvements, and fish passage work.

Implementing projects under the No-action Alternative could result in some construction impacts to water service. However, coordination and timing should limit any such impacts. No other construction related impacts to utilities are anticipated.

4.19.1.2 Long-term Impacts

Long-term impacts on utilities from implementing the No-action Alterative would relate to increased power consumption.

Increased power use would likely be associated with any project that increases pressurized water pumping versus historical gravity flow, such as the COIC Irrigation Efficiencies and Pump Exchange, IPID Dryden or Full Pump Exchange project, and the groundwater augmentation portion of the LNFH improvements. These increases in power use would not affect regional power supplies.

4.19.2 Alternative 1 (Base Package)

Under Alternative 1, short-term effects to utilities include potential impacts to water service by the City of Leavenworth and irrigation districts. Preventative steps such as construction on Alpine Lakes projects occurring during normal or high water years and coordinating construction projects with water purveyors would minimize potential effects. Long-term impacts to utilities include increased water service and power consumption. Increased power consumption is not expected to affect regional power supplies and is considered insignificant.

4.19.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction for this project would require the Alpine Lakes to be drawn down prior to construction. To avoid service disruptions to IPID, which relies on the water stored in these lakes to provide irrigation water to their district in drought years, construction would have to be scheduled for a normal or above average water year.

IPID Irrigation Efficiencies

Under the IPID Irrigation Efficiencies Project, construction activities would likely include piping or lining canals and on-farm irrigation efficiency upgrades. These construction activities would occur outside the irrigation season, and water service disruptions would be unlikely. There are no anticipated impacts on other utility types.

COIC Irrigation Efficiencies and Pump Exchange

The COIC Irrigation Efficiencies and Pump Exchange Project would include a point of diversion change and pressurized piping of the current canal system. Construction activities would occur outside the irrigation season, and there are no anticipated water service disruptions. No other service disruptions are anticipated under this project.

Domestic Conservation Efficiencies

Construction activities under the Domestic Conservation Efficiencies Project would include replacing mainlines and installing new meters. Other aspects of this project are more administrative in nature. Some service disruption could occur as a result of mainline replacements. However, this would be of short duration and would be coordinated with water users to minimize the impact.

Eightmile Lake Storage Restoration

Construction of the Eightmile Lake Storage Restoration Project would require Eightmile Lake to be drawn down. To avoid service disruptions to IPID, which relies on the water stored in this lake to provide irrigation water to their district in drought years, construction would have to be scheduled for a normal or above average water year.

Tribal Fishery Preservation and Enhancement

Any construction activities associated with this project are not expected to have impacts on utility service.

Habitat Protection and Enhancement

Any construction activities associated with this project are not expected to have impacts on utility service.

Instream Flow Rule Amendment

This is an administrative action with no construction component. No short-term impacts to utilities are anticipated.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

One aspect of the LNFH Conservation and Water Quality Improvements Project involves rehabilitating the LNFH intake structure. If COIC is still sharing a point of diversion with LFNH when construction occurs, it could impact COIC delivery. To minimize any impacts, construction activities would be coordinated with COIC if they are still sharing a point of diversion at the time of construction. No other short-term utility impacts are anticipated.

Fish Passage Improvements

Construction activities related to fish passage are generally not expected to impact water service delivery or any other utility. However, construction activities at the Boulder Field have the potential to impact both the City of Leavenworth and IPID's diversion given their proximity to the Boulder Field. Construction activities related to passage at the Boulder Field would need to be coordinated with both entities to minimize any impacts and disruption to their service.

Fish Screen Compliance

Fish Screen installation would have to be coordinated with the City of Leavenworth, IPID, LNFH, and COIC to ensure no impact on water service. No other short-term utility impacts are anticipated.

Water Markets

This is an administrative action with no construction component. No short-term impacts to utilities are anticipated.

4.19.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

The Alpine Lakes Optimization, Modernization, and Automation Project would provide water for instream flow benefit when the district generally does not need to use the water stored in the Alpine Lakes (non-drought years). Because the water would still be available to IPID when they need it, there are no anticipated long-term effects to water service.

Power for automation would be provided by a small solar panel. There are no anticipated impacts to electrical utilities.

IPID Irrigation Efficiencies

Lining and piping portions of the IPID canal is not anticipated to have any impacts to water delivery by the district.

Because the system would continue to be gravity fed, there are no anticipated impacts to electrical utilities.

COIC Irrigation Efficiencies and Pump Exchange

Piping the COIC canal and changing the point of diversion is not anticipated to impact water delivery by the district.

The COIC pump station on the Wenatchee River would likely use solar power to operate; thus, there are no anticipated impacts to electrical utilities.

Domestic Conservation Efficiencies

Under the Domestic Conservation Efficiencies Project, water made available through domestic conservation efforts would go to new domestic users. This would allow increased water service in the City of Leavenworth and potentially for other small water purveyors that provide water to rural domestic water users.

Impacts on electrical use are expected to be neutral.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project would make additional water available to the City of Leavenworth and rural domestic water users. This would allow increased water service in the City of Leavenworth and potentially for other small water purveyors that provide water to rural domestic water users.

If the City of Leavenworth takes any additional water from their Icicle Creek diversion, the impact on electrical use is expected to be minimal. However, if the City of Leavenworth takes any additional water made available from this project from their Wenatchee River well field then power consumption would increase. This increased power demand would likely be provided by Chelan PUD and would not affect regional power supplies.

Tribal Fishery Preservation and Enhancement

This project is not expected to have long-term impacts on water service or power utilities.

Habitat Protection and Enhancement

This project is not expected to have long-term impacts on water service or power utilities.

Instream Flow Rule Amendment

The Instream Flow Rule Amendment Project would provide additional water for rural domestic use within the Icicle Creek Subbasin. This would allow increased water service from small water purveyors that provide water to rural domestic water users. Additionally, it would make more water available for small domestic groundwater users.

Power consumption would likely increase because of increased groundwater use. However, this increased electrical use is expected to be relatively small, and would not affect regional power supplies.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The LNFH Conservation and Water Quality Improvements Project is not anticipated to have long-term impacts on water service within the Icicle project area.

It is currently unknown what impact this project would have on power consumption, although with increased reliance on groundwater sources and the use of circular tanks, power use would likely increase. However, this increase in electrical use is expected to be relatively small and may be partially offset by reduction in the use of chillers for egg temperature control. Impacts would be less than significant and would not affect regional power supplies.

Fish Passage Improvements

Fish passage projects are not anticipated to have any impact on water service or electrical utilities.

Fish Screen Compliance

The Fish Screen Compliance Project is not anticipated to have any impact on water service or electrical utilities.

Water Markets

The Water Markets Project is not anticipated to have any impact on water service or electrical utilities.

4.19.3 Alternative 2

Alternative 2 contains many of the same project elements as Alternative 1, with the addition of the IPID Dryden Pump Exchange Project and the removal of the Alpine Lakes Optimization, Modernization, and Automation Project. This section describes the short- and long-term impacts of the IPID Dryden Pump Exchange Project. All other project impacts are described under Alternative 1.

4.19.3.1 Short-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project proposes to pump water from the Wenatchee River rather than from Icicle Creek. Construction activities are not expected to impact utility service or have any other short-term impacts to utilities.

4.19.3.2 Long-term Impacts

IPID Dryden Pump Exchange

IPID’s point of diversion on Icicle Creek is gravity fed and requires no electricity to operate. Using a pump station on the Wenatchee River to reduce use on Icicle Creek would lead to increased power consumption. However, this increase in electrical use is expected to be relatively small and would not affect regional power supplies.

Water service is not expected to be significantly impacted by this project.

4.19.4 Alternative 3

Alternative 3 contains many of the same project elements as Alternative 2, with the addition of the Legislative Change Creating OCPI Authority for Alternative 3 Project and the removal of the Eightmile Lake Storage Restoration Project. This section describes the short- and long-term impacts of the Legislative Change Creating OCPI Authority for Alternative 3 Project. All other project impacts are described under Alternative 1 and Alternative 2.

4.19.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

The Legislative Change to OCPI Project is an administrative action without a construction component. There are no anticipated short-term impacts to utilities resulting from this project.

4.19.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

Under this project, domestic water use could increase. This would allow increased water service from the City of Leavenworth and small water purveyors that provide water to rural domestic water users.

Power consumption would likely increase because of increased pumping associated with increased water use. However, this increased electrical use is expected to be relatively small, and would not affect regional power supplies.

4.19.5 Alternative 4

Alternative 4 contains many of the same project elements as Alternative 1, except that the Eightmile Lake Storage Restoration Project would replace the Eightmile Lake Storage Enhancement Project, and the Upper Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects would be added. This section describes the short- and long-term impacts of those additional projects. All other project impacts are described under Alternative 1.

4.19.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

Construction of the Eightmile Lake Storage Enhancement Project would require Eightmile Lake to be drawn down. To avoid service disruptions to IPID, which relies on the water stored in this lake to provide irrigation water to their district in drought years, construction would have to be scheduled for a normal or above average water year.

Upper Klonaqua Lake Storage Enhancement

Construction of the Upper Klonaqua Lake Storage Enhancement Project would involve construction at Upper Klonaqua Lake, which is currently not managed for IPID water delivery. There are no expected short-term impacts to water service or other utility use.

Upper and Lower Snow Lakes Storage Enhancement

Construction of Upper and Lower Snow Lakes Storage Enhancement Project would require Upper Snow and Lower Snow Lakes to be drawn down. IPID relies on water stored in these lakes to provide irrigation water during drought years only. USFWS relies on storage to sustain water supply to the hatchery every year, but the need is greater during dry years. To avoid service disruptions to IPID and the USFWS, construction would have to be scheduled for a normal or above average water year.

4.19.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would make additional water available to the City of Leavenworth and rural domestic water users. The impacts to utilities are similar to the Eightmile Lake Storage Restoration Project (4.19.2.2, Long-term Impacts). This project would allow increased water service in the City of Leavenworth and potentially for other small water purveyors that provide water to rural domestic water users.

If the City of Leavenworth takes any additional water from their Icicle Creek diversion, the impact on electrical use is expected to be minimal. However, if the City of Leavenworth takes any additional water made available from this project from their Wenatchee River well field, the anticipated increase in power demand is not expected to not affect regional power supplies.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project would primarily benefit instream flows. Some water might be made available to the City of Leavenworth and rural domestic water users. This would allow increased water service in the City of Leavenworth and potentially for other small water purveyors that provide water to rural domestic water users.

If the City of Leavenworth takes any additional water from their Icicle Creek diversion, the impact on electrical use is expected to be minimal. However, if the City of Leavenworth takes any additional water made available from this project from their Wenatchee River well field, increase in power demand is expected. This increased demand would not affect regional power supplies.

Upper and Lower Snow Lakes Storage Enhancement

The Upper and Lower Snow Lakes Storage Enhancement Project would primarily benefit instream flows. Some water might be made available to the City of Leavenworth and rural domestic water users. This would allow increased water service in the City of Leavenworth and potentially for other small water purveyors that provide water to rural domestic water users.

If the City of Leavenworth takes any additional water from their Icicle Creek diversion, the impact on electrical use is expected to be minimal. However, if the City of Leavenworth takes any additional water made available from this project from their Wenatchee River well field, increase in power demand is expected. This increased demand would not affect regional power supplies.

4.19.6 Alternative 5

Alternative 5 contains many of the same project elements as Alternative 1, with the addition of the IPID Full Piping and Pump Exchange Project and the removal of the IPID Irrigation Efficiencies Project. This section describes the short- and long-term impacts of the IPID Dryden Pump Exchange Project. All other project impacts are described under Alternative 1.

4.19.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

The IPID Full Piping and Pump Exchange Project proposes to pipe the entire IPID system and pump water from the Wenatchee River rather than from Icicle and Peshastin Creek. Construction activities are not expected to impact water or utility service or have any other short-term impacts to utilities.

4.19.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

IPID's point of diversion on Icicle Creek is gravity fed and requires no electricity to operate. Using pump stations on the Wenatchee River to replace use from Icicle Creek would lead to increased power consumption, likely provided by Chelan PUD. At this point in project planning, the exact impacts have not been fully analyzed, however power consumption is not anticipated to affect regional power supplies and is therefore not viewed as a significant effect.

Water service is not expected to be significantly impacted by this project.

4.19.7 Mitigation Measures

This section discusses mitigation measures to address impacts identified and discussed above.

4.19.7.1 Short-term Impacts

The primary short-term impact identified above is potential disruptions of water service by the City of Leavenworth or irrigation districts. Coordinating the timing of construction work should mitigate many of these potential impacts.

4.19.7.2 Long-term Impacts

Long-term impacts identified in this section include improved water service and increased power consumption. The increased power consumption is not anticipated to affect regional power supplies and is therefore not viewed as a significant effect. Improved water service is also not considered a significant effect.

4.20 Transportation

This section discusses the short- and long-term impacts of the alternatives on transportation. Anticipated short-term impacts are related to construction activities and include the movement of heavy equipment to and from the project sites as well as commutes by workers during construction. Long-term impacts relate primarily to maintenance trips from project operation. Many of the project elements are located at already existing infrastructure. For already existing infrastructure in the Alpine Lakes Wilderness Area, the number of maintenance trips is expected to decline. For new infrastructure, such as the IPID pump station, maintenance trips would increase.

4.20.1 No-action Alternative

4.20.1.1 Short-term Impacts

Under the No-action Alternative, various agencies and other entities would continue to undertake individual actions to restore and enhance fish and aquatic resources in the Icicle Creek Watershed project area, but those actions would not be part of a coordinated program implemented with the support of the IWG. Actions implemented by individual agencies and entities could include construction of diversion improvements, irrigation system upgrades, LNFH improvements, and fish passage work.

The No-Action Alternative would likely result in construction activities in lower Icicle Creek and near the confluence of Icicle Creek and the Wenatchee River. Transporting equipment to project sites would likely impact traffic flow on Icicle Road and Highway 2. Additionally, commutes from construction workers would increase traffic on these roads. No roadways would be closed and standard safety procedures would be followed for transport of heavy equipment to the project sites.

4.20.1.2 Long-term Impacts

Transportation is expected to be relatively unchanged under the No-action Alternative. IPID would continue flying or hiking into their lake sites several times per season for maintenance and inspection activities, and points of diversions and water conveyance structures on lower Icicle Creek would undergo a similar level of maintenance and inspection as they currently do. There would likely be no new projects implemented that would require additional trips for monitoring or maintenance.

4.20.2 Alternative 1 (Base Package)

Under Alternative 1, short-term impacts to transportation include increased traffic or traffic slowdowns resulting from the transportation of heavy equipment and workers to construction sites, and increased air support and foot traffic to construction sites within the Alpine Lakes Wilderness Area. Long-term impacts to transportation are considered insignificant. They include a potential slight increase in maintenance trips to some project sites and decreased maintenance trips to the Alpine Lakes.

4.20.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Construction of the Alpine Lakes Optimization, Modernization, and Automation Project would require the use of hand and power tools, which would either be packed in via trails or flown in by helicopter. Workers would have to either hike in or be flown in as well. This would create a temporary increase in foot and air traffic to the Alpine Lakes sites. The USFS Environmental Assessment found the use of helicopter transport to support IPID maintenance activities to be acceptable (USFS, 1981). However, this increase could disrupt wilderness use as discussed in Section 4.17, Wilderness. To minimize impacts to wilderness uses of increased air and foot traffic, construction activities could occur in fall after the peak backpacking season, and construction notices would be posted so users would be aware of potential impacts.

IPID Irrigation Efficiencies

Under the IPID Irrigation Efficiencies Project, construction activities, such as canal lining and piping, would impact transportation by increasing traffic from construction worker commuter trips and slowing traffic from heavy equipment transport. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

COIC Irrigation Efficiencies and Pump Exchange

Under the COIC Irrigation Efficiencies and Pump Exchange and Pump Exchange Project, construction activities, such as canal piping and building a pump station, would impact transportation by increasing traffic from construction worker commuter trips and slowing traffic from heavy equipment transport. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

Domestic Conservation Efficiencies

Construction activities, such as mainline replacement and meter installation, would impact transportation by increasing traffic from construction worker commuter trips and slowing traffic from heavy equipment transport. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

Eightmile Lake Storage Restoration

Construction of the Eightmile Lake Storage Restoration Project would require the use of hand and power tools, which would either be packed in via trails or flown in by helicopter, and the use of heavy equipment, which would likely have to be flown in or walked up National Forest Road 7601 and overland adjacent to the Eightmile Lake Trail. Workers would likely have to hike in to the site or be flown in by helicopter, with support equipment being flown or packed in. This would create a temporary increase in foot and air traffic to the lake site. The USFS Environmental Assessment found the use of helicopter transport to support IPID maintenance activities to be acceptable (USFS, 1981). However, this increase could disrupt wilderness use as discussed in Section 4.17, Wilderness. To minimize impacts to wilderness uses, construction activities may occur in fall after the peak backpacking season, and construction notices would be posted so users would be aware of potential impacts.

Tribal Fishery Preservation and Enhancement

Some minor construction activities could be associated with this project. Any transportation of heavy equipment or increased construction worker commuter traffic could increase or slow traffic. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

Habitat Protection and Enhancement

Construction activities associated with the Habitat Protection and Enhancement Project would include grading, vegetation planting and removal, and placement of logs and rocks in riparian areas. Impacts to transportation would include increased traffic from construction worker commuter trips and slowed traffic from heavy equipment transport. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

Instream Flow Rule Amendment

The Instream Flow Rule Amendment Project is an administrative action with no construction component. No short-term impacts to transportation are anticipated.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

Construction activities associated with the LNFH Conservation and Water Quality Improvements Project would include well drilling, installing circular tanks, installation of a pump at the hatchery outfall, and rehabilitating the intake structure. Impacts to transportation would include increased traffic from construction worker commuter trips and slowed traffic from heavy equipment transport. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

Fish Passage Improvements

Construction activities associated with the Fish Passage Improvements Project include modifying or removing passage barriers. Impacts to transportation would include increased traffic from construction worker commuter trips and slowed traffic from heavy equipment transport. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

Fish Screen Compliance

Construction activities associated with the Fish Screen Compliance Project involve replacing/installing fish screens at major diversions. Impacts to transportation would include increased traffic from construction worker commuter trips and slowed traffic from heavy equipment transport. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

Water Markets

The Water Markets Project has no construction component and therefore no short-term impacts to transportation are anticipated.

4.20.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

The Alpine Lakes Optimization, Modernization, and Automation Project would result in fewer operational trips to the lake sites. Releases from the lakes would be automated, and trips to adjust gates throughout the season would not be required. There would still be occasional maintenance and inspection trips to the lake sites to ensure equipment and dams are in good repair.

IPID Irrigation Efficiencies

There are no significant long-term impacts to transportation associated with the IPID Irrigation Efficiencies Project. Routine inspection and maintenance trips would be required, but would not be more frequent than current trips required to maintain the existing infrastructure.

COID Irrigation Efficiencies

There are no significant long-term impacts to transportation associated with the COIC Irrigation Efficiencies and Pump Exchange and Pump Exchange Project. Routine inspection and maintenance trips would be required, but would not be more frequent than current trips required to maintain the existing infrastructure.

Domestic Conservation Efficiencies

There are no significant long-term impacts to transportation associated with the Domestic Conservation Efficiencies Project. Routine inspection and maintenance already occurs on this infrastructure.

Eightmile Lake Storage Restoration

There are no significant long-term impacts to transportation associated with the Eightmile Lake Storage Restoration Project. Routine inspection and maintenance already occurs on this infrastructure.

Tribal Fishery Preservation and Enhancement

This project is not expected to impact the use of transportation infrastructure in the long-term.

Habitat Protection and Enhancement

Under the Habitat Protection and Enhancement Project, some routine maintenance or inspection of plantings, logjams, and other improvements could be required. However, this is not expected to significantly impact traffic or transportation.

Instream Flow Rule Amendment

Amendment of the Instream Flow Rule is not expected to increase the use of transportation infrastructure.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

There are no significant long-term impacts to transportation associated with the LNFH Conservation and Water Quantity Improvements Project. Routine inspection and maintenance already occurs on LNFH's operational infrastructure.

Fish Passage Improvements

Under the Fish Passage Improvements Project, some routine maintenance or inspection of infrastructure may be required. However, this is not expected to significantly impact traffic or transportation.

Fish Screen Compliance

There are no significant long-term impacts to transportation associated with the Fish Screen Compliance Project. Routine inspection and maintenance already occurs at the major diverters points of diversion.

Water Markets

The implementation of the Icicle Water Market Project is not expected to increase the use of transportation infrastructure in the long term.

4.20.3 Alternative 2

Alternative 2 contains many of the same project elements as Alternative 1, with the addition of the IPID Dryden Pump Exchange Project and the removal of the Alpine Lakes Optimization, Modernization, and Automation Project. This section describes the short- and long-term impacts of the IPID Dryden Pump Exchange Project. All other project impacts are described under Alternative 1.

4.20.3.1 Short-term Impacts

IPID Dryden Pump Exchange

Construction activities, such as canal piping and building a pump station, would impact transportation by increasing traffic from construction worker commuter trips and slowing traffic from heavy equipment transport. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

4.20.3.2 Long-term Impacts

IPID Dryden Pump Exchange

Under the IPID Dryden Pump Exchange Project, some routine maintenance or inspection of infrastructure could be required. However, this is not expected to significantly impact traffic or transportation.

4.20.4 Alternative 3

Alternative 3 contains many of the same project elements as Alternative 2, with the addition of the Legislative Change Creating OCPI Authority for Alternative 3 Project and the removal of the Eightmile Lake Storage Restoration Project. This section describes the short- and long-term impacts of the Legislative Change Creating OCPI Authority for Alternative 3. All other project impacts are described under Alternative 1 and Alternative 2.

4.20.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

The Legislative Change Creating OCPI Authority for Alternative 3 Project is an administrative action without a construction component. There are no anticipated short-term impacts to transportation resulting from this project.

4.20.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

It is not anticipated that long-term impacts to transportation would result from the Legislative Change Creating OCPI Authority for Alternative 3.

4.20.5 Alternative 4

Alternative 4 contains many of the same project elements as Alternative 1, except for the removal of the Eightmile Lake Storage Restoration Project and the addition of the Eightmile Lake Storage Enhancement Project, Upper Klonaqua Lake Storage Enchantment Project, and Upper and Lower Snow Lakes Storage Enhancement Project. This section describes the short- and long-term impacts of those additional projects. All other project impacts are described under Alternative 1.

4.20.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

Construction of the Eightmile Lake Storage Enhancement Project would require the use of hand and power tools, which would either be packed in via trails or flown in by helicopter, and the use of heavy equipment, which would likely have to be flown in via helicopter or be walked up National Forest Road 7601 and overland adjacent to the Eightmile Lake Trail. Workers would likely have to hike in to the site, with support equipment being flown or packed in. This would create a temporary increase in foot and air traffic to the lake site. The USFS Environmental Assessment found the use of helicopter transport to support IPID maintenance activities to be acceptable (USFS, 1981). However, this increase could disrupt wilderness use as discussed in Section 4.17, Wilderness. To minimize impacts to wilderness uses construction activities could occur in fall after the peak backpacking season, and notices would be posted so users would be aware of potential impacts.

Upper Klonaqua Lake Storage Enhancement

Construction of the Upper Klonaqua Lake Storage Enhancement Project would require the use of hand and power tools, which would either be packed in via trails or flown in by helicopter, and potentially the use of heavy equipment, which would likely be walked up National Forest Road 7600 and trails. Workers would have to hike in or fly into the site, with support equipment being flown or packed in. This would create a temporary increase in foot and air traffic to the lake site. The USFS Environmental Assessment found the use of helicopter transport to support IPID maintenance activities to be acceptable (USFS, 1981). However, this increase could disrupt wilderness use as discussed in Section 4.17, Wilderness. To minimize impacts to wilderness uses, construction activities could occur in fall after the peak backpacking season, and notices would be posted so users would be aware of potential impacts.

Upper and Lower Snow Lakes Storage Enhancement

Construction of the Upper and Lower Snow Lakes Storage Enhancement Project would require the use of hand and power tools, which would either be packed in via trails or flown in by helicopter, and potentially the use of heavy equipment, which would likely be walked up Icicle Road and the Snow Lakes Trail. Workers would likely have to hike in to the site, with support equipment being flown or packed in. This would create a temporary increase in foot and air traffic to the lakes site. The USFS Environmental Assessment found the use of helicopter transport to support IPID maintenance activities to be acceptable (USFS, 1981). However, this increase could disrupt wilderness use as discussed in Section 4.17, Wilderness. To minimize impacts to wilderness uses, construction activities could occur in fall after the peak backpacking season, and notices would be posted so users would be aware of potential impacts.

4.20.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

There are no significant long-term impacts to transportation associated with the Eightmile Lake Storage Enhancement Project. Routine inspection and maintenance already occurs on this infrastructure.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project would require maintenance and inspection trips to Upper Klonaqua Lake, which do not currently occur. These trips could be coordinated with inspection and maintenance trips to lower Klonaqua Lake that currently occur.

Upper and Lower Snow Lakes Storage Enhancement

There are no significant long-term impacts to transportation associated with the Upper and Lower Snow Lakes Storage Enhancement Project. Routine inspection and maintenance already occurs on this infrastructure.

4.20.6 Alternative 5

Alternative 5 contains many of the same project elements as Alternative 1, with the addition of the IPID Full Piping and Pump Exchange Project would replace the IPID Irrigation Efficiencies Project. This section describes the short- and long-term impacts of the IPID Full Piping and Pump Exchange Project. All other project impacts are described under Alternative 1.

4.20.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

Construction activities, such as canal piping and building a pump station, would impact transportation by increasing traffic from construction worker commuter trips and slowing traffic from heavy equipment transport. No roadway closures are anticipated and standard safety procedures would be followed for transport of heavy equipment.

4.20.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

Under the IPID Full Piping and Pump Exchange Project, some routine maintenance or inspection of infrastructure could be required. However, this is not expected to significantly impact traffic or transportation.

4.20.7 Mitigation Measures

This section describes mitigation measures to reduce short-term and long-term impacts identified throughout Section 4.20.

4.20.7.1 Short-term Impacts

Mitigation measures to reduce construction-related impacts on transportation would include using flaggers and signage, and providing detour routes where possible and appropriate. Private access to properties would be maintained during construction activities. Advanced notice would be provided to wilderness users to minimize impacts of transportation on those users.

4.20.7.2 Long-term Impacts

For most of the alternatives, there would be no significant long-term impacts on transportation and no mitigation would be necessary. The Upper Klonaqua Lake Storage Enhancement Project under Alternative 4 would require inspection and maintenance trips in the Wilderness Area that do not currently occur. The impact of these inspection and maintenance trips would be reduced by coordinating them with trips that already occur to Lower Klonaqua Lake.

4.21 Cultural Resources (Archaeological, Ethnographic, and Historic Sites of Significance)

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.21, Cultural Resources, from construction and operation related to the No-action Alternative and Program Alternatives.

4.21.1 No-action Alternative

4.21.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that could result in short-term impacts on cultural resources in the Icicle Creek Watershed project area. This is anticipated to entail construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability. Short-term impacts would generally be associated with projects that require construction. Although impacts would occur as the result of construction, they would not be permanent. Cultural resources would be adversely affected if any of these activities disturbed or damaged archaeological sites, historic structures, or other important cultural properties.

Ground-disturbing activities can potentially damage archaeological resources that may be otherwise hidden below ground. Construction activities can alter or damage historic structures, such as buildings, to an extent that the culturally important features are compromised. Cultural properties may also include areas where activities have occurred or are occurring that contribute to the cultural identity of a group of people or that are a significant part of a unique historic event. Depending on the nature and extent of the construction activities, it is also possible to disrupt or damage the important features of cultural properties. Sites that are sacred to Indian tribes are addressed in Section 4.22, Indian Sacred Sites.

Although projects have the potential to affect cultural resources, various local, state, and federal laws and regulations protect sensitive cultural resources as described in Section 1.9, Related Permits, Actions, and Laws. Prior to construction, federal agencies taking actions on the projects would be required to ensure compliance with these regulations. Projects involving state capital funding would be required to comply with Governor’s Executive Order 05-05, which requires consultation with DAHP, Bureau of Indian Affairs, and potentially affected Indian tribes as part of the decision to provide funds.

Compliance could result in the development of mitigation measures to reduce cultural resources impacts, such as conducting site-specific surveys and evaluations, minimizing ground-disturbing activities, stopping work if previously unknown cultural resources are uncovered, and compensating for any impacts that cannot be avoided (Section 4.21.7, Mitigation Measures). Therefore, short-term impacts under the No-action Alternative are not expected to be significant.

4.21.1.2 Long-term Impacts

As discussed above, any impacts with the potential to result in lasting damage to cultural resources would be addressed prior to construction. For the most part, the No-action Alternative is not expected to result in any additional changes that would adversely affect cultural resources. Operational and maintenance activities, particularly those that would result in any ground disturbance or additional modifications to sensitive resources could have a limited potential to result in cultural resources impacts. However, this chance would be low given that the activities would be affecting areas already evaluated as described above. Potential long-term impacts on sites sacred to Indian tribes are addressed in Section 4.22, Indian Sacred Sites.

4.21.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in both increased adverse and beneficial impacts to cultural resources compared with the No-action Alternative because there would be greater likelihood that multiple projects would be implemented and the scale of certain efforts would likely be greater. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.21.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Under the Alpine Lakes Optimization, Modernization, and Automation Project, most of the work would occur in upland areas. Some limited work would occur within the lake shorelines but within the dry when the lakes are drawn down at the end of the summer. As discussed in Section 3.21, Cultural Resources, pedestrian surveys at Eightmile, Square, Klonaqua, and Colchuck Lakes revealed no archaeological sites along the passable section of the shoreline. The remainder of the area is too steep to traverse and unlikely to contain archaeological materials.

The majority of workers and equipment could be flown in, but IPID could also walk in some equipment via the Eightmile Lake Trail. No cultural resources were observed along the existing width of the trail that would be affected by this activity.

As discussed in Section 3.21, Cultural Resources, four of the five dams where construction activities are proposed are considered potentially eligible for listing in the NRHP. Eligibility is recommended because the facilities are associated with historically significant and controversial water management infrastructure in Chelan County. The facilities are unique in style and influenced by the extremely difficult terrain and constraints of mid-century construction methods, and they have the potential to yield data about early twentieth century engineering and construction.

Proposed construction activities at these lakes include mounting actuators on headgates where possible to remotely control operation. At some of the lakes, this could involve renovating or replacing some of the surrounding infrastructure, such as gates or pipes leading to and from the headgate, headwall, or housing. Electronic equipment would be powered by solar panel-charged batteries. These activities would occur at Eightmile, Square, Colchuck, Klonaqua, and Upper Snow/Nada Lakes.

If these activities altered any of the existing features such that the criteria listed above were no longer met, there would be a potential for a significant impact on these resources. More specifically, significant impacts could occur if any of the visible, historic components, such as the masonry dams, concrete headwalls, or headgate cranks, were removed or altered. These impacts could potentially be avoided, minimized, or mitigated by installing replacement structures that are consistent with historic components and by installing equipment on historic components. Replacing in the same location infrastructure that is not visible and is of unknown age, such as pipes running from headgates to release channels, would not significantly alter the structures and would therefore avoid potentially significant adverse impacts.

Impacts could also occur if equipment were placed on historic components in a manner that diminishes their integrity. These impacts could potentially be avoided, minimized, or mitigated by implementing mitigation measures. These could include placing removable equipment that does not damage the structures, provided the equipment is not visible (for example, inside an existing vault) or is designed to blend in with the existing structure, or placing equipment in the vicinity but not on the structures (for example, a solar panel in a nearby tree).

Activities at these lakes would require an inadvertent discovery plan and compliance with various local, state, and federal regulations that address in part the protection of cultural resources as described in Section 4.21.6, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

IPID Irrigation Efficiencies

Construction activities associated with this project include the conversion of irrigation canals to pipelines and lining of irrigation canals with concrete. Work within already disturbed areas, such as existing irrigation canals, is not likely to encounter archaeological resources.

These activities would require compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.6, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

COIC Irrigation Efficiencies and Pump Exchange

Construction activities associated with the COIC Efficiencies Project would result in short-term impacts similar to those described above with the exception of a new COIC pump station to be constructed along the shoreline of Icicle Creek or the Wenatchee River. Based on the analysis summarized in Section 3.21, Cultural Resources, there is a moderate to high potential for construction of the COIC pump station to encounter cultural resources along Icicle Creek or the Wenatchee River.

These activities would require an inadvertent discovery plan (IDP) and compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.6, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Domestic Conservation Efficiencies

Certain components of the Domestic Conservation Efficiencies Project, such as evaluating conservation-oriented rate structures and expanding conservation education, xeriscape, and rebate programs, would not result in any construction activities. Other activities, such as replacing leaky water mains and residential meters, could result in some minor construction activities, including the potential for ground disturbance. However, any ground work would occur in areas that were previously disturbed during construction of the initial plumbing and pipework. Therefore, the potential for any impacts on cultural resources would be low.

Eightmile Lake Storage Restoration

The Eightmile Lake Storage Restoration Project involves demolishing the existing dam, installing a new low-level outlet pipeline, and constructing new impoundment and water control structures to restore the maximum water storage level in the lake to an elevation of 4,671 feet and restore the accessible storage in the lake to the volume permitted by IPID's water right (2,500 acre-feet). While most construction equipment (potentially including a small tracked excavator) and materials would likely be flown into the project site via helicopter, IPID is considering the option of walking in a larger tracked excavator or a spider excavator.

As noted previously, the water release system at Eightmile Lake is recommended for listing in the NRHP based on the criteria listed in Section 4.21.2.1, Short-term Impacts, Alpine Lakes Optimization, Modernization, and Automation. No cultural resources were observed along the margins of the lake or within the existing width of the trail to the project site.

Construction activity would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down. Construction would involve making improvements to and/or replacing failing infrastructure, including replacing the low-level outlet pipeline and possibly extending it further downstream, replacing the damaged headgate, and replacing the rock masonry, concrete, and embankment dam structure with a new concrete and embankment dam structure.

If improvements and additions are constructed in materials that are similar to the historically used materials, the potential impacts on cultural resources would likely be low. Because the project would completely replace much of the water release system, the potential impacts would likely be significant.

These activities would require an inadvertent discovery plan and compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Tribal Fishery Preservation and Enhancement

The focus of this project is to ensure that there would be no adverse effects on tribal fishing as a result of implementing other projects as part of the overall Icicle Strategy. The specifics of this project are not yet determined, but would involve elements of restoration along the lower Icicle Creek that could result in localized construction-related ground disturbance. At this stage, the primary options under consideration include the construction of facilities such as plumbing needed to create a bubble curtain, a sprayer, or other modifications near the spillway in front of the LNFH to promote favorable fishing conditions.

Depending on the location and extent of any necessary ground disturbance, there is a potential for impacts on any previously undiscovered cultural resources. Generally speaking, any activities that occur within the water have a low potential to affect cultural resources. However, any ground disturbance in upland areas would have a higher chance of encountering archaeological sites.

These activities would require compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Habitat Protection and Enhancement

The Habitat Protection and Enhancement Project could involve grading; planting and thinning vegetation; and hauling and placing logs, rock, soil, and other materials in or adjacent to lower Icicle Creek. Depending on the location and extent of any necessary ground disturbance, there is a potential for impacts on any previously undiscovered cultural resources. Generally speaking, any activities that occur within the water have a low potential to affect cultural resources. However, any ground disturbance in upland areas would have a higher chance of encountering archaeological sites.

These activities would require compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Instream Flow Rule Amendment

Cultural resources impacts are not anticipated to occur under the Instream Flow Rule Amendment project because it would not involve any construction work.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

As noted in Section 3.21, Cultural Resources, the LNFH is listed in the NRHP. Previous studies at the LNFH have indicated that it is located in an area that was previously an active part of the Icicle Creek channel, but has now been filled and armored. Therefore, there is a low potential for archaeological resources to occur at this location.

The focus of this project is to implement improvements for water quality and water use efficiency. Some ground disturbance would occur as well as modifications to the facility.

Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential short-term impacts under NEPA would be completed once the full scope of the project is determined. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of the existing LNFH instream structures in Icicle Creek as well as instream modifications to the Boulder Field near RM 5.6. This work would result in disturbances along the streambank and within Icicle Creek that would be addressed in subsequent environmental review and permitting once project specifics are determined.

Depending on the location and extent of any necessary ground disturbance, there is a potential for impacts on any previously undiscovered cultural resources. Generally speaking, any activities that occur within the water have a low potential to affect cultural resources. However, any ground disturbance in upland areas would have a higher chance of encountering archaeological sites.

These activities would require an inadvertent discovery plan and compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Fish Screen Compliance

This project involves replacing fish screens at three different diversions on lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Some ground-disturbing activities would likely be required.

Depending on the location and extent of any necessary ground disturbance, there is a potential for impacts on any previously undiscovered cultural resources. Generally speaking, any activities that occur within the water have a low potential to affect cultural resources. However, any ground disturbance in upland areas would have a higher chance of encountering archaeological sites.

These activities would require an inadvertent discovery plan and compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Water Markets

Cultural resources impacts are not anticipated to occur under the Water Markets Project because it would not involve any construction work.

4.21.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Similar to existing conditions and the No-action Alternative, some level of ongoing operations and maintenance activities would occur under this project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lakes would result in changes in how frequently the lakes are drawn down, but would not result in any changes in the high or low levels. As noted in Section 3.18, Shorelines, increased frequency of withdrawals are not anticipated to result in increased erosion that could inadvertently expose buried cultural resources.

As noted above, this project would require compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

IPID Irrigation Efficiencies

As noted above, the IPID Irrigation Efficiencies Project would not involve ground disturbance in areas that are not already developed with existing irrigation facilities. Operation and maintenance activities of these facilities would have limited potential to result in long-term impacts on cultural resources.

COIC Irrigation Efficiencies and Pump Exchange

In general, the long-term impacts associated with the COIC Irrigation Efficiencies and Pump Exchange Project would be similar to those described for the IPID Irrigation Efficiencies Project with the exception of those related to the COIC pump station and intake facilities. These facilities would result in ground disturbance along lower Icicle Creek or the Wenatchee River and depending on the specific location could adversely affect cultural resources that may be present at the selected site. The potential for long-term impacts affecting cultural resources would be addressed prior to construction as described in greater detail in Section 4.21.7, Mitigation Measures.

Domestic Conservation Efficiencies

The Domestic Conservation Efficiencies Project involves evaluating conservation-oriented rate structures and expanding conservation education, xeriscape, and rebate programs, which would not affect cultural resources. After completing any elements involving construction, such as fixing leaky water mains and replacing residential meters, operation and maintenance activities affecting these facilities are expected to be less than what would occur with existing conditions and the No-action Alternative. As noted in 4.21.2.1, Short-term Impacts, any ongoing work in these areas would have a very low potential for encountering cultural resources.

Eightmile Lake Storage Restoration

Similar to existing conditions and the No-action Alternative, some level of ongoing operations and maintenance activities would occur under the Eightmile Lake Storage

Restoration Project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lake would allow the lake to rise to approximately 4 feet higher than the current high level to match the historical high water surface elevation. The lake would typically be full, to the new high water surface elevation, for less than a month in early summer. It would also allow for the lake to be drawn down to approximately 22.4 feet below the existing low. As noted in Section 3.18, Shorelines, these changes are not anticipated to result in increased erosion and therefore would not be expected to inadvertently expose buried cultural resources.

As noted above, this project would require compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Tribal Fishery Preservation and Enhancement

As noted in 4.21.2.1, Short-term Impacts, the specifics of this project are not yet determined, but could involve some minor new facilities along Icicle Creek, near the LNFH. It is not anticipated that operation and maintenance activities would result in any new or ongoing impacts on cultural resources; however, as noted above, this project would require compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Habitat Protection and Enhancement

As noted in 4.21.2.1, Short-term Impacts, the specifics of this project are not yet determined, but would include restoration and enhancement activities that are not likely to include new facilities that would require any ongoing operation or maintenance activities. As noted above, this project would require compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Instream Flow Rule Amendment

The Instream Flow Rule Amendment Project involves an administrative change to the instream flow rule to allow for additional water withdrawals to occur in the Icicle Creek Subbasin if certain conditions are met and would not result in any long-term changes that would affect cultural resources.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

As noted in 4.21.2.1, Short-term Impacts, the specifics of this project are not yet determined, but would involve some modifications to the LNFH. Operation and maintenance activities would occur within the facilities and would be likely to affect cultural resources over the long term; however, as noted above, because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential impacts under NEPA would be completed once the full scope of the project is determined. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with Reclamation, USFWS, DAHP, and other affected parties if applicable. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek, as well as instream modifications to the Boulder Field near RM 5.6. After completing any elements involving construction, operation and maintenance activities would occur within areas already developed and would have limited potential to result in impacts on cultural resources.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. After completing any elements involving construction, operation and maintenance activities would occur within areas already developed and would have limited potential to result in impacts on cultural resources. Additionally, these activities are expected to be less than what currently occurs or would occur under the No-action Alternative and therefore would not result in long-term impacts on cultural resources.

Water Markets

The Water Markets Project involves the creation of a market system with the intention of increasing water availability within the Icicle Creek Subbasin and would not result in any long-term changes that would affect cultural resources.

4.21.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Impacts associated with other project elements proposed under Alternative 2 are discussed under Alternative 1.

4.21.3.1 Short-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project would involve constructing a new pump station and intake facilities on the bank of the Wenatchee River near the town of Dryden to deliver water to the IPID canals and possibly a new re-regulation pond. Based on the analysis summarized in Section 3.21, Cultural Resources, there is a moderate to high potential for construction of the IPID pump exchange facilities to encounter cultural resources, depending on the site that is selected.

These activities would require an inadvertent discovery plan and compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

4.21.3.2 Long-term Impacts

IPID Dryden Pump Exchange

As noted above, the IPID Dryden Pump Exchange Project would construct an IPID pump station on the Wenatchee River and possibly a re-regulation pond. Operation and maintenance activities of these facilities would take place within developed areas and would have limited potential to result in long-term impacts on cultural resources.

4.21.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 Project would be included while the Eightmile Lake Storage Restoration Project would not. This section describes the specific short- and long-term impacts associated with the Legislative Change Creating OCPI Authority for Alternative 3 Project. Impacts associated with other projects proposed under this alternative are discussed in Alternative 1 and Alternative 2.

4.21.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts on cultural resources are expected.

4.21.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority Project for Alternative 3 Project were enacted, there could be potential conflicts with instream flow allocations; however, these changes would not have the potential to affect cultural resources.

4.21.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1 with the exception that the Eightmile Lake Storage Enhancement Project would replace the Eightmile Lake Storage Restoration Project, and the Upper Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects would be included. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.21.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

The Eightmile Lake Storage Enhancement Project would involve demolishing the existing dam, installing new piping, and constructing new impoundment and water control structures that would allow for an increase in the accessible storage at Eightmile Lake to 3,500 acre-feet. The spillway elevation would be raised to allow for storage at a higher level (4,682 feet) than current or historical water storage levels and the project would allow for additional draw down of the lake.

As noted previously, the water release system at Eightmile Lake is recommended for listing in the NRHP based on the criteria listing in Section 4.21.2.1, Short-term Impacts, Alpine Lakes Optimization, Modernization, and Automation. No cultural resources were observed along the margins of the lake or within the existing width of the trail to the project site.

Construction activity would occur along the banks and within the dry areas of the lake margins once the lake has been drawn down. Construction would involve making improvements to and/or replacing failing infrastructure, including replacing the low-level outlet pipeline and possibly extending it further downstream, replacing the damaged headgate, and replacing the rock masonry, concrete, and embankment dam structure with a new concrete and embankment dam structure. Because the project would completely replace much of the water release system, the potential impacts would likely be significant.

These activities would require an inadvertent discovery plan and compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.6, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Upper Klonaqua Lake Storage Enhancement

The Upper Klonaqua Lake Storage Enhancement Project would likely include ground disturbance in an area that has not been surveyed for archaeological resources at Upper Klonaqua Lake. Depending on the location and extent of any necessary ground disturbance, there is a low to moderate potential to encounter any previously undiscovered cultural resources.

As noted previously, the water release system at Klonaqua Lake is recommended for listing in the NRHP based on the criteria listing in Section 4.21.2.1, Short-term Impacts, Alpine Lakes Optimization, Modernization, and Automation; however, there is no irrigation infrastructure at the Upper Lake where construction activities are proposed and therefore no potential for construction to result in adverse impacts on this resource.

In addition, these activities would require an inadvertent discovery plan and compliance with various local, state, and federal regulations that address in part the protection of cultural resources as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Upper and Lower Snow Lakes Storage Enhancement

This project would likely include modification of existing dam structures at Upper and Lower Snow Lakes. The structures have not been recorded, and it is not known whether they would contribute to either the LNFH or the potential Alpine Lakes Irrigation Historic District. If they do, then project activities have the potential to result in a significant adverse effect on this resource.

The area has also not been surveyed for other archaeological resources. Depending on the location and extent of any necessary ground disturbance, there is a low to moderate potential to encounter any previously undiscovered cultural resources.

This project would require an inadvertent discovery plan and compliance with various local, state, and federal regulations, including NEPA, which would address the protection of cultural resources as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP.

With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

4.21.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Similar to existing conditions and the No-action Alternative, some level of ongoing activities would occur for operations and maintenance under the Eightmile Lake Storage Enhancement Project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lake would allow the lake to rise to approximately 15 feet higher than the current high and 11 feet higher than the historical high water level. The lake would operate full to the new high water level for less than a month in early summer. It would also allow for the lake to be drawn down to approximately 24.4 feet below the existing low. As noted in Section 3.18, Shorelines, these changes are not anticipated to result in increased erosion and therefore would not be expected to inadvertently expose buried cultural resources.

As noted above, this project would require compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Upper Klonaqua Lake Storage Enhancement

Compared to existing conditions and the No-action Alternative, some level of ongoing activities would occur for operations and maintenance under the Upper Klonaqua Lake Storage Enhancement Project; however, these activities would focus on maintaining and operating the new facilities and are not expected to result in any substantial changes to the structures or ground disturbance.

Re-operation of the lake would allow Upper Klonaqua Lake to be lowered approximately 20 feet, which would likely occur for 1 to 2 months in the late summer. There would be no changes at Lower Klonaqua Lake. As noted in Section 3.18, Shorelines, these changes are not anticipated to result in increased erosion and therefore would not be expected to inadvertently expose buried cultural resources.

In addition, this project would require compliance with various local, state, and federal regulations that address the protection of cultural resources as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

Upper and Lower Snow Lakes Storage Enhancement

Similar to existing conditions and the No-action Alternative, some level of ongoing activities would occur for operations and maintenance under the Upper and Lower Snow Lakes Storage Enhancement Project; however, because the facilities would be newer and operated remotely by USFWS, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lakes would allow both lakes to rise to approximately 5 feet higher than the current high level and 3 feet lower than the current low level. As noted in Section 3.18, Shorelines, these changes are not anticipated to result in increased erosion and therefore would not be expected to inadvertently expose buried cultural resources.

In addition, this project would require compliance with various local, state, and federal regulations, including NEPA, which address the protection of cultural resources as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

4.21.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange project would be included.

4.21.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

The IPID Full Piping and Pump Exchange project would involve fully replacing the IPID canal systems with a pressurized pump delivery system and constructing three intake and pump station facilities on the Wenatchee River. Existing surface water diversion facilities on Icicle and Peshastin Creeks could be removed. Based on the analysis summarized in Section 3.21, Cultural Resources, there is a moderate to high potential for construction of the IPID pump station facilities to encounter cultural resources within the IPID service area, especially along the Wenatchee River or lower Icicle Creek.

These activities would require an inadvertent discovery plan and compliance with various local, state, and federal regulations that address in part the protection of cultural resources, as described in Section 4.21.7, Mitigation Measures. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with DAHP. With implementation of appropriate mitigation, this project is not anticipated to result in any significant impacts on cultural resources.

IPID Full Piping and Pump Exchange Project

As noted above, the IPID Full Piping and Pump Exchange project would construct three pump stations on the Wenatchee River, as well as fully replace the existing IPID canal system with a pressurized pipeline. Operation and maintenance activities of the pump facilities would take place within developed areas and would have limited potential to result in long-term impacts on cultural resources.

4.21.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.21.7.1 Short-Term Impacts

The Icicle Strategy would be required to comply with the Guiding Principles, which includes ensuring the suite of selected projects does not result in significant adverse impacts on tribal resources. In addition, federal actions and projects receiving state capital funds require coordination with potentially affected Indian tribes.

Continued coordination is ongoing and the potential for cultural resources to be affected would be addressed during project-level review. In the event of potential short-term impacts, the following types of mitigation measures may be implemented.

- Conduct tribal outreach to identify potentially affected cultural and tribal resources and avoid potential access conflicts or permanent changes adversely affecting these resources to the extent feasible.
- Limit the timing of construction activities with the potential to disturb use of affected cultural and tribal resources.
- Document the historic infrastructure before it is altered or removed.
- Compensate for potential disturbance to affected cultural and tribal resources as appropriate.

4.21.7.2 Long-term Impacts

As discussed above, any impacts with the potential to result in lasting damage to cultural resources would be addressed prior to construction.

4.22 Indian Sacred Sites

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.22, Indian Sacred Sites, from construction and operation related to the No-action Alternative and Program Alternatives.

4.22.1 No-action Alternative

4.22.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that have the potential to affect sacred sites that may be present in the Icicle Creek Watershed project area. The No-action Alternative would include construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability.

Construction activities can disturb sacred sites by resulting in increased noise, dust, or activity that conflicts with the use of the sacred site. Construction could also result in physical changes that can disrupt or conflict with the sacred or ceremonial use. The extent of the impact would depend on the specific uses at the site and the nature and extent of the construction activity.

Prior to construction, project proponents would be required to ensure compliance with regulations related to sacred sites as described in Section 1.9, Related Permits, Actions, and Laws. Compliance could result in the development of mitigation measures to reduce impacts, such as minimizing disruptive activities, implementing timing restrictions on the activities, and compensating for any impacts that cannot be avoided (Section 4.22.7, Mitigation Measures).

4.22.1.2 Long-term Impacts

Any impacts with the potential to result in lasting damage to sacred sites would be addressed prior to construction. For the most part, the No-action Alternative is not expected to result in any additional changes that would adversely affect sacred sites over the long term. Operational and maintenance activities, particularly those that would result in any ground disturbance or additional modifications to sensitive resources could have a limited potential to result in impacts. The potential would be low given that the activities would be affecting areas already evaluated as described above.

4.22.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in both increased adverse and beneficial impacts on sacred sites compared with the No-action Alternative because there would be greater likelihood that multiple projects would be implemented and the scale of certain efforts would likely be greater. Compliance with the Guiding Principles addresses tribal resources in general by improving instream flows, improving the sustainability of LNFH, protecting tribal and non-tribal harvest, and enhancing Icicle Creek riparian habitat. In addition, federal actions and projects receiving state capital funds require coordination with potentially affected Indian tribes. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.22.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

As noted in Section 3.21, Cultural Resources, historically, there has been relatively limited study of the project site for cultural activities related to sacred sites because of its remoteness. As noted in Section 3.22, Indian Sacred Sites, no sacred sites have been formally identified with the Alpine Lakes Optimization, Modernization, and Automation Project sites.

Most of the work would occur in upland areas. Some limited work would occur within the lake shorelines but within the dry when the lakes are drawn down at the end of the summer. This work is expected to have a low potential to result in short-term impacts of any sacred sites. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

IPID Irrigation Efficiencies

Construction activities associated with this project include the conversion of irrigation canals to pipelines and lining of irrigation canals with concrete. This work would occur within already developed areas and has a low likelihood of disturbing sacred sites. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

COIC Irrigation Efficiencies and Pump Exchange

Construction activities associated with COIC Efficiencies would be similar to those described for the IPID Irrigation Efficiencies project with the exception of a new COIC pump station to be constructed along the shoreline of Icicle Creek or the Wenatchee River. Depending on the specific location and the presence of any sacred sites, there is a potential for this project to result in short-term impacts. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Domestic Conservation Efficiencies

Certain components of the Domestic Conservation Efficiencies Project, such as evaluating conservation-oriented rate structures and expanding conservation education, xeriscape, and rebate programs, would not result in any construction activities. Other activities, such as replacing leaky water mains and residential meters, could result in some minor construction activities, including the potential for ground disturbance. However, any ground work would occur in areas that were previously disturbed during construction of the initial plumbing and pipework. Therefore, the potential for any impacts on sacred sites would be very low.

Eightmile Lake Storage Restoration

As noted in Section 3.21, Cultural Resources, historically, there has been relatively limited study of the Eightmile Lake Storage Restoration Project site for cultural activities related to sacred sites because of its remoteness. As noted in Section 3.22, Indian Sacred Sites, no sacred sites have been formally identified within the project site.

Construction activities for this project would be largely limited to the dry lake margins and existing structures and is expected to have a low potential to result in short-term impacts of any sacred sites. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Tribal Fishery Preservation and Enhancement

The specifics of this project are not yet determined, but could involve some minor new facilities along Icicle Creek near the LNFH. Depending on the specifics of this project, there is a potential that construction activity could affect Indian sacred sites in the short term.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Habitat Protection and Enhancement

The specifics of the Habitat Protection and Enhancement Project are not yet determined, but would likely involve some construction activity, including grading; planting and thinning vegetation; and hauling and placing logs, rock, soil, and other materials in or adjacent to lower Icicle Creek. Depending on the specifics of this project, there is a potential that construction activity could affect Indian sacred sites in the short term.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review.

Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Instream Flow Rule Amendment

The Instream Flow Rule Amendment Project would not involve any construction activities, physical changes, or disturbance in the short term and would therefore not result in any short-term impacts on Indian sacred sites.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The focus of this project is to implement improvements for water quality and water use efficiency. Some ground disturbance would occur as well as modifications to the facility. Most activity is anticipated to occur within the boundaries of the hatchery; however, there would be some construction activities along lower Icicle Creek.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential short-term impacts under NEPA would be completed once the full scope of the project is determined. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek as well as instream modifications to the Boulder Field near RM 5.6. This work would result in disturbances along the streambank and within Icicle Creek.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on Lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Some ground-disturbing activities would likely be required.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Water Markets

The Water Markets Project would not involve any construction activities, physical changes, or disturbance in the short-term and would therefore not result in any short-term impacts on sacred sites.

4.22.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Similar to existing conditions and the No-action Alternative, some level of ongoing operations and maintenance activities would occur under the Alpine Lakes Optimization, Modernization, and Automation Project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lakes would result in changes in how frequently the lakes are drawn down, but would not result in any changes in the high or low levels. As noted in Section 3.18, Shorelines, increased frequency of withdrawals are not anticipated to result in increased erosion that would significantly alter the shoreline.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

IPID Irrigation Efficiencies

As noted above, the IPID Irrigation Efficiencies Project would not involve ground disturbance in areas that are not already developed with existing irrigation facilities. Operation and maintenance activities of these facilities would have limited potential to result in long-term impacts adversely affecting Indian sacred sites.

COIC Irrigation Efficiencies and Pump Exchange

In general, the long-term impacts associated with the COIC Irrigation Efficiencies and Pump Exchange Project would be similar to those described for the IPID Irrigation Efficiencies Project with the exception of those related to the COIC pump station and intake facilities. These facilities would result in new facilities along lower Icicle Creek or the Wenatchee River and depending on the specific location could adversely affect sacred sites that may be present at the selected site. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Domestic Conservation Efficiencies

The Domestic Conservation Efficiencies Project involves evaluating conservation-oriented rate structures and expanding conservation education, xeriscape, and rebate programs, which would have a very low potential to affect sacred sites. After completing any elements involving construction, such as fixing leaky water mains and replacing residential meters, operation and maintenance activities affecting these facilities are expected to be less than what would occur with existing conditions and the No-action Alternative.

Eightmile Lake Storage Restoration

Similar to existing conditions and the No-action Alternative, some level of ongoing operations and maintenance activities would occur under the Eightmile Lake Storage Restoration Project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lake would allow the lake to rise to approximately 4 feet higher than the current high level, which would occur for less than a month in early summer. It would also allow for the lake to be drawn down to approximately 22.4 feet below the existing low. As noted in Section 3.18, Shorelines, increased frequency of withdrawals are not anticipated to result in increased erosion and therefore would not be expected to inadvertently expose buried cultural resources.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Tribal Fishery Preservation and Enhancement

As noted above, the specifics of the Tribal Fishery Preservation and Enhancement Project are not yet determined, but could involve some minor new facilities along Icicle Creek near the LNFH. It is not anticipated that operation and maintenance activities would result in any new or ongoing impacts on Indian sacred sites.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Habitat Protection and Enhancement

The specifics of the Habitat Protection and Enhancement Project are not yet determined, but would include restoration and enhancement activities that are not likely to include new facilities that would require any ongoing operation or maintenance activities. There would be limited potential for long-term impacts affecting Indian sacred sites.

Instream Flow Rule Amendment

The Instream Flow Rule Amendment Project involves an administrative change to the Instream Flow Rule to allow for additional water withdrawals to occur on Icicle Creek if certain conditions are met.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

As noted above, the specifics of this project are not yet determined, but would involve some modifications to the LNFH. Operation and maintenance activities would occur within the facilities and would not be likely to affect sacred sites over the long term.

Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential impacts under NEPA would be completed once the full scope of the project is determined. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Fish Passage Improvements

As noted above, the specifics of the Fish Passage Improvements Project are not yet determined, but could involve some minor new facilities along Icicle Creek near the LNFH. It is not anticipated that operation and maintenance activities would result in any new or ongoing impacts on sacred sites. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Fish Screen Compliance

As noted above, the specifics of the Fish Screen Compliance Project are not yet determined, but would involve replacing fish screens along Icicle Creek. It is not anticipated that operation and maintenance activities would result in any new or ongoing impacts on sacred sites. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Water Markets

The Water Markets Project is expected to result in beneficial impacts for increased water availability within the Icicle Creek Subbasin and is not expected to adversely affect Indian sacred sites.

4.22.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. Compliance with the Guiding Principles addresses tribal resources in general by improving instream flows, improving the sustainability of LNFH, protecting tribal and non-tribal harvest, and enhancing Icicle Creek riparian habitat. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Impacts of other projects proposed under Alternative 2 are discussed under Alternative 1.

4.22.3.1 Short-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project involves construction of a new IPID pump station and intake facilities on the Wenatchee River. Depending on the specific location in relation to any sacred sites, there is a potential that construction activity could affect that sacred site in the short term. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

4.22.3.2 Long-term Impacts

IPID Dryden Pump Exchange

As noted above, the IPID Dryden Pump Exchange Project would construct an IPID pump station on the Wenatchee River and possibly a re-regulation pond. Operation and maintenance activities of these facilities would take place within developed areas and would have limited potential to result in long-term impacts on Indian sacred sites.

4.22.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 Project needed to allow for permitting additional domestic supplies would be included while the Eightmile Lake Storage Restoration Project would not. Compliance with the Guiding Principles addresses tribal resources in general by improving instream flows, improving the sustainability of LNFH, protecting tribal and non-tribal harvest, and enhancing Icicle Creek riparian habitat. This section describes the specific short- and long-term impacts associated with the Legislative Change Creating OCPI Authority for Alternative 3 Project. Impacts of other projects proposed under this Alternative are discussed under Alternative 1 and Alternative 2.

4.22.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts on Indian sacred sites.

4.22.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority for Alternative 3 Project were enacted, there could be potential conflicts with instream flow allocations. Under the proposed changes, junior domestic water rights could be exercised even when the Instream Flow Rule is not met.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

4.22.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1 with the exception that the Eightmile Lake Storage Enhancement project would replace the Eightmile Lake Storage Restoration project, and the Upper Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects would be included. Compliance with the Guiding Principles addresses tribal resources in general by improving instream flows, improving the sustainability of LNFH, protecting tribal and non-tribal harvest, and enhancing Icicle Creek riparian habitat. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.22.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

As noted in Section 3.21, Cultural Resources, historically, there has been relatively limited study of the project site for cultural activities related to sacred sites because of its remoteness. As noted in Section 3.22, Indian Sacred Sites, no sacred sites have been formally identified with the Eightmile Lake Storage Enhancement Project site.

Construction activities for this project would be largely limited to the dry lake margins and existing structures and is expected to have a low potential to result in short-term impacts of any sacred sites. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.6, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Upper Klonaqua Lake Storage Enhancement

As noted in Section 3.21, Cultural Resources, historically, there has been relatively limited study of the project site for cultural activities related to sacred sites because of its remoteness. As noted in Section 3.22, Indian Sacred Sites, no sacred sites have been formally identified with the Upper Klonaqua Lake Storage Enhancement Project site.

Construction activities for this project would be largely limited to the dry lake margins and existing structures and is expected to have a low potential to result in short-term impacts of any sacred sites. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Upper and Lower Snow Lakes Storage Enhancement

As noted in Section 3.21, Cultural Resources, historically, there has been relatively limited study of the project site for cultural activities related to sacred sites because of its remoteness. As noted in Section 3.22, Indian Sacred Sites, no sacred sites have been formally identified with the Upper and Lower Snow Lakes Storage Enhancement Project site.

Construction activities for this project would be largely limited to the dry lake margins and existing structures and is expected to have a low potential to result in short-term impacts of any sacred sites. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

4.22.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Similar to existing conditions and the No-action Alternative, some level of ongoing activities would occur for operations and maintenance under the Eightmile Lake Storage Enhancement Project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lake would allow the lake to rise to approximately 15 feet higher than the current high level and 11 feet higher than the historical high water levels. The lake would operate full to the new high water level for less than a month in early summer. It would also allow for the lake to be drawn down to approximately 24.4 feet below the existing low. As noted in Section 3.18, Shorelines, increased frequency of withdrawals are not anticipated to result in increased erosion and therefore would not be expected to inadvertently expose buried cultural resources.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Upper Klonaqua Lake Storage Enhancement

Compared to existing conditions and the No-action Alternative, some level of ongoing activities would occur for operations and maintenance under the Upper Klonaqua Lake Storage Enhancement Project; however, these activities would focus on maintaining and operating the new facilities and are not expected to result in any substantial changes to the structures or ground disturbance.

Re-operation of the lake would allow Upper Klonaqua Lake to be lowered approximately 20 feet, which would likely occur for 1 to 2 months in the late summer. There would be no changes at Lower Klonaqua Lake. As noted in Section 3.18, Shorelines, these changes are not anticipated to result in increased erosion and therefore would not be expected to inadvertently expose buried cultural resources.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

Upper and Lower Snow Lakes Storage Enhancement

Similar to existing conditions and the No-action Alternative, some level of ongoing activities would occur for operations and maintenance under the Upper and Lower Snow Lakes Storage Enhancement; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lakes would allow both lakes to rise to approximately 5 feet higher than the current high level and 3 feet lower than the current low. As noted in Section 3.18, Shorelines, these changes are not anticipated to result in increased erosion and therefore would not be expected to inadvertently expose buried cultural resources.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review, which would include NEPA. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

4.22.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange project would be included.

4.22.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange Project

The IPID Full Piping and Pump Exchange project involves construction of three new pump stations and intake facilities on the Wenatchee River, and fully replacing the existing IPID canal delivery system with a pressurized pipeline. Depending on the specific location in relation to any sacred sites, there is a potential that construction or ground disturbing activity could affect that sacred site in the short term. Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

4.22.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange Project

As noted above, the Full Project would construct three new pump stations on the Wenatchee River and replace the existing canal delivery system. Operation and maintenance activities of the pump stations would take place within developed areas and would have limited potential to result in long-term impacts on Indian sacred sites.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for sacred sites to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.22.7, Mitigation Measures, would ensure any potential impacts on Indian sacred sites are addressed.

4.22.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.22.7.1 Short-Term Impacts

As noted in Section 1.2, The Icicle Strategy Guiding Principles, the Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring the suite of selected projects does not result in significant adverse impacts on tribal harvest, among other things. In addition, federal actions and projects receiving state capital funds require coordination with potentially affected Indian tribes.

Continued coordination is ongoing and the potential for Indian sacred sites to be affected would be addressed during project-level review. In the event of potential short-term impacts, the following types of mitigation measures could be implemented.

- Conduct tribal outreach to identify potentially affected cultural and tribal resources, including sacred sites, and avoid potential access conflicts or permanent changes adversely affecting sacred sites to the extent feasible.
- Limit the timing of construction activities with the potential to disturb use of affected cultural and tribal resources, including sacred sites.
- Compensate for potential disturbance to affected cultural and tribal resources, including sacred sites as appropriate.

4.22.7.2 Long-term Impacts

As discussed above, any impacts with the potential to result in lasting damage to sacred sites would be addressed prior to construction.

4.23 Indian Trust Assets and Fishing Harvest

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.23, Indian Trust Assets and Fishing Harvest, from construction and operation related to the No-action Alternative and Program Alternatives. Potential impacts on water quality are addressed in Section 4.5, Water Quality. Potential impacts on fish and special-status species are addressed in Sections 4.7, Fish, and 4.10, Threatened and Endangered Species, respectively. Any impacts to land-based ITAs such as reservation lands or Native Allotments would require review by the Bureau of Indian Affairs (BIA). Impacts to resource-based ITAs such as treaty-protected fisheries rights would require negotiation between the Indian tribe and the State of Washington. Projects involving state capital funding would also be required to comply with Governor’s Executive Order 05-05, which requires consultation with potentially affected Indian tribes as part of the decision to provide funds.

4.23.1 No-action Alternative

4.23.1.1 Short-term Impacts

Under the No-action Alternative, various entities and agencies would undertake individual actions that have the potential to affect ITAs that may be present in the Icicle Creek Watershed project area. The No-action Alternative would include construction of water diversion modifications, general habitat enhancement projects, LNFH improvements, required fish screening upgrades, modernization of infrastructure at the

Alpine Lakes including the restoration of the Eightmile Lake Dam, and improvements to existing irrigation systems to support agricultural reliability.

Construction activities can disturb ITAs by blocking access to the resource, including any Usual & Accustomed fishing areas, such as occur near the LNFH plunge pool, or by resulting in other environmental impacts that can degrade the ITAs, such as water quality impacts adversely affecting fish. Water quality impacts are addressed in Section 4.5, Water Quality.

Prior to construction, federal agencies taking action on the projects would be required to ensure compliance with the regulations specific to the protection of ITAs described in Section 1.9, Related Permits, Actions, and Laws. Any impacts to land-based ITAs such as reservation lands or Native Allotments would require review by the Bureau of Indian Affairs (BIA). Impacts to resource-based ITAs such as treaty-protected fisheries rights would require negotiation between the Indian tribe and the State of Washington. Projects involving state capital funding would also be required to comply with Governor’s Executive Order 05-05, which requires consultation with potentially affected Indian tribes as part of the decision to provide funds.

Compliance could result in the development of mitigation measures to reduce impacts, such as minimizing disruptive activities, implementing timing restrictions on construction activities, and compensating for any impacts that cannot be avoided (see Section 4.23.7, Mitigation Measures).

4.23.1.2 Long-term Impacts

Any impacts with the potential to result in lasting damage to ITAs would be addressed prior to construction through the compliance processes described above. For the most part, the No-action Alternative is not expected to result in any additional changes that would adversely affect ITAs over the long term because most of the affected facilities already exist, would not be located in areas where ITAs exist, or would have already been evaluated prior to construction as described above. Potential long-term impacts on sites sacred to Indian tribes are addressed in Section 4.22, Indian Sacred Sites.

4.23.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in an increase in impacts on tribal resources compared with the No-action Alternative because there would be greater likelihood that multiple projects would be implemented and the scale of certain efforts would likely be greater. Compliance with the Guiding Principles addresses tribal resources in general by improving instream flows, improving the sustainability of LNFH, protecting tribal and non-tribal harvest, and enhancing Icicle Creek riparian habitat. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.23.2.1 Short-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

As noted in Section 3.23, Indian Trust Assets and Fishing Harvest, no ITAs have been formally identified within the Alpine Lakes Optimization, Modernization, and Automation Project sites and no tribal fish harvest is known to occur at the project site. However, coordination with the Confederated Tribes and Bands of the Yakama Indian Nation (YN) and Confederated Tribes of the Coleville Reservation (CTCR) is ongoing with the intention of minimizing the potential for impacts on any ITAs.

Most of the work would occur in upland areas. Some limited work would occur within the lake shorelines but within the dry when the lakes are drawn down at the end of the summer. This work is expected to have a low potential to result in short-term impacts on any ITAs. The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review.

IPID Irrigation Efficiencies

Construction activities associated with the IPID Irrigation Efficiencies Project include the conversion of irrigation canals to pipelines and lining of irrigation canals with concrete. This work would occur within already developed areas and has a low likelihood of disturbing ITAs, including tribal fish harvest. The Icicle Creek Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

COIC Irrigation Efficiencies and Pump Exchange

Construction activities associated with the COIC Irrigation Efficiencies and Pump Exchange Project would be similar to those described above with the exception of a new COIC pump station to be constructed along the shoreline of Icicle Creek or the Wenatchee River. Depending on the specific location of the pump station, there is a potential for construction activities to disturb ITAs, including tribal fish harvest, in the short term. Potential impacts on fish in general are addressed in Section 4.7, Fish.

The Icicle Creek Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Domestic Conservation Efficiencies

Certain components of the Domestic Conservation Efficiencies Project, such as evaluating conservation-oriented rate structures and expanding conservation education, xeriscape, and rebate programs, would not result in any construction activities. Other activities, such as replacing leaky water mains and residential meters, could result in some minor construction activities, including the potential for ground disturbance. However, any groundwork would occur in areas that were previously disturbed during construction of the initial plumbing and pipework. Therefore, the potential for any impacts on ITAs would be low.

Eightmile Lake Storage Restoration

As noted in Section 3.23, Indian Trust Assets and Fishing Harvest, no ITAs have been formally identified with the Eightmile Lake Storage Restoration Project site and no tribal fish harvest occurs at the project site. However, coordination with the YN and CTCR is ongoing with the intention of minimizing the potential for impacts on any ITAs.

Construction activities for this project would be largely limited to the dry lake margins and existing structures and is expected to have a low potential to result in short-term impacts of any ITAs.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Tribal Fishery Preservation and Enhancement

The specifics of the Tribal Fishery Preservation and Enhancement Project are not yet determined, but could involve some minor new facilities along Icicle Creek near the LNFH. Depending on the specifics of this project, there is a potential that construction activity could affect ITAs, including potential disruption of fishing activities, in the short term. The potential impacts on fish in general are addressed in Section 4.7, Fish. The overall project is intended to preserve ITAs in accordance with the Guiding Principles.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Habitat Protection and Enhancement

The specifics of the Habitat Protection and Enhancement Project are not yet determined, but would likely involve some construction activity, including grading; planting and thinning vegetation; hauling and placing logs, rock, soil, and other materials; and some in-water work on lower Icicle Creek. Depending on the specifics of this project, there is a potential that construction activity could affect ITAs, including potential disruption of fishing activities, in the short term. The potential impacts on fish in general are addressed in Section 4.7, Fish.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Instream Flow Rule Amendment

The Instream Flow Rule Amendment Project would not involve any construction activities or physical changes or disturbance in the short-term and would therefore not result in any short-term impacts on ITAs.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

The focus of this project is to implement improvements for water quality and water use efficiency at the LNFH. Some ground disturbance would occur as well as modifications to the facility. Most activity is anticipated to occur within the boundaries of the hatchery; however, there would be some construction activities along lower Icicle Creek. Depending on the specifics of this project, there is a potential for construction activity to affect ITAs, including disruption of fishing activities, in the short term. The potential impacts on fish in general are described in Section 4.7, Fish.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review. Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential short-term impacts under NEPA would be completed once the full scope of the project is determined, which could include the development of mitigation measures, such as are listed in Section 4.23.6, Mitigation Measures.

Fish Passage Improvements

The Fish Passage Improvements Project would potentially involve modification of existing LNFH instream structures in Icicle Creek as well as instream modifications to the Boulder Field near RM 5.6. This work would result in disturbances along the streambank and within Icicle Creek. Depending on the specifics of this project, there is a potential for construction activity to affect ITAs, including disruption of fishing activities, in the short term. The potential impacts on fish in general are described in Section 4.7, Fish.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Fish Screen Compliance

The Fish Screen Compliance Project involves replacing fish screens at three different diversions on Lower Icicle Creek: LNFH/COIC, the City of Leavenworth, and IPID. Some ground-disturbing activities would likely be required. Depending on the specifics of this project, there is a potential for construction activity to affect ITAs, including disruption of fishing activities, in the short term. The potential impacts on fish in general are described in Section 4.7, Fish.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Water Markets

The Water Markets Project would not involve any construction activities, physical changes, or disturbance in the short term and would therefore not result in any short-term impacts on ITAs.

4.23.2.2 Long-term Impacts

Alpine Lakes Optimization, Modernization, and Automation

Similar to existing conditions and the No-action Alternative, some level of ongoing operations and maintenance activities would occur under the Alpine Lakes Optimization, Modernization, and Automation Project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lakes would result in changes in how frequently the lakes are drawn down, but would not result in any changes in the high or low levels. As noted in Sections 3.11, Aesthetics, and 3.18, Shorelines, increased frequency of withdrawals are not anticipated to result in substantial visual changes or increased erosion that would significantly alter the shoreline. Therefore, the potential for long-term impacts affecting any ITAs that might occur within this area is low.

As noted in Section 4.7, Fish, there is a potential for impacts on fish as the result of increased flows in lower Icicle Creek. These impacts could include some localized changes in habitat, increased competition between fish for any limiting resources, and some genetic mixing within otherwise distinct populations of the same species; however, the overall impacts are anticipated to be beneficial for fish and for related fisheries, including those supporting tribal harvest.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation and monitoring measures, such as are listed in Section 4.23.7, Mitigation Measures.

IPID Irrigation Efficiencies

As noted in Section 4.23.2.1, Short-term Impacts, the IPID Irrigation Efficiencies Project would not result in the development of new facilities. Operation and maintenance activities of existing facilities would have limited potential to result in long-term impacts adversely affecting ITAs or fish harvest.

As discussed in greater detail in Section 4.7, Fish, this project would result in changes to instream flows that have a potential to alter the distribution of fish within lower Icicle Creek. These changes may affect tribal fishing. As part of the overall Icicle Strategy, efforts to characterize the impacts of the managed flows on fish species are ongoing. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs and tribal fishing to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.23.7, Mitigation Measures, would ensure any potential impacts are addressed.

COIC Irrigation Efficiencies and Pump Exchange

In general, the long-term impacts associated with the COIC Irrigation Efficiencies and Pump Exchange Project would be similar to those described for the IPID Irrigation Efficiencies Project with the exception of those related to the COIC pump station and intake facilities. These facilities would result in new facilities along lower Icicle Creek or the Wenatchee River, and depending on the specific location could adversely affect ITAs and tribal fishing. Continued coordination with potentially affected Indian tribes is ongoing and the potential for these resources to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.23.7, Mitigation Measures, would ensure any potential impacts are adequately addressed.

Domestic Conservation Efficiencies

The Domestic Conservation Efficiencies Project involves evaluating conservation-oriented rate structures and expanding conservation education, xeriscape, and rebate programs, which are not expected to affect ITAs. After completing any elements involving construction, such as fixing leaky water mains and replacing residential meters, operation and maintenance activities affecting these facilities are expected to be less than what would occur with existing conditions and the No-action Alternative.

Eightmile Lake Storage Restoration

Similar to existing conditions and the No-action Alternative, some level of ongoing operations and maintenance activities would occur under the Eightmile Lake Storage Restoration Project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lake would allow the lake to rise to approximately 4 feet higher than the current high level, which would occur for less than a month in early summer. It would also allow for the lake to be drawn down to approximately 22.4 feet below the existing low. As noted in Sections 3.11, Aesthetics, and 3.18, Shorelines, increased frequency of withdrawals are not anticipated to result in substantial visual changes or increased erosion that would significantly alter the shoreline. Therefore, the potential for long-term impacts affecting any ITAs that might occur within this area is low.

As noted in Section 4.7, Fish, there is a potential for impacts on fish as the result of flow changes in lower Icicle Creek. These impacts could include some localized changes in habitat, increased competition between fish for any limiting resources, and some genetic mixing within otherwise distinct populations of the same species; however, the overall impacts are anticipated to be beneficial for fish and for related fisheries, including those supporting tribal harvest. The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.6, Mitigation Measures.

Tribal Fishery Preservation and Enhancement

As noted above, the specifics of the Tribal Fishery Preservation and Enhancement Project are not yet determined, but could involve some minor new facilities along Icicle Creek near the LNFH. It is not anticipated that operation and maintenance activities would result in any new or ongoing impacts on ITAs.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Habitat Protection and Enhancement

The specifics of the Habitat Protection and Enhancement Project are not yet determined, but would include restoration and enhancement activities that are not likely to include new facilities that would require any ongoing operation or maintenance activities. There would be limited potential for long-term impacts affecting ITAs.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Instream Flow Rule Amendment

This project involves an administrative change to the Instream Flow Rule to allow for additional water withdrawals to occur on Icicle Creek if certain conditions are met.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Leavenworth National Fish Hatchery Conservation and Water Quality Improvements

As noted above, the specifics of this project are not yet determined, but would involve some modifications to the LNFH. Operation and maintenance activities would occur within the facilities and would not be likely to affect ITAs over the long term.

Because this facility is owned by Reclamation and operated by USFWS, an evaluation of the potential impacts under NEPA would be completed once the full scope of the project is determined. The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Fish Passage Improvements

As noted above, the specifics of the Fish Passage Improvements Project are not yet determined, but could involve some minor new facilities along Icicle Creek near the LNFH. It is not anticipated that operation and maintenance activities would result in any new or ongoing impacts on ITAs. The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Fish Screen Compliance

As noted in 4.23.2.1, Short-term Impacts, the specifics of the Fish Screen Compliance Project are not yet determined, but would involve replacing fish screens along Icicle Creek. It is not anticipated that operation and maintenance activities would result in any new or ongoing impacts on ITAs. The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Water Markets

The Water Markets Project is expected to result in beneficial impacts for increased water availability within the Icicle Creek Subbasin and is not expected to adversely affect ITAs.

4.23.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project. Impacts of other projects are discussed in Alternative 1.

4.23.3.1 Short-term Impacts

IPID Dryden Pump Exchange

The IPID Dryden Pump Exchange Project involves construction of a new IPID pump station and intake facilities on the Wenatchee River. Depending on the specifics of this project, there is a potential that construction activity could affect ITAs, including fishing harvest, in the short term.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

4.23.3.2 Long-term Impacts

IPID Dryden Pump Exchange

As noted above, the IPID Dryden Pump Exchange Project would construct an IPID pump station on the Wenatchee River and possibly a re-regulation pond. Operation and maintenance activities of these facilities would take place within developed areas and would have limited potential to result in long-term impacts on ITAs.

4.23.4 Alternative 3

Alternative 3 would result in the implementation of many of the same projects included in Alternative 2 with the exception that the Legislative Change Creating OCPI Authority for Alternative 3 Project would be included while the Eightmile Lake Storage Restoration Project would not. This section describes the specific short- and long-term impacts associated with the Legislative Change Creating OCPI Authority for Alternative 3 Project.

4.23.4.1 Short-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

There are no construction activities proposed under this project and therefore no potential short-term impacts on ITAs.

4.23.4.2 Long-term Impacts

Legislative Change Creating OCPI Authority for Alternative 3

If the proposed Legislative Change Creating OCPI Authority for Alternative 3 Project were enacted, there could be potential conflicts with instream flow allocations. Under the proposed changes, junior domestic water rights could be exercised even when the Instream Flow Rule is not met.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

4.23.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1 with the exception that the Eightmile Lake Storage Enhancement Project would replace the Eightmile Lake Storage Restoration Project, and the Upper Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects would be included. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.23.5.1 Short-term Impacts

Eightmile Lake Storage Enhancement

As noted in Section 3.23, Indian Trust Assets and Fishing Harvest, no ITAs have been formally identified with the Eightmile Lake Storage Enhancement Project site and no tribal fish harvest occurs at the project site. However, coordination with the YN and CTCR is ongoing with the intention of minimizing the potential for impacts on any ITAs.

Construction activities for this project would be largely limited to the dry lake margins and existing structures and is expected to have a low potential to result in short-term impacts of any ITAs.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Upper Klonaqua Lake Storage Enhancement

As noted in Section 3.23, Indian Trust Assets and Fishing Harvest, no ITAs have been formally identified with the Upper Klonaqua Lake Storage Enhancement Project site and no tribal fish harvest occurs at the project site. However, coordination with the YN and CTCR is ongoing with the intention of minimizing the potential for impacts on any ITAs.

Construction activities for this project would be largely limited to the dry lake margins and existing structures and is expected to have a low potential to result in short-term impacts of any ITAs.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Upper and Lower Snow Lakes Storage Enhancement

As noted in Section 3.23, Indian Trust Assets and Fishing Harvest, no ITAs have been formally identified with the Upper and Lower Snow Lakes Storage Enhancement Project site and no tribal fish harvest occurs at the project site. However, coordination with the YN and CTCR is ongoing with the intention of minimizing the potential for impacts on any ITAs.

Construction activities for this project would be largely limited to the dry lake margins and existing structures and is expected to have a low potential to result in short-term impacts of any ITAs.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

4.23.5.2 Long-term Impacts

Eightmile Lake Storage Enhancement

Similar to existing conditions and the No-action Alternative, some level of ongoing operations and maintenance activities would occur under the Eightmile Lake Storage Enhancement project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lake would allow the lake to rise to approximately 15 feet higher than the current high level and 11 feet higher than the historical high water level. The lake would operate full to the new high water level for less than a month in early summer. It would also allow for the lake to be drawn down to approximately 24.4 feet below the existing low.

As noted in Sections 3.11, Aesthetics, and 3.18, Shorelines, increased frequency of releases are not anticipated to result in substantial visual changes or increased erosion that would significantly alter the shoreline. Therefore, the potential for long-term impacts affecting any ITAs that might occur within this area is low.

As noted in Section 4.7, Fish, there is a potential for impacts on fish as the result of flow changes in lower Icicle Creek. These impacts could include some localized changes in habitat, increased competition between fish for any limiting resources, and some genetic mixing within otherwise distinct populations of the same species; however, the overall impacts are anticipated to be beneficial for fish and for related fisheries, including those supporting tribal harvest. The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation and monitoring measures, such as are listed in Section 4.23.7, Mitigation Measures.

Upper Klonaqua Lake Storage Enhancement

Compared to existing conditions and the No-action Alternative, some level of ongoing activities would occur for operations and maintenance under the Upper Klonaqua Lake Storage Enhancement Project; however, these activities would focus on maintaining and operating the new facilities and are not expected to result in any substantial changes to the structures or ground disturbance.

Re-operation of the lake would allow Upper Klonaqua Lake to be lowered approximately 20 feet, which would likely occur for 1 to 2 months in the late summer. There would be no changes at Lower Klonaqua Lake. As noted in Sections 3.11, Aesthetics, and 3.18, Shorelines, increased frequency of withdrawals are not anticipated to result in substantial visual changes or increased erosion that would significantly alter the shoreline. Therefore, the potential for long-term impacts affecting any ITAs that might occur within this area is low.

As noted in Section 4.7, Fish, there is a potential for impacts on fish as the result of flow changes in lower Icicle Creek. These impacts could include some localized changes in habitat, increased competition between fish for any limiting resources, and some genetic mixing within otherwise distinct populations of the same species; however, the overall impacts are anticipated to be beneficial for fish and for related fisheries, including those supporting tribal harvest. The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

Upper and Lower Snow Lakes Storage Enhancement

Similar to existing conditions and the No-action Alternative, some level of ongoing activities would occur for operations and maintenance under the Upper and Lower Snow Lakes Storage Enhancement Project; however, because the facilities would be newer and operated remotely by IPID, any trips to and from the lakes or activities needed to maintain the facilities are expected to be less frequent and extensive than what would occur compared to existing conditions and the No-action Alternative.

Re-operation of the lakes would allow both lakes to rise to approximately 5 feet higher than the current high level and 3 feet lower than the current low. As noted in Sections 3.11, Aesthetics, and 3.18, Shorelines, increased frequency of withdrawals are not anticipated to result in substantial visual changes or increased erosion that would significantly alter the shoreline. Therefore, the potential for long-term impacts affecting any ITAs that might occur within this area is low.

As noted in Section 4.7, Fish, there is a potential for impacts on fish as the result of flow changes in lower Icicle Creek. These impacts could include some localized changes in habitat, increased competition between fish for any limiting resources, and some genetic mixing within otherwise distinct populations of the same species; however, the overall impacts are anticipated to be beneficial for fish and for related fisheries, including those supporting tribal harvest. The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures.

4.23.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange project would be included.

4.23.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

The IPID Full Piping and Pump Exchange project involves construction of new pump stations and intake facilities on the Wenatchee River. This project would also fully replace the IPID canal systems with a pressurized pipeline delivery system. Depending on the specifics of this project, there is a potential that construction activity could affect ITAs, mainly fishing harvest, in the short term.

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on tribal harvest. Continued coordination with potentially affected Indian tribes is ongoing and the potential for ITAs to be affected would be addressed during project-level review, which could include the development of mitigation measures, such as are listed in Section 4.23.7, Mitigation Measures. Potential impacts on fish in general are addressed in Section 4.7, Fish.

4.23.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

As noted above, the IPID Full Piping and Pump Exchange Project would construct three new pump stations on the Wenatchee River and replace the entire existing IPID canal delivery system with a pressurized pipeline. Operation and maintenance activities of the pump stations would take place within developed areas and would have limited potential to result in long-term impacts on ITAs.

Continued coordination with potentially affected Indian tribes is ongoing and the potential for these resources to be affected would be addressed during project-level review. Compliance with the regulations as discussed in Section 4.23.7, Mitigation Measures, would ensure any potential impacts are adequately addressed.

4.23.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.23.7.1 Short-Term Impacts

The Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring the suite of selected projects does not result in significant adverse impacts on tribal harvest. In addition, federal actions and projects receiving state capital funds require coordination with potentially affected Indian tribes.

Continued coordination is ongoing and the potential for ITAs to be affected would be addressed during project-level review. In the event of potential short-term impacts, the following types of mitigation measures could be implemented.

- Conduct tribal outreach to identify potentially affected cultural and tribal resources, including ITAs, and avoid potential access conflicts or permanent changes adversely affecting ITAs to the extent feasible.
- Limit the timing of construction activities with the potential to disturb use of affected cultural and tribal resources, including ITAs.
- Compensate for potential disturbance to affected cultural and tribal resources, including ITAs as appropriate.

4.23.7.2 Long-term Impacts

As discussed above, any impacts with the potential to result in lasting conflicts or damage to ITAs would be addressed prior to construction.

- Adaptive monitoring of the Tribal Harvest as project implementation occurs.

4.24 Socioeconomics

This section describes the potential short- and long-term impacts that could affect the resources identified in Section 3.24, Socioeconomics, from construction and operation related to the No-action Alternative and Program Alternatives.

Although a cost-benefit analysis is not required by the State Environmental Policy Act, one may be completed to aid in the consideration of environmentally different Program Alternatives and has, therefore, been completed to provide additional decision-making information. To this end, Ecology's Office of Economic and Regulatory Research completed an analysis of anticipated costs and benefits, using the Washington State OFM 2007 Input/Output Model for the No Action and Alternatives 1 through 4. The analysis need not be displayed in monetary terms when there are important qualitative considerations (WAC 197-11-726). Although the OFM modeling did not include Alternative 5, the discussion of costs and benefits presented below does address the relative socioeconomic impacts of Alternative 5 in qualitative terms.

Results from the Office of Financial Management (OFM) 2007 Input/Output Model are presented in Table 4-5. Inputs to the model, such as construction costs, are preliminary estimates to be refined as the project elements are more fully developed and designed. For this reason, the model results are most useful for comparing the costs and benefits of the Program Alternatives rather than providing an absolute value of costs or benefits. The output categories include the total number of jobs created, the corresponding labor income, and the related long-term economic impact of the increase in spending and jobs. Outputs also include the number of additional households that would be served by increased domestic water supply afforded under each Program Alternative, the associated increase in land value as the result of development, and the corresponding increases in property tax revenue that would be generated as the result of the additional households. These results are more fully described in the sections that follow for each Program Alternative.

Table 4-5
OFM 2007 Input/Output Model Results for Costs and Benefits Associated with Program Alternatives

	Construction Costs[1]	Job Creation	Labor Income	Long-term Economic Impact	Additional Households Served by Increased Domestic Water Supply	Increase in Land Value Associated with Additional Households	Increase in Property Tax Revenue Associated with Additional Households
Alternative 1	$43.7 M	514	$29.2 M	$100.4 M	10,076	$1,312.6 M	$1.6 M
Alternative 2	$49.0 M	576	$32.7 M	$112.5 M	10,076	$1,312.6 M	$1.6 M
Alternative 3	$47.8 M	562	$32.0 M	$109.9 M	5,709	$743.7 M	$0.9 M
Alternative 4	$45.2 M*	531	$30.2 M	$103.8 M	12,473	$1,624.8 M	$2.0 M
Alternative 5[2]	$43.7 M +	514 +	$29.2 M +	$100.4 M +	10,076	$1,312.6 M	$1.6 M

Source: Washington State Department of Ecology
[1] OFM model input based on assumed costs of construction. Not a model output.
[2]The costs and benefits of Alternative 5 are unknown at this point, but are expected to be great than Alternative 1. This is because Alternative 5 includes the same projects as Alternative 1, but IPID Irrigation Efficiency project is replaced by the IPID Full Piping and Pump Exchange project. Construction costs and instream flow benefits will be greater for the IPID Fulling Piping and Pump Exchange project.
*Construction costs unavailable for Upper Klonaqua Lake Storage Enhancement Project because it is currently in the conceptual stage.
M = million
OFM = Washington State Office of Financial Management

In addition to the OFM analysis, biologists with Ecology analyzed the anticipated net increases in wild steelhead (*Oncorhynchus mykiss*) and hatchery fish for the Icicle Creek Reach 2. The number of returning fish was based on several factors, including the anticipated instream flow increases described in Sections 2.5, 2.6, 2.7, and 2.8, and the expected escapement and stock size. The analysis further assumes that the fish would return to their natal streams over a period of 20 years. A per-fish value of $7,200 was assigned, based on Layton et al.'s research *Valuing Programs to Improve Multi-Species Fisheries* (Layton et al., 1999). As with the results from the OFM 2007 Input/Output Model, the findings presented in Table 4-6 are most useful when considered as the basis for a relative comparison. Additional increases in fish populations beyond those presented in Table 4-6 are anticipated to occur within the Wenatchee River.

Table 4-6
Assumed Fish Increases for Each Program Alternative

	Wild Steelhead	Hatchery Fish	Total Value of Fish Increases
Alternative 1	50	28	$561,600
Alternative 2	54	31	$612,000
Alternative 3	49	28	$554,400
Alternative 4	51	29	576,000
Alternative 5	69	39	$777,600

4.24.1 No-action Alternative

Under the No-action Alternative, projects could be developed and executed on their own that would lead to some job creation, labor income, long-term economic impacts, increased housing and growth, changes in land values, and additional property tax revenue. However, there would be no coordinated and integrated effort to ensure that the projects move forward in a well-planned manner. Because implementation of individual projects would be more localized, the socioeconomic benefits are expected to be lower compared to the other Program Alternatives.

4.24.2 Alternative 1 (Base Package)

Relative to the other Program Alternatives, Alternative 1 would result in the lowest construction costs, job creation, labor income, and long-term economic impact. Job creation and the long-term economic impact reflect the cycles of spending and earning in the economy as the initial construction investment works its way through the economy. Essentially, construction spending provides a jump-start to broader economic growth.

As increased water becomes available for future land development and growth, additional housing is expected to be developed. Alternative 1 ranks in the middle regarding the number of households likely to increase as a result and in the middle with respect to the expected increase in land value and property tax revenue associated with development.

Based on the amount of water made available that would benefit fish, Alternative 1 would result in the second lowest increase in fish.

4.24.3 Alternative 2

Alternative 2 is assumed to have the highest construction costs, and, therefore, is expected to result in the highest job creation, labor income, and long-term economic impact compared to the other Program Alternatives. These results could change once construction costs for Upper Klonaqua Lake Storage Enhancement can be estimated for Alternatives 4 and 5. Construction costs for that project were not available at the time of this analysis.

Alternative 2 provides for the same increase as Alternative 1 in the number of households likely to be supported by the increase in domestic water supply, and by extension, the same increase in land value and property tax revenue. Both are in the middle range compared to the other Program Alternatives.

The anticipated fish increases are greater than Alternatives 1, 3, and 4, but less than Alternative 5.

4.24.4 Alternative 3

Construction costs, job creation, labor income, and long-term economic impact with Alternative 3 are higher than Alternatives 1 and 4, but less than Alternative 2[1] and most likely Alternative 5. The increase in households related to increased domestic water supply and associated increases in land value and property tax revenue are approximately half of what is anticipated with Alternatives 1 and 2. This decline in the number of additional households by comparison is likely due to the fact that Alternative 3 would require adoption of a legislative change to allow for some additional water to be withdrawn to support future growth, meaning water available for future development would be more limited. Because less water is available to meet domestic needs, there would be less growth in the number of households expected under Alternative 3.

The increases in the number of and overall value of fish would be lowest.

4.24.5 Alternative 4

Alternative 4 is assumed to have greater construction costs, and therefore, higher job creation, labor income, and long-term economic impact than Alternative 1, but less than

[1] As noted previously, costs associated with Alternative 3 may be less than Alternative 4 after incorporation of construction costs for the Upper Klonaqua Lake Storage Enhancement Project, which were not available at the time of this analysis.

Alternatives 2, 3, and 5 although it is possible that construction costs and job creation associated with Alternative 4 could be close to the highest overall after incorporation of construction costs for the Upper Klonaqua Lake Storage Enhancement Project; however, this information was not available at the time of this analysis. In terms of the domestic water supply, Alternative 4 provides for the greatest increase in households served and the associated increases in land value and property tax overall. It also provides for the third greatest increase in the number and value of fish just below Alternatives 2 and 5.

4.24.6 Alternative 5

Although this information was not available at the time this EIS was published, Alternative 5 is expected to have the highest construction costs of all the Program Alternatives because the cost of the IPID Full Piping and Pump Exchange Project alone is $72.5 to $83.7 million. The higher the costs of construction, the greater the job creation, labor income, and long-term economic impact. Alternative 5 is also expected to result in the greatest increase in fish for the Icicle Reach 2 of all the Program Alternatives.

4.25 Environmental Justice

This section considers the potential to disproportionately affect minority and low-income populations, as described in Section 3.25, Environmental Justice, from construction and operation related to the No-action Alternative and Program Alternatives.

Environmental justice impacts occur when significant environmental impacts disproportionately affect minority or low-income populations. To determine the potential for environmental justice impacts, this analysis first assesses the presence of populations or important resources to these populations within the Icicle Creek Watershed project area.

As noted in Section 3.25, Environmental Justice, U.S. Census Bureau data do not indicate the presence of minority or low-income populations in a substantially greater proportion compared to Chelan County or the State of Washington. However, as discussed in Sections 3.21, Cultural Resources; 3.22, Indian Sacred Sites; and 3.23, Indian Trust Assets and Fishing Harvest, there are important cultural and tribal resources that are especially important resources to the Confederated Tribes and Bands of the Yakama Nation and Confederated Tribes of the Colville Reservation. These Indian tribes are both members of the IWG and preliminary information has been gathered during initial project planning and early coordination with these Indian tribes. Ongoing coordination through the IWG and subsequent project-level permitting and review, including formal environmental justice assessments for any federal actions, would occur through program implementation. Accordingly, the analysis in this section focuses on the potential for the

Icicle Strategy to result in significant impacts on cultural and tribal resources as discussed in greater detail below.

4.25.1 No-action Alternative

4.25.1.1 Short-term Impacts

In the short term, environmental justice impacts would occur if construction significantly disturbed cultural or tribal resources. Depending on the extent of ground disturbance, construction activities could damage any archaeological resources or sacred sites that may be present. Construction can also disturb or conflict with ceremonial uses, ITAs, and use of any Usual & Accustomed Areas, including tribal fishing harvest.

Under the No-action Alternative, the greatest potential for environmental justice impacts would be related to projects involving work in areas with high archaeological potential as noted in Section 3.21, Cultural Resources, or within or near waterways in areas that could directly or indirectly conflict with tribal fishing as noted in Section 3.23, Indian Trust Assets and Fishing Harvest.

As noted previously, prior to construction, federal agencies taking action on the projects would be required to ensure compliance with the regulations specific to the protection of ITAs described in Section 1.9, Related Permits, Actions, and Laws. Any impacts to land-based ITAs such as reservation lands or Native Allotments would require review by the BIA. Impacts to resource-based ITAs such as treaty-protected fisheries rights would require negotiation between the Indian tribe and the State of Washington. Projects involving state capital funding would also be required to comply with Governor's Executive Order 05-05, which requires consultation with potentially affected Indian tribes as part of the decision to provide funds.

Compliance could result in the development of mitigation measures to reduce impacts, such as minimizing disruptive activities, implementing timing restrictions on construction activities, and compensating for any impacts that cannot be avoided (Section 4.25.7, Mitigation Measures).

4.25.1.2 Long-term Impacts

The greatest potential for environmental justice impacts would occur for any projects resulting in long-term operations and maintenance activities that could conflict with tribal uses, including sacred or ceremonial sites, ITAs, or tribal fishing harvest. These impacts would be primarily related to any new or upgraded facilities, affecting flow changes, or long-term access to fishing areas. Under the No-action Alternative, the projects likely to be implemented are expected to improve aquatic habitat, which would benefit tribal fishing; however, work at the LNFH or any new facilities along Icicle Creek could result in potential long-term conflicts with tribal fishing. As noted previously, compliance with applicable local, state, and federal regulations would require addressing potential impacts on these resources (Section 4.25.7, Mitigation Measures).

4.25.2 Alternative 1 (Base Package)

Implementation of Alternative 1 has the potential to result in greater impacts on cultural and tribal resources, and, therefore, environmental justice impacts, compared with the No-action Alternative, because there would be higher likelihood that certain projects would be implemented and the scale of certain efforts would likely be greater. Compliance with the Guiding Principles addresses tribal resources in general by improving instream flows, improving the sustainability of LNFH, protecting tribal and non-tribal harvest, and enhancing Icicle Creek riparian habitat. The following sections describe the short- and long-term impacts that would occur under Alternative 1.

4.25.2.1 Short-term Impacts

Implementation of Alternative 1 would result in an increase in the potential for short-term impacts on cultural and tribal resources compared to the No-action Alternative. Under Alternative 1, there is a moderate to low potential for significant short-term impacts on cultural and tribal resources at Eightmile Lake (primarily associated with changes to the dam structure), at the LNFH, and at other locations, not yet determined, along the lower Icicle Creek. Depending on the specific location for the COIC pump station, potential impacts could also occur along the Wenatchee River.

Depending on the specific location and extent of the activities, construction disturbance in these areas could adversely affect any sacred or ceremonial sites or ITAs if the activities altered important features of these resources or directly disturbed their use. Construction activities within or along the shoreline of Icicle Creek could also alter the quality of fishing habitat, directly harm or disturb fish, or block access to fishing areas.

As noted in Section 1.2, The Icicle Strategy Guiding Principles, the Icicle Strategy would be required to comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Continued coordination with potentially affected Indian tribes is ongoing and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the short term would be low.

4.25.2.2 Long-term Impacts

Because potential impacts resulting in the direct damage or disturbance of cultural or tribal resources, including sacred sites, ceremonial uses, or ITAs, would largely be addressed during project-level permitting prior to construction, the greatest potential for long-term environmental justice impacts would occur as the result of operation and maintenance activities, including long-term flow changes affecting Icicle Creek, that could adversely affect tribal fishing.

As noted in Section 4.7, Fish, implementation of the projects being considered under Alternative 1 would generally result in beneficial impacts on fish and by extension, tribal fishing; however, there is the potential for some of the projects to result in localized impacts on tribal fishing over the long term. Specifically, operation and maintenance activities at LNFH and the management of releases from the Alpine Lakes by IPID and USFWS could result in changes to aquatic habitat and fishing conditions within lower Icicle Creek over time.

In recognition of these potential impacts, the Icicle Strategy would comply with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Additionally, implementation of Alternative 1 includes the Tribal Fishery Preservation and Enhancement Project to ensure that any long-term impacts on tribal fishing are appropriately mitigated. Continued coordination with potentially affected Indian tribes is ongoing and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the long term would be low.

4.25.3 Alternative 2

Alternative 2 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project would be included while the Alpine Lakes Optimization, Modernization, and Automation Project would not. Compliance with the Guiding Principles addresses tribal resources in general by improving instream flows, improving the sustainability of LNFH, protecting tribal and non-tribal harvest, and enhancing Icicle Creek riparian habitat. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project and describes the primary differences in impacts from not implementing the Alpine Lakes Optimization, Modernization, and Automation Project compared to Alternative 1 and the No-action Alternative.

4.25.3.1 Short-term Impacts

The potential impacts on cultural and tribal resources would be similar to those described under Alternative 1 with the exception that there would be no modernization of facilities at Colchuck, Upper Klonaqua, Square, Nada, and Upper and Lower Snow Lakes. Therefore, the relatively low potential to adversely affect cultural or tribal resources at these lakes would not occur. By comparison, Alternative 2 would result in a slightly increased potential for disturbing archaeological resources and possibly tribal fishing along the Wenatchee River. The overall likelihood is considered to be moderate and the degree of the impact would depend on the specific location of the IPID Dryden pump exchange.

Similar to Alternative 1, Alternative 2 would require complying with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Continued coordination with potentially affected Indian tribes would continue and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the short term would be low.

4.25.3.2 Long-term Impacts

Over the long term, the potential for impacts on cultural or tribal resources would be similar to Alternative 1. Under Alternative 2, the majority of the projects are the same with the exception that there would be an additional new facility, the IPID Dryden Pump Exchange Project, constructed on the Wenatchee River. This would result in a slightly increased potential for long-term impacts on tribal fishing compared to Alternative 1, depending on the specific location of the facilities.

Similar to Alternative 1, Alternative 2 would require complying with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Additionally, implementation of Alternative 1 includes the Tribal Fishery Preservation and Enhancement Project to ensure that any long-term impacts on tribal fishing are appropriately mitigated. Continued coordination with potentially affected Indian tribes would continue and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the long term would be low.

4.25.4 Alternative 3

Alternative 3 would result in implementation of many of the same projects included in Alternative 1 with the exception that the IPID Dryden Pump Exchange Project and the Legislative Change Creating OCPI Authority for Alternative 3 Project would also be included, while the Alpine Lakes Optimization, Modernization, and Automation and Eightmile Lake Storage Restoration Projects would not. Compliance with the Guiding Principles addresses tribal resources in general by improving instream flows, improving the sustainability of LNFH, protecting tribal and non-tribal harvest, and enhancing Icicle Creek riparian habitat. This section describes the specific short- and long-term impacts associated with the IPID Dryden Pump Exchange Project and the Legislative Change Creating OCPI Authority for Alternative 3 Project and describes the primary differences in impacts from not implementing the Alpine Lakes Optimization, Modernization, and Automation or Eightmile Lake Storage Restoration Projects compared to Alternative 1 and the No-action Alternative.

4.25.4.1 Short-term Impacts

The potential impacts on cultural and tribal resources at the Alpine Lakes would be lower compared with Alternative 1 because there would no activities proposed at any of the lakes under Alternative 3. Potential impacts along Icicle Creek and the Wenatchee River corridors would generally be the same as Alternative 2 except for a slight potential increase to result in impacts related to construction of the IPID Dryden Pump Exchange Project.

Alternative 3 would also be implemented in compliance with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Continued coordination with potentially affected Indian tribes would continue and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the short term would be low.

4.25.4.2 Long-term Impacts

Over the long term, the potential for impacts on cultural or tribal resources would be slightly greater compared to Alternative 1. This is because Alternative 3 would require implementing the Legislative Change Creating OCPI Authority for Alternative 3 Project to ensure there was adequate future water for municipal users over the long term. If implemented, this change could result in the withdrawal of additional water from Icicle Creek that could potentially conflict with minimum instream flows, resulting in adverse impacts on aquatic habitat in general, including possible adverse impacts on tribal fishing.

Alternative 3 would also be implemented in compliance with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Additionally, implementation of Alternative 1 includes the Tribal Fishery Preservation and Enhancement Project to ensure that any long-term impacts on tribal fishing are appropriately mitigated. Continued coordination with potentially affected Indian tribes would continue and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the long term would be low.

4.25.5 Alternative 4

Alternative 4 would result in implementation of many of the same projects included in Alternative 1. The Eightmile Lake Storage Restoration Project would be replaced with the Eightmile Lake Storage Enhancement Project, and the Upper Klonaqua Lake and Upper and Lower Snow Lakes Storage Enhancement Projects would be included. Compliance with the Guiding Principles addresses tribal resources in general by improving instream flows, improving the sustainability of LNFH, protecting tribal and non-tribal harvest, and enhancing Icicle Creek riparian habitat. This section describes the specific short- and long-term impacts associated with these projects compared to Alternative 1 and the No-action Alternative.

4.25.5.1 Short-term Impacts

The potential for short-term impacts on cultural and tribal resources at the Alpine Lakes would be greater under Alternative 4 compared to Alternative 1. This is because there would be more extensive construction disturbance at Eightmile, Upper Klonaqua, and

Upper and Lower Snow Lakes under this Program Alternative. The potential for disturbance of cultural or tribal resources along Icicle Creek or the Wenatchee River would be the same as Alternative 1.

Alternative 4 would also be implemented in compliance with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Continued coordination with potentially affected Indian tribes would continue and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the short term would be low.

4.25.5.2 Long-term Impacts

Over the long term, the potential for impacts on cultural or tribal resources would be similar to Alternative 1. Alternative 4 would also be implemented in compliance with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Additionally, implementation of Alternative 1 includes the Tribal Fishery Preservation and Enhancement Project to ensure that any long-term impacts on tribal fishing are appropriately mitigated. Continued coordination with potentially affected Indian tribes would continue and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the long term would be low.

4.25.6 Alternative 5

Alternative 5 would result in implementation of the same projects as Alternative 1 except instead of the IPID Irrigation Efficiencies, the IPID Full Piping and Pump Exchange project would be included.

4.25.6.1 Short-term Impacts

IPID Full Piping and Pump Exchange

The potential impacts on cultural and tribal resources would be greater compared to those under Alternative 1. This is because Alternative 5 would result in an increased potential for disturbing archaeological resources related to full piping of the IPID conveyance system and at three pump station locations along the Wenatchee River.

Alternative 5 would require compliance with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Continued coordination with potentially affected Indian tribes would continue and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the short term would be low.

4.25.6.2 Long-term Impacts

IPID Full Piping and Pump Exchange

Over the long term, the potential for impacts on cultural or tribal resources would be similar to Alternative 1. Under Alternative 5, the majority of the projects are the same with the exception that there would be three pump stations constructed on the Wenatchee River and the existing IPID canal delivery system would be fully replaced with a pressurized pipeline. This would result in a slightly increased potential for long-term impacts on tribal fishing compared to Alternative 1, depending on the specific location of the pump stations.

Alternative 5 would require compliance with the Guiding Principles, which include ensuring there are no significant adverse impacts on cultural and tribal resources. Additionally, implementation of Alternative 1 includes the Tribal Fishery Preservation and Enhancement Project to ensure that any long-term impacts on tribal fishing are appropriately mitigated. Continued coordination with potentially affected Indian tribes would continue and the potential for tribal resources to be affected would be addressed during project-level review. With implementation of mitigation as described in Section 4.25.7, Mitigation Measures, the potential for significant environmental justice impacts in the long term would be low.

4.25.7 Mitigation Measures

This section describes required permits and approvals that would help to mitigate the potential environmental impacts identified above. Additional mitigation measures are also identified as appropriate.

4.25.7.1 Short-term Impacts

Short-term impacts on cultural and tribal resources would be mitigated by meeting the goals of the Guiding Principles, continuing coordination with potentially affected Indian tribes, and complying with the terms and conditions of local, state, and federal regulations and obtaining required project-specific permits and approvals. Common mitigation measures that would protect these resources from short-term impacts are addressed in the following sections:

- Section 4.5, Water Quality
- Section 4.7, Fish
- Section 4.8, Vegetation
- Section 4.9, Wildlife
- Section 4.10, Threatened and Endangered Species
- Section 4.21, Cultural Resources
- Section 4.22, Indian Sacred Sites
- Section 4.23, Indian Trust Assets and Fishing Harvest

4.25.7.2 Long-term Impacts

Potential impacts associated with the potential for lasting conflicts or damage to cultural or tribal resources would be addressed prior to construction as noted above. In addition, evaluation and monitoring of the potential impacts to fish and fish habitat related to the management of instream flows would be ongoing. For an additional discussion of how the Icicle Strategy proposes to evaluate these issues over time, see Section 4.7.7, Mitigation Measures in Section 4.7, Fish.

4.26 Summary of Impacts and Benefits of the Icicle Strategy by Alternative

4.26.1 Short-Term

Construction activities required for many of the project elements comprising the Program Alternatives would cause short-term impacts. These impacts include erosion and sedimentation, construction dewatering, vegetation removal, construction emissions and dust, noise, aesthetic impacts for equipment and stock piles, and traffic delays. Construction may also temporarily block access to areas near construction sites, resulting in temporary disruption to activities in those areas, such as fishing or recreational use. Additionally, other impacts such as increased noise and dust or aesthetic changes might create a disturbance for recreationalists and wilderness users. Noise and vibrations could also temporary disturb fish and wildlife species. Cultural resources could also be disturbed during construction and access to Usual & Accustomed Fishing sites could be temporary restricted, especially for any construction near the plunge pool in front of the LNFH. These access impacts would be temporary and could be minimized by scheduling construction after the fishing season. Table 4-7 provides short-term impacts of implementation for the five Program Alternatives and the No-Action Alternative.

Implementation of the various projects under the Program Alternatives would be phased overtime depending on the design process, environmental review, and available funding. Because of this, construction impacts for various projects under an alternative are not likely to occur at the same time, minimizing the cumulative impact at any given time. Additionally, some project may be phased specifically to reduce recreational, Indian Trust Assets, and wilderness user impacts.

Many of the projects proposed under the Program Alternatives could advance under the No-action Alternative. Ongoing projects would likely include work at LNFH to implement water re-use, water quality improvements, and groundwater augmentation. Additionally, Fish Screening Compliance, COIC Irrigation Efficiencies and Pump Exchange, and some fish passage would likely continue. The construction level, short-term impacts for these project elements would be the same under the Program

Alternatives and the No-action Alternative. But because fewer projects would likely be implemented, overall construction-related impacts would be lowest under the No-action Alternative compared with other alternatives. IPID and USFWS would likely maintain and upgrade their storage facilities under the No-action Alternative, and construction level impacts could be similar to those discussed in the Program Alternatives.

The short-term impacts identified for Alternatives 1, 2, 3, and 5 are similar because they contain many of the same projects. The most significant difference is there would be fewer construction-related impacts in the Alpine Lakes Wilderness Area under Alternative 2, 3, and 5 and more along the Wenatchee River corridor. This could lead to increased impacts to fish and shorelines with the construction of a Wenatchee River pump stations under Alternative 2, 3, and 5, but fewer impacts to other threatened and endangered species and wilderness users. Alternative 3 would have no construction-related short-term impacts in the Alpine Lakes Wilderness Area.

Alternative 4 would have the greatest construction impacts because it is made up of the most projects. In addition to the short-term impacts identified for Alternative 1 in common with Alternative 4, there would be additional impacts from building two additional storage enhancement projects, and expending storage at Eightmile Lake. In addition to Alternative 4 having more projects, the scale of the storage projects is relatively larger than the scale of other water development projects proposed in Alternative 1.

Table 4-7
Summary of Short-Term Impacts

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Earth	Construction-related erosion and sedimentation from ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Surface Water Resources	Use of cofferdams and dewatering during construction of on-going project.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Groundwater Resources	Dewatering impacts during construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Water Quality	Construction of ongoing projects could result in temporary water quality impacts. Impacts include risk of erosion and contamination from construction activities.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Water Use	Potential construction related impacts to surface water diversions. Work would be coordinated to minimize impacts.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Fish	Temporary habitat disturbance, construction-related impacts.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Vegetation	Some vegetation removal from construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Wildlife	Temporary disruption of habitat during construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Threatened and Endangered Species	Temporary disruption of habitat during construction from noise and disturbance. Construction would generally occur outside breeding season, reducing impacts.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Aesthetics	Construction activities and equipment of ongoing projects would generally create impacts on visual settings.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Air Quality	Construction related emissions from ongoing projects including transportation and use of heavy equipment.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Climate Change	Minor amounts of greenhouse gas emissions related to construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Noise	Increased noise from construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Recreation	Access restriction, nuisance noise, and aesthetics impacts during construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Land Use	Temporary access restrictions during construction of ongoing projects. Private owner access would be maintained.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Wilderness Area	Ongoing projects would likely be outside ALWA. No wilderness impacts are anticipated.	Temporary impacts to wilderness character related to construction activities include noise, construction equipment transport and staging, and presence and housing of construction workers.	Less than Alternative 1	Projects would likely be outside ALWA. No wilderness impacts are anticipated.	Greater than Alternative 1	Less than Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Shorelines	Increased potential for shoreline erosion related to ground disturbing activities.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Utilities	Potential temporary disruption in water service related to instream construction activities near diversions.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Transportation	Traffic delays associated with equipment transport and construction of ongoing projects.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Cultural Resources	Ground disturbing activities and construction work on culturally significant structures could result in impacts. Compliance with regulations and coordination with affected tribes would ensure any potential issues and mitigation measures would be addressed prior to construction.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Indian Sacred Sites	Ground disturbing activities would have the potential to impact sacred sites. Ongoing coordination with potentially affected tribes and compliance with regulations would ensure any potential issues would be addressed prior to construction.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Indian Trust Assets and Fishing Harvest	Potential to temporarily block access to Usual & Accustomed fishing areas.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Socioeconomics	Increased construction jobs from ongoing projects. Impacts would be smallest of all alternatives because fewer projects would be constructed.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Greater than Alternative 1

4.26.2 Long-Term

Implementation of the Icicle Strategy would provide benefit to Icicle Creek Subbasin by meeting the Guiding Principles. The Guiding Principles, which are discussed in detail in Section 1.2, The Icicle Strategy Guiding Principles, of this document, include improved instream flows, improved sustainability of LNFH, protection of the tribal and non-tribal fish harvest, improved domestic supply, improved agricultural reliability, enhancement of Icicle Creek habitat, and compliance with state and federal laws and Wilderness Acts. All Program Alternatives would meet the Guiding Principles and provide these benefits; although there are important differences, which are summarized below. Additionally, all the Program Alternatives would increase resiliency to stream impacts resulting from climate change. Table 4-8 provides an overview of long-term impacts for each Program Alternative and the No-action Alternative.

The No-action Alternative would not meet the goals and provide the benefits prescribed in the Guiding Principles, although some instream flow, LNFH, fish passage, and screening improvements would be made. Under the No-action Alternative, ongoing projects could increase streamflow by approximately 32 cfs, with localized benefit in water quality, fish habitat, and improved riparian vegetation. Impacts of the No-action Alternative would include decreased ability to respond to climate change and conflict between water users would not be resolved. Under the No-action Alternative, IPID would still manage, operate, and repair their dam sites, so long-term impacts identified by these activities would still likely occur under the No-action Alternative.

Alternative 1 would provide 88 cfs of instream flow benefit and meet all the Guiding Principles. Additionally, Alternative 1 would allow flexibility in flow management and allow the instream flow goal of 100 cfs to be met in 2080 under low, medium, and high climate change scenarios. Additionally, under Alternative 1 there would be net-benefit water quality improvements, increased available water for out-of-stream users, improved habitat benefit for fish and wildlife, and improved water-based recreational opportunities. Impacts of Alternative 1 would include noise disturbance resulting from the operation of a pump station, and aesthetic impacts resulting from increased draw down at Eightmile Lake and installation of modernized equipment in the ALWA, which could be minimized by construction design.

Alternative 2 would provide 83 cfs of instream flow benefit and meet all the Guiding Principles. Additionally, Alternative 2 would allow the instream flow goal of 100 cfs to be met in 2080 under low and medium climate change scenarios, but not under a high climate change scenario. Many of the net benefits to water quality, water use, habitat, and recreation that would exist under Alternative 1 would also exist under Alternative 2 because of the commonality of projects. Additionally, Alternative 2 would have many of the same impacts as Alternative 1. The impact of Alternative 2 compared to Alternative 1 is reduced flexibility in flow management that would result from not implementing the Alpine Lake Optimization, Modernization, and Automation Project.

Alternative 3 would provide 71 cfs of instream flow benefit and meet all the Guiding Principles. Many of the net benefits to water quality, water use, habitat, and recreation that would exist under Alternative 1 would also exist under Alternative 3 because many projects are common to both alternatives. In addition, many of the impacts under Alternative 1 would also occur under Alternative 3. The primary impacts of Alternative 3 compared to Alternative 1 would be less resiliency to climate change and no flexibility in flow management.

Alternative 4 would provide 131 cfs of instream flow benefit and meet all the Guiding Principles. Alternative 1 would allow flexibility in flow management and allow the instream flow goal of 100 cfs to be met in 2080 under low, medium, and high climate change scenarios. As with other alternatives, there would also be net benefits to water quantity, water use, and water-based recreation. Alternative 4 would have the greatest impact on wilderness character and recreation in the Wilderness Area. This is because more infrastructure would be built or expanded in the Wilderness Area. Additionally, this would have an increased impact on shoreline vegetation and habitat.

Alternative 5 would provide 195 cfs of instream flow benefit and meet all the Guiding Principles. Additionally, Alternative 5 would allow the instream flow goal of 100 cfs to be met in 2080 under low, medium, and high climate change scenarios. Many of the net benefits to water quality, water use, habitat, and recreation that would exist under Alternative 1 would also exist under Alternative 5 because of the commonality of projects. Additionally, Alternative 5 would have many of the same impacts as Alternative 1.

Table 4-8
Summary of Long-Term Impacts

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Earth	Some potential for erosion, and sediment transport resulting from long-term operation of ongoing projects. These impacts are expected to be minor.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Surface Water Resources	Ongoing projects would likely increase stream flow by 20 to 30 cfs. Benefits would be localized.	Similar but greater impacts compared to No-action. Would increase instream flow by 88 cfs. Increases expected when flow is naturally at its lowest. Flexibility in flow management to respond to low-flow conditions.	Similar to Alternative 1. Would increase instream flow by 83 cfs. Increases expected when flow is naturally at its lowest.	Less than Alternative 1. Would increase instream flow by 71 cfs. Increases expected when flow is naturally at its lowest.	Greater than Alternative 1. Would increase instream flow by 88 cfs. Increases expected when flow naturally at its lowest. Flexibility in flow management to respond to low-flow conditions.	Similar to Greater than Alternative 1. Would increase stream flow by 195 cfs. Increases expected when flow is naturally at its lowest.
Groundwater Resources	Groundwater recharge near Icicle Creek is expected to decrease compared to other alternatives. Groundwater recharge could increase in some areas compared with other alternatives because some conservation projects (piping canals or fix leaky pipes) would not be implemented.	Increased groundwater use; increased groundwater recharge near Icicle Creek; reduced groundwater recharge resulting from conservation projects.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Water Quality	Localized benefits from ongoing water quantity and quality improvements. Expected benefits include increased dissolved oxygen and cooler temperatures.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Water Use	Water use would be relatively unchanged. Localized instream flow benefit from ongoing conservation projects. No water made available for projected domestic growth.	Increased water available for instream and out-of-stream uses. Water available to meet projected domestic growth.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Fish	Ongoing projects could provide localized habitat and flow improvements. However, critical low-flow periods would likely persist in some reaches, which would continue to impact habitat availability and passage.	Increased stream flow, passage improvements, and habitat improvements. Flow releases from Alpine Lakes would be managed to provide greatest fisheries benefit and minimize any impacts.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Vegetation	Localized benefits to riparian vegetation from ongoing projects.	Improvements to riparian habitat resulting from increased flows and riparian habitat restoration efforts. Relatively small negative impacts from increased Eightmile Lake level; however, this is within historical range. Installation of pump station may also have small impacts.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Wildlife	Largely beneficial for wildlife dependent on Icicle Creek because ongoing projects would seek to improve instream flows during low-flow season. Benefit is more limited than under other alternatives	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Threatened and Endangered Species	Ongoing projects would provide localized habitat and flow improvements.	Similar but great impacts compared to No-Action. Overall positive impacts from habitat improvements. Minor changes in shoreline associated with Eightmile project and new pump station not anticipated to impact threatened and endangered species.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Aesthetics	Anticipated to be largely beneficial for aesthetics because the projects likely to be implemented are expected to improve habitat and upgrade aging and degraded infrastructure.	Similar but great impacts compared to No-Action. Potential visual impacts from pump station project, which would be mitigated. Less than significant impacts of increased lake bed exposure.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Air Quality	No significant long - term impacts identified	No significant long - term impacts identified	No significant long - term impacts identified	No significant long - term impacts identified	No significant long - term impacts identified	No significant long - term impacts identified

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Climate Change	Water supply shortages and critically low stream flow conditions would likely become worse. Limited ability to respond to climate change-induced impacts.	Increased instream flow and water supplies. Ability to adaptively manage flow to respond to impacts of climate change. Meets 100cfs streamflow goals in 2080 under low, medium, and high climate change scenarios.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Noise	Increased noise related to pump station operation. Construction measures would ensure compliance with Chapter 137-60 WAC.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Recreation	Increased streamflow resulting from implementation of ongoing projects expected to improve water-based recreation.	Similar but greater impacts compared to No-action. Increased lake levels may have some impacts on current location of campsites and trails at Eightmile Lake. However, these impacts are expected to be limited because lake level increase would be modest.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Land Use	Easements or property acquisition could be required for some ongoing projects. Long-term impacts on current land use trends.	Similar but greater impacts compared to No-action. Potential land use change from market reallocation of water and increased water for domestic supply. Conversion of some upland areas from private to public ownership.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Wilderness Area	Ongoing projects would likely be outside ALWA. No wilderness impacts are anticipated. Maintenance activities by IPID and USFWS in ALWA would remain unchanged.	Long-term impacts to wilderness character would include installation result from project in ALWA. Concealing equipment and implementing architectural style to complement the area would minimize impacts.	Similar to Alternative 1	Same as No-action.	Greater than Alternative 1	Similar to Alternative 1
Shorelines	Long-term impacts on shorelines would be mitigated by complying with the terms and conditions of local, state, and federal regulations.	Similar but greater impacts compared to No-action.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Utilities	No anticipated impacts on water-based utilities associated with this project. Power demand is not expected to significantly increase because of ongoing projects.	Increased water service potential related to increased domestic supply. Power demand is not expected to significantly increase because of projects.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Transportation	No long-term impacts to transportation anticipated.	Reduced helicopter supported transport in the Wilderness Area related to IPID maintenance activities	No long-term impacts to transportation anticipated.	No long-term impacts to transportation anticipated.	Similar to Alternative 1	No long-term impacts to transportation anticipated. Similar to Alternative 1
Cultural Resources	For all projects, coordination with DAHP and mitigation measures would be required.	Alpine Lakes dams are eligible for listing under the National Register of Historic Places. Mitigation measures would be required to avoid significant adverse impacts. For all projects, coordination with DAHP and mitigation measures would be required.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1

Resources	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Indian Sacred Sites	No expected adverse impacts to Indian Sacred Sites.	Ongoing coordination with potentially affected tribes and compliance with regulations would ensure any potential issues would be addressed prior to construction.	Similar to Alternative 1	Less than Alternative 1	Greater than Alternative 1	Similar to Alternative 1
Indian Trust Assets and Fishing Harvest	No significant long-term impacts as required by Guiding Principles.	No significant long-term impacts as required by Guiding Principles	No significant long-term impacts as required by Guiding Principles	No significant long-term impacts as required by Guiding Principles	No significant long-term impacts as required by Guiding Principles	No significant long-term impacts as required by Guiding Principles
Socioeconomics	Assumed lowest socioeconomic benefits because fewer projects would be implemented.	Lowest construction costs, job creation, and long-term economic benefit of Program Alternatives.	Highest construction costs, job creation, and long-term economic benefit of Program Alternatives.	Higher construction jobs and long-term economic benefit than Alternatives 1 and 4.	Higher construction jobs and long-term economic benefit than Alternative 1.	Highest construction costs, job creation, and long-term economic benefit of Program Alternatives.
Environmental Justice	Ongoing projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.	Projects are not expected to disproportionately impact minority or low income communities.

4.27 Cumulative Impacts

Cumulative impacts are the sum of incremental effects of an action when added to other past, present, and reasonably foreseeable future actions. These impacts can be individually minor, but collectively significant impacts. To a degree, many of the cumulative impacts are discussed throughout this chapter are inherently cumulative because certain actions anticipated to continue into the future (conservation actions) are part of the impact analysis. Generally, an impact can be considered cumulative if the impacts of various actions occur at the same place, impacts to a specific resource are similar in nature, and impacts are long-term. This section highlights the major cumulative impacts that could result from the implementation of the Program Alternatives.

4.27.1 Past Actions

Since the late 19th and early 20th century logging, agricultural, and residential development altered the Icicle Creek Subbasin through the installation of dams on the Wenatchee (Lamb-Davis mill dam) and diversions on Icicle Creek. This created passage barriers, decreased flows, changes in stream morphology and floodplain function, water quality, and overall instream habitat degradation. The construction of LNFH in the mid-20th century and continued development have exacerbated these issues and have led to conflict of instream and out-of-stream water use.

4.27.2 Present and Reasonably Foreseeable Future Actions

Present and reasonably foreseeable future actions that are anticipated in the project area that are relevant to the Icicle Strategy includes:

- Efforts by LNFH to obtain an NPDES permit
- New residential and commercial development
- Changes in agricultural crops
- Changes in precipitation patterns resulting from climatic changes

While water quality upgrades at LNFH is part of the Icicle Strategy, obtaining an NPDES permit is not directly called for in the IWG Guiding Principles. LNFH is currently working the EPA and Ecology to obtain all necessary water quality permits. This action will improve water quality in the Icicle Creek Subbasin, and will help active water quality goals established in the by the IWG. It will also help ensure improved sustainability of LNFH.

Ongoing residential and commercial development in the Icicle Creek Subbasin and Leavenworth area, which has been planned for as part of regional land use planning, would be facilitated by improvements in water supply that would occur under the Program Alternatives.

Agricultural development is not expected to increase in the project area, as there will be no increased irrigation acreage made available under the Icicle Strategy. However, the Program Alternatives would increase the reliability of water supplies, which could lead to crop changes and irrigation application methodologies.

Climate Change is predicated to increase temperatures and change the patterns of precipitation in the Icicle Creek Subbasin. This is expected to shift the hydrograph so peak flows occur earlier in the year, with low flow periods spanning more of the summer months. These changes in streamflow are expected to impact habitat, water quality, water supply, and fish passage.

4.27.3 Cumulative Impacts of the Alternatives

Overall, the cumulative effect of the Icicle Strategy is expected to be beneficial. The Icicle Strategy is expected to provide benefit to the project area, as laid out in the Guiding Principles. The Program Alternatives are intended to substantially improve low flow conditions, aquatic habitat, and water supply in the project area. The integrated planning approach developed for the Icicle Strategy is intended to improve water resources and the riverine ecosystem on a watershed scale. While all Program Alternatives are intended to improve streamflow, habitat, and supply issues in the project area, the cumulative impacts vary based between Alternatives.

4.27.3.1 Alternative 1 (Base Package)

Under this Alternative 1, streamflow in lower Icicle Creek is anticipated to increase by 88 cfs. There would also be flow increases in other portions of Icicle Creek and several tributaries. This Alternative is expected to decrease the potential for adverse impacts from low flow, passage barriers, changes in stream morphology and floodplain function, water quality, and overall instream habitat degradation to accumulate and contribute to conditions that have negatively affected water resources in the project area.

Improved water supply would lead to continued, ongoing residential and commercial development in the Icicle Creek Subbasin and Leavenworth area, which has been planned for as part of regional land use planning. This development could increase impacts on habitat that have resulted from past development. However, current regulations and overall instream flow benefit would minimize these impacts.

Agricultural development is not expected to increase in the project area, as there would be no increased irrigation acreage made available under the Icicle Strategy. However, the Program Alternatives would increase the reliability of water supplies, which could lead to crop changes and irrigation application methodologies. This is not expected to create cumulative impacts based on past, present, and foreseeable future actions.

The impacts of instream flow benefit would improve adaptability to climate change within the Icicle Creek Subbasin. Additionally, under this alternative there would be flexibility to manage flow based on conditions in the creek, ameliorating many of the flow impacts that are expected to result from climate change.

4.27.3.2 Alternative 2

The cumulative impacts to surface water under Alternative 2 is less than under Alternative 1. Under this alternative, streamflow in lower Icicle Creek is anticipated to increase by 83 cfs. There would also be flow increases in other portions of Icicle Creek and several tributaries. This Alternative is expected to decrease the potential for adverse impacts from low flow, passage barriers, changes in stream morphology and floodplain function, water quality, and overall instream habitat degradation to accumulate and contribute to conditions that have negatively affected water resources in the project area.

Improved water supply would lead to continued, ongoing residential and commercial development in the Icicle Creek Subbasin and Leavenworth area, which has been planned for as part of regional land use planning. This development could increase impacts on habitat that have resulted from past development. However, current regulations and overall instream flow benefit would minimize these impacts.

Agricultural development is not expected to increase in the project area, as there would be no increased irrigation acreage made available under the Icicle Strategy. However, the Program Alternatives would increase the reliability of water supplies, which could lead to crop changes and irrigation application methodologies. This is not expected to create cumulative impacts based on past, current, and foreseeable future actions.

The impacts of instream flow benefit would improve adaptability to climate change within the Icicle Creek Subbasin. Additionally, under this alternative there would be flexibility to manage flow based on conditions in the creek, ameliorating many of the flow impacts that are expected to result from climate change.

4.27.3.3 Alternative 3

The cumulative impacts to surface water under Alternative 3 would be less than under any other Program Alternative. Under this alternative, streamflow in lower Icicle Creek is anticipated to increase by 71 cfs. This Alternative is expected to decrease the potential for adverse impacts from low flow, passage barriers, changes in stream morphology and floodplain function, water quality, and overall instream habitat degradation to accumulate and contribute to conditions that have negatively affected water resources in the project area.

Improved water supply would lead to continued, ongoing residential and commercial development in the Icicle Creek Subbasin and Leavenworth area, which has been planned for as part of regional land use planning. This development could increase impacts on habitat that have resulted from past development. Current regulations would minimize potential impacts to riparian and floodplain habitat. However, under this alternative flow benefits would not be perfectly matched with increased domestic use. This, when considered with past impacts, could decrease streamflow during critical low-flow periods, decrease water quality metrics such as dissolved oxygen and temperatures, and increase passage issues in Icicle Creek.

Agricultural development is not expected to increase in the project area, as there would be no increased irrigation acreage made available under the Icicle Strategy. However, the Program Alternatives would increase the reliability of water supplies, which could lead to crop changes and irrigation application methodologies. This is not expected to create cumulative impacts based on past, current, and foreseeable future actions.

The impacts of instream flow benefit would improve adaptability to climate change within the Icicle Creek Subbasin.

4.27.3.4 Alternative 4

Under this alternative, streamflow in lower Icicle Creek is anticipated to increase by 131 cfs. There would also be flow increases in other portions of Icicle Creek and several tributaries. This Alternative is expected to decrease the potential for aversion impacts from low flow, passage barriers, changes in stream morphology and floodplain function, water quality, and overall instream habitat degradation to accumulate and contribute to conditions that have negatively affected water resources in the project area.

Improved water supply would lead to continued, ongoing residential and commercial development in the Icicle Creek Subbasin and Leavenworth area, which has been planned for as part of regional land use planning. This development could increase impacts on habitat that have resulted from past development. However, current regulations and overall instream flow benefit would minimize these impacts.

Agricultural development is not expected to increase in the project area, as there would be no increased irrigation acreage made available under the Icicle Strategy. However, the Program Alternatives would increase the reliability of water supplies, which could lead to crop changes and irrigation application methodologies. This is not expected to create cumulative impacts based on past, current, and foreseeable future actions.

The impacts of instream flow benefit would improve adaptability to climate change within the Icicle Creek Subbasin. Additionally, under this alternative there would be flexibility to manage flow based on conditions in the creek, ameliorating many of the flow impacts that are expected to result from climate change.

4.27.3.5 Alternative 5

The cumulative impacts to surface water under Alternative 5 is greater than under Alternative 1. Under this alternative, streamflow in lower Icicle Creek is anticipated to increase by 195 cfs. There would also be flow increases in other portions of Icicle Creek and several tributaries. This Alternative is expected to decrease the potential for adverse impacts from low flow, passage barriers, changes in stream morphology and floodplain function, water quality, and overall instream habitat degradation to accumulate and contribute to conditions that have negatively affected water resources in the project area.

Improved water supply would lead to continued, ongoing residential and commercial development in the Icicle Creek Subbasin and Leavenworth area, which has been planned for as part of regional land use planning. This development could increase impacts on habitat that have resulted from past development. However, current regulations and overall instream flow benefit would minimize these impacts.

Agricultural development is not expected to increase in the project area, as there would be no increased irrigation acreage made available under the Icicle Strategy. However, the Program Alternatives would increase the reliability of water supplies, which could lead to crop changes and irrigation application methodologies. This is not expected to create cumulative impacts based on past, current, and foreseeable future actions.

The impacts of instream flow benefit would improve adaptability to climate change within the Icicle Creek Subbasin. Additionally, under this alternative there would be flexibility to manage flow based on conditions in the creek, ameliorating many of the flow impacts that are expected to result from climate change.

4.28 Unavoidable Adverse Impacts

Significant unavoidable adverse impacts are generally considered to be impacts that remain more than moderate after mitigation. Potentially significant impacts were identified for several resources in Chapter 4. Many of these impacts are related to short-term construction activities, although some long-term impacts were identified. With mitigation measures, such as compliance with applicable local, state, and federal regulations and the use of BMPs, most impacts would likely be less than moderate after mitigation. The following sections summarize impacts and mitigation measures.

4.28.1 Earth, Surface Water, Water Quality, Shorelines, and Fish

The potential for increased erosion and sedimentation resulting from increased stream flow was identified as a potential impact. However, this increased potential for erosion and sedimentation is expected to be non-significant given that increased flows would remain within the natural flow range. The potential for occurrence of these impacts would be mitigated by following the required regulatory permits for construction and operation of projects. Additional impacts include fish and redds stranding associated with releases from the Alpine Lakes. Alpine Lakes releases could be timed and managed to minimize any concerns of water quality and fish habitat impacts. Mitigation measures are expected to result in impacts being less than moderately significant.

Benefits to vegetation, riparian habitat, floodplain function, and the riverine ecosystem are anticipated to counteract these impacts. The primary long-term impact associated with the Program Alternatives is increased flow, habitat, and improved water quality.

4.28.2 Aesthetics, Recreation, and Wilderness

Potential impacts to aesthetics could result from construction of the COIC and the IPID pump stations if the COIC Irrigation Efficiencies and Pump Exchange, IPID Dryden Pump Exchange Project, or IPID Full Piping and Pump Exchange Project are implemented. The COIC Irrigation Efficiencies and Pump Exchange Project is included in all Program Alternatives. The IPID Dryden Pump Exchanges are included in Alternative 2, 3, and 5. Potential impacts could be minimized based on siting or use of vegetation screening.

Aesthetic impacts are also possible under the Alpine Lakes Optimization, Modernization, and Automation Project. This project is included in Alternative 1 and Alternative 2. The greatest potential long-term impact is from new equipment installed to automate lake releases. This equipment also has the potential to impact wilderness character. Designing structures to blend into the natural environment and using local construction materials can minimize these impacts. Mitigation measures are expected to result in impacts being less than moderately significant.

The Eightmile Lake Storage Restoration Project also has the potential to create visual impacts. This project is proposed under Alternative 1, 2, and 5. One potential impact is the dam replacement structure. This also has the potential to impact wilderness character. Involving an architect in the design of the facility to ensure it matches the look of the current dam structure and blends into the natural environment would help minimize this impact. The increase in lake level also has the potential to impact current camp locations at Eightmile Lake. However, with the modest rise in lake level, this impact would be minor. Additionally, this condition existed in the past, as recently as the 1990’s. Mitigation measures are expected to result in impacts being less than moderately significant.

Storage enhancement projects proposed under Alternative 4 have the potential to impact aesthetics, wilderness character, and recreation. These impacts and specific mitigation measures would be addressed in project-level environmental review.

While impacts to wilderness character is a controversial issue, this analysis found that long-term impacts to wilderness character can be mitigated through construction techniques and timing/management of draw down at the Alpine Lakes. Additionally, benefits to wilderness character would result from fewer maintenance trips and reduced helicopter use within the Alpine Lakes Wilderness Area.

4.28.3 Land Use

All land acquisitions or easements for projects proposed in the Program Alternatives would need to provide appropriate compensation in accordance with applicable state or federal regulations. Any land acquired under the Habitat Protection and Enhancement Project, which is included in all Program Alternatives, would require a willing seller. Mitigation measures are expected to result in impacts being less than moderately significant.

4.28.4 Climate Change

Changes in stream flow and water availability caused by climate change would constrain instream and out-of-stream uses. The Program Alternatives would provide for increased stream flow and the flexibility to adaptively manage flow in response to conditions. Mitigation measures are expected to result in impacts being less than moderately significant.

4.28.5 Cultural Resources

Four of the dams and water release structures at the Alpine Lakes are eligible for listing on the National Register of Historic Places. To reduce cultural resources impacts associated with the Alpine Lakes Optimization, Modernization, and Automation Project and the Eightmile Storage Restoration Project, coordination with DAHP would occur to identify appropriate mitigation. With implementation of mitigation, these projects are not anticipated to result in any significant impacts on cultural resources. Mitigation measures might include maintaining some historical infrastructure and ensuring structure design is consistent with the historical structures. Mitigation measures are expected to result in impacts being less than moderately significant.

For all projects that involve ground disturbance, additional cultural resource review would be required once specific locations for project elements are identified. Coordination with affected tribes and DAHP would help minimize any potential impacts. Prior to construction, any potential long-term impacts affecting cultural resources would be addressed.

4.29 Irreversible and Irretrievable Commitments of Resources

This section discusses the permanent loss of or commitment of resources that would be associated with the Program Alternatives. Irretrievable and irreversible commitments are the use or removal of a resource (including time and money spent), that cannot be recovered. These commitments often apply to nonrenewable resources.

For the Program Alternatives, irretrievable commitments would include time and money. Additionally, a small amount of land that was previously submerged would be submerged again under Alternative 1, 2, and 5, and additional lands would be submerged under Alternative 4. Table 4-9 provides a summary of irreversible and irretrievable commitments associated with building the Program Alternatives.

Table 4-9
Irreversible and Irretrievable Commitments

	Direct Construction Costs (millions)	Submerged Lands (acres)
Alternative 1	$79.2	3.6
Alternative 2	$88.8	3.6
Alternative 3	$86.9	0
Alternative 4	$83.8 +	> 13.6
Alternative 5	$174.7	3.6

Notes: Costs include 25-percent contingency. Construction costs for Upper Klonaqua Lake Storage Enhancement Project unknown at this time

In addition to the resources described in Table 4-9, Program Alternatives that result in non-wilderness uses within he ALWA has the potential to cause irretrievable commitments to wildness resources. Alternative 1, 2 and 5 include changes to already occurring or historical uses within the ALWA. Alternative 4 calls for expanded storage within the ALWA.

Each Program Alternative also includes irreversible commitments of water, soil, rock, and energy for construction of projects.

4.30 Environmental Commitments

Environmental commitments are measures or practices to reduce or avoid adverse effects resulting from project operations (long-term impacts). The co-leads would have the primary responsibility to ensure these met if an action is implemented. The project elements proposed in the Program Alternatives are at various stages in the planning process, so the detail of specific mitigation measures varies. Additional measures would be developed during project-level environmental review if needed. The following sections summarize major environmental commitments for the Icicle Strategy.

4.30.1 Earth, Surface Water, Water Quality, Shorelines, & Fish

Impacts to these resources are generally mitigated for through applicable Federal, State, and local environmental review and permitting processes. In most cases, impacts would be mitigated by following the required regulatory permits for the construction and operation of projects.

Construction facilities in accordance with all applicable design requirements, and monitoring to ensure that potential impacts do not develop during operations would minimize potential earth impacts. Dam safety permits and inspection and monitoring requirements would identify any emerging long-term issues with water storage facilities

Table 5-2 provides a list of all applicable permits for each project considered in the Program Alternatives.

4.30.2 Aesthetics, Recreation, and Wilderness

Involving an architect in the design of facilities would ensure they meet management objects and minimize potential impacts on aesthetics and wilderness character. Coordination and consultation with the USFS, would limit impacts on recreation and wilderness character. Projects that require a special use permit issued by the USFS may also require additional measures to project aesthetics, recreation, and wilderness character.

4.30.3 Land Use

All land acquisitions or easements for project proposed in the Alternatives would need to provide appropriate compensation in accordance with applicable State or Federal regulations. Any land acquired under the Habitat Enhancement project, which is included in all Program Alternatives, would require a willing seller. All changes in land use would have to comply with Chelan County's comprehensive plan and land use zoning.

4.30.4 Cultural Resources

Consultation with DAHP would occur to identify appropriate mitigation for impacts to cultural resources. Adherence with the National Historic Preservation Act would be required as part of the CWA Section 404 review.

For all projects that involve ground disturbance, additional cultural resource review would be required once specific locations for project elements are identified. Coordination with affected tribes and DAHP would help minimize any potential impacts.

CHAPTER 5.0 CONSULTATION & COORDINATION

This chapter describes the consultation and coordination process the co-leads, Ecology and Chelan County, in coordination with the IWG, have taken to date and future actions that will occur. Public outreach and consultation will continue throughout the development and implementation of the Icicle Strategy.

5.1 Public Involvement

Public involvement allows interested and affected individuals, organizations, agencies, and other governmental entities to be consulted and included in the decision-making process. The IWG has incorporated public involvement into their quarterly meetings, which are open to the public, and have made numerous presentations at conferences, to local community groups, and individual stakeholder groups to raise awareness of the Icicle Strategy and the PEIS process. The IWG co-leads Chelan County and Ecology also solicited comments from the public on the proposed Icicle Strategy through the SEPA scoping process to help shape the alternatives considered in this document and the analysis of the impacts. Formal and informal input was used.

5.1.1 SEPA Scoping

The SEPA Scoping process began on February 9, 2016, when the co-leads issued a threshold determination of significance on the Icicle Strategy. Scoping is the process of soliciting input on a proposal to define the scope of the EIS. The comments received during the scoping process allowed the co-leads to identify significant issues, identify elements of the environment that could be affected, develop alternatives, and determine the appropriate environmental documents to be prepared.

Public notice of SEPA scoping was provided via publication in the Wenatchee World and Leavenworth Echo and through mailings to residents. Ecology issued a press release on February 16, 2016 to provide information about the Icicle Strategy, SEPA and the Scoping deadlines. Public comments were received through May 11, 2016. One comment letter signed by 40 organizations was received and accepted after the end of the comment period.

5.1.2 Public Meetings

Under WAC 197-11-410, the co-leads elected to expand the scoping process, and held a public open house in Leavenworth, Washington on April 20, 2016 at the Leavenworth Fire Hall. Approximately 70 participants attended the open house. At the meeting, the co-leads provided a presentation that included an overview of the SEPA process, the Icicle Strategy, and the base package (Alternative 1). Additionally, display materials and handouts were available. Members of the public informally discussed points of views and formally submitted comments during the meeting. The materials from the public open house are still available on the Chelan County website.[1]

[1] http://www.co.chelan.wa.us/natural-resources/pages/sepa-public-open-house

5.1.3 Scoping Comments

Including those submitted at the open house, a total of 49 written comments were received. Comment detail and input varied and ranged from general notes of support, general notes of disapproval, suggestions for alternatives to be considered, and concerns about specific resources or impacts. The comments received are summarized below. All comments and the comment responsiveness summary are provided in Appendix A.

5.1.3.1 General Comments

Comments included both general statements of support and opposition to the Icicle Strategy. Many of the general comments received were value statements on how water should be used and processed. There were comments supporting the collaborative effort and public outreach conducted and opposing the collaborative effort; comments supporting agricultural water use and comments opposed to additional agricultural water use; and comments opposed to increasing domestic water supplies and comments supporting domestic water supplies. There were also general comments that there should be more storage included in the proposal and concerns that conservation is not enough of a priority.

Several comments recommended prioritizing the Guiding Principles or including alternative projects should some of the proposed projects be deemed unfeasible. Other comments reflected concern that the SEPA checklist was not complete enough, concern over funding, and one comment opposed the role of agencies as conveners of the IWG.

There were also general comments in support of wilderness and wilderness character, and opposition to the use of the term “reservoir” to describe lakes that are currently used for water storage in the ALWA.

5.1.3.2 Alternatives and Projects

Many comments regarded support or opposition to a project, and requests to consider alternatives or additional projects.

Base Package (Alterative 1)

There was general support for many of the projects proposed in Alternative 1. These included IPID Irrigation Efficiencies Project, COIC Irrigation Efficiencies and Pump Exchange project, Domestic Conservation, LNFH Conservation and Water Quality Improvements, Fish Passage, Fish Screen Compliance, and Water Markets. One comment received indicated the LNFH project should be prioritized and be implemented as soon as possible. Additionally, several enhancements to the domestic conservation project were recommended, mainly water reuse and bans on lawn watering.

There were also mixed comments on the Alpine Lakes Optimization, Modernization, and Automation project and the Eightmile Lakes Storage Restoration Project.

There were also comments that expressed opposition to the boulder field passage improvements, which is a component of the Fish Passage Improvement project.

Additional Alternatives or Projects Recommended

Several projects and alternatives were recommended during the scoping process. Recommended projects included storage enhancement projects, which several commenters expressed opposition to, and implementation of the IPID pump station project.

There were requests to provide alternatives in the PEIS rather than looking at a no action alternative and a preferred alternative. Several alternatives were proposed including an alternative that would exclude projects within the ALWA, an alternative that focused on water conservation, an alternative to remove the dams in the ALWA, and an alternative to relinquish water rights.

5.1.3.3 Impacts to Resources

Comments included concerns regarding impacts to specific resources. These resources included Indian trust assets, cultural resources, Indian sacred sites, wilderness character, threatened and endangered species, groundwater, surface water, fish, shoreline, water quality, wildlife, vegetation, soil, and aesthetics. Additional concerns about the impact of climate change on water resources and the efficacy of the proposal were also raised. There were also requests to discuss current conditions and helicopter transport.

5.1.3.4 Permitting and Compliance with Laws

Scoping comments also included concerns over water right permitting, transfers, and relinquishment, and compliance with federal laws including ESA and wilderness regulations. There were also comments regarding the need for NEPA and project level review.

5.1.4 Other Meetings and Outreach

Other meetings were held to provide information and answer questions about the Icicle Strategy. These meetings included public outreach events held in Seattle, Washington at the Good Shepherd Center on February 17, 2015 and March 30, 2016, and at the Phinney Ridge Neighborhood Association on July 18, 2016.

The IWG and co-leads also conducted several outreach activities to raise awareness of the Icicle Strategy and the PEIS process, hold meetings quarterly that are open to the public, and have opportunities for public comment.

The Table 5-1 describes these outreach activities.

Table 5-1
Outreach Efforts

	Description	Methods
Feb. 2014	Presentation, Q&A with conservation leaders in Seattle	Meeting, Presentation
Nov. 2014	Wenatchee Habitat Subcommittee	Presentation
Jan. 2015	Upper Columbia Regional Technical Team	Presentation
Dec. 7, 2015	Tree Fruit Industry Conference	Presentation
Jan. 4, 2016	First funding coordination meeting.	Meeting
Jan. 20, 2016	Wenatchee Habitat Subcommittee	Presentation
Feb. 10, 2016	UC Regional Technical Team	Presentation
Feb. 12, 2016	Legal Advertisement - SEPA DS	Public Notice
Feb. 16, 2016	PEIS/Scoping Press Release	Public Notice
Feb. 18, 2016	Capital Press article - public comment	News Article
Mar. 9, 2016	Leavenworth Echo	News Article
Mar. 30, 2016	Seattle conservation leaders	Meeting, Presentation
Apr. 5, 2016	KOHO Radio Interview	Radio Interview
Apr. 19, 2016	LNFH Alternatives Analysis Presentation - Congressional staff attendance	Presentation
Apr. 20, 2016	Public Open House	Presentation, Handouts, Posters
Apr. 21, 2016	Wenatchee World	News Article
Apr. 25, 2016	Wenatchee World	Editorial
May 4, 2016	WVC-Water Resources Class	Presentation, Discussion
May 29, 2016	KOMO News	News Article
May 29, 2016	Seattle Times – AP	News Article
June 1, 2016	Cashmere Rotary	Presentation
June 27, 2016	Congressman Reichert	Meeting and Tour at LNFH
Summer 2016	Sen. Murray, Cantwell, Congr. Newhouse	Meetings
July 18, 2016	Conservation Groups in Seattle	Meeting
July 18, 2016	Seattle conservation leaders	Presentation
Sept. 2016	Tour to Eightmile Lake	Hike, Tour infrastructure
Sept. 9, 2016	LNFH Salmon Festival VIP Tour. Included regional directors of USBOR, USFWS and USFS	Handout, LNFH Site Tour
Oct. 4, 2016	USBR and USFWS Regional Directors Meeting at LNFH	Meeting and Tour at LNFH
Oct. 19, 2016	Wenatchee Habitat Subcommittee	Presentation
Nov. 10, 2016	Water Rights Transfers Conference	Panel Presentation
Dec. 8, 2016	Columbia River Policy Advisory Group	Presentation
June 2017	American Water Resource Association – Climate Change Conference (Washington DC)	Presentation
Nov. 6, 2018	USBR and USFWS Regional Directors Meeting	Meeting
Nov. 7, 2017	American Water Resource Association National Conference (Portland, OR)	Presentation
March 27, 2018	American Water Works Association National Conference (Seattle, WA)	Presentation

5.1.5 Draft PEIS Comment Period

Publication and distribution of the Draft PEIS occurred at the end of May or beginning of June. The distribution begins a 60-day public review and comment period. Written comments will be accepted by Chelan County through the commend period. Comments on this draft document will be considered by the co-leads and the IWG to help shape the final PEIS.

5.2 Coordination and Consultation

5.2.1 Agencies

Chelan County and Ecology are the co-lead agencies responsible for the preparation of this PEIS and meeting lead agency obligations required by SEPA. There has also been extensive participation in the development of the Icicle Creek Strategy by other local, state, and federal agencies, as well as other stakeholders, throughout the planning process.

The following state and federal agencies have jurisdiction and expertise regarding resources with the potential to be affected by the Icicle Creek Strategy. Several of these agencies are also party to the IWG. Tribal consultation and coordination are addressed in Section 5.2.2, Tribal Consultation and Coordination.

The following agencies have provided input and information regarding the development of the PEIS and will continue to provide coordination and consultation regarding other applicable regulatory requirements as individual projects begin to move forward. Their involvement is discussed further below. Also, the following agencies along with Ecology and Chelan County have been consulted on possible permits that could be required for the different project elements listed with each of the Alternatives. Table 5-2 provides a breakdown of the possible permits and describes what project elements may trigger the permits.

5.2.1.1 National Marine Fisheries Service

As noted in Section 1.9, Related Permits, Actions, and Laws, NMFS, along with USFWS, is responsible for the implementation of the ESA. NMFS has jurisdiction over anadromous fish species while USFWS has jurisdiction over terrestrial species and some freshwater species. To this end, NMFS participates in the IWG and provided input on the development of the Icicle Creek Strategy with respect to listed anadromous fish. As individual projects move forward to implementation, coordination with NMFS will be completed for those projects with the potential to affect special-status species and their habitat over which NMFS has jurisdiction. For information regarding the regulations appointing this authority to NMFS, refer to Section 1.9, Related Permits, Actions, and Laws. For information regarding the potential effects on ESA-listed species and habitat, refer to Section 4.10, Threatened and Endangered Species.

5.2.1.2 U.S. Fish and Wildlife Service

In addition to its responsibilities pursuant to the ESA, USFWS manages the LNFH. USFWS also manages and operates dams and related facilities on the Upper and Lower Snow Lakes and Nada Lake. These facilities are owned and operated by USFWS to release flows for hatchery use, but improvements to the facilities are funded and implemented by USBR.

Similar to NMFS, USFWS participated in the development of the Icicle Creek Strategy as a member of the IWG and provides expertise with respect to ESA-listed terrestrial and freshwater species. As individual projects move forward to implementation, coordination with USFWS will be completed for those projects with the potential to affect species and their habitat over which USFWS has jurisdiction. For information regarding the regulations appointing this authority to NMFS, refer to Section 1.9, Related Permits, Actions, and Laws. For information regarding potential effects on ESA-listed species and habitat, refer to Section 4.10, Threatened and Endangered Species.

5.2.1.3 U.S. Forest Service

The USFS manages the Alpine Lakes Wilderness Area and is responsible for ensuring activities are consistent with the Wilderness Act and other management requirements specific to National Forests. USFS also participated in the development of the Icicle Creek Strategy as a member of the IWG.

5.2.1.4 U.S. Environmental Protection Agency

The EPA is the agency responsible for, among other regulations, implementation of the CWA and CAA. Although EPA delegates many of its responsibilities to Ecology within the state of Washington, EPA retains authority over permits for federal facilities, such as the LNFH.

5.2.1.5 U.S. Bureau of Reclamation

LNFH, which is located on Lower Icicle Creek near Leavenworth, operates to mitigation USBR projects in the Columbia Bain. Reclamation participated in the development of the Icicle Creek Strategy as a member of the IWG.

5.2.1.6 U.S. Army Corps of Engineers

The USACE is responsible for issuance of permits and conducting compliance related to Section 404 of the CWA, which regulates placement of dredged or fill material into wetlands, lakes, streams rivers, estuaries, and certain other types of waters of the United States. For additional information about the CWA, refer to Section 1.9, Related Permits, Actions, and Laws.

5.2.1.7 Washington Department of Fish and Wildlife

The WDFW is also a member of the IWG and provides input regarding sensitive plant and animal species with the potential to be affected by the Icicle Creek Strategy. As individual projects move towards implementation, WDFW will also be responsible for issuing HPAs for any projects with the potential to affect state waters.

5.2.1.8 Washington Department of Natural Resources

WDNR is responsible for issuing leases of state aquatic lands. Leases of state aquatic lands may be required for projects that are located within tidelands, shorelands, harbor areas, and the beds of navigable waters. For additional information about WDNR's Aquatic Use Authorization, refer to Section 1.9, Related Permits, Actions, and Laws.

5.2.1.9 Washington Department of Archaeology and Historic Preservation

In addition to ensuring that the public interest in cultural and tribal resources is considered in the development of the Icicle Creek Strategy, the DAHP is also responsible for ensuring that subsequent federal actions are consistent with the National Historic Preservation Act (NHPA). Because this PEIS is programmatic and specific project details are not known at this time, subsequent cultural review and consultation would be undertaken, if needed, as individual projects are carried forward. Depending on the specific project, this could also include coordination with tribes and other interested parties.

5.2.2 Tribal Consultation and Coordination

5.2.2.1 Confederated Tribes and Bands of the Yakama Nation

The Confederated Tribes and Bands of the Yakama Nation is a member of the IWG and has participated in the development of the Icicle Creek Strategy. In spring of 2018, the co-lead agencies began government to government consultation on this PEIS with the Yakima Nation. Additionally, as individual projects move forward, depending on the specific project, the appropriate federal lead agency will initiate formal government-to-government consultation consistent with the NHPA.

5.2.2.2 Confederated Tribes of the Colville Reservation

The Confederated Tribes of the Colville Reservation is a member of the IWG and has participated in the development of the Icicle Creek Strategy. In spring of 2018, the co-lead agencies began government to government consultation on this PEIS with the Confederated Tribes of the Colville Reservation. In addition, as individual projects move forward, depending on the specific project, the appropriate federal lead agency will initiate government-to-government consultation consistent with the NHPA.

Table 5-2
Draft Permits, Approvals, and Relevant Triggers[1]

Permit/Approval and Relevant Triggers	All Alternatives									
	COIC Irrigation Efficiencies	IPID Irrigation Efficiencies	Domestic Conservation[1]	Tribal and Non-Tribal Fisheries	Habitat Protection and Enhancement	Instream Flow Rule Amendment[1]	LNFH Conservation and Water Quality Improvements	Fish Passage Improvements	Fish Screen Compliance	Water Markets[1]
Clean Water Act Section 404 review Work within jurisdictional waters of the US	1	1		1	1		1	1	1	
USFS Special Use Permit Work on USFS lands not covered by easement.										
Endangered Species Act Federal action	2	2		2	2		2	2	2	
Magnuson-Stevens Fishery Conservation and Management Act Federal action	2	2		2	2		2	2	2	
National Historic Preservation Act Federal action	2	2		2	2		2	2	2	
Fish and Wildlife Coordination Act Federal action	2	2		2	2		2	2	2	
FEMA Flood Rise Analysis Modifications to floodplain	2	2								
CWA Section 401 Water Quality Certification	3	2		3	3		3	3	3	
FCC Licensing										
Ecology Dam Construction Permit/Review										
Ecology Water Right Permit	4	3		4	4			4	4	
Ecology Sand and Gravel Permit										
WNDR Burn Permit										
WDFW Hydraulic Project Approval Work affecting bed/flow of state waters	5			5	5		4	5	5	
WDNR Aquatic Use Authorization Work within state aquatic lands	5			5	5		4	5	5	
Ecology NPDES Construction Stormwater Permit Construction within waters of the US/state	6						5			
EPA NDPES Discharge Permit for Operation							6			
Chelan County Shoreline Substantial Development Permit/Conditional Use Permit Work within state shorelands	7			6	6			6	6	
Chelan County Fill and Grade Permit **Chelan County Building Permit**	8									

[1]This table lists potential permits for individual projects being considered per the Icicle Creek Strategy. The permits listed are based on our current understanding of the project components and final permits would be evaluated based upon final design and project components. Table notes correspond to specific projects in the following pages.

Table 5-2 (cont.)
Draft Permits, Approvals, and Relevant Triggers[1]

Permit/Approval and Relevant Triggers	Alt. 1 / 4	Alt. 1 / 2	Alt. 2 / 3	Alt. 3	Alt. 4			Alt. 5
	Alpine Lakes Modernization, Optimization, and Automation	Eightmile Lake Restoration	IPID Dryden Pump Exchange	OCPI Legislative Change1	Eightmile Lake Storage Enhancement	Upper Klonaqua Lake Storage Enhancement	Upper and Lower Snow Lake Storage Enhancement	IPID Full Piping and Pump Station
Clean Water Act Section 404 review Work within jurisdictional waters of the US	1	1	1		1	1	1	1
USFS Special Use Permit Work on USFS lands not covered by easement.	2						2	
Endangered Species Act Federal action	3	2	2		2	2	3	2
Magnuson-Stevens Fishery Conservation and Management Act Federal action	3	2	2		2	2	3	2
National Historic Preservation Act Federal action	3	2	2		2	2	3	2
Fish and Wildlife Coordination Act Federal action	3	2	2		2	2	3	2
FEMA Flood Rise Analysis Modifications to floodplain		2			2	2	3	
CWA Section 401 Water Quality Certification	4	2	3		3	3	4	3
FCC Licensing	5							
Ecology Dam Construction Permit/Review		4			4	4	5	
Ecology Water Right Permit	6	5	4		5	5	6	4
Ecology Sand and Gravel Permit		6			6		7	
WNDR Burn Permit		7			7	6	8	
WDFW Hydraulic Project Approval Work affecting bed/flow of state waters	7	8	5		8	7	9	5
WDNR Aquatic Use Authorization Work within state aquatic lands	7	8	5		8	7	9	5
Ecology NPDES Construction Stormwater Permit Construction within waters of the US/state		9	6		9	8	10	6
EPA NDPES Discharge Permit for Operation								
Chelan County Shoreline Substantial Development Permit/Conditional Use Permit Work within state shorelands	8	10	7		10	9	11	7
Chelan County Fill and Grade Permit / Chelan County Building Permit		11	8		11	10		8

[1]This table lists potential permits for individual projects being considered per the Icicle Creek Strategy. The permits listed are based on our current understanding of the project components and final permits would be evaluated based upon final design and project components. Table notes correspond to specific projects in the following pages.

NOTES:

COIC Efficiencies

1. Depending on specific activities within waters of the US, compliance is anticipated to be addressed through a Nationwide Permit (NWP).
2. Corps permit evaluation will address consistency with these regulations.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Required to address the change point of diversion and instream flows.
5. Compliance handled through the JARPA review process and expected to be minimal.
6. General permit anticipated, requiring compliance with general conditions.
7. County approval likely required. Project-level SEPA evaluation (e.g., SEPA checklist) completed by COIC.
8. COIC submittal required prior to construction.

IPID Irrigation Efficiencies – Additional environmental permits/approvals may be required to implement projects identified in updated conservation plans.

1. Depending on the specific modifications, work on the IPID canals may be exempt from CWA compliance.
2. Not required if considered exempt from Corps jurisdiction.
3. Required for putting water into a trust.

Domestic Conservation

1. Proposed activities largely within existing developed areas or not resulting in physical changes. Aside from Programmatic EIS review for funding, no additional environmental permits/approval likely required.

Tribal and Non-Tribal Fisheries – Required environmental permits/approvals would depend on the specifics of project activities that have not yet been determined; however, it is anticipated that work affecting waters of the US and state would trigger the following types of permits/approvals.

1. Depending on specific activities within waters of the US, compliance is anticipated to be addressed through a NWP.
2. Corps permit evaluation will address consistency with these regulations.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Required to address the change point of diversion and instream flows.
5. Compliance handled through the JARPA review process and expected to be minimal.
6. County approval likely required. Project-level SEPA evaluation (e.g., SEPA checklist) completed by project applicant(s).

Habitat Protection and Enhancement – Required environmental permits/approvals would depend on the specifics of project activities that have not yet been determined; however, it is anticipated that work affecting waters of the US and state would trigger the following types of permits/approvals.

1. Depending on specific activities within waters of the US, compliance is anticipated to be addressed through a NWP.
2. Corps permit evaluation will address consistency with these regulations.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Required to address the change point of diversion and instream flows.
5. Compliance handled through the JARPA review process and expected to be minimal.
6. County approval likely required. Project-level SEPA evaluation (e.g., SEPA checklist) completed by project applicant(s).

Instream Flow Rule Amendment

1. Administrative changes. Aside from PEIS review for funding, no additional environmental permits/approval likely required. SEPA compliance is required for agency rules. Ecology could rely on the original SEPA determination for Chapter 173-545 WAC, this PEIS, or a separate SEPA action.

LNFH Conservation and Water Quality Improvements

1. Depending on the specific activities that would affect waters of the US, compliance is anticipated to be addressed through a NWP.
2. Federal action for the project by USBR and USFWS would ensure compliance with these federal regulations.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Compliance handled through the JARPA review process and expected to be minimal.
5. EPA NPDES permit required for updates to hatchery operations.
6. Permits may not be required. Need to confirm with Chelan County. It is possible that Ecology review if required as indicated in Note 4 would suffice to support the County's approval.

Fish Passage Improvements / Fish Screen Compliance

1. Depending on specific activities within waters of the US, compliance is anticipated to be addressed through a NWP.
2. Corps permit evaluation will address consistency with these regulations except for projects involving federal agencies as proponents (e.g., LNFH fish screen) where those agencies would serve as federal lead.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Required to address the change point of diversion and instream flows.
5. Compliance handled through the JARPA review process and expected to be minimal.
6. County approval likely required. Project-level SEPA evaluation (e.g., SEPA checklist) completed by project applicant(s).

Water Markets

1. Administrative changes. Aside from PEIS review for funding, no additional environmental permits/approval are likely required other than water right permitting.

Alpine Lakes Modernization, Optimization, and Automation Project

1. USACE NWP / NEPA Categorical Exclusion (CatEx) are the likely level of regulatory compliance for this project. Compliance with General Conditions 20 would require completion of a preconstruction notification (PCN), acknowledging potentially eligible resources pursuant to the National Historic Preservation Act; however, given the nature of the activities, it is anticipated that minimal review would be required and would most likely apply only to activities proposed at Eightmile Lake. PCN is fulfilled by filling out the Washington State JARPA.
2. USFS special use permit is likely required at Snow Lake and Square Lake, and possibly Colchuck Lake.
3. Corps permit evaluation will address consistency with these regulations. Review is anticipated to be relatively straightforward for the proposed project activities. USFS would most likely serve as the federal lead agency responsible for demonstrating applicable compliance with federal regulations at lakes where a special use permit is deemed necessary.
4. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
5. Federal Communications Commission (FCC) approval may be required for radio repeater placement. Federal review consistency likely to be addressed by work completed by Corps or USFS as indicated in Note 3.
6. Required for adding instream flows as secondary uses.

7. Compliance handled through the JARPA review process and expected to be minimal.
8. May not be required. Need to confirm with Chelan County. IPID would be the applicant, but presumably PEIS and related federal permits/approvals would provide information needed to make permit decision if required.

Eightmile Lake Restoration Project

1. Corps NWP / NEPA CatEx are the likely level of regulatory compliance for this project. Compliance with General Conditions 20 would require completion of a PCN, acknowledging potentially eligible resources pursuant to the National Historic Preservation Act; however, given the nature of the activities, it is anticipated that minimal review would be required. PCN is fulfilled by filling out the Washington JARPA.
2. Corps permit evaluation will address consistency with these regulations.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Ecology review requiring submittal of engineering plans unless dam is considered “minor.”
5. Required for adding instream flows as secondary uses.
6. Needed if on-site gravel would be quarried for construction to save costs.
7. A permit to burn cleared logs would only be required if it exceeded the specifications (i.e., fire content, size, and timing limitation) set forth by the WDNR.
8. Compliance handled through the JARPA review process and expected to be minimal.
9. General permit anticipated, requiring compliance with general conditions.
10. SSDP may not be required. Need to confirm with Chelan County. Past O&M activities have most often resulted in the County issuing approval versus a formal SSDP.
11. Permits may not be required. Need to confirm with Chelan County. It is possible that Ecology review if required as indicated in Note 4 would suffice to support the County’s approval.

IPID Dryden Pump Exchange

1. Depending on specific activities within waters of the US, compliance is anticipated to be addressed through a NWP.
2. Corps permit evaluation will address consistency with these regulations.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Required to address the change point of diversion and instream flows.
5. Compliance handled through the JARPA review process and expected to be minimal.
6. General permit anticipated, requiring compliance with general conditions.
7. County approval likely required. Project-level SEPA evaluation (e.g., SEPA checklist) completed by COIC.
8. IPID submittal required prior to construction.

OCPI Legislative Change

1. Administrative changes. Aside from PEIS review for funding, no additional environmental permits/approval required.

Eightmile Lake Storage Enhancement

1. Corps Nationwide Permit / NEPA CatEx are the likely level of regulatory compliance for this project. Compliance with General Conditions 20 would require completion of a PCN, acknowledging potentially eligible resources pursuant to the National Historic Preservation Act; however, given the nature of the activities, it is anticipated that minimal review would be required. PCN is fulfilled by filling out the Washington JARPA.
2. Corps permit evaluation will address consistency with these regulations.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.

4. Ecology review requiring submittal of engineering plans unless dam is considered “minor.”
5. Required for adding instream flows as secondary uses.
6. Needed if on-site gravel would be quarried for construction to save costs.
7. A permit to burn cleared logs would only be required if it exceeded the specifications (i.e., fire content, size, and timing limitation) set forth by the WDNR.
8. Compliance handled through the JARPA review process and expected to be minimal.
9. Water quality compliance would be required and addressed by obtaining a general construction permit.
10. SSDP may not be required. Need to confirm with Chelan County. Past O&M activities have most often resulted in the County issuing approval versus a formal SSDP.
11. Permits may not be required. Need to confirm with Chelan County. It is possible that Ecology review if required as indicated in Note 4 would suffice to support the County’s approval.

Upper Klonaqua Lake Storage Enhancement

1. Corps Nationwide Permit / NEPA CatEx are the likely level of regulatory compliance for this project. Compliance with General Conditions 20 would require completion of a PCN, acknowledging potentially eligible resources pursuant to the National Historic Preservation Act; however, given the nature of the activities, it is anticipated that minimal review would be required. PCN is fulfilled by filling out the Washington JARPA.
2. Corps permit evaluation will address consistency with these regulations. Review is anticipated to be relatively straightforward for the proposed project activities.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Ecology review requiring submittal of engineering plans unless dam is considered “minor.”
5. Required for adding instream flows as secondary uses.
6. A permit to burn cleared logs would only be required if it exceeded the specifications (i.e., fire content, size, and timing limitation) set forth by the WDNR.
7. Compliance handled through the JARPA review process and expected to be minimal.
8. Water quality compliance would be required and addressed by obtaining a general construction permit.
9. SSDP may not be required. Need to confirm with Chelan County. Past O&M activities have most often resulted in the County issuing approval versus a formal SSDP.
10. Permits may not be required. Need to confirm with Chelan County. It is possible that Ecology review if required as indicated in Note 4 would suffice to support the County’s approval.

Upper and Lower Snow Lake Storage Enhancement

1. Corps Nationwide Permit / NEPA CatEx are the likely level of regulatory compliance for this project. Compliance with General Conditions 20 would require completion of a PCN, acknowledging potentially eligible resources pursuant to the National Historic Preservation Act; however, given the nature of the activities, it is anticipated that minimal review would be required. PCN is fulfilled by filling out the Washington JARPA.
2. USFS special use permit is likely required. USFS would likely serve as the federal lead agency responsible for federal consultation under NEPA.
3. Corps permit evaluation will address consistency with these regulations. Review is anticipated to be relatively straightforward for the proposed project activities. USFS may act as federal lead responsible for consistency review at lakes where a special use permit is deemed necessary.
4. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
5. Ecology review requiring submittal of engineering plans unless dam is considered “minor.”
6. Required for adding instream flows as secondary uses.
7. Needed if on-site gravel would be quarried for construction to save costs.
8. A permit to burn cleared logs would only be required if it exceeded the specifications (i.e., fire content, size, and timing limitation) set forth by the WDNR.

9. Compliance handled through the JARPA review process and expected to be minimal.
10. Water quality compliance would be required and addressed by obtaining a general construction permit.
11. May not be required. Need to confirm with Chelan County. 2009 activities at Nada Lake did receive County approval although no permit was issued.

IPID Full Piping and Pump Exchange Project

1. Depending on specific activities within waters of the US, compliance is anticipated to be addressed through a NWP.
2. Corps permit evaluation will address consistency with these regulations.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Required to address the change point of diversion and instream flows.
5. Compliance handled through the JARPA review process and expected to be minimal.
6. General permit anticipated, requiring compliance with general conditions.
7. County approval likely required. Project-level SEPA evaluation (e.g., SEPA checklist) completed by COIC.
8. IPID submittal required prior to construction.

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CHAPTER 7.0 LIST OF CONTRIBUTORS

Co-Lead Agencies

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Melissa Downes	Input, Oversight, Document Review
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APPENDIX A

SEPA Responsiveness Summary

No.	Commenter	Comment Summary	Response
1	Guy Moura, Project Manager Tribal Historic Preservation Officer Confederated Tribes of the Colville Reservation	1) Concern regarding protection of Tribal Treaty Fishing Rights 2) Archaeological, ethnographic, and historical sites of significance within program area	Compliance with state and federal laws, including Tribal fishing rights, is one of the Guiding Principles. Continue consultation with the Confederated Tribes of the Colville Reservation. The PEIS will include a cultural resource survey of areas potentially impacted by projects proposed to meet the Guiding Principles. Consultation with Washington Department of Archaeology and Historic Preservation.
2	William B. Beyers, President Alpine Lakes Foundation	1) Extent of water rights when the Alpine Lakes Wilderness Area was created in 1976 2) Full or partial relinquishment of water rights before or after the creation of the Alpine Lakes Wilderness Area 3) Relationship between storage and diversion rights, and if storage rights are subject to relinquishment if diversion right is exercised 4) Legal ability to build or expand structures on Alpine Lakes 5) Legal ability to construct or expand structures or tunnels upstream from the lakes 6) Legal ability to construct a tunnel	Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will evaluate reasonable alternatives. Existing easements, in-holder agreements, and State water rights will be reviewed.

		7) Rights granted by USFS to IPID and authority to grant those rights during a land transaction in 1990 8) Legal ability to change the purpose of use of a water right 9) To what extent can the IWG process supersede state and federal laws 10) Can the Department of Ecology make objective decisions regarding status of IPIDs water rights	
3	Edward Whitesell 816 Plymouth St., SW Olympia, WA 98502	1) Concern regarding infringement upon the wilderness character of the Alpine Lakes Wilderness. 2) Concern that water management strategy activities/actions would be at odds with 1964 Wilderness Act.	The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws.
4	Derek Poon 400 Boylston Ave E, #2 Seattle, WA 98102 206-729-9378 cell, derekcpoon@gmail.com 206-602-6565 land line	1) How and when will federal provisions and ESA regulations be incorporated into the Icicle Strategy? 2) Are the ESA recovery plan voluntary roadmaps to recovery (delisting) already incorporated into the Icicle Strategy? 3) Have designated use (DU) protections been accommodated within the Icicle Strategy? will my DU matrix be used and published (Alpine Lake 2-17-15, attached)?	Compliance with state and federal law is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal law, including the Endangered Species Act and Clean Water Act.

		4) If the Icicle Strategy cannot adequately protect certain DUs, are economic exemptions planned or have already been explored under the CWA Use Attainability Analysis (UAA, also see CWA Watershed Academy, p. 11), ESA God Squad Decision, or Congressional exemptions? Attachments: 1) ESA Section 4F Recovery Plan criteria, GAO summary.pdf 2) Alpine Lake 2-17-15 IWG mtg, with CWA DU MATRIX.pdf 3) DP 3-4-15 letter, BNR, 3-10-15 meeting.pdf.	
5	Natalie Williams nataliesees@gmail.com	Removal of any resource from a federally-designated wilderness area is a violation of the Wilderness Act and the Alpine Lakes Wilderness Area Management Plan. The EIS should include Alternatives that: 1) protects and preserves the Alpine Lakes water resource in compliance with the above Act and Management Plan 2) acknowledges the limits of the City of Leavenworth, IPID, and other users of the original purpose and legal agreement of the above Act and Management Plan 3) establishes a water rights/volume swap water market in addition to implementing aggressive conservation measures, including	Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will evaluate reasonable alternatives. The PEIS will include narrative of the current state of water rights in the basin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project.

		raising prices, issuing limits, scheduled watering, etc.	
6	Norm Stoddard 12556 Shore Street, Leavenworth, WA 98826	What will be the impact of water conservation measures on domestic water wells? Will loss of groundwater dry up wells?	The PEIS will consider impacts to groundwater for projects proposed to meet the Guiding Principles.
7	Steve McKenna 12490 Shore Street, Leavenworth, WA 98826	Commends the IWG for successful collaboration. Enjoyed the presentation. Was very pleased with the outreach and involvement of the community in the process.	General support for the project noted. Additional outreach opportunities are forthcoming at the Draft PEIS stage, Final PEIS, and related to any additional project level EIS's.
8	Scot Brower TU Leavenworth Chapter	Concerns regarding manipulation or alteration of the existing Boulder Field: 1) Is upper Icicle Creek suitable habitat for Steelhead? 2) Will Steelhead passage into upper Icicle Creek result in closure of existing rainbow trout fishery (due to ESA status of Steelhead)?	The PEIS will consider potential aquatic habitat, habitat suitability, and recreational impacts of the projects proposed to meet the Guiding Principles. Opportunities for fish passage improvements throughout Icicle Creek will be evaluated. Compliance with state and federal law is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal law, including the Endangered Species Act.

9	Nete Olsen 836 NW 61st St Seattle, WA 98107	1) A Water Balance Chart should be prepared for the Icicle Creek system: a) baseline flows expected for Icicle Creek and the lakes during “normal” and “drought” years, and anticipated future flows related to global warming. b) water outputs from Icicle Creek under current operations during “normal” and “drought” years showing the locations of the diversions, maximum rates and volumes of diversion, whether the diversions are firm or interruptible, and the holders of the diversionary rights. c) locations of problem areas in the drainage system that the IWG is trying to address to improve instream flows. 2) The Guiding Principles outlined by the IWG need to be ranked in order to establish the relative importance of each principle. Consider assigning “Required” and “Additional” as categories for the Guiding Principles. 3) “Conservation First” should be added as the 10th Guiding Principle. 4) Relocating the diversion locations along Icicle Creek must be considered as an alternative to meet the Guiding Principle of Improving Instream Flow. 5) Transferability of water rights must be demonstrated in the Eightmile Lake Restoration Project.	All of the Guiding Principles have equal priority and must be met as a package to effectuate the proposal endorsed by the Icicle Workgroup. Existing documents provide background on baseline flows, diversions, and current conditions in the Icicle Creek Subbasin, (see county website). The PEIS will provide additional detail on streamflow, diversions, out-of-stream use, and a need statement relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles. The PEIS will evaluate reasonable alternatives. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will describe potential projects and impacts under the proposed program. Additional detail will be provided in any subsequent project level EIS. The PEIS will include narrative of the current state of water rights in the basin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project. The PEIS will discuss proposed actions under the Guiding Principles and related projects that are required by state/federal law. The PEIS will discuss water conservation to meet the Guiding Principles.

		6) Limits of Inundation of Eightmile Lake perimeter should be mapped. 7) Alpine Lakes Optimization, Modernization, and Automation operation strategy needs to be defined: a) How much water will be taken from each lake during a “normal” water year? b) Will the ease of water withdrawal increase the “baseline” withdrawal rate that currently gets drawn? For example, will irrigated acreage increase so that the needs for irrigation rise, and every year becomes a “drought” year? Providing a more regular supply may only make for more severe shortages as the impacts of global warming become clearer. c) How will the benefits to Instream Flows (as an interruptible flow) be balanced with the needs of irrigation (as a firm demand)? 8) Stage/Storage data and bathymetry needs to be developed for each of the Alpine Lakes within the “optimization” program.	The PEIS will provide detail regarding Alpine Lakes Optimization, Modernization, and Automation including release rates, hydrologic inputs, changes to inundated area, and instream flow benefits.
10	Roy McMurtrey	We need wilderness kept pristine, get the water some other way.	Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws.

			The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles.
11	Ken Hemberry General Manager Peshastin Hi-Up Growers	Orchardists/Growers depend on a reliable source of water for irrigation. It was great to learn that the [Icicle] Work Group was focused on meeting the needs of all stakeholders through a consensus process. We both appreciate and support the Work Group's plans and Guiding Principles.	General support for project noted. Agricultural reliability is one of the Guiding Principles.
12	Jori Adkins 301 Puyallup Ave. Tacoma, WA 98421 253-365-1459	Concern about the Icicle group's proposal to use the Alpine Lakes as reservoirs. Wilderness areas are a place of rejuvenation and healthy hiking and wildlife watching.	Using the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles.
13	Vic Clayson Cashmere, WA	Appreciative of opportunity for public comment. Very much in favor of increased water storage in the subbasin. Concerned about where funding will come from.	General support for project noted. Additional outreach opportunities are forthcoming at the Draft PEIS stage, Final PEIS, and related to any additional project level EIS's. Storage projects will be evaluated as part of reasonable alternatives to meet the Guiding Principles.

			Funding for the proposal is expected to be comprised of local, state, and federal funding sources.
14	Merrie Davis	In favor of additional water storage in the Alpine Lakes area. I hope the proposal is a success.	General support for project noted. Storage projects will be evaluated as part of reasonable alternatives to meet the Guiding Principles.
15	Cristina Hill Leavenworth, WA	As part of the Conservation initiative of the proposed project, the City of Leavenworth should initiate a water metering program and tiered pricing for residential customers. In favor of improving passage at Boulder Field. In favor of upgrading fish screens and new rearing tanks at LNFH. In favor of piping irrigation diversion/delivery systems.	The PEIS will evaluate reasonable alternatives, including conservation incentives. The PEIS will consider impacts on fish passage and screening of the projects proposed to meet the Guiding Principles. General support for project noted.
16	Tim Gartland 9120 Woodworth Avenue Gig Harbor, WA 98332	SEPA Environmental Checklist for the Project may be incomplete. The responses appear to ignore the upstream impacts. Additionally, the manipulated flows meant to provide additional water during the late summer and early fall are by definition unnatural and will have deleterious effects on wildlife, wildlife systems and humans.	The PEIS will assess the potential impacts to wildlife and recreation that might result from the projects proposed to meet the Guiding Principles. The PEIS will provide detailed streamflow, diversions, and out-of-stream use information relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles.

		Increased late-season instream flows will make Icicle Creek unsafe for upstream property owners, camp site users, and other visitors to swim, wade, or bathe themselves.	
17	Ed Burns	Conservation efforts seem to have the lowest priority. The remote control of output from the lakes would seem to be relatively innocuous; the rebuilding of the Eightmile dam less so (interesting that in the reports the "historic" level of the lake is the level after the original dam was built); and the diversion from Upper Klonaqua Lake, outrageous.	All of the Guiding Principles have equal priority and must be met as a package to effectuate the proposal endorsed by the Icicle Workgroup. The PEIS will evaluate reasonable alternatives.
18	Margie Van Cleve 272 Mapleway Road Selah, WA 98942	1) Objects to the term "reservoir" to describe the lakes within the Alpine Lakes Wilderness Area and to the purpose of the project (to manage release from the reservoirs that would optimize water supply in the Icicle Creek subbasin and be coordinate among all users). 2) Conservation of municipal water should be a higher priority. Conservation initiatives should be addressed as a primary means of increasing instream flows; optimizing, modernizing, and automating reservoir management should come secondary. 3) Concerned that IPID's agricultural water rights associated with the	Using the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles. The PEIS will describe the history of the Alpine Lakes, existing reservoirs, and current operations. All of the Guiding Principles have equal priority and must be met as a package to effectuate the proposal endorsed by the Icicle Workgroup. The PEIS will evaluate reasonable alternatives. The PEIS will evaluate projects to meet the Guiding Principles, including conservation and reclaimed water, agricultural to domestic water right conversions, and storage.

		Alpine Lakes will be converted to domestic water rights. 4) Opportunities for utilizing reclaimed water should be considered as an alternative.	The PEIS will provide detailed streamflow, diversions, and out-of-stream use information relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles.
19	Fred Smith PO Box 357 Dryden, WA 98821 509-860-3997	1) The number one priority should be whichever project increases stream flow the greatest during mid to late summer. This should be the rebuilding of the dam at Eightmile Lake to the original height, along with installation of automated valves. 2) Regarding the Boulder Field: learn to live with it (i.e., make no change).	All of the Guiding Principles have equal priority and must be met as a package to effectuate the proposal endorsed by the Icicle Workgroup. Project phasing and timelines will be included in the PEIS. The PEIS will provide detailed streamflow, diversions, and out-of-stream use information relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles. The PEIS will evaluate reasonable alternatives. Opportunities for fish passage improvements throughout Icicle Creek will be evaluated.
20	Lisa Pelly Director, Trout Unlimited-Washington Water Project Mike Wyant President, Icicle Valley Chapter of Trout Unlimited TU Washington Water Project 103 Palouse Street, Suite 14 Wenatchee, WA 98801 509.888.0970	1) TU is concerned that the Project package meeting Icicle Creek demands through 2050 is not substantiated because no assessment has been conducted specifically addressing future water supply and climate scenarios in the subbasin. Recommends procurement of a water supply and climate change analysis from a team of experts (e.g., UW Climate Impacts Group). TU has provided an analysis of stream flow for Icicle Creek.	The PEIS will consider climate change and its impact on proposed projects. The PEIS will evaluate reasonable alternatives. The PEIS will include a narrative of the current state of water rights in the Icicle Creek Subbasin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project. The PEIS will describe NEPA and other permitting requirements

		2) The IWG should develop a full list of project alternatives, should any of the projects in the proposed package require replacement. 3) Lead agency under NEPA should be identified. 4) Flow objectives could be monitored at the USGS gauge station above the Snow Creek confluence. 5) Concerns about changes to the Alpine Lakes Wilderness area has been expressed by various stakeholders and user groups; these concerns should be taken seriously. 6) TU has ongoing restoration projects in the subbasin. These projects will continue to be managed independent of the IWG Strategy process. 7) The IWG should articulate benefit/cost information for projects in the proposed package. Preferably, this analysis should be conducted independent of the IWG.	The PEIS will assess flow improvements in Icicle Creek at multiple locations. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. The PEIS will include a narrative of projected costs and benefits of projects proposed to meet the Guiding Principles. The PEIS will describe "Alternatives Not Considered" to meet the Guiding Principles, but could be evaluated in another environmental review.

21	Rob Newsom Eightmile Creek Leavenworth, WA 98826 Cell 509-670-3166	I am glad for the water use study in the Icicle. Two things of concern: 1) Every time extra water is released from Colchuck Lake there is a tremendous sediment load suddenly flowing by in Eightmile Creek/ Mountaineer Creek. This is a completely unnatural condition for fish and people in late summer. 2) The continued use of helicopter support and further construction of dams in the Alpine Lakes Wilderness Area is blatantly at odds with the spirit of The Wilderness Act.	General support for project noted. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. The PEIS will discuss potential water quality impacts from projects proposed to meet the Guiding Principles. Using and maintaining the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles.
22	Ruth Dight, AICP (206) 283 9254 2549 11th Ave W Seattle, WA 98119	1) The EIS must consider a Wilderness Protection Alternative to promote wilderness values (Wilderness Act of 1964) and would not allow new water infrastructure or diversions inside the Alpine Lakes Wilderness, and would require all new water supply to be obtained outside the Alpine Lakes Wilderness. 2) The EIS must consider a Water Conservation Alternative, to use aggressive water conservation measures (inclusive of lawn-water restrictions). This alternative should also assess transfer of water rights from irrigation districts to cities, where agricultural land-use has	Using the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles. The PEIS will evaluate reasonable alternatives. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will include narrative of the current state of water rights in the basin. For each project designed to meet the Guiding Principles, the PEIS will prescribe

		been replaced by residential land-use. This alternative should also assess agricultural irrigation efficiency (e.g., replacing open gravity canals with pipes and pumps). 3) The EIS must consider an Irrigation District Water Right Change Alternative to evaluate moving the IPID water right diversion from Icicle Creek downstream ~3 miles to the Wenatchee River. This measure, which would permanently fix Icicle Creek's low flow problem, would convert the IPID diversion from gravity flow to pumping (requiring electrical power). The Icicle Work Group should therefore analyze renewable energy options to supply that power, including solar, wind and in-canal hydroelectric. 4) The EIS must consider a Water Right Relinquishment Alternative. Loss of potential water resulting from lower dam at Eightmile Lake should be considered as relinquishment of water rights.	what existing and new permits would be necessary for the project.

23	W. Thomas Soeldner Valleyford, Washington	1) The EIS must consider a Wilderness Protection Alternative that would promote the wilderness values set forth in the Wilderness Act of 1964. 2) The EIS must consider a Water Conservation Alternative. 3) The EIS must consider an Irrigation District Water Right Change Alternative, which would involve evaluating a move of the IPID water right diversion to the Wenatchee River Downstream, converting the diversion from gravity flow to pumping. Renewable energy options should be able to supply such power. 4) The EIS should consider a Water Right Relinquishment Alternative, since the dam at Eightmile Lake collapsed decades ago.	The PEIS will evaluate reasonable alternatives. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will include a narrative of the current state of water rights in the Icicle Creek Subbasin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project.
24	John de Yonge President Wise Use Movement PO Box 17804 Seattle, WA 98127	Unacceptable for work group to include agency conveners. IWG must comply with Federal Advisory Committee Act. Programmatic EIS should not preclude project level environmental review. NEPA is required The PEIS should identify existing and historic hydrologic conditions in Icicle Creek.	General objection to the project noted. The PEIS will evaluate reasonable alternatives. The PEIS will describe NEPA and other permitting requirements Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. Objection to SEPA checklist noted. The checklist was an optional process the IWG elected to do in order to

		Comments on completeness of SEPA Checklist Request for the PEIS to describe potential affected environment and identify potential impacts of program and proposed projects. Request for the PEIS to include mitigation measures for potential impacts. The PEIS should address the relationship between the LNFH and Icicle Creek, including purpose and need, fish production, and water withdrawals. The PEIS should address tribal and non-tribal harvest of wild and hatchery fish in Icicle Creek. The PEIS should provide background and need for domestic water supply in the Icicle Creek Subbasin. The PEIS should provide a Wilderness Alternative. The PEIS should identify existing fish passage barriers and projects which would improve fish passage. The PEIS should comply with all local, state, and federal laws. Projects proposed to meet the Guiding Principles should evaluate the potential	provide transparency. A Determination of Significance was issued. The PEIS will provide detailed streamflow, diversions, and out-of-stream use information relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles. PEIS will include a narrative of the current state of water rights in the Icicle Creek Subbasin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project. The PEIS will describe potential projects and impacts under the proposed program. Additional detail will be provided in any subsequent project level EIS. The PEIS will include background information related to the development of the Guiding Principles, current condition in the Icicle Subbasin, and a need statement. This background information will include background on information on LNFH and domestic water supply. The PEIS will identify targets for instream flows to support spawning, rearing, and migration of ESA-listed salmon, steelhead, and bull trout in Icicle Creek. The PEIS will assess the potential impacts to wilderness and recreation, that might result from the projects proposed to meet the Guiding Principles. The PEIS will consider potential aquatic habitat, habitat suitability, and recreational impacts of the projects proposed to meet the Guiding Principles. Opportunities for fish passage improvements throughout Icicle Creek will be evaluated.

		for increased irrigation efficiencies and conservation practices, water markets, operational improvements to the LNFH, and improvements to fish screening. The PEIS should identify the locations of all proposed projects.	
25	Thomas H. Walker 3815 Bagley Ave N Seattle, WA 98103	1) The Alpine Lakes Wilderness is a shared natural resource that must be respected and protected. 2) The EIS should include a "Wilderness Protection" alternative, which should include an alternation of public purchase (buy-back) of private water rights in the Alpine Lakes. 3) The EIS should include a "Water Right Relinquishment" alternative. 4) The EIS should include an alternative that recognizes Icicle Working Group members' water rights are limited to the purposes for which they were initially granted, and cannot be redirected to other purposes. 5) The EIS should include a "Water Conservation" alternative that emphasizes aggressive water conservation measures by the local water users. 6) The EIS should include a "Water Right Change" alternative.	The PEIS will evaluate reasonable alternatives. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will include a narrative of the current state of water rights in the Icicle Creek Subbasin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project. The PEIS will consider impacts of lake/reservoir draw-down from proposed projects The PEIS will identify targets for instream flows to support spawning, rearing, and migration of ESA-listed salmon, steelhead, and bull trout in Icicle Creek. The PEIS will describe potential projects and impacts under the proposed program. Additional detail will be provided in any subsequent project level EIS.

		7) The EIS should analyze each proposed action's site-specific impacts, past practices, and the restoration, mitigation, and funding that are needed in the future. At each site, proposed construction activities and proposed water diversions need to be spelled out in detail. 8) The EIS should discuss the hydrological and biological impacts of the current drawdown of the lakes, and any proposed changes. 9) The EIS should provide a detailed operations, maintenance, and environmental monitoring plan for the water infrastructure, and analysis of the wilderness impacts of specific maintenance actions, including helicopter use. 10) The EIS should fully explain the purpose and need for the water these projects would provide. 11) The EIS should fully explain what human activities caused the degraded conditions that the projects seek to improve. 12) The EIS should analyze adequacy of proposed in-stream flows to support spawning, rearing, and migration of steelhead and bull trout.	Existing documents provide background on baseline flows, diversions, and current conditions in the Icicle Creek Subbasin, (see county website). The PEIS will provide additional detail on streamflow, diversions, out-of-stream use, and a need statement relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles. The PEIS will consider monitoring, maintenance, and operation of projects proposed to meet the Guiding Principles. The PEIS will consider monitoring, maintenance, and operation of projects proposed to meet the Guiding Principles.

26	Michael Wyant 12125 Emig Drive Leavenworth, WA 98826 (509) 548 7747	I am concerned that the projections for water savings to reach flow targets are overly optimistic: • The projections rely on all of the proposed projects being completed. The suite of proposals should include additional options so that meeting the target for flows does not rely on completing all of the projects. • The proposed positive effects of identified water management strategies are overly optimistic given many of the climate change projections for the next 50 years. Though I consider myself a staunch supporter of wilderness, I am in favor of the proposed changes at the lakes in the Alpine Lakes Wilderness that are managed as water storage reservoirs. • I support those changes because maintaining the existence of the reservoirs was grandfathered in when the wilderness was established. • It makes sense to use the water in those reservoirs as efficiently as possible, even though doing so intrudes and will continue to intrude on the wilderness experience. • I support the reconstruction of Eightmile Lake dam to its original height even though doing so will inundate land that	General support for project noted. The PEIS will consider monitoring, maintenance, and operation of projects proposed to meet the Guiding Principles. The PEIS will provide detailed streamflow, diversions, and out-of-stream use information relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles.

		has been above lake level for many years. • I oppose raising the height of the original reservoir because that would represent a change to the agreement to keep the existing reservoirs when the wilderness was established. I would like to be assured that sufficient scientific study is in place to make it relatively certain that the project will have the positive effects that are proposed and that the possibility that the project will have unintended negative consequences has been thoroughly considered. I would also like to know that each project that has the potential to impact the icicle ecosystem includes a plan and the resources necessary to study the post-project impacts. • Too often projects are completed with the idea that they will improve an ecosystem when there is no post-project evidence that they actually had the intended effects and that they are not, in fact, having a negative or unintended effect.	
27	Winnie Becker	1) Please preserve the Alpine Lakes Wilderness. To build dams and change water rights would not be in keeping with the wilderness. 2) The EIS should include a "Wilderness Protection" alternative. The increase of water removal from	Using the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles. The PEIS will evaluate reasonable alternatives.

		the Alpine Lakes Wilderness is not in keeping with protecting the wilderness which is so very important for generations to come. Water should be obtained from sources outside the Wilderness. The Wilderness Protection alternative should comply with all the provisions in the Forest Service's administrative Alpine Lakes Wilderness Management Plan, including: " Except as provided for in Section 4(D)(4) of the Wilderness Act, watersheds will not be altered or managed to provide increased water quantity, quality or timing of discharge. 3) The Wilderness Protection alternative should evaluate public purchase (buy-back) of private water rights in the Alpine Lakes, which would allow removal of dams and other structures from the lakes to restore the area to its true natural character. 4) The EIS should include "Water Right Relinquishment" alternative. The alternative should analyze existing water rights to the Alpine Lakes and acknowledge those rights that have been relinquished or abandoned. 5) The EIS should include an alternative that recognizes IWG members" water rights are limited to the purposes for which they were initially granted (irrigation is an	The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will consider impacts of lake/reservoir draw-down from proposed projects. The PEIS will identify targets for instream flows to support spawning, rearing, and migration of ESA-listed salmon, steelhead, and bull trout in Icicle Creek. The PEIS will describe potential projects and impacts under the proposed program. Additional detail will be provided in any subsequent project level EIS. Existing documents provide background on baseline flows, diversions, and current conditions in the Icicle Creek Subbasin, (see county website). The PEIS will provide additional detail on streamflow, diversions, out-of-stream use, and a need statement relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles The PEIS will consider monitoring, maintenance, and operation of projects proposed to meet the Guiding Principles. The PEIS will include narrative of the current state of water rights in the basin. For each project designed to meet the Guiding Principles, the PEIS will prescribe

		example) and cannot be redirected to other purposes (such as suburban development). 6) The EIS should include a "Water Conservation" alternative that emphasizes aggressive water conservation measures by the city of Leavenworth, Icicle-Peshastin Irrigation District, the Leavenworth fish Hatchery and other water users. This alternative should evaluate water markets that facilitate selling and trading of water rights. 7) The Water Conservation alternative should evaluate a transfer of water rights from IPID to Leavenworth for properties within the city limits that have now converted from orchards to residential properties. This alternative should analyze how appropriate reductions in water usage (that is, not using agricultural water quantities for lawn irrigation) would save that would then be available for other Leavenworth needs. 8) The Water Conservation alternative should evaluate how IPID spills large quantities of water back into the Wenatchee River at the end of several of its canals. The alternative should evaluate how this 19th century irrigation practice could be replaced with modern pumping and piping technologies. The EIS should work to reduce water	what existing and new permits would be necessary for the project.

		demand as an alternative to water supply. 9) The EIS should include a "Water Right Change" alternative. This alternative would evaluate improving Icicle Creek flows by moving IPID's point of diversion downstream (to the Wenatchee River). This measure, which would add 100 cfs of water to Icicle Creek every year, would convert the IPID diversion from gravity flow to pumping (requiring electrical power). This alternative should therefore analyze renewable energy options to supply that power, including solar, wind and in-canal hydroelectric. 10) The EIS should discuss the hydrological and biological impacts of the current drawdowns of the lakes, and any proposed changes. The analysis should include a review of scientific literature on the impacts of water removals upon wildlife, vegetation, soil and wilderness values 11) The EIS should analyze each proposed action's site-specific impacts, past practices and the restoration, mitigation and funding that are needed in the future. At each site, proposed construction activities and proposed water diversions need to be spelled out in detail.	

		12) The EIS should provide a detailed operations, maintenance and environmental monitoring for the water infrastructure, and analysis of the wilderness impacts of specific maintenance actions including helicopter use. 13) The EIS should fully explain the purpose and need for water these projects would provide. 14) The EIS should fully explain what human activities caused the degraded conditions (such as low instream flows in Icicle Creek) that the projects seek to improve. 15) The EIS should analyze adequacy of proposed instream flows to support spawning, rearing and migration of steelhead and bull trout.	
28	Dean and Martha Effler	Please do not allow any agreement to provide water to commercial or residential users that would impact the hydrology and natural beauty of the Alpine Lakes Wilderness. A wilderness no longer is a wilderness when you drain its natural resource or flood its land. Only allow growth in local cities and counties based on water conservation methods rather than tapping into the waters of a protected wilderness.	Using the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles.

29	Jena F. Gilman, P.E. (WA 23673) 1480 SW 10th Street North Bend, WA 98045	1) The EIS should fully explain the purpose and need for each of the water projects outlined in the "Icicle Strategy". 2) The EIS should analyze each of the proposed action's site-specific impacts, past practices, and the restoration, mitigation and funding needed in the future. At each site, proposed construction activities need to be explained and illustrated in detail as well as how wilderness and habitat values will be maintained throughout the period of construction for Wilderness users and the complete array of fauna and flora that inhabit these areas. 3) The EIS should discuss the hydrological and biological impacts of the current drawdowns of the lakes within the Wilderness and the incremental impacts of any proposed changes. The analysis should include the impacts of water removals upon all wildlife, vegetation, soil and wilderness values.	The PEIS will evaluate reasonable alternatives. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will consider impacts of lake/reservoir draw-down. The PEIS will identify targets for instream flows to support spawning, rearing, and migration of ESA-listed salmon, steelhead, and bull trout in Icicle Creek. The PEIS will describe potential projects and impacts under the proposed program. Additional detail will be provided in any subsequent project level EIS. The PEIS will include background information related to the development of the Guiding Principles, current condition in the Icicle Creek Subbasin, and a need statement.

		4) The EIS should provide detailed operations and maintenance plans for proposed infrastructure and an analysis of the impacts on the wilderness experience of specific maintenance actions, including helicopter operations. 5) The EIS should consider a Wilderness Protection Alternative. This alternative would promote wilderness values as set forth in the Wilderness Act of 1964, would not allow new water infrastructure or diversions inside the Alpine Lakes Wilderness, and would require all new water supply to be obtained outside the Alpine Lakes Wilderness. 6) The EIS should consider a serious Water Conservation Alternative. This alternative would assess using aggressive water conservation measures by area cities, including restrictions on lawn watering and provision for landscaping that is suited to the climate without irrigation for any new development. This alternative should also assess transfer of water rights from irrigation districts to cities, where orchards have already been torn out and replaced with residential subdivisions. This alternative should also assess agricultural irrigation efficiency, such as replacing open gravity canals with pipes and pumps. This	The PEIS will consider monitoring, maintenance, and operation of projects proposed to meet the Guiding Principles. The PEIS will include narrative of the current state of water rights in the basin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project.

		Alternative should also consider water re-use technologies. 7) The EIS should consider an Irrigation District Water Right Change Alternative, which would fix Icicle Creek's low flow problem. This alternative would evaluate moving the Icicle-Peshastin Irrigation District's water right diversion, which presently takes 100 cubic feet per second out of Icicle Creek, to the Wenatchee River downstream. 8) The EIS should consider a Water Right Relinquishment Alternative. Removal of water from the Alpine Lakes Wilderness is an issue only because the Icicle-Peshastin Irrigation District holds water rights that were grandfathered when the Wilderness was created. When the dam at Eightmile Lake failed the Irrigation District did not fix it because they did not need the water. When a party doesn't use their rights, they lose them. The "Use It or Lose It" doctrine should govern. The EIS needs to acknowledge this issue.	
30	Carmen Andonaegui WDFW, Region 2 Habitat Program Manager 1550 Alder St NW Ephrata, WA 98823 (509) 754-4624	1) It is essential the PEIS describes the sequencing and timing of permittable projects and identifies the beneficiaries of in-stream and out-of-stream flow improvements. WDFW is concerned that water will be allocated for out-of-stream uses before an adequate amount of flow	Continue consultation with WDFW. Appropriate habitat and wildlife surveys will be conducted on affected environment for each of the proposed projects. The PEIS will provide detailed streamflow, diversions, instream and out-of-stream use information

		improvements are made in Icicle Creek. 2) At the public scoping meeting held in Leavenworth it was stated by Aspect Consulting that the timeframe associated with implementing projects ranged from 5-20 years. In order to “track” flow improvements that may occur over the next 5-20 years, a project implementation schedule should be included in the PEIS so readers can adequately provide comments, mitigation recommendations, and resource protection expectations within the context of “real water” in “real time”. 3) Please describe the “Alternative Projects” being contemplated for replacing projects that may not be feasible. WDFW expectations are that alternative projects would be identified through a collaborative process to replace those benefits and functions intended by the project determined to be infeasible. 4) As fisheries co-managers for the state of Washington, WDFW does not support waiting 5-20 years to upgrade the Leavenworth Hatchery. We respect Ecology and CCNRD’s efforts to find non-litigious solutions to upgrading the hatchery to meet state and federal laws. However, we also want to be clear that though our agency is an active member of the IWG, we are in no way	relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles. All of the Guiding Principles have equal priority and must be met as a package to effectuate the proposal endorsed by the Icicle Workgroup. Project phasing and timelines will be included in the PEIS. The PEIS will include a narrative of projected costs and benefits of projects proposed to meet the Guiding Principles. The PEIS will evaluate reasonable alternatives. The PEIS will discuss proposed actions under the Guiding Principles and related projects that are required by state/federal law. The PEIS will consider climate change and its impact on proposed projects. The PEIS will identify and discuss early implementation items. The PEIS will describe NEPA and other permitting requirements The PEIS will describe “Alternatives Not Considered” to meet the Guiding Principles, but could be evaluated in another environmental review. The Guiding Principles include robust instream flow improvement. Construction of projects designed to provide this instream flow improvement may have some terrestrial impacts, which will be evaluated in the PEIS. The adequacy of lands proposed for acquisitions under

		advocating delaying compliance-related upgrades at the hatchery as a result of being a project element of the PEIS. We suggest providing details within the PEIS that "cross-walks" your efforts to solve hatchery issues with the U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service's efforts. 5) It is essential that long-term climate change scenarios serve as the "backbone" to developing the PEIS. Refill scenarios for the Alpine Lakes remain uncertain, as do in-stream flows influenced from timing and quantity of annual precipitation. WDFW urges Ecology not to over-commit water for out-of-stream uses made "available" as a result of implementing any of the projects. We would not be doing our job as a resource agency if we did not safeguard stream flows to protect fish and their habitat throughout this PEIS process. We assume the same level of safeguarding will occur from Ecology to protect senior water right holders from harm or avoid project actions that may cause adverse impacts to stream flows or water quality. WDFW expects to see a robust section in the PEIS that evaluates climate change effects on project operational scenarios (e.g. new water management of the Alpine Lakes) and then illustrates how stream flow improvements will be	the guidance of the Upper Wenatchee Community Lands Plan will be scaled appropriately. Fish life stages will be described in the PEIS, as well as impacts to various species based on different instream flow quantities.

		achieved while simultaneously providing additional water for out-of-stream uses (i.e. show the math). 6) Ecology and CCNRD have indicated that some of the projects listed above may be described with a higher level of detail within the PEIS than the broader ICWRMS projects, making some projects ready for early implementation. Evaluation of projects considered for early implementation should include an assessment of natural resource costs and benefits as a function of project sequencing/early implementation within a subsequent project-level EIS, as necessary. 7) As you are aware, WDFW is actively working on several fish screen and diversion replacement projects in Icicle and Peshastin Creeks to protect fish life; these projects are slated to occur in the near future. WDFW staff will continue to manage these projects and our own environmental compliance process, associated grant awards, and partnerships independent of the Icicle Strategy. However, our WDFW team is always available to assist with project planning and/or provide expertise to support PEIS development. 8) Please provide a hardy, water conservation and reduction section in the PEIS. For example, what are	

		some ways CCNRD and Ecology will reduce the current gallon per capita per day as a tool to provide water for future growth and respond to drought effects? How will those endeavors be coordinated with investigating new water supply in the Alpine Lakes? WDFW recommends including a plan in the PEIS by which (1) CCNRD and Ecology will partner with utility providers to offer rebates for using less water, (2) to update local regulations and/or develop ordinances to promote and/or require water savings wherever possible, and (3) to develop water conservation and reduction incentive programs. 9) WDFW still isn't clear how the Upper Wenatchee Community Lands Plan is linked to the ICWMRS. WDFW habitat and wildlife staff have communicated with CCNRD that parcels identified in the Upper Wenatchee Community Lands Plan for acquisition may modestly add habitat value for wildlife or watershed protection in of itself. WDFW doubts these lands will be sufficient to provide "commensurate compensation for impacts to fish and wildlife resources" in the Icicle Creek basin. In addition to low habitat value, the scope of the Upper Wenatchee Community Plan includes Cashmere to Stevens Pass, with	

		three sub-areas not located in the Icicle Creek Basin including: 1) Blewett Pass/Peshastin, 2) Chumstick Valley, and 3) Nason & Coulter Creek. The Wenatchee Community Lands Plan webpage makes no clear reference to how these "out-of-basin lands" are linked to the ICWRMS. WDFW recommends Ecology and CCNRD work with resource experts to assess lands for acquisition and/or enhancement within the Icicle Creek basin that can provide valuable fish and wildlife habitat. As you are aware, mitigation should be similar to the resource values lost through project development; out-of-place and/or out-of-kind mitigation is only appropriate when all other in-place mitigation opportunities have been exhausted. 10) WDFW encourages Ecology and CCNRD to identify a lead federal agency to undertake the NEPA process as soon as possible. WDFW is unclear if federal participation on the IWG and dedication of time and personnel constitutes a "major federal action" within the meaning of NEPA. WDFW suggests delineating projects in the PEIS that cannot proceed until NEPA has been fulfilled. This will ensure local, state, and federal agencies, tribes, and other stakeholder groups have a clear understanding of project	

		implementation timelines and associated in-stream flow benefits for each project (i.e. when will the water be in Icicle Creek and how much). ***Wildlife*** • The WDFW Priority Habitat and Species (PHS) data layers are a tool for planning purposes. These data sources cannot be assumed complete or exhaustive in expanses of wilderness considered in the PEIS. Lack of information for any species does not indicate a lack of presence. If the U.S. Forest Service (USFS) does not have species presence/absence surveys, WDFW recommends terrestrial surveys be completed for species likely to occur within the project footprint. • Project activities requiring the use of helicopters pose a significant disturbance threat to mountain goats in the Alpine Lakes Wilderness - flying over mountain goats is considered to be a direct disturbance. WDFW recommends conducting surveys for concentrations of mountain goats for PEIS development. Specific consideration should be made for the timing of helicopter use to avoid the period when females are giving birth and following weeks when raising young. • Golden eagles, peregrine falcons, northern goshawks, and northern	

		spotted owls all occupy, nest, and rear young in associated habitats in the wilderness and may be located within the project footprint. WDFW recommends conducting surveys within the project footprint so a plan can be developed to avoid disturbing nest sites, particularly until young have fledged. The high elevation and colder conditions of the wilderness will extend fledging dates into the summer later than warmer low elevation habitats. • WDFW recommends conducting surveys for pika within the project footprint and to work closely with WDFW and the USFS to avoid impacts to this species at the project planning stage. • Any open water habitat included within the project footprint should be surveyed for common loon nesting. The potential for direct impacts to loon nests is high for any project activities that would result in a rise of water elevation on any lakes. • The USFS and WDFW are coordinating in summer of 2016 to conduct amphibian and reptile surveys at wetlands, lakes, ponds or streams located within and whereas water-levels or flows are impacted by the package of projects in the PEIS. Data collected and information in the final report should be used to	

		develop the Final PEIS and for future, subsequent EISs. ***Habitat*** • Installation of a flow meter, with access to the data should be made publicly available to confirm proposed minimum instream flows designated for the Historic Channel in Icicle Creek are being met. • WDFW support CCNRDs efforts to fund and install meters on all diversions. • The water market being developed for Icicle Creek will need to be coordinated annually with fisheries co-managers to avoid seasonal harm to instream flows, including winter flows to protect fish life. ***Fish*** • Fish passage improvements should include flow as an important component to ensure riffles are passable to upstream migrating salmonids. • WDFW can provide fish stocking data for the Alpine Lakes if requested. Our agency has a vested interest in ensuring changes in operations at the lakes do not adversely impact fish • Modeling flow scenarios out of each and/or all of the Alpine Lakes being contemplated in the PEIS will help prioritize flows scenarios that maximize benefits to fish at each relevant life stage. Focal	

		species and relevant life stages include Steelhead (adult, rearing), Rainbow trout (adult, rearing), Bull Trout (adult/sub-adult, rearing), Cutthroat Trout (adult, rearing), and Lamprey (adult). • Bringing fish screening associated with diversions into compliance with state and federal requirements should be a nondiscretionary "early action" item of the PEIS; this action should be funded and pursued in the immediate future as a priority of the ICWRMS.	
31	Doug Scott Wilderness Consulting 1723 18th Avenue, Suite 25 Seattle, WA 98122	The Alpine Lakes Wilderness Area is a beloved part of America's National Wilderness Preservation System: The Wilderness Area--every acre of it -- is protected with the full strength of the 1964 Wilderness Act. The building of new dams or water diversions, however "minor" you may think they would be, is illegal. Were your proposal to succeed, it would constitute a very serious and unacceptable precedent.	Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. Using the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles.

32	Alpine Lakes Protection Society; Alpine Lakes Foundation; Alliance for the Wild Rockies; American Whitewater; Aqua Permanente; Center for Environmental Law & Policy; Conservation Congress; El Sendero; Endangered Species Coalition; Federation of Western Outdoor Clubs; Friends of the Bitterroot; Friends of Bumping Lake; Friends of the Clearwater; Friends of the Enchantments; Friends of Lake Kachess; Friends of Wild Sky; Great Old Broads for Wilderness; Issaquah Alps Trail Club; Kachess Homeowners Association; Kachess Ridge Maintenance Association; Kittitas Audubon Society; Kittitas County Fire District #8; The Mazamas; Middle Fork Recreation Coalition; North Cascades Conservation Council; North Central Washington Audubon Society; Olympic Forest Coalition; River Runners for Wilderness; Save Our Sky Blue Waters; Seattle Audubon Society; Sierra Club; Spokane Mountaineers; Spring Family Trust for Trails; Washington Native Plant Society; Washington Wild; Western Lands Project; Wilderness Watch; Wild Fish Conservancy; Doug Scott Wilderness Consulting; and Rachael Osborn	1) We suggest several reasonable alternatives to fully evaluate project opportunities, impacts and needed mitigation. We believe that the alternatives below are reasonable and can feasibly attain or approximate a proposal's objectives, but at a lower environmental cost or decreased level of environmental degradation: 2) The EIS should include a "Wilderness Protection" alternative. 3) The EIS should include a "Water Right Relinquishment" alternative. 4) The EIS should include a "Water Conservation" alternative 5) The EIS should include a "Water Right Change" alternative 6) Given the fact that the Wilderness Area is federally managed, the relationship between these two different review processes should be disclosed. 7) The impact of each alternative on Icicle Creek's resilience to climate change, particularly with regard to changes in amount or timing of precipitation and instream flow, should be evaluated. 8) The EIS should discuss the hydrological and biological impacts of the current drawdowns of the lakes, and how the proposed	The PEIS will evaluate reasonable alternatives. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will consider impacts of lake/reservoir draw-down from proposed projects. Using the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles. The PEIS will consider monitoring, maintenance, and operation of projects proposed to meet the Guiding Principles. Existing documents provide background on baseline flows, diversions, and current conditions in the Icicle Creek Subbasin, (see county website). The PEIS will provide additional detail on streamflow, diversions, out-of-stream use, and a need statement relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles The PEIS will describe all potential projects and impacts under the proposed program in detail. Additional detail will be provided in any subsequent project level EIS. The PEIS will identify targets for instream flows to support spawning, rearing, and migration of ESA-listed salmon, steelhead, and bull trout in Icicle Creek. The PEIS will provide detailed streamflow, diversions, and out-of-stream use information relevant to the

		changes will affect the current situation. 9) The EIS should provide a detailed operations, maintenance, and environmental monitoring plan for the water infrastructure, and analysis of the wilderness impacts of specific maintenance actions, including helicopter use. 10) The EIS should fully explain the purpose and need for the water these projects would provide. 11) The EIS should analyze each proposed action's site-specific impacts, past practices, and the restoration, mitigation, and funding that would be needed in the future. 12) The EIS should analyze the adequacy of proposed instream flows to support spawning, rearing and migration of steelhead, salmon and bull trout. 13) The EIS should include maps, diagrams and photos to clearly show the current situation (including the place of diversion and amount of water diverted) at each of the lakes and other project locations and how that would change under the proposed action(s) under each alternative	Guiding Principles and the projects proposed to meet the Guiding Principles. The PEIS will include narrative of the current state of water rights in the basin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project. Using the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles Existing easements, in-holder agreements, and State water rights will be reviewed.

33	Jasa Holt Data Specialist WDNR Washington Natural Heritage Program 1111 Washington St SE MS 47001 Olympia, WA 98504-7001	A summary of information on rare plants or rare and/or high quality ecological communities in the vicinity of your project accompanies this letter (Excel file; GIS shapefile).	Comment noted. Information provided by WDNR will be incorporated into the PEIS.
34	Eric Rickerson State Supervisor USFWS Washington Fish and Wildlife Office Central Washington Field Office 215 Melody Lane, Suite 103 Wenatchee, WA 98801	1) The USFWS recommends that a single Coordination Act Report be requested for the entire proposed Project package in collaboration with Ecology, CCNRD, WDFW, and the USFWS. 2) The PEIS should include the sequencing and timing of proposed Projects. The PEIS should also develop a phased implementation schedule to facilitate Section 7(a)(2) consultation with the USFWS to assess individual and cumulative impacts of Projects. 3) 'Early and Often' coordination with the USFWS Central Washington Field Office and federal partners is encouraged. 4) A single federal agency should be selected to lead Section 7(a)(2) consultation and NEPA processes. 5) Please carefully consider the scoping comments provided by the WDFW.	Continue consultation with the USFWS and WDFW Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. All of the Guiding Principles have equal priority and must be met as a package to effectuate the proposal endorsed by the Icicle Workgroup. Project phasing and timelines will be included in the PEIS. The PEIS will describe NEPA and other permitting requirements Comment noted.

35	American Rivers, The Wilderness Society, Washington Trails Association, The Mountaineers	1) Our organizations recommend the IWG explore non-Wilderness options for improving instream flows. 2) We are very concerned by the potential negative impacts to recreation in the Enchantment Lakes region. These impacts should be identified through the PEIS and alternatives should be provided that avoid all negative impacts to aesthetics, user experience, trails, access and camping. There should be no net loss of recreational access and experience. 3) We are concerned that the scope of the Icicle Strategy may extend beyond the valid, existing water rights as limited by relinquishment and recorded agreements. We recommend that all water rights be analyzed for valid use. 4) Our organizations recommend the evaluation of improving Icicle Creek flows by moving the Icicle-Peshastin Irrigation District's point of diversion downstream to the Wenatchee River. 5) We recommend identification of a federal agency that will serve as the lead during NEPA processes 6) Our organizations recommend the development of a list of proposed project alternatives that will meet the Guiding Principles established by the IWG and that are practical, feasible and implementable. Project alternatives will also demonstrate that the final package contains projects that have the greatest	The PEIS will evaluate reasonable alternatives. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will include narrative of the current state of water rights in the basin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. The PEIS will describe NEPA and other permitting requirements Using the Alpine Lakes as reservoirs is the existing condition. One of the Alternatives being considered is to improve the operation of the Alpine Lakes reservoirs to meet the Guiding Principles

		conservation benefit for the most effective cost.	
36	Bob and Linda Welsh	1) Please do not seek any increase in the amount of water removed from the Alpine Lakes Wilderness area. 2) The EIS should include a Wilderness protection alternative 3) The EIS should include a Water Conservation alternative. 4) The EIS should include a Water Right Change alternative 5) The EIS should analyze each proposed action's site-specific impacts, past practices, and the restoration, mitigation, and funding that are needed in the future. 6) The EIS should provide a detailed operations, maintenance, and environmental monitoring plan for the water infrastructure, and analysis of the wilderness impacts of the specific maintenance actions, including helicopter use.	The PEIS will evaluate all reasonable alternatives. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will describe potential projects and impacts under the proposed program. Additional detail will be provided in any subsequent project level EIS. Existing documents provide background on baseline flows, diversions, and current conditions in the Icicle Creek Subbasin, (see county website). The PEIS will provide additional detail on streamflow, diversions, out-of-stream use, and a need statement relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles.

		7) The EIS should fully explain the purpose and need for the water these projects would provide. 8) The EIS should fully explain what human activities caused the degraded conditions that the projects seek to improve.	The PEIS will consider monitoring, maintenance, and operation of projects proposed to meet the Guiding Principles.
37	Chester Marler Leavenworth	1) The PEIS should present the documentation that establishes the historic high water line at Eightmile Lake. 2) Mitigation for activities at Eightmile Lake might include some trail re-routing around the lake, constructing new campsites on higher ground, softening the appearance of vegetation removal for the higher reservoir, etc. 3) PEIS need to acknowledge the goal of protecting Wilderness values, not simply meet the letter of the law—acknowledge the feelings of Wilderness enthusiasts. 4) Optimization and modernization of the flow from the lakes are great—should have been accomplished long ago. 5) Water conservation by IPID and COIC does not appear as robust as it could. This should be more specific. Both districts need to address the non-agricultural use of a significant portion of their water—watering of extravagant and very large “lawns”. This tends to lessen	The PEIS will provide detail regarding Alpine Lakes Optimization, Modernization, and Automation including release rates, hydrologic inputs, changes to inundated area, and instream flow benefits. The PEIS will provide detailed streamflow, diversions, and out-of-stream use information relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles. The PEIS will consider environmental monitoring as appropriate for potential impacts of any proposed projects. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. The PEIS will evaluate reasonable alternatives.

		the public image of the districts, and makes one wonder if legislative changes to the state's water rights laws are in order. 6) At some point in the future the pressure on water resources will be much greater and I would not be surprised to see many responsible citizens asking for fundamental changes to water law. This could include reducing water rights when lands change from agricultural use to suburban. The PEIS could look ahead and discuss how some of these issues will require being more flexible and creative in finding solutions.	
38	Charles Raymond 3798 NE 97th St. Seattle, WA 98115 (206) 522-3798 cfr98115@gmail.com	1) The PEIS needs to present a range of alternatives with significantly more extensive analysis than given in the present information for scoping. 2) Recognition of Wilderness values. All alternatives need to account for the special circumstances for construction and maintenance of structures in Wilderness Areas. 3) Some alternatives (at least one and perhaps all) should include the aim to enhance Wilderness values through reduction in footprint, appearance of structures and the mode of maintaining them. What is the cost benefit ratio for each of the 7 managed lakes? Could one or more of them be returned to a	The PEIS will evaluate reasonable alternatives. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will provide detailed streamflow, diversions, and out-of-stream use information relevant to the Guiding Principles and the projects proposed to meet the Guiding Principles.

		natural condition without significant loss of flexibility or dependability? Could there be public buyback of associated water right to enable compensating adjustment on the user end? 4) The PEIS needs to give historical background on actual water withdrawal and use and a clear explanation of corresponding water rights including identification of purposes for which they were granted. 5) The PEIS should evaluate alternative diversion points (e.g., outside Icicle Creek in the Wenatchee River). 6) The PEIS should include a conservation alternative.	
39	Patricia Danner Spokane County and Washington State lifelong resident and registered voter Alpine Lakes Wilderness Hiker	Wilderness areas need to remain WILD…Please, please, please use your position and ability to protect this gem of a wilderness area…If there is not enough water for the humans, then limit the human expansion in the area. Don't drain and destroy the wilderness!	Comment noted. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws.

40	Andy Zahn, Toutle, WA	I am especially opposed to the reconstruction of the Eightmile lake dam and any new construction on Klonaqua lakes… Such projects are not compatible with the primeval character of wilderness. These are the two parts of the proposal with which I take the most issue, but I would like to express my disapproval of most everything else it contains. I would see all the Icicle Basin dams on alpine lakes removed and the region restored to its natural state. These structures are an ugly blemish on an otherwise pristine and spectacular region. Please explore other options such as water conservation rather than cause further degradation of the Alpine Lakes Wilderness.	Comment noted. The PEIS will evaluate reasonable alternatives. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles.
41	Laurel Schandelmier	1) The public would appreciate a better understanding of the purpose and intent of making these proposed changes to improve instream flows. The EIS should provide alternatives that minimize, or even reverse, damage to existing wilderness area. 2) The EIS should include a "Wilderness Protection" alternative that would not increase the amount of water removed from the Alpine Lakes Wilderness, not create a disturbance or encroach on wilderness lands, and not expand easements should be considered. 3) The EIS should evaluate the feasibility of purchasing back private water rights to the Alpine Lakes to	The PEIS will evaluate reasonable alternatives. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will consider impacts of lake/reservoir draw-down from proposed projects. The PEIS will describe potential projects and impacts under the proposed program. Additional detail will be provided in any subsequent project level EIS.

		allow removal of dams and other structures to restore the wilderness to its pre-developed state. If this is not possible, I agree that installing remotely controllable valves to allow for the controlled drawdown of lake levels over a season, responding to current weather patterns and water needs, would add flexibility and robustness to the system. 4) The EIS should consider a "Water Right Relinquishment" option for existing water rights in the Alpine Lakes if any have been relinquished or abandoned. 5) The EIS should consider a "Water Conservation" option emphasizing aggressive water conservation. 6) The EIS should analyze each proposed action's site-specific impacts, past practices, and any restoration, mitigation, or funding needed in the future. For each site, proposed construction activities and water diversions should be laid out in detail. 7) The EIS should discuss the hydrological and biological impacts of the current level of lake drawdown, as well as any proposed future changes. 8) A detailed operations, maintenance, and environmental monitoring plan for the water infrastructure alongside an analysis of wilderness	The PEIS will consider monitoring, maintenance, and operation of projects proposed to meet the Guiding Principles.

		impacts of specific maintenance actions.	
42	Philip Fenner Seattle	I understand the rationale behind your proposal to revive the old dams on some of the lakes there. I can see why you would like to do it. But I don't think you should. Doing that ought to be the absolute LAST thing you consider if water in the Wenatchee basin runs low. And here's why: Alpine Lakes Wilderness is a sacred place, in many ways to many people. It should not be subjected to artificial manipulation - period. Just because it was manipulated in the past is no reason to start manipulating it again now. If you're short on water do EVERYTHING else first, starting with a ban on lawn watering and taking other such water conservation measures. And the fish hatchery is a big water waster, fix that first. It just makes NO sense to damage a natural area if anything else could be done beforehand to see if the water equation could work without damaging Wilderness.	The PEIS will include background information related to the development of the Guiding Principles, current condition in the Icicle Creek Subbasin, and a need statement. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles. The PEIS will evaluate reasonable alternatives.

43	Greg Shannon 313 Olive Street Cashmere, WA 98815	I have concerns about the collaborative efforts by members of the Icicle Working Group and the agency participation in the study. I also have a concern about increasing water for development (transfer of water rights) without having a detailed PEIS alternative to look at major conservation of water by all users. Any impacts in the Alpine Lakes Wilderness should be addressed in a specific alternative.	Comment noted. The PEIS will evaluate reasonable alternatives. The PEIS will assess the potential impacts to wilderness and recreation that might result from the projects proposed to meet the Guiding Principles.
44	Robert Mullins 234 Mine St. Leavenworth, WA	I support, actually I demand, that Icicle-Peshastin Irrigation District will fully and completely use its water rights including any related construction, transportation, use of aircraft, use of power equipment, use of all legitimate activity, equipment, and construction related to full implementation of Icicle-Peshastin Irrigation District water rights and resultant uses in the Alpine Lakes Wilderness as existed before the creation of the Alpine Lakes Wilderness. These rights pre-exist and are more important than the Alpine Lakes Wilderness and any uses of any visitors to the Alpine Lakes Wilderness. I understand the water rights, my family and I are dependent on that water.	Comment noted. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws.

45	Ann Fink 201 Mine Street Leavenworth, WA 98826 northfork@nwi.net May 11, 2016	1) The Irrigation districts has easements on only 2 of the 4 sections that underlie Eightmile Lake. The other two sections are wilderness and don't appear to have "easements". Please explain how the IWG can flood congressionally designated wilderness lands without involving the U.S. Forest Service in these discussions. 2) The Icicle Irrigation District should provide its records regarding its use of water from this lake. 3) I would like to see a discussion of how the Irrigation District and its partners will mitigate some of the ugly visual effects of raising the level of the lake and then lowering well below current levels. The effects to plants and wildlife need to also be addressed. Improvements at other lakes also need to consider the visual and ecological effects. 4) Remote monitoring and control of existing facilities appear to be a good modern option if the equipment needed for this activity can be blended into the surroundings without intruding on wilderness values. 5) The Icicle Working Groups needs to champion conservation measures and improved facilities (non-leaky) water distribution systems for rational and equitable water distribution.	The PEIS will evaluate reasonable alternatives. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will assess potential impacts to aesthetics. The PEIS will consider mitigation measures for likely impacts identified in the document. The PEIS will consider impacts of lake/reservoir draw-down from proposed projects.

46	Kimberly Wells	I urge the county to consult the applicable federal laws, including NEPA, the Wilderness Act, and the Endangered Species Act, and to reconsider the proposed project before proceeding to violate them.	Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws.
47	Jerry Bodine 585 SW Mt. Cedar Dr. Issaquah, WA 98027	1) The EIS should include a “Wilderness Protection” alternative. This alternative should promote Wilderness values by not seeking any increase in the amount of water removed from the Alpine Lakes Wilderness; not expanding easements; not encroaching on wilderness lands; not using mechanical transport; and not building any structure or installation in the Wilderness. Under the Wilderness Protection alternative, any new water supplies should be obtained from sources outside the Wilderness, and use non-Wilderness options for improving instream flows (for example, the IPID change in diversion point discussed below). The Wilderness Protection alternative should comply with all provisions in the Forest Service’s administrative Alpine Lakes Wilderness Management Plan, including: “Except as provided for in Section 4(d)(4) of the	The PEIS will evaluate reasonable alternatives. Compliance with state and federal laws, including the Wilderness Acts, is one of the Guiding Principles. The PEIS will discuss the compatibility of projects proposed to meet the Guiding Principles with applicable state and federal laws. The PEIS will describe potential projects and impacts under the proposed program. Additional detail will be provided in any subsequent project level EIS. The PEIS will consider impacts of lake/reservoir draw-down from proposed projects. The PEIS will consider monitoring, maintenance, and operation of projects proposed to meet the Guiding Principles. Existing documents provide background on baseline flows, diversions, and current conditions in the Icicle Creek Subbasin, (see county website). The PEIS will provide additional detail on streamflow, diversions, out-of-stream use, and a need statement relevant to the

		Wilderness Act, watersheds will not be altered or managed to provide increased water quantity, quality or timing of discharge." 2) The Wilderness Protection alternative should evaluate public purchase (buy-back) of private water rights in the Alpine Lakes, which would allow removal of dams and other structures from the lakes to restore the Wilderness area to its true natural character. 3) The EIS should include a "Water Right Relinquishment" alternative. This alternative should analyze existing water rights to the Alpine Lakes and acknowledge those rights that have been relinquished or abandoned. 4) The EIS should include an alternative that recognizes IWG members' water rights are limited to the purposes for which they were initially granted (for example, irrigation) and cannot be redirected to other purposes (such as suburban development). 5) The EIS should include a "Water Conservation" alternative that emphasizes aggressive water conservation measures by the City of Leavenworth, Icicle-Peshastin Irrigation District, the Leavenworth Fish Hatchery and other water users. This alternative should	Guiding Principles and the projects proposed to meet the Guiding Principles. The PEIS will identify targets for instream flows to support spawning, rearing, and migration of ESA-listed salmon, steelhead, and bull trout in Icicle Creek. The PEIS will include narrative of the current state of water rights in the basin. For each project designed to meet the Guiding Principles, the PEIS will prescribe what existing and new permits would be necessary for the project.

		evaluate water markets that facilitate selling and trading of water rights. 6) The Water Conservation alternative should evaluate a transfer of water rights from IPID to Leavenworth for properties within the city limits that have now converted from orchards to residential properties. This alternative should analyze how appropriate reductions in water usage (that is, not using agricultural water quantities for lawn irrigation) would save water that would then be available for other Leavenworth needs. 7) The Water Conservation alternative should evaluate how IPID spills large quantities of water back into the Wenatchee River at the end of several of its canals. This alternative should evaluate how this 19th century irrigation practice (which was required to ensure water made it to the furthermost customers) could be replaced with modern pumping and piping technologies. The EIS should consider the resulting reduction in water demand as an alternative water supply. 8) The EIS should include a "Water Right Change" alternative. This alternative would evaluate improving Icicle Creek flows by moving IPID's point of diversion downstream (to the Wenatchee	

		River). This measure, which would add 100 cfs of water to Icicle Creek every year, would convert the IPID diversion from gravity flow to pumping (requiring electrical power). This alternative should therefore analyze renewable energy options to supply that power, including solar, wind and in-canal hydroelectric. 9) The EIS should analyze each proposed action's site-specific impacts, past practices, and the restoration, mitigation and funding that are needed in the future. At each site, proposed construction activities and proposed water diversions need to be spelled out in detail. 10) The EIS should discuss the hydrological and biological impacts of the current drawdowns of the lakes, and any proposed changes. The analysis should include a review of scientific literature on the impacts of water removals upon wildlife, vegetation, soil and wilderness values. 11) The EIS should provide a detailed operations, maintenance and environmental monitoring plan for the water infrastructure, and analysis of the wilderness impacts of specific maintenance actions, including helicopter use.	

		12) The EIS should fully explain the purpose and need for the water these projects would provide. 13) The EIS should fully explain what human activities caused the degraded conditions (such as low instream flows in Icicle Creek) that the projects seek to improve. We should not be repeating the mistakes of the past. 14) The EIS should analyze adequacy of proposed instream flows to support spawning, rearing and migration of steelhead and bull trout.	
48	Michael J. Painter Californians for Western Wilderness P.O. Box 210474 San Francisco, CA 94121-0474 info@caluwild.org	Californians for Western Wilderness fully endorses the comments submitted by Alpine Lakes Protection Society and 39 other organizations, dated May 11, 2016.	Comment noted. Responses to the endorsed letter are provided under comment 32.

49	Kayt Hoch kayt@kaythoch.com	Proposed plan looks like a good approach that seems to have minimal impacts for a great benefit to region. I hope there isn't going to be negative fall-out from the Puget Sound group Do you have some construction impacts estimations/projections? After the quick recovery of our own property after the impacts form the bridge project I'm not, concerned, just curious.	General support noted. The PEIS will describe potential projects and impacts under the proposed program. Additional detail will be provided in any subsequent project level EIS.

From:	Mary Jo Sanborn
To:	Meghan O"Brien
Cc:	Dan Haller
Subject:	FW: icicle strategy
Date:	Wednesday, February 17, 2016 2:40:47 PM

Hi Meghan – Here's the first SEPA comment we've gotten.

Thanks,

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department

Please Note Our NEW ADDRESS:
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
Fax: (509)-667-6527
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Monday, February 15, 2016 12:38 PM
To: Guy Moura (HSY)
Cc: 'Ellis, Liz (ECY)'; 'Kaehler, Gretchen (DAHP)'; Karen Capuder (HSY); Chuck Brushwood (Charles.Brushwood@colvilletribes.com); Mary Jo Sanborn
Subject: RE: icicle strategy

Thank you, Mr. Moura, email received. We look forward to future consultation. I cc'ed Chuck Brushwood, who has been a participant in the efforts of the Icicle Work Group and may be able to assist you internally with project descriptions, context, etc.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

Please note our new address

From: Guy Moura (HSY) [mailto:Guy.Moura@colvilletribes.com]
Sent: Saturday, February 13, 2016 9:18 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Cc: 'Ellis, Liz (ECY)' <lell461@ECY.WA.GOV>; 'Kaehler, Gretchen (DAHP)' <Gretchen.Kaehler@DAHP.wa.gov>; Guy Moura (HSY) <Guy.Moura@colvilletribes.com>; Karen Capuder (HSY) <Karen.Capuder@colvilletribes.com>
Subject: icicle strategy

Dear Mr. Kaputa:

Please be advised that the various undertakings in the Icicle Basin are in the traditional territory of the Wenatchee Tribe, a constituent tribe of the Confederated Tribes of the Colville Reservation. It also appears all of the projected projects are within what many consider the Wenatshapam Reserve. A reserve set aside for the Wenatchi under Article 10 of the 1855 Yakama Treaty (this story is told @ http://www.colvilletribes.com/wenatchi_indians.php). The *p’¤sqŸaw’s* (Wenatchi) recently regained their fishing rights in the icicle (*na'sik-elt*) via a court case. Establishment of the reserve is being negotiated. The vicinity of the proposed projects has archaeological, ethnographic, and historic sites of significance to the Confederated Tribes of the Colville Reservation.

We await continued consultation, which may be with the Department of Ecology, under various federal and state laws, regulations, and mandates. We recommend a cultural resource report to identify existing archaeological and traditional sites.

We appreciate you consulting with the Confederated tribes of the Colville Reservation.

lim ləmt, qeʔciéwyew (thank you)

Guy Moura
Program Manager, History/Archaeology
Tribal Historic Preservation Officer
Confederated Tribes of the Colville Reservation
(509) 634-2695

William B. Beyers
7159 Beach Drive SW
Seattle, Washington 98136

February 20, 2016

Mr. Mike Kaputa, Director
Chelan County Natural Resources Department
411 Washington Street, Suite 201
Wenatchee, WA 98801

Re: Icicle Strategy Scoping Comments

Dear Mr. Kaputa:

The Alpine Lakes Foundation would like to offer these comments on the scope of the environmental impact statement that Chelan County and the Washington State Department of Ecology plan to prepare on the Icicle Creek Water Management Strategy (hereafter "Icicle Strategy").

The Alpine Lakes Foundation is a Washington non-profit corporation in good standing since 1993, when it was established to act as an advocate and protector for the resources of the Alpine Lakes area. It has served in this role for the past 23 years.

All of the lakes that are the subject of your Icicle Strategy are within the Alpine Lakes Wilderness Area, established by Congress in 1976. The Icicle Strategy proposes the construction or restoration of a number of structures at these lakes, including dams, pumps, and tunnels. These raise a number of questions under the Alpine Lakes Management Act of 1976, 16 U.S.C. 1132. Note Section 2(c) of this Act states:

> The Federal lands designated as the Alpine Lakes Wilderness shall be administered in accordance with the provisions of this Act and with the provisions of the Wilderness Act (78 Stat. 890), whichever is the more restrictive.

Section 2(e) of this Act provides that non-federal within the Wilderness and Intended Wilderness will become part of the Alpine Lakes Wilderness when acquired by the Federal Government. Thus, all the lakes included in the Icicle Strategy are now within the Alpine Lakes Wilderness and must be administered according to the Alpine Lakes Management Act and the Wilderness Act.

The Wilderness Act, 16 U.S.C. 1131-36, provides in section 4(c):

> PROHIBITION OF CERTAIN USES
>
> (c) Except as specifically provided for in this Act, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this Act and, except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act (including measures required

> in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area.

Applying this section, courts have held that Congressional awareness at the time it created a wilderness that a pre-existing dam was in the area declared wilderness does not create an implied exception to the Wilderness Act prohibition on structures. Courts also have held that the prohibition on structures in a wilderness applies equally to rebuilding, maintaining, or repairing them.

The Icicle Strategy appears to rely on water rights held by the Icicle Peshastin Irrigation District (hereafter "irrigation district"), based on rights granted to its predecessor in 1927.

The relationship between those rights, the statutes mentioned above, and the Icicle Strategy plans for lakes within the Alpine Lakes Wilderness (hereafter "Alpine Lakes") raise these questions, numbered for ease of reference:

1. What was the extent of the irrigation district's existing water rights within the Alpine Lakes Wilderness when Congress created that Wilderness in 1976?
2. Has the irrigation district forfeited any of those rights through non-use or only partial use before or after creation of the Wilderness?
3. If the irrigation district has diverted more water from streams in the Icicle basin than it stored at any of the Alpine Lakes, does that additional diversion offset any forfeiture of storage or use rights that it did not use at those lakes?
4. Whether the right to store and use water from an Alpine Lake includes the right to build or expand structures now when the irrigation district has previously relied on pumping or other non-structural methods to obtain lake water?
5. Whether the right to store and use water from an Alpine Lake includes the right to build or expand structures or tunnels upstream in the Wilderness from that lake.
6. Whether a tunnel is a "structure" or "installation" prohibited by the Wilderness Act.
7. Did the US Forest Service expand, revive, or have the authority to expand or revive any of the irrigation district's rights by granting an easement to the irrigation district in 1990 when the irrigation district conveyed lands adjoining Eightmile Lake and within the Wilderness to the federal government?
8. May the irrigation district use any of its water rights for purposes other than irrigation when that was the sole basis on which they were granted?
9. To what extent do these same issues apply to water rights claimed by the US Bureau of Reclamation and/or the US Fish and Wildlife Service for operation of the Leavenworth National Fish Hatchery with waters stored, diverted, or used from lakes within the Alpine Lakes Wilderness?

Finally, we have two procedural questions:

A. To what extent can the Icicle Work Group's so-called stakeholder-based collaborative process supersede state and federal laws (for example, the Clean Water Act and Endangered Species Act)?

B. Can the state Department of Ecology, acting as Washington state's water regulator, make objective decisions about the status of the irrigation district's water rights and the extent to which they may have been forfeited, when DOE itself is one of the lead agencies on this project, has a material interest in its success, and that success would depend on DOE's rulings?

Please share these comments with the Washington State Department of Ecology and consider them when drafting your environmental impact statement.

Should you have any questions, please feel free to contact us.

ALPINE LAKES FOUNDATION

By

William B. Beyers, President
7159 Beach Drive S.W.
Seattle, WA 98136

Tel (home): (206) 935-6282
beyers@u.washington.edu

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Thursday, May 12, 2016 9:26 AM
To: Jordan Sanford; Meghan O'Brien
Subject: FW: Icicle Strategy Public Comment

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Thursday, March 24, 2016 2:47 PM
To: Ted Whitesell
Cc: Mary Jo Sanborn
Subject: RE: Icicle Strategy Public Comment

Thanks, Ed, we'll make sure your comments are entered into the record.

If you have a chance I'd appreciate talking with you. You can try me at the number below.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

Please note our new address

From: Ted Whitesell [mailto:ted.whitesell@gmail.com]
Sent: Wednesday, March 23, 2016 8:50 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Icicle Strategy Public Comment

Mr. Mike Kaputa
Director of Natural Resources

Chelan County

Dear Mr. Kaputa,

I understand that the Icicle Work Group is developing a water management strategy that could include infringing upon the wilderness character of the Alpine Lakes Wilderness by constructing dams, altering water levels, and issuing water rights for several lakes in the Wilderness Area. Even if only part of this is true, it would infringe upon the mandate, established by Congress in the 1964 Wilderness Act, to protect our designated Wilderness Areas in an untrammeled condition for all future generations. Even if you feel that there are some legal pathways that might sanction such infringement of the wilderness character of the area, it is important to remember that there are many individuals and organizations who stand ready to defend all designated Wilderness Areas from such infringement, through the courts and the political process, if necessary.

The National Wilderness Preservation System is just a remnant of the once magnificent wilderness our ancestors enjoyed in this country only a few generations ago. We must resolutely defend every parcel that is left, no matter how convenient and logical it may seem to take a little water here or there, "just this once." Wilderness designation is intended to provide the most durable and stringent protection of any federal land classification. It must never be compromised.

Please enter my comments in the record of public comments on the Icicle Strategy.

Thank you.

Edward Whitesell
816 Plymouth St., SW
Olympia, WA 98502

From: **Derek Poon** <derekcpoon@gmail.com>
Date: Wed, Feb 18, 2015 at 10:34 AM
Subject: 2/17/15 Alpine Lakes Icicle Work Group meeting, Seattle; a CWA DU protection matrix
To: Mike.Kaputa@co.chelan.wa.us, thomas.tebb@ecy.wa.gov, Charity.Davidson@dfw.wa.gov, jmanning@cascadialaw.com, deortman@msn.com, patsump@juno.com, rr.wolfe@comcast.net, Andrea@wildwarivers.org
Cc: John Osborn <John@waterplanet.ws>, Rachael Osborn <rdpaschal@earthlink.net>, Joan Crooks <joan@wecprotects.org>, Becky Kelley <becky@wecprotects.org>, Environmental Priorities Coalition <lisa@wecprotects.org>, "kurt@wildfishconservancy.org" <kurt@wildfishconservancy.org>

As discussed at the Icicle Work Group (IWG) meeting last night at Seattle, I attached my working draft of the Clean Water Act (CWA) Matrix of Existing and Designated Uses (DU) versus the level of DU protection. This matrix distills the nine Icicle Creek Guiding Principles into an easy format for analysis of the Wilderness Act, SEPA, NEPA, CWA 401 certification, or Endangered Species Act (ESA) Section 7 determination.

Note that CWA and ESA are integrated because ESA species are a protected CWA DU. I submit the very essence of the CWA is DU protection.

I attended this meeting at the urging of Dr. John Osborn of Sierra Club and Center for Environmental Law and Policy (CELP). Thank you for the opportunity to meet with and listen to you, particularly Rachael Osborne, a CELP co-founder and IWG member. John's invitation with Rachael's Conservation Alternative is pasted below.

One of your participants Dr. Rebecca Wolfe spoke to the possibility of adding the "precautionary principle" to your recommendations. I agree with her proposal and took the liberty of providing a recent short analysis on why CWA water quality standards are by necessity (or should be) precautionary (See KFNC Suitability Determination, second letter dated 1/19/15 and citing "precautionary principle" at the end of the letter.). This Suitability Determination may differ from the IWG process, but the analysis is relevant.

I speak only for myself as an independent observer and am responsible for any interpretations or accuracy. My one-page resume is attached FYI. I apologize for my ignorance and for my limited understanding of your project specifics. Please use or delete any of my concepts as you see fit.

All the best, and thanks again for your indulgence.

Derek
--
Derek Poon
400 Boylston Ave E, #2
Seattle, WA 98102
206-729-9378, derekcpoon@gmail.com

"All it takes is for the right people in the right position to take action."
David Lewis, SCIENCE FOR SALE, 2014

---------- Forwarded message ----------
From: **John Osborn** <John@waterplanet.ws>
Date: Mon, Feb 16, 2015 at 11:09 PM
Subject: Alpine Lakes Wilderness: new irrigation dams vs. viable water solutions
To: John Osborn <John@waterplanet.ws>

For those of you attending Tuesday's Seattle meeting on proposed irrigation dams for the Enchantments / Alpine Lakes Wilderness, Rachael has prepared a handout on viable water solutions for the Icicle Work Group Process

Conservation Alternative for the Icicle Work Group Process

Rachael will also be driving over from Spokane to attend, and will bring copies of the Conservation Alternative. Again, here is the meeting information:

Meeting - **new irrigation dams & diversions proposed for Alpine Lakes Wilderness, Enchantments**
When: **Tuesday, Feb. 17 7 p.m.**

Where: **Seattle, Good Shepard Center, Rm 202**
Additional links -

- Rachael's 4-part blog: News Dams & Diversions in the Alpine Lakes Wilderness?
- Interviews with Harriet Bullitt and Russ Bush on Icicle River and Elwha River: Water Heroes: Never Give Up

For those of you who have fought so hard to protect and expand the Alpine Lakes Wilderness, we hope you are able to attend the meeting.

Best wishes - and thank you for caring about Alpine Lakes Wilderness and Icicle River.

John Osborn MD
CELP, Sierra Club
509.939-1290

Matrix of Clean Water Act (CWA) Existing or Designated Uses (DU) and DU protection under the CWA water quality standards For Alpine Lake Icicle Working Group

Working Draft subject to edits, Derek Poon, 2/17/15

X axis (independent variables):

A long **CWA DU list**: use 1, use 2, use 3.........use to the nth; e.g. **Water uses, Tribal treaty rights, ESA species, recreation, Wilderness Act specification, etc.**

Y axis (dependent variables):

A list of subprojects (by location, timing, or task) of the total project.

Within each subproject, list **four DU protection categories** and explain application or non-application of each category.

1. **Protected;**
2. **Unprotected but adequately mitigated (agreement reached consistent with the law);**

3. **Unprotected and inadequately mitigated (agreed to disagree);**
4. **Economic exemption granted by Congress, CWA Use Attainability Analysis (UAA), or ESA God Squad.**

Application to the Wilderness Act, SEPA, NEPA, CWA 401 certification, ESA Section 7 determination:

- Findings and conclusions should be based on Matrix.
- Specific to ESA Section 7:
    - No jeopardy
    - Likely to Adversely Affect (LAA)
    - Reasonable and prudent measures and terms/conditions prescribed consistent with
        - ESA Section 7(a)(1) to proactively promote ESA species recovery and delisting.
        - ESA planning principle of "Not Everything Everywhere All The Time (NEEATT), balancing project mitigation requirement (e.g. Leavenworth Hatchery) with Wilderness Act.

Derek Poon Letter to the Washington Board of Natural Resources
For March 10, 2015 Board meeting
Sent by email March 4, 2015

Members of the Washington Board of Natural Resources:

As an experienced and recently retired scientist and administrator in the Endangered Species Act (ESA) and the Clean Water Act (CWA), I speak only for myself and not for any organization or coalition.

My one-page resume is pasted at the end of this letter for your information.

I understand the Board is developing, at the same time, the Sustainable Harvest Calculation (SHC) and the Long Term Conservation Strategy (LTCS) for the ESA-listed Marbled Murrelet (MaMu). Since the LTCS places caveats on timber harvest locations, methods, and rates, it makes sense that the LTCS be completed before the SHC and be applied to the SHC, as advocated by the Washington Environmental Council and others.

Several ESA and CWA provisions assist LTCS and SHC.

1. Under ESA, LTCS is based on the concept of "Not Everything Everywhere All The Time" (NEEATT) allowing for timber harvest and protecting Washington (WA) Department of Natural Resources (DNR) fiduciary responsibility, as long as MaMu recovery and delisting use best available science in a completed ESA recovery plan according to the law.
2. For environmental protection, ESA planning priority goes to the listed species. Moreover, under CWA, ESA species are Existing and Designated "uses" (DU) protected under the CWA water quality standards. A trajectory to successful MaMu recovery and delisting satisfies both ESA and CWA policies.
3. Under ESA Section 7(a)(1), federal agencies will use their program authorities to promote ESA species recovery and delisting, thus proactive regulatory assistance to DNR MaMu management comes from the US Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), US Environmental Protection Agency (EPA), and the (CWA delegated state agency) WA Department of Ecology.
4. Deference to adaptive management to achieve MaMu recovery and delisting is entirely appropriate as long as there is upfront agreement on targets and "SMART" contingencies or "plan B's," where SMART stands for specific, measurable, attainable, relevant, and time-bound.
5. Incentives of money, regulatory flexibility, and recognition should supplement environmental regulations and assist timber-dependent communities.
6. Should achievement of SHC and DNR fiduciary responsibility preclude MaMu recovery and delisting, economic exemptions can be granted by Congress; via the CWA Use Attainability Analysis (UAA); or by an ESA God Squad decision.

I hope this input is useful to your planning, and please help us avoid extinction of the little MaMu seabird while supporting economic viability of our coastal communities.

Respectfully submitted,

Derek Poon
400 Boylston Ave E, #2
Seattle, WA 98102
206-729-9378
derekcpoon@gmail.com

Derek Poon

derekcpoon@gmail.com, 206-729-9378

EDUCATION: Ph.D. Fisheries, Oregon State University, 1977
B.A. Zoology, University of California, Berkeley, 1967

EXPERIENCE:

NATURAL RESOURCE CONSULTANT (Since retirement 12/8/11)
[Current work on Adaptive Management and compliance with Endangered Species Act (ESA) and Clean Water Act (CWA)]

REGIONAL SALMON ECOLOGIST and ESA SPECIALIST
US Environmental Protection Agency, Seattle, Washington (2001-2011)

ENDANGERED SPECIES ACT BIOLOGIST
Sustainable Fisheries Division
National Marine Fisheries Service, Seattle, Washington (1997-2001)

ADMINISTRATOR, Washington State Timber/Fish/Wildlife (TFW) Policy Group
Seattle, Washington, 1996 to 1997

CO-CHAIR, Washington State TFW Policy Group, 1994-1995

CHIEF, King County Natural Resource Planning Section
Seattle, Washington, 1986 to 1995

FACILITATOR, US Section, US/Canada Salmon Treaty Negotiations
Seattle, Washington, 1985

Pacific Northwest Salmon and Steelhead ENHANCEMENT COORDINATOR
Salmon and Steelhead Conservation & Enhancement Act
Portland, Oregon and Seattle, Washington, 1983 to 1986

CONSULTANT, Northwest Power Planning Council
COUNCIL-DESIGNATED REVIEWER, Columbia Basin Fish & Wildlife Program
Portland, Oregon, 1981 to 1983

GENERAL MANAGER, Northern Southeast Regional Aquaculture Association
Sitka, Alaska, 1977 to 1981

PROGRAM AND POLICY MANAGER, Governor's Special Projects Office
Juneau, Alaska, 1977

FISHERIES PROGRAM DIRECTOR, Sheldon Jackson College
Sitka, Alaska, 1973 to 1975

SALMON RESEARCHER
National Marine Fisheries Service (Alaska Region) and Oregon State University
1968 to 1973, 1975 to 1977

Current Interests: Marathon running; news; reading; music.

March 2015

****

ESA Section 4F Recovery Plan criteria are as follows.

> ***http://www.gao.gov/new.items/d06463r.pdf***
>
> *The Endangered Species Act requires each recovery plan to incorporate, to the maximum extent practicable:*
>
> *(1)* ***Site specific management actions*** *- descriptions of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species.*
> *(2)* ***Time and cost estimates*** *- for completing site specific management actions; estimates of the time required and cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.*
> *(3)* ***Recovery criteria*** *- objective, measurable criteria which, when met, would result in a determination, in accordance with provisions of the act, that the species be removed from the list of threatened and endangered species (i.e., delisted). Courts have found that the Endangered Species Act requires the services to address each of five delisting factors to the maximum extent practicable when designing recovery criteria.*
>
> > *These five delisting factors are the same factors that are considered when listing a species: (1)* ***the present or threatened destruction, modification, or curtailment of a species' habitat or range****; (2)* ***overutilization of the species for commercial, recreational, scientific, or educational purposes****; (3)* ***disease or predation;*** *(4) t****he inadequacy of existing regulatory mechanisms****; or (5)* ***other natural or manmade factors affecting a species' continued existence.***

Jordan Sanford

From: Meghan O'Brien
Sent: Tuesday, March 29, 2016 11:36 AM
To: Jordan Sanford
Subject: FW: ESA and CWA Questions: Icicle Strategy, March 30, 2016 Seattle meeting
Attachments: ESA Section 4F Recovery Plan criteria, GAO summary.pdf; Alpine Lake 2-17-15 IWG mtg, with CWA DU MATRIX.pdf; DP 3-4-15 letter, BNR, 3-10-15 meeting.pdf

This one just came in…

Thanks,
Meghan

Meghan O'Brien | Aspect Consulting LLC | Project Specialist | Direct: 509.895.5261 | Cell: 509.607.0059

From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Tuesday, March 29, 2016 11:26 AM
To: Dan Haller <dhaller@aspectconsulting.com>; Meghan O'Brien <mobrien@aspectconsulting.com>
Subject: FW: ESA and CWA Questions: Icicle Strategy, March 30, 2016 Seattle meeting

Public comments for the record…

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department

Please Note Our NEW ADDRESS:
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
Fax: (509)-667-6527
www.co.chelan.wa.us/nr

From: Derek Poon [mailto:derekcpoon@gmail.com]
Sent: Monday, March 28, 2016 5:13 PM
To: Mike Kaputa; (GTEB461@ecy.wa.gov)
Cc: Karl Forsgaard (karlforsgaard@comcast.net); Andrea Imler; Kitty Craig; Benjamin Greuel; deortman@msn.com; Rachael Osborn (rosborn@celp.org); Lisa Pelly; Susan Adams; Greg McLaughlin (greg@washingtonwatertrust.org); Mary Jo Sanborn; Jim Brown (James.Brown@dfw.wa.gov); Keith Goehner; Jay Manning; Downes, Melissa M. (ECY); Lisa Dally Wilson (lisadallywilson@gmail.com); Charity Davidson (Charity.Davidson@dfw.wa.gov); Jen Watkins; (okeefe@americanwhitewater.org); kgeraght@gmail.com; sarahk@mountaineers.org; rckmcguire@gmail.com; espackard@msn.com; Don Parks; voice4wild@aol.com; tom@wawild.org; kurt@wildfishconservancy.org; Michael Garrity; efr98115@tpl.org; AMY K. SNOVER; GUILLAUME S. MAUGER (gmauger@uw.edu); Harriet Bullit; drieman@tumwater.net; James Schroeder; Paul Kundtz; trolfe@celp.org; patsump@juno.com; rr.wolfe@comcast.net; Andrea@WildWaRivers.org; John Osborn; Joan Crooks; Becky Kelley; Environmental Priorities Coalition; spmalloch@gmail.com
Subject: ESA and CWA Questions: Icicle Strategy, March 30, 2016 Seattle meeting

Mike and Tom,

Thank you for providing information on the programmatic environmental impact statement (PEIS) for the *Icicle Strategy*, developed by Chelan County and the WA Department of Ecology/Office of the Columbia River. I will attend the March 30 Seattle workshop at Phinney Center to learn from your presentation.

Since the WA Department of Ecology (Ecology) is the
US Environmental Protection Agency (EPA) delegated state entity
to implement
much of
the federal
Clean Water Act (
CW

A
)
in Washington,
and since Endangered Species Act (ESA) species are

protected Existing and Designated Uses (DU) under the CWA water quality standards
,
Ecology guidance is particularly meaningful for CWA actions, including effects on ESA species
and their designated critical habitat
.

To

provide time for pre-meeting analysis
, I defined the following
ESA and CWA
questions to be asked
at the
March 30
meeting
, based on your PEIS and my 3/30/15 letter

(pasted below)

to you following your last Seattle workshop on 2/17/15.

1. Based on ESA Section 7(a)(1), **all federal agencies**

   are to use their programmatic authorities to promote ESA species recovery, and for the National Oceanic and Atmospheric Administration (NOAA) and US Fish and Wildlife Service (USFWS),

   priority goes to the listed species

. Since some of these federal developments are still incomplete, particularly the non-discretionary ESA Section 7 consultation Terms & Conditions

,

how and when will federal provisions and ESA regulations be incorporated into the *Icicle Strategy*?

2. ESA recovery plans are required for every ESA-listed species (Recovery Plan requirement

 summary

 file attached). Since each recovery plan should have a voluntary roadmap to recovery (delisting), **are these roadmaps already incorporated into the *Icicle Strategy*?**

3. Every agency is either required to

apply

or

to

comport with

 CWA DU protection

according to the law

, exemptions, and antidegradation (See p, 9-21 of CWA Watershed Academy).

Since DU includes such uses as ESA species, Tribal rights, commercial and aesthetic water uses, and Wilderness Act, **have these DU protections been accommodated within the *Icicle Strategy***,

such

as indicated by question #7 in your "Supplemental Sheet under nonproject actions"? More specifically, my proposed DU protection matrix (Alpine Lake 2-17-15…file attached) was designed to address DU protection in one single table; **will this DU matrix be used and published?**

4. Given the complexities and

realities

 of

some

incompatible uses, DU protections must be negotiated and some not

likely

met. If the *Icicle Strategy* cannot

adequately

protect certain uses, **are economic exemptions planned or have already been explored** under the CWA Use Attainability Analysis (UAA, also see CWA Watershed Academy, p. 11), ESA God Squad Decision, or Congressional exemptions?

(See #6, attached DP 3-4-15 letter.)

For full disclosure, I am participating at request of Dr. John Osborn of the Sierra Club, but I speak only for myself. For those who don't know me, my one-page resume is in the attached "DP 3-4-15 letter, BNR, 3-10-15 meeting.pdf."

Since this email and its attachments are public documents in the administrative record, feel free to use, distribute, dispute, or delete, as you see fit. Thank you for your continuous work on this complex project. See you March 30.

Best,

Derek

Attachments:

1) ESA Section 4F Recovery Plan criteria, GAO summary.pdf
2
) Alpine Lake 2-17-15 IWG mtg, with CWA DU MATRIX.pdf
3)
DP 3-4-15 letter, BNR, 3-10-15 meeting.pdf.

--
Derek Poon
400 Boylston Ave E, #2
Seattle, WA 98102
206-729-9378 cell, derekcpoon@gmail.com
206-602-6565 land line

"All it takes is for the right people in the right position to take action."
David Lewis, SCIENCE FOR SALE, 2014
"This insecticide is dedicated to a healthier world." EPA approved slogan, 2007.
E. G. Vallianatos, POISONED SPRING, 2014

---------- Forwarded message ----------
From: **Mike Kaputa** <Mike.Kaputa@co.chelan.wa.us>
Date: Sun, Mar 20, 2016 at 5:19 PM
Subject: RE: Icicle Strategy, March 30, 2016, Phinney Community Center, Seattle

To: "Karl Forsgaard (karlforsgaard@comcast.net)" <karlforsgaard@comcast.net>, Andrea Imler <aimler@wta.org>, Kitty Craig <kitty_craig@tws.org>, Benjamin Greuel <benjamin_greuel@tws.org>, "deortman@msn.com" <deortman@msn.com>, "Rachael Osborn (rosborn@celp.org)" <rosborn@celp.org>, Lisa Pelly <Lisa.Pelly@tu.org>, Susan Adams <susan@washingtonwatertrust.org>, "Greg McLaughlin (greg@washingtonwatertrust.org)" <greg@washingtonwatertrust.org>, Mary Jo Sanborn <MaryJo.Sanborn@co.chelan.wa.us>, "Jim Brown (James.Brown@dfw.wa.gov)" <James.Brown@dfw.wa.gov>, Keith Goehner <Keith.Goehner@co.chelan.wa.us>, Jay Manning <jmanning@cascadialaw.com>, "Downes, Melissa M. (ECY)" <MNIH461@ecy.wa.gov>, "Lisa Dally Wilson (lisadallywilson@gmail.com)" <lisadallywilson@gmail.com>, "Charity Davidson (Charity.Davidson@dfw.wa.gov)" <Charity.Davidson@dfw.wa.gov>, Jen Watkins <jwatkins@conservationnw.org>, "(okeefe@americanwhitewater.org)" <okeefe@americanwhitewater.org>, "kgeraght@gmail.com" <kgeraght@gmail.com>, "sarahk@mountaineers.org" <sarahk@mountaineers.org>, "rckmcguire@gmail.com" <rckmcguire@gmail.com>, "espackard@msn.com" <espackard@msn.com>, Don Parks <dlparks398@gmail.com>, "voice4wild@aol.com" <voice4wild@aol.com>, "tom@wawild.org" <tom@wawild.org>, "kurt@wildfishconservancy.org" <kurt@wildfishconservancy.org>, Michael Garrity <mgarrity@americanrivers.org>, "efr98115@tpl.org" <efr98115@tpl.org>, "AMY K. SNOVER" <aksnover@uw.edu>, "GUILLAUME S. MAUGER (gmauger@uw.edu)" <gmauger@uw.edu>, Harriet Bullit <harrietb@sleepinglady.com>, "drieman@tumwater.net" <drieman@tumwater.net>, James Schroeder <jschroeder@tnc.org>, Paul Kundtz <paul.kundtz@tpl.org>, "trolfe@celp.org" <trolfe@celp.org>, Derek Poon <derekcpoon@gmail.com>, "patsump@juno.com" <patsump@juno.com>, "rr.wolfe@comcast.net" <rr.wolfe@comcast.net>, "Andrea@WildWaRivers.org" <Andrea@wildwarivers.org>, John Osborn <John@waterplanet.ws>, Joan Crooks <joan@wecprotects.org>, Becky Kelley <becky@wecprotects.org>, Environmental Priorities Coalition <lisa@wecprotects.org>, "(GTEB461@ecy.wa.gov)" <GTEB461@ecy.wa.gov>, "spmalloch@gmail.com" <spmalloch@gmail.com>

The Icicle Work Group is holding a Seattle-area workshop to provide details on its *Icicle Strategy*. Chelan County and the WA Department of Ecology/Office of the Columbia River have recently initiated development of a programmatic environmental impact statement for the *Icicle Strategy* and will accept comments until May 11, 2016. See attached documents.

The workshop will be held March 30, 7 PM at the Phinney Center, 6532 Phinney Ave N, Seattle, WA 98103.

We hope that you will be able to attend this workshop to learn more about the *Icicle Strategy* and how to provide input during environmental review. Please feel free to circulate this email and let others know about the workshop. For more information, please visit our website at the following link: http://www.co.chelan.wa.us/natural-resources/pages/icicle-work-group?parent=Planning

Thanks.

Mike

Attachments:
Icicle Strategy DS Signed.pdf
Icicle Strategy SEPAchecklist.pdf

Mike Kaputa, Director

Chelan County Natural Resource Department

411 Washington Street, Suite 201

Wenatchee, WA 98801

Phone: (509) 670-6935

---------- Forwarded message ----------
From: **Derek Poon** <derekcpoon@gmail.com>
Date: Mon, Mar 30, 2015 at 4:16 PM
Subject: DP thanks, with info: Icicle Work Group Seattle Meeting February 17, 2015
To: Mike Kaputa <Mike.Kaputa@co.chelan.wa.us>
Cc: Keith Goehner <Keith.Goehner@co.chelan.wa.us>, "glearnedsr@hotmail.com" <glearnedsr@hotmail.com>, "amatzke@gmail.com" <amatzke@gmail.com>, "patsump@juno.com" <patsump@juno.com>, "rr.wolfe@comcast.net" <rr.wolfe@comcast.net>, Lisa Pelly <Lisa.Pelly@tu.org>, Trish Rolfe <trolfe@celp.org>, "lfetterly_47@hotmail.com" <lfetterly_47@hotmail.com>, Benjamin Greuel <benjamin_greuel@tws.org>, "tony.iid.pid@nwi.net" <tony.iid.pid@nwi.net>, "Lisa Dally Wilson (lisadallywilson@gmail.com)" <lisadallywilson@gmail.com>, "Charity Davidson (Charity.Davidson@dfw.wa.gov)" <Charity.Davidson@dfw.wa.gov>, "(GTEB461@ecy.wa.gov)" <GTEB461@ecy.wa.gov>, Andrea Imler <aimler@wta.org>, Jay Manning <jmanning@cascadialaw.com>, "dlparks398@gmail.com" <dlparks398@gmail.com>, "HBRomb@aol.com" <HBRomb@aol.com>, "Karl Forsgaard (karlforsgaard@comcast.net)" <karlforsgaard@comcast.net>, "voice4wild@aol.com" <voice4wild@aol.com>, "raelene@seanet.com" <raelene@seanet.com>, "deortman@msn.com" <deortman@msn.com>, "espackard@msn.com" <espackard@msn.com>, "buukrat@gmail.com" <buukrat@gmail.com>, "paulkgould@comcast.net" <paulkgould@comcast.net>, "Rachael Osborn (rdpaschal@earthlink.net)" <rdpaschal@earthlink.net>, Janine Blaeloch <blaeloch@westernlands.org>, Susan Adams <susan@washingtonwatertrust.org>, Michael Garrity <mgarrity@americanrivers.org>, "tom@wawild.org" <tom@wawild.org>, John Osborn <John@waterplanet.ws>, Ron Walter <Ron.Walter@co.chelan.wa.us>, Doug England <Doug.England@co.chelan.wa.us>, "Kuiken, Jason J -FS" <jkuiken@fs.fed.us>, Jeff Rivera <jrivera02@fs.fed.us>, Mary Jo Sanborn <MaryJo.Sanborn@co.chelan.wa.us>, "dhaller@aspectconsulting.com" <dhaller@aspectconsulting.com>, "David W. Rice" <drice@anchorqea.com>

Mike,

Your notes of the February 17 IWG meeting and the Powerpoint are much appreciated!

To keep everyone equally informed, I am providing to the notes distribution my suggested data analysis format sent to you on February 18, in the file "**Alpine Lakes 2-17-15 IWG mtg, with CWA DU MATRIX.pdf**). I also attached several files on Clean Water Act (CWA) Existing and Designated uses (DU) protection and Endangered Species Act (ESA) Section 7(a)(1), both referenced in my recommendations.

To all, feel free to delete or use these files as you see fit. Since they all went to policy folks, they are provided to give full disclosure. For those who don't know me, I attached my one-page resume in the attached file, "DP 3-4-15 letter, BNR, 3-10-15 meeting.pdf."

Again, Mike, thanks for your efforts and all the best in this challenging project.

Derek

Four attachments:
1) Alpine Lake 2-17-15 IWG mtg, with CWA DU MATRIX.pdf
2) CWA DU protection and ESA 7(a)(1), 3-26-15.pdf
3) KFNC suitability determination, to Kelsey at ACOE, January, 2015.pdf
4) DP 3-4-15 letter, BNR, 3-10-15 meeting.pdf

--
Derek Poon
400 Boylston Ave E, #2
Seattle, WA 98102
206-729-9378, derekcpoon@gmail.com

"All it takes is for the right people in the right position to take action."
David Lewis, SCIENCE FOR SALE, 2014
"This insecticide is dedicated to a healthier world." EPA approved slogan, 2007.
E. G. Vallianatos, POISONED SPRING, 2014

On Sun, Mar 29, 2015 at 9:30 AM, Mike Kaputa <Mike.Kaputa@co.chelan.wa.us> wrote:

Thank you all for attending the February 17 meeting to discuss Icicle Work Group efforts and, specifically, those efforts in the Alpine Lakes Wilderness. Attached are notes from that meeting. Please let me know if you have any edits by April 10. The Powerpoint from the meeting is available on our website at http://www.co.chelan.wa.us/natural-resources/iwgminutes?parent=Planning

I could not decipher email addresses from the following people: Ann Wechsler, Morgan Ahouse, and Connor Briggs. Please forward this email to them or send me their email addresses.

I appreciated the opportunity to follow up with many of you in early March and look forward to getting into more details and, as we discussed, a potential site visit when weather permits.

Again, many thanks for your time and involvement.

Mike

Mike Kaputa, Director

Chelan County Natural Resource Department

411 Washington Street, Suite 201

Wenatchee, WA 98801

Phone: (509) 670-6935

Please note our new address

Written Comment Sheet for

Scoping the Icicle Strategy Programmatic Environmental Impact Statement

Scoping is the process used to determine what should be evaluated in an environmental impact statement (EIS). It is conducted before any analysis of impacts is begun. You can participate in this process by submitting your scoping comments below.

Comments will be accepted through May 11, 2016 and can be sent to Mike Kaputa at mike.kaputa@co.chelan.wa.us or 411 Washington Street, Suite 201, Wenatchee, WA 98801

DEPARTMENT OF ECOLOGY
State of Washington

Contact Info (Required)

Name: NATALIE WILLIAMS Date: 20 APRIL '16

Address:

Telephone: Email: nataliesees@gmail.com

☒ Please send me an electronic copy of the draft EIS.

☐ Please send me a paper copy of the draft EIS.

Your Comments

Removal of any resource from a Federally designated Wilderness is a violation of the Wilderness Act and the Alpine Lakes Wilderness Area Management Plan. The NHSEL is a good example - even though that would have been argued under "education" outlined in the Act. Section 4d-4 specifically prohibits any 'taking' - increase or change, of the water resource, either quality or quantity. All 'added' water needs to come from 'added' sources - CONSERVATION

- The EIS should include an Alternative that Protects & Preserves the ALW water resource in compliance with the Wilderness Act and ALWAMP.
- The EIS should include an Alt that acknowledges the limits of the City of Leavenworth, Icicle Irr. Dist and all other Uses to the ORIGINAL purpose and legal agreement of Section 4(d)-4.
- The EIS should include an Alt that establishes a water rights / volume swap-barter market in addition to implementing aggressive conservation measures (eg; King County) including raising prices, issuing limits, scheduling watering, etc. ALL avenues of conservation and reclamation must be exhausted before (if ever) violating a Wilderness resource.

Written Comment Sheet for

Scoping the Icicle Strategy Programmatic Environmental Impact Statement

Scoping is the process used to determine what should be evaluated in an environmental impact statement (EIS). It is conducted before any analysis of impacts is begun. You can participate in this process by submitting your scoping comments below.

Comments will be accepted through May 11, 2016 and can be sent to Mike Kaputa at mike.kaputa@co.chelan.wa.us or 411 Washington Street, Suite 201, Wenatchee, WA 98801

DEPARTMENT OF ECOLOGY State of Washington

Contact Info (Required)

Name: Norm Stoddard Date: 4/20/2016

Address: 12556 Shore St. Leavenworth, Wa. 98826

Telephone: 509-548-4898 Email:

☐ Please send me an electronic copy of the draft EIS.

☒ Please send me a paper copy of the draft EIS.

Your Comments

What will be the impact of conservation on domestic water wells. will loss of ground water dry up wells?

Written Comment Sheet for

Scoping the Icicle Strategy Programmatic Environmental Impact Statement

Scoping is the process used to determine what should be evaluated in an environmental impact statement (EIS). It is conducted before any analysis of impacts is begun. You can participate in this process by submitting your scoping comments below.

Comments will be accepted through May 11, 2016 and can be sent to Mike Kaputa at mike.kaputa@co.chelan.wa.us or 411 Washington Street, Suite 201, Wenatchee, WA 98801

DEPARTMENT OF ECOLOGY State of Washington

Contact Info (Required)

Name: Steve McKenna Date: ____

Address: 12490 Shore St

Telephone: 509-670-1104 Email: smckenna @ nwi.net

☐ Please send me an electronic copy of the draft EIS.

☐ Please send me a paper copy of the draft EIS.

Your Comments

I commend the IWG for this most impressive collaboration! You've come together and worked for over 3 year to arrive at consensus on projects to improve stream flow on the Icicle. Having local entities, with often competing values, come together for solutions is a model for others to follow. The presentation was thorough, thought provoking. Nice job involving the community as part of this process.

Written Comment Sheet for

Scoping the Icicle Strategy Programmatic Environmental Impact Statement

Scoping is the process used to determine what should be evaluated in an environmental impact statement (EIS). It is conducted before any analysis of impacts is begun. You can participate in this process by submitting your scoping comments below.

Comments will be accepted through May 11, 2016 and can be sent to Mike Kaputa at mike.kaputa@co.chelan.wa.us or 411 Washington Street, Suite 201, Wenatchee, WA 98801

DEPARTMENT OF ECOLOGY State of Washington

Contact Info (Required)

Name: Scot Brower Date: 4/20/16

Address: 5821 Icicle Rd Leavenworth WA 98826

Telephone: 548-4160 Email: scotbrower@comcast.net
206-818-3202

☒ Please send me an electronic copy of the draft EIS.

☐ Please send me a paper copy of the draft EIS.

Your Comments

TU - leavenworth chapter

Concerns reguarding Boulder Field Removal

1) will upper Icicle Creek support Steelhead or is it too cold or lack sufficient food

2) will Steelhead passage into upper Icicle result in closure of trout fishery (Rainbow) because Steelhead protected by Endangered Species Act?

Nete Olsen
836 NW 61st St
Seattle, WA 98107

April 19, 2016

Via email: Mike.Kaputa@co.chelan.wa.us

Chelan County Natural Resources Department
Attn: Mike Kaputa, Director
411 Washington Street, Suite 201
Wenatchee, WA 98801

RE: Scope of Programmatic EIS for Icicle Creek Water Resource Management Strategy

Dear Mr. Kaputa,

Thank you for the opportunity to comment on the Scope of the Programmatic Environmental Impact Statement for the Icicle Creek Water Resource Management Strategy. It is my understanding that you are currently soliciting questions, recommendations and comments regarding the Guiding Principles that helped to delineate the scope, as well as the baseline projects briefly outlined in the "Icicle Strategy". My comments are as follows:

1. **A Water Balance Chart should be prepared for the Icicle Creek system.** This chart should show: a) the baseline flows expected for Icicle Creek and the tributary lakes during a "normal" flow year, a "drought" year, and anticipated future flows that take into account the impacts of global warming; b) water outputs from Icicle Creek under current operations during "normal" and "drought" years showing the locations of the diversions, the maximum rates and volumes of diversion, whether the diversions are firm or interruptible, and the holders of the diversionary rights; and c) locations of problem areas in the drainage system that the IWG is trying to address to improve instream flows. Note that all of the flow rates and volumes should be presented for each individual water right—for example, Snow/Nada Lakes should be broken into the diversions for the Fish Hatchery and for the Icicle Peshastin Irrigation District (IPID).

2. **The Guiding Principles outlined by the IWG need to be ranked in order to establish the relative importance of each principle.** Clearly, some of the principles are legal requirements (Tribal Treaty Harvest, State and Federal

Laws, Wilderness Act), which take precedence over other principles presented (eg. Improve Domestic Supply, Improve Agricultural Reliability). For that reason, not all guidelines are created equal. Rather, there are Required Guiding Principles and Additional Guiding Principles, and they should be noted as such. This ranking must be done because the projects that will follow from this scoping document will all be tied to these Guiding Principles, and not all of them will be able to be met. So, the ranking system will help to define which project should take precedence.

3. **"Conservation First" should be added as the 10th Guiding Principle**. While conservation of water as a limited resource is of clear interest to those within the working group, defining Conservation First as a separate Guiding Principle will more clearly demonstrate the IWG's desire to meet water needs through conservation before attempting to find and develop any "new" sources of water. Additionally, bringing water conservation to the forefront will keep conservation as the first line of action in meeting future water needs. Generally, conservation is cheaper, easier, and faster than developing new water sources.

4. **Relocating the diversion locations along Icicle Creek must be considered as an alternative to meet the Guiding Principle of Improving Instream Flow.** Clearly, if the stretch of Icicle Creek that most suffers from reduced stream flow is the segment downstream of the diversion structures for the irrigation districts, the City of Leavenworth, and the Fish Hatchery, then using a pumping system to divert flows to the gravity diversion channels from the confluence must be studied, considered, and compared.

5. **Transferability of water rights must be demonstrated in the Eightmile Lake Restoration Project.** It appears that the water rights for the Alpine Lakes (including Eightmile Lake) were granted to the IPID, and the agreements with the Forest Service in the Wilderness Act were negotiated with the IPID. It is not clear to me how any changes made to Eightmile Lake can be made in order to provide water to a municipal water provider, as that appears to be outside of the water usages established by these two agreements. The summary of the water rights presented in the *Alpine Lake Optimization and Automation* report prepared by Aspect Consulting and Anchor QEA describe the rights as certified "for the purpose of irrigation of 7,000 acres lying within the lands of the Icicle and Peshastin Irrigation Districts."

6. **Limits of Inundation of Eightmile Lake perimeter should be mapped.** This mapping would help to define what the potential impacts would be of raising the water level of Eightmile Lake by 4 feet, including the impacts to trails, campsites, forested areas, and habitat. It would also help to determine the feasibility of raising the lake—ie would the lake even be able to impound the

higher water level, or are there geologic factors that would keep the lake from being able to impound a higher level of water?

7. **Alpine Lakes Optimization, Modernization, and Automation operation strategy needs to be defined**, particularly since it is linked to the "Improve Instream Flow" Guiding Principle:
   a) How much water will be taken from each lake during a "normal" water year?
   b) Will the ease of water withdrawal increase the "baseline" withdrawal rate that currently gets drawn? For example, will irrigated acreage increase so that the needs for irrigation rise, and every year becomes a "drought" year? We all know that demands will rise as supply becomes available, and providing a more regular supply may only make for more severe shortages as the impacts of global warming become clearer.
   c) How will the benefits to Instream Flows (as an interruptible flow) be balanced with the needs of irrigation (as a firm demand)?

8. **Stage/Storage data and bathymetry needs to be developed for each of the Alpine Lakes within the "optimization" program.**

Thank you again for this opportunity to comment. Please include me in all future mailings on this project.

Sincerely,

Nete Olsen
836 NW 61st St
Seattle, WA 98107
neteolsen@olsenviolins.com

Jordan Sanford

From: Meghan O'Brien
Sent: Thursday, April 21, 2016 1:03 PM
To: Jordan Sanford
Subject: FW: No dams in Alpine Lakes Wilderness!

Here is another public comment to add to the table.
Thanks,
Meghan

Meghan O'Brien | Aspect Consulting LLC | Project Specialist | Direct: 509.895.5261 | Cell: 509.607.0059

From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Thursday, April 21, 2016 12:45 PM
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: No dams in Alpine Lakes Wilderness!

Comment below…

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Sunday, April 17, 2016 7:57 PM
To: Roy & Jean McMurtrey
Cc: Mary Jo Sanborn
Subject: RE: No dams in Alpine Lakes Wilderness!

Hi Roy. I will make sure your comment is in the record.

Are you aware that dams were constructed on several alpine lakes in the early 1900s, before the wilderness designation, and are currently maintained operated by agreement between the US Forest Service and Icicle Irrigation District? Your comment suggested to me that you thought dams did not exist up there.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201

Wenatchee, WA 98801
Phone: (509) 670-6935

From: Roy & Jean McMurtrey [mailto:dmcmurtrey@msn.com]
Sent: Sunday, April 17, 2016 4:10 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: No dams in Alpine Lakes Wilderness!

What a terrible idea. We need wilderness kept pristine, get the water some other way, please.

Roy McMurtrey

Sent from Mail for Windows 10

Jordan Sanford

From: Meghan O'Brien
Sent: Monday, April 25, 2016 11:02 AM
To: Jordan Sanford
Subject: FW: Icicle Stategy

Meghan O'Brien | Aspect Consulting LLC | Project Specialist | Direct: 509.895.5261 | Cell: 509.607.0059

From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Monday, April 25, 2016 11:03 AM
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: Icicle Stategy

Comment below…

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Friday, April 22, 2016 11:47 AM
To: Mary Jo Sanborn
Subject: FW: Icicle Stategy

From: Ken Hemberry [mailto:ken@hiupgrowers.com]
Sent: Friday, April 22, 2016 11:08 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Icicle Stategy

Mike
Peshastin Hi-Up Growers President of the Board Rudy Prey Jr. and I attended the Icicle Strategy Meeting held in Leavenworth on April 20th. As the General Manager of a company that packs 50 million pounds of pears annually, I am acutely aware of the value of water. There really isn't anything that is more important to our growers and countless other growers than having a dependable source for irrigation. While Rudy and I came to the meeting with our personal interests in mind, it was great to learn that the Work Group was focused on meeting the needs of all stakeholders through a consensus process.

On April 21st our board held its monthly meeting. Rudy and I reported on the Icicle Strategy. Our board was very pleased to hear of both your efforts and your approach. We want to pass on to you that we both appreciate and support the Work Group's plans and Guiding Principles. If there is any way that we can assist please let us know.

Ken Hemberry
General Manager
Peshastin Hi-Up Growers

Jordan Sanford

From: Meghan O'Brien
Sent: Monday, April 25, 2016 11:08 AM
To: Jordan Sanford
Subject: FW: Save the Alpine Lakes Wilderness!
Attachments: IMG_6448.JPG

Meghan O'Brien | Aspect Consulting LLC | Project Specialist | Direct: 509.895.5261 | Cell: 509.607.0059

From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Monday, April 25, 2016 11:04 AM
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: Save the Alpine Lakes Wilderness!

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Friday, April 22, 2016 9:29 AM
To: joriadkins@mac.com
Cc: Dorothy Walker; Mary Jo Sanborn
Subject: RE: Save the Alpine Lakes Wilderness!

Thanks, Jori, for your comments. We'll make sure that they are entered into the record.

I wanted to make sure you knew that Snow, Nada, Colchuck, Square, Klonaqua and Eightmile Lakes already have dams in place and were constructed before the wilderness designation. I read your email to say that you thought there are not dams there now and that the Icicle Work Group is proposing to build new ones. Here are some photos that show some of these lakes from last year and the dam at Eightmile.

Let me know if I can provide any additional
information.

From: joriadkins@mac.com [mailto:joriadkins@mac.com]
Sent: Tuesday, April 19, 2016 10:53 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Cc: Dorothy Walker <dorothyw@centurylink.net>
Subject: Save the Alpine Lakes Wilderness!

Dear Mike Kaputa,

I am very concerned about the Icicle group's proposal to use the Alpine Lakes as *reservoirs* for, when the smoke lifts, new housing starts in the Leavenworth area as well as other Chelan County suburbs.

Their plan looks "balanced" but it isn't when it is looked at closely. Yes, they play lip service to Fisheries, yes, they mention the Widerness Acts and complying with State and Federal laws, but basically the list of stakeholders are those that profit from the water and would like to control it for more direct growth of that profit. Their tactics are very arrogant, making statements that make it sound as if it were a done deal! Calling the lakes reservoirs is the worst! This is all very wrong!

I am one of the people that sees wilderness areas as a place of rejuvenation and healthy hiking and wildlife watching, to see an area like Alpine Lakes is to see something that has not been affected by humans (that is the definition of a wilderness area). People like me do not dam the lakes for the profit of a few but leave it for others and our grandchildren to enjoy and seek healthy renewal.

This proposal uses our taxes too and we were not notified in time for meetings because we are not an organization but individuals that go out to hike in the wilderness.
This project uses our taxes and they are being spent to benefit a few. This is very wrong!

Please leave the Alpine Lakes Wilderness alone as the pristine Alpine wilderness it is!

Thank you for your time and consideration,

Jori Adkins
301 Puyallup Ave.
Tacoma, WA 98421
253-365-1459

Jordan Sanford

From:	Meghan O'Brien
Sent:	Monday, April 25, 2016 11:09 AM
To:	Jordan Sanford
Subject:	FW: Comment on Icicle Basin water

Meghan O'Brien | Aspect Consulting LLC | Project Specialist | Direct: 509.895.5261 | Cell: 509.607.0059

From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Monday, April 25, 2016 11:04 AM
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: Comment on Icicle Basin water

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Friday, April 22, 2016 9:14 AM
To: Mary Jo Sanborn
Subject: FW: Comment on Icicle Basin water

From: Mike Kaputa
Sent: Friday, April 22, 2016 9:13 AM
To: 'Vic Clayson' <vkclayson@charter.net>
Subject: RE: Comment on Icicle Basin water

Thanks, Vic, we'll make sure your comments are entered into the record. Please let me know if there is any more information we can provide.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department

411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Vic Clayson [mailto:vkclayson@charter.net]
Sent: Friday, April 22, 2016 8:17 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Comment on Icicle Basin water

Good morning,

I appreciate the opportunity you're giving for public comment on the Icicle Basin water issue.

I'm very much in favor of increasing the capacity for water storage. I don't know just how this is going to be done or if the source of funding is known. If funding is available and the various agencies can come to an agreement to repair dams where necessary or whatever needs to be done to get more storage, I'm all for it. I'm not claiming to be an expert in how to do it but I'm sure that there are experts who know how to get the job done and I'm going to trust them to do that.

It seems like such a waste to see all of the brown, muddy water going down the Wenatchee River every spring. I assume that whatever is done in the Icicle Basin probably won't do much, if anything, to reduce the high level of water that we see so often during parts of the year. Even so, if there's a way we could even do more to contain some of that water I'd also be for that but I'm realistic enough to know that isn't likely to happen.

Sincerely,
Vic Clayson
Cashmere

Jordan Sanford

From: Meghan O'Brien
Sent: Monday, April 25, 2016 11:09 AM
To: Jordan Sanford
Subject: FW: Icicle Water project

Meghan O’Brien | Aspect Consulting LLC | Project Specialist | Direct: 509.895.5261 | Cell: 509.607.0059

-----Original Message-----
From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Monday, April 25, 2016 11:04 AM
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: Icicle Water project

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
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Cell: (509)-860-2135
www.co.chelan.wa.us/nr

-----Original Message-----
From: Mike Kaputa
Sent: Friday, April 22, 2016 9:12 AM
To: Merrie Davis
Cc: Mary Jo Sanborn
Subject: RE: Icicle Water project

Thanks, Merrie, we'll make sure your comments are entered into the record. Please let me know if there is any additional information we can provide you.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

-----Original Message-----
From: Merrie Davis [mailto:wmdavis@yesimadeit.com]
Sent: Thursday, April 21, 2016 10:56 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Icicle Water project

I am in favor of the proposal for additional water storage in the Alpine Lakes area. I hope the proposal is a success.

Merrie Davis

Jordan Sanford

From: Dan Haller
Sent: Wednesday, April 27, 2016 11:28 AM
To: Jordan Sanford
Subject: Fwd: IWG Comments

Sent from my U.S. Cellular® Smartphone

-------- Original message --------
From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Date: 4/27/16 11:17 AM (GMT-08:00)
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: IWG Comments

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Tuesday, April 26, 2016 3:58 PM
To: Cristina Hill
Cc: Mary Jo Sanborn
Subject: RE: IWG Comments

Thanks for taking the time to provide comments, I'll make sure they are entered into the record…Mike

From: Cristina Hill [mailto:cristina.e.hill@gmail.com]
Sent: Monday, April 25, 2016 12:50 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: IWG Comments

Dear Mr. Kaputa,

As part of the IWG SEPA public comment period, I would like to ask that the City of Leavenworth initiate a water metering program and tiered pricing for residential customers. As part of the stated effort to improve conservation efforts, this one is perhaps the most obvious. Not only do people not know how much water they currently use, but there is no financial incentive for conservation? This should change.

In addition, I completely support improvement of passage conditions at the Icicle Boulder Field, installation of fish screening at the Leavenworth National Fish Hatchery intake, along with their upgrade to circular tanks for fish rearing. The conversion of any delivery systems to irrigators to on-demand pumps with pressurized pipes is also a good one, though their users should also be asked to allow metering in exchange for public financing of their infrastructure. Thank you for consideration of my comments.

Cristina Hill
Leavenworth Resident

Jordan Sanford

From:	Dan Haller
Sent:	Wednesday, April 27, 2016 3:45 PM
To:	Jordan Sanford
Subject:	FW: Comment regarding Icicle Work Group and SEPA Checklist

Daniel R. Haller, PE, CWRE | Aspect Consulting, LLC | Principal Engineer | Direct: 509.895.5462 | Cell: 509.952.8607

From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Wednesday, April 27, 2016 3:05 PM
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: Comment regarding Icicle Work Group and SEPA Checklist

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
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www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Wednesday, April 27, 2016 11:35 AM
To: timgartland@centurytel.net
Cc: Mary Jo Sanborn
Subject: RE: Comment regarding Icicle Work Group and SEPA Checklist

Thanks, Tim, we appreciate the thorough review and will make sure these comments are entered into the record and considered.

Mike

From: Timothy R Gartland [mailto:timgartland@centurytel.net]
Sent: Wednesday, April 27, 2016 10:44 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Comment regarding Icicle Work Group and SEPA Checklist

Dear Mr. Kaputa,

It appears to me that answers submitted in your SEPA Environmental Checklist related to Icicle Work Group proposals are incomplete. That is, your responses ignore the upstream impacts of the Icicle Work Group's proposed increases to water flows over those upper stretches of Icicle Creek and its tributaries. The manipulated flows meant to provide additional water during the late summer and early fall are by definition unnatural, and as such will (of course) have an impact. Yet your SEPA responses make no mention of this simple fact.

Here are some examples to support my observation:

Regarding:
Section B. Environmental Elements
Subsection 8. Land and Shoreline Use
Question a: What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.
Your answer: "The proposal will increase instream flow, which will provide beneficial results for a variety of agricultural, recreational, domestic, commercial, and natural uses on adjacent properties."
This response fails to account for the deleterious effects to wildlife, wildlife systems and humans that have come to count upon the natural seasonal reductions to instream flows (upstream of the proposal's beneficiaries.)
Question j: Approximately how many people would the completed project displace?
Your answer: "None anticipated."
This response fails to account for the upstream property owners, camp site users and other visitors who count on using the natural seasonal reductions for swimming and wading who will be discouraged by the danger presented by the increased flows. If the water flow were increased 30 or 50% on the stretch where I generally camp it would render the stream unsafe for entry. As it is now, I and other campers can wade, swim or bathe themselves naturally. The increased flows could result in the entire population of future campers losing swimming areas forever.

Subsection 12. Recreation
a. Would the proposed project displace any existing recreational uses? If so, describe.
Your answer: "The proposal would improve some recreational opportunities by enhancing the natural aesthetic of the affected geographical area through increased streamflow in Icicle Creek."
This response fails to account again for the upstream property owners, camp site users and other visitors who count on using the natural seasonal reductions for swimming and wading who will be discouraged by the danger presented by the increased flows.

Section D. Supplemental Sheet for NonProject Actions
Question 2. How would the proposal be likely to affect plants, animals, fish or marine life?
Your answer: "The program is designed to improve instream flow and habitat for fish."
The response fails again to account for the deleterious effects to wildlife and humans that have come to count upon the natural seasonal reductions to flows upstream of the proposal's beneficiaries.
Question 4. How would the proposal be likely to use or affect environmentally sensitive areas or areas designated for governmental protection; such as parks, wilderness, wild and scenic rivers, threatened or endangered species habitat, historic or cultural sites, wetlands, floodplains, or prime farmlands?
Your answer: "Implementation of the Guiding Principles would not result in any long-term changes, new construction or lasting disturbance to any environmentally sensitive areas."
This response fails to account for the permanent presence of unnatural, counter seasonal increased water flows from originating sources within wilderness areas through to the downstream beneficiaries. To repeat, the increased flows would be permanent and unnatural.

The few examples above illustrate how your responses ignore upstream impacts of the increased water flows. Which is surprising because the impacts of artificially storing and releasing water flows are well documented from a long history of numerous projects around the globe. The impacts include those associated with river-line erosion and changes in water temperature, not to mention the increased dangers to humans wishing to bathe in and along its shores. River-line erosion impacts shores and riverbed, and threaten shoreline ecosystems. Further, stream beds can deepen and thus narrow over time. The counter seasonal increases also result in the cooling of the waters. These cooler temperatures can impact fish, flora and fauna in ways not addressed in your responses.

Water flows have seasonally ebbed and flowed since time began. Aquatic and land animals have come to depend upon this ancient system, including myself. I look forward to the naturally low volumes and warmer waters to cool myself during the hot summer months. Aquatic animals may depend upon the lower volumes to breed or build fat stores. Land animals may advantage the lower flows to traverse the river or complete migratory travel. The artificial manipulation of the flows is by definition abnormal and unnatural, and as such will definitely impact the systems and the animals which populate the flows. Your responses should acknowledge and respect this fact. Its my observation that they do not. And as such, you should make amendments to correct the omissions.

Respectfully submitted,

Tim Gartland
9120 Woodworth Avenue
Gig Harbor, WA 98332
Frequent recreational visitor to the Icicle River and Valley

Jordan Sanford

From: Meghan O'Brien
Sent: Thursday, April 28, 2016 2:46 PM
To: Jordan Sanford
Cc: Dan Haller
Subject: FW: comments on IWG scoping

Meghan O’Brien | Aspect Consulting LLC | Project Specialist | Direct: 509.895.5261 | Cell: 509.607.0059

-----Original Message-----
From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Thursday, April 28, 2016 2:15 PM
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: comments on IWG scoping

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

-----Original Message-----
From: Mike Kaputa
Sent: Thursday, April 28, 2016 2:09 PM
To: Ed Burns
Cc: Mary Jo Sanborn
Subject: RE: comments on IWG scoping

Thanks, Ed, we'll get your comments into the record and included in our scoping effort. We appreciate your time and effort to participate and put these together.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201

Wenatchee, WA 98801
Phone: (509) 670-6935

-----Original Message-----
From: Ed Burns [mailto:rpwa2003@yahoo.com]
Sent: Thursday, April 28, 2016 11:53 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: comments on IWG scoping

The main limitation I see with the plan is that conservation efforts seem to have the lowest priority. In the area where I live, which is served by COIC, there is no incentive to conserve since the water is basically free ($80/yr/acre) and essentially nobody does conserve. The vast majority of usage appears to be lawn watering in an inefficient manner. At the height of last years snowpack drought people were not even making minimal efforts to conserve, e.g., they watering in the middle of 100 degree days, watering daily, over watering, etc. Lining the ditch won't have any effect on usage and the small amount saved will just be dumped in the Wenatchee.   I don't see where the incentive for users to conserve will come from. Since it's a user-owned district the users are not going to vote to do something that will cost them money such as metering, or even agree to it if someone else pays costs of installing meters. I see nothing in the plan that will persuade them into giving up their lush green lawns in mid summer which, although ridiculous in an area which ranges from semi arid to outright desert, seem to be regarded as a god-given right (the irony is, if you drive to Seattle in the summer, the majority of people there let their lawns go dormant in mid summer). Why weren't the costs of a California-like scheme to pay people to go to xeriscaping considered? I also don't see how the pumping options help because it seems like it's a robbing Peter to pay Paul scheme where flow in the lower Icicle is increased whereas flow in the Wenatchee decreased.

From my observations it seems that the lack of conservation efforts are the norm in the area. I see the same watering behavior in Leavenworth and in the domestic users in the IPID as in COIC. The manager of IPID is quoted during last summer's drought: “Icicle users have been using record amounts of water......We have been pushing the canal as hard a we can push it.” He also claims that agricultural users irrigation efficiency is basically maxed out, but again, I saw sprinklers going in the middle of the day, and I'd wager that Israeli farmers are getting by with about half the water for the same crops. Although Leavenworth claims to have reduced per capita water usage, this was the result of a one-time (step function) decrease in usage when they installed meters, and it has not declined since then.

As far as environmental impact of individual projects: the remote control of output from the lakes would seem to be relatively innocuous; the rebuilding of the eightmile dam less so (interesting that in the reports the “historic” level of the lake is the level after the original dam was built); and the diversion from Upper Klonaqua lake, outrageous.

In summary, I think the plan proposes spending vast amounts of money on projects to provide water which serious conservation efforts, especially on the part of residential users, could largely provide.

272 Mapleway Road
Selah, WA 98942
April 30, 2016

Mike Kaputa
411 Washington Street
Suite 201
Wenatchee, WA 98801
Mike.kaputa@co.chelan.wa.us

Dear Mr. Kaputa,

Thank you for the opportunity to comment on the preparation of the Programmatic Environmental Impact Statement (PEIS) for the Icicle Strategy. I have the following comments:

Regarding the handouts shown on the website http://www.co.chelan.wa.us/natural-resources/pages/sepa-public-open-house,

1. Alpine Lakes Optimization, Modernization and Automation handout: I have a strong objection to the project description: "Seven *reservoirs* (emphasis added) located within the Alpine Lakes Wilderness Area are currently used to augment water supply for Icicle and Peshastin Irrigation Districts (IPID) and the US Fish and Wildlife Service Leavenworth National Fish Hatchery: Upper and Lower Snow, Nada, Colchuck, Eightmile, Klonaqua, and Square Lake." Further, "The purpose of this project is to manage release from these "*reservoirs*" (emphasis added) based on water levels and changing conditions in a way that would optimize the water supply in the basin and be coordinated among all users."

   Nowhere does it mention that these "reservoirs" are not, in fact, "reservoirs" but named geographic features (lakes) located within the Alpine Lakes Wilderness. It is also apparent that there was no consideration made for "users" of the Alpine Lake Wilderness, only for those who wish to consume the water from those "reservoirs" aka, lakes, from within the Alpine Lakes Wilderness.

2. Domestic Conservation Efficiencies handout: Quoting the project description, "Future conservation projects identified by the IWG include replacing residential meters, *evaluating* (emphasis added) a conservation oriented rate structure, expand conservation education and xeriscape programs, increase domestic leak detection programs, and rebates for efficient residential fixtures. Additionally, City of Leavenworth is *exploring* (emphasis added) opportunities for reclaimed water and replacing leaky watermains.

In the 1970's and 1980's, energy conservation was looked at as a stop-gap measure used prior to construction of coal or nuclear plants. The coal or nuclear plants would then provide the "real" energy necessary for an expanding economy.

We now know that those coal and nuclear plants were not necessary and energy conservation is the preferred alternative in the Pacific Northwest.

So why is the IWG providing first for hard engineering regarding "optimizing, modernizing and automating" the "reservoirs" but only "evaluates" and "explores" conservation opportunities? Shouldn't it be the other way around? Why do you first want to mine the water in the Alpine Lakes Wilderness before you have evaluated and explored the potential for conservation?

As a senior water right holder in the Yakima basin, I am familiar with the rush towards high dollar capital projects for new water sources (especially when the State or Federal government is paying) with conservation playing second or third fiddle.

I do understand that IPID has specific water rights from the Alpine Lakes Wilderness. My understanding is that those rights are for agricultural purposes. I question the conversion of those agricultural right to domestic water rights, especially when the IWG is only proposing an "evaluation" of a conservation oriented rate structure and the City of Leavenworth is only proposing "exploring" opportunities for reclaimed water and replacing leaky watermains.

Shouldn't you at least replace the leaky watermains? With all respect, replacing leaky watermains would appear to be a good place to spend capital dollars. Leaky watermain replacement could provide additional water through conservation with a side effect of improving the city's infrastructure.

I would like to see an alternative that does not allow "optimizing, modernizing and automating" the "reservoirs" but does require a conservation oriented rate structure, increased domestic leak detection, rebates for efficient residential fixtures and replacement of leaky watermains. Opportunities for reclaimed water should also be evaluated.

Thank you for your consideration of these comments.

Kind regards,

Margie Van Cleve

Written Comment Sheet for

Scoping the Icicle Strategy Programmatic Environmental Impact Statement

Scoping is the process used to determine what should be evaluated in an environmental impact statement (EIS). It is conducted before any analysis of impacts is begun. You can participate in this process by submitting your scoping comments below.

Comments will be accepted through May 11, 2016 and can be sent to Mike Kaputa at mike.kaputa@co.chelan.wa.us or 411 Washington Street, Suite 201, Wenatchee, WA 98801

DEPARTMENT OF ECOLOGY State of Washington

Contact Info (Required)

Name: Fred Smith Date: 5/5/2016

Address: P.O. Box 357

Telephone: 860-3997 Email:

☐ Please send me an electronic copy of the draft EIS.

☒ Please send me a paper copy of the draft EIS.

Your Comments

The number one priority should be which ever project increases stream flow the greatest during mid to late summer. This would have the greatest positive effect on fish, and it would also insure a more reliable water flow for the Wenatchee Valley agricultural industry.

That project/projects would be the rebuilding of the Eight Mile Lake Dam to it orginal "legal" height, along with installing automated valves.

As for the bolder field, learn to live with it, as past generations have.

TROUT UNLIMITED

Trout Unlimited: America's Leading Coldwater Fisheries Conservation Organization

TO: Tom Tebb
Director, Office of Columbia River
Washington State Department of Ecology
1250 Alder Street
Union Gap, WA 98903

Mike Kaputa
Director, Chelan County Natural Resources Department
411 Washington Street, Suite 201
Wenatchee, WA 98801

RE: Request for Comments on the Scope of the Programmatic Environmental Impact Statement (PEIS) for the Icicle Creek Water Resource Management Strategy (Icicle Strategy)

DATE: May 4, 2016

Dear Dir. Tebb and Dir. Kaputa,

The Washington State Department of Ecology (Ecology) directed the Chelan County Natural Resource Department (CCNRD) to develop a PEIS for the Icicle Strategy. Currently, the potential project package established by the Icicle Work Group (IWG) is open to public comment. Comments will be used to inform a draft State Environmental Policy Act (SEPA) PEIS for the Icicle Strategy. Trout Unlimited (TU) appreciates the opportunity to provide comments during the scoping period.

The purpose of the SEPA PEIS is to address probable significant adverse impacts associated with implementation of a suite of projects within the Icicle Creek basin aimed at enhancing stream flow and habitat conditions for fisheries and other aquatic organisms, improving operations and water storage at historical reservoirs within the Alpine Lakes Wilderness, maintaining water security and supply reliability for out of stream users of Icicle Creek water, and reinstating water reserves that will facilitate growth/development in Chelan County.

TU sits on the IWG Steering Committee and has worked with IWG membership to ensure the proposed package aligns with TU's mission to conserve, protect, and restore North America's coldwater fisheries and their watersheds. These projects include:

- Efficiency upgrades for Icicle Peshastin Irrigation District (IPID) and Cascade Orchards Irrigation Company (COIC)
- Domestic conservation and efficiencies
- Diversion screening upgrades (IPID, COIC, and City of Leavenworth)

- Eightmile Lake restoration and Alpine Lakes reservoir management optimization and automation
- Leavenworth National Fish Hatchery water conservation and water quality improvements, intake rehabilitation, and Structure #2 operational improvements
- Icicle Creek habitat improvements/land acquisitions
- Fish passage and tribal fishery improvements
- Water markets/banks
- Instream Flow Rule amendment

TU understands that a primary purpose of the SEPA PEIS is to help clarify resources and information that will inform programmatic environmental review for the Icicle Strategy as well as individual environmental review processes for each project. TU takes seriously its role within the IWG and wishes that the Icicle Strategy have a lasting positive benefit for the people and environment in North Central Washington. Moreover, TU understands that the IWG approved the current suite of projects for public comment and SEPA review, but that it does not necessarily represent the final project package or approval of individual projects in the PEIS.

TU has the following concerns and comments that should be addressed during the SEPA review and PEIS development:

1. An article on the Icicle Strategy in the April 22, 2016 print issue of the Wenatchee World noted that in the opinion of the IWG, "If implemented in full, the (Icicle Strategy) will support area population growth while also supplying fish and irrigators with the water they need through 2050." TU is concerned that the ability of the proposed project package meeting Icicle Creek demands through 2050 is not substantiated because no assessment has been conducted specifically addressing future water supply and climate scenarios in the Icicle Creek basin. Potential impacts of a changing climate in the Pacific Northwest include reduced snowpack and decreased summer stream flows. IWG guiding principles include instream flow objectives of 60 cfs in drought years and 100 cfs in non-drought years. TU encourages the IWG to review the attached analysis of Icicle Creek water/climate conditions performed by Dick Rieman and TU-Washington Water Project staff and urges the IWG to procure a water supply and climate change analysis from a team of experts such as the University of Washington Climate Impacts Group. It does not seem prudent to move a final project list forward without first securing water supply information so the Icicle Strategy is built on sound science and solid fundamentals.

2. TU understands that the success of the Icicle Strategy hinges on implementation of the full suite of proposed projects. However, it is unclear what projects have been identified to replace those in the proposed package should any one become unattainable due to logistics, lack of public support, unanticipated expenses, or other reason(s). TU strongly urges the IWG to develop a list of proposed project alternatives that will also meet IWG guiding principles and that are practical, feasible, and implementable. In addition to identifying potential replacement projects should one of the proposed projects drop from the final package, a comprehensive list of project alternatives will also demonstrate that the final package contains projects that have the greatest conservation benefit for the most effective cost.

3. TU understands that the National Environmental Policy (NEPA) process must be undertaken by a lead federal agency. At this time no lead agency has been identified. TU recommends identification of a federal agency that will serve as the lead during NEPA processes and procedures.

4. TU understands that IWG flow objectives may focus on LNFH historic channel flow. TU wonders if flow objectives ought to be observed at the USGS gauge station above the Snow Creek confluence since this location has an established, long-running monitoring record that may be useful in historic, contemporary, and future analyses.

5. Multiple parties have indicated concerns about changes to the lakes in the Alpine Wilderness area. TU urges the Department of Ecology and Chelan County to take these concerns seriously and work closely with the Forest Service to determine what can and cannot be constructed or designed in that area.

6. Project implementation is an on-going process in Icicle Creek like most watersheds throughout North Central Washington. TU and numerous other entities are currently working on restoration projects within the Icicle Creek and Wenatchee River basins and will continue to manage these projects independent of the Icicle Strategy process.

7. Future materials should clearly articulate benefit/cost information for projects envisioned by the IWG. TU recommends that this process be undertaken independent of the IWG.

TU supports collaborative efforts to develop a holistic water resource management strategy for Icicle Creek and commends the work of member organizations, tribes, agencies, and individuals who have spent significant time to participate. The needs of fish, farms, and families must be balanced to ensure the region supports healthy ecosystems, maintains a robust economy, and shares the costs of the Icicle Strategy among the various users.

Sincerely,

Lisa Pelly

Lisa Pelly
Director, Trout Unlimited-Washington Water Project

Michael Wyant

Mike Wyant
President, Icicle Valley Chapter of Trout Unlimited

Stream flow, temperature, and snow water equivalent in Icicle Creek basin, Washington: historic conditions and potential future scenarios

Trout Unlimited-Washington Water Project[1] and Dick Rieman[2]

[1]Trout Unlimited-Washington Water Project, 103 Palouse Street, Wenatchee, WA, 98801
[2]Concerned citizen (please direct questions to Cody Gillin, Project Manager with Trout Unlimited-Washington Water)

Background

Trout Unlimited-Washington Water Project and Leavenworth resident Dick Rieman conducted an examination of Icicle Creek stream flow and climate conditions. Analyses focused on historical conditions but also included some effort to understand possible future scenarios. USGS stream gauge station #12458000 on Icicle Creek above the Snow Creek confluence provided baseline stream flow data. Public data repositories for SNOTEL site #791 at Stevens Pass, University of Washington Climate Impacts Group (CIG), and National Weather Service Cooperative Observer Program (COOP) provided historical and future temperature data. Snow water equivalent (SWE) data were provided by the University of Washington Climate Impacts group. Future stream flow projections were derived from National Stream Internet (NSI) attribute data joined to the National Hydrography Dataset (NHD) streamlines geospatial layer.

Methodology

USGS gauge station #12458000 was operational 1937-present with a 23-year period of decommission 1971-1993. This analysis utilized all available data for complete water years (1937-1970 and 1994-2015). Stream flow data (cubic feet per second or cfs and acre feet or ac-ft) were evaluated numerically and graphically by examining raw data, trends/patterns, and measures of central tendency. Evaluated time periods included annual, monthly, daily, and center time (date by which half the total annual water volume flowed past the gauge station). Annual data were considered based on the water year calendar October 1-September 30.

Monthly stream flow data were compared with monthly water demand placed on Icicle Creek by existing out of stream uses and minimum instream environmental flows outlined by the Icicle Working Group (IWG). Out of stream uses vary by month and include Icicle-Peshastin Irrigation District (IPID), Leavenworth National Fish Hatchery (LNFH), Cascade Orchards Irrigation Company (COIC), and City of Leavenworth (Leavenworth). Minimum environmental flow restoration objectives described in the IWG Guiding Principles are 60 cfs for drought years and 100 cfs for normal years. Note that this analysis used drought year environmental flow values of 60 cfs when calculating demand so all years are considered drought years. Demand for out of stream uses and environmental flows outlined in the IWG guiding principles are referred to as IWG water demands.

Median monthly temperatures for SNOTEL site #791 (Stevens Pass) were evaluated for the entire period of record (1984-2013).

COOP historical mean monthly temperature raster data were compared with CIG Western US Hydroclimate Scenarios Project projected 2040s mean monthly temperature data derived from the CMIP3 global model archive for the A1B emissions scenario. CIG and COOP data were resampled to a finer resolution to facilitate visualization at the scale of the Icicle Creek basin. Raster data were quantified and percent change in watershed area comprised by the raster classes was calculated.

Historical mean monthly SWE data were compared with future data. SWE data were resampled to the same cell size as temperature data to facilitate visualization. All geospatial data were analyzed using ESRI ArcMap 10.4. All graphs were developed using Microsoft Excel. Numerical calculations were conducted using both ESRI ArcMap 10.4 and Microsoft Excel.

Results and Observations

Historical Data: Stream Flow

Mean volume of water passing USGS gauge station #12458000 was approximately 450,000 ac-ft in 1937 and 442,000 ac-ft in 2015 (Fig. 1). Linear regressions suggested total mean monthly water volumes are increasing each month from November 1-March 31 and decreasing each month from April 1-October 31 (e.g., Figs. 2, 3, 4). Mean center time at USGS gauge station #12458000 was May 27 in 1937 and May 8 in 2015 (Fig. 5). Variability of center time (range of center time date) increased through the period of record. During the two gauge station periods of operation, the earliest center time date during the early period occurred on April 30, 1960. Nearly 25% of center time dates during the recent period of operation occurred earlier than April 30, including two dates in early March and one date in late February (Fig. 5).

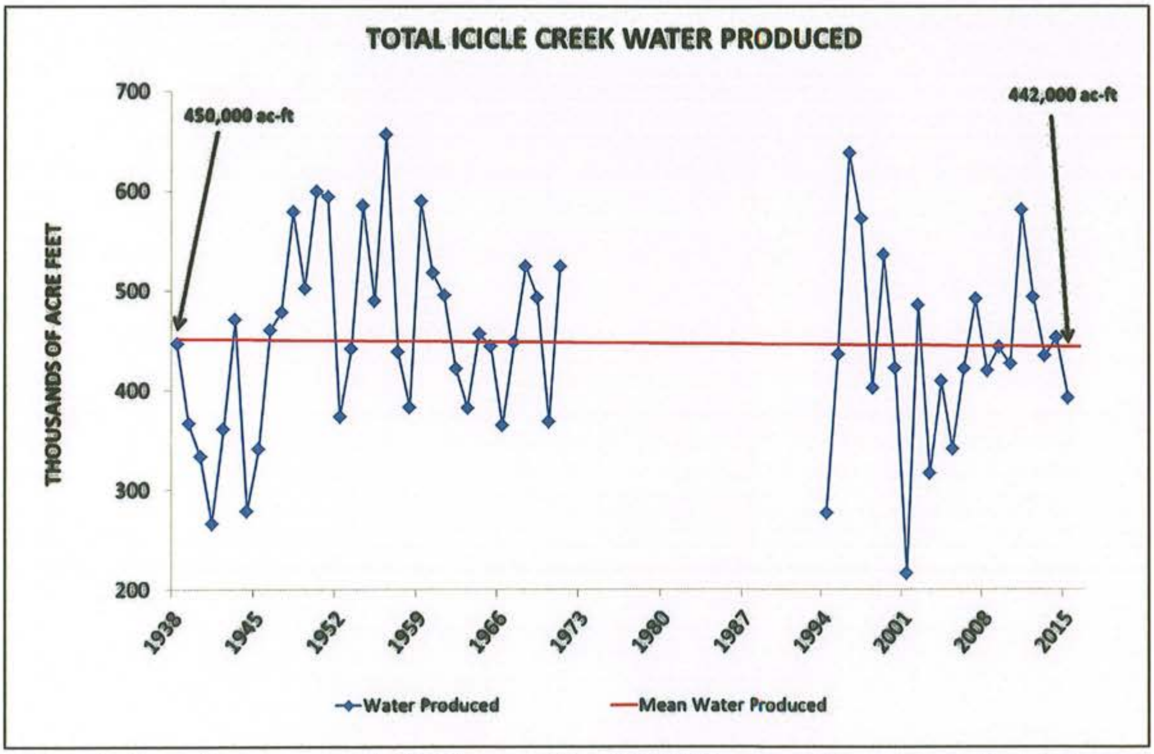

Figure 1. Total volume of water measured at USGS gauge station #12458000 was variable on an annual basis but on average remained relatively unchanged through the period of record.

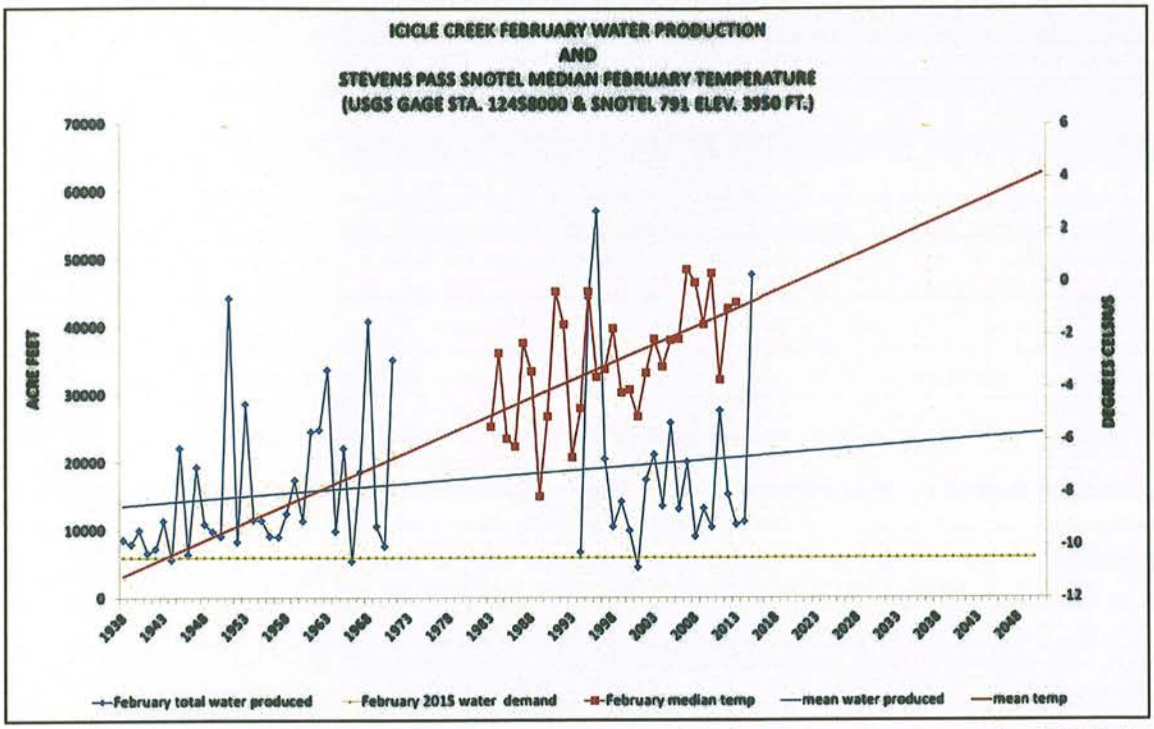

Figure 2. Total volume of water measured at USGS gauge #12458000 and median temperature measured at SNOTEL site #791 increased for the month of February. The same result (increased water production and temperature) was found for all months during the period November 1-March 31).

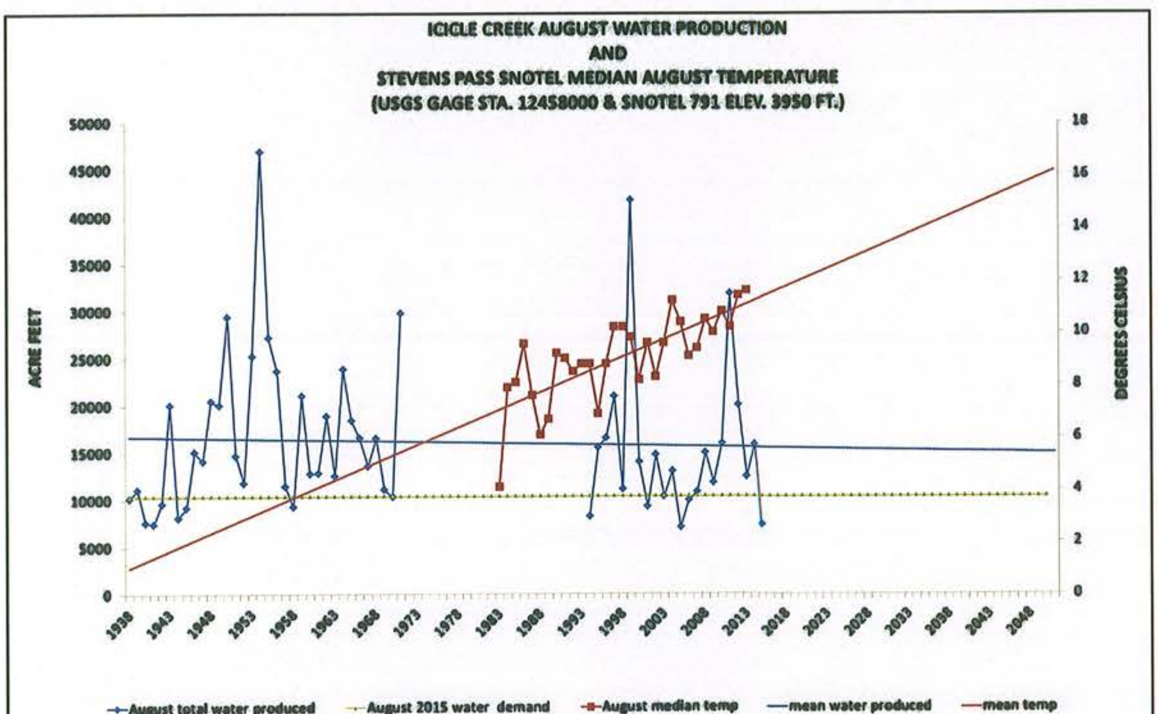

Figure 3. Total volume of water measured at USGS gauge #12458000 decreased and median temperature measured at SNOTEL site #791 increased for the month of August. The same result (decreasing water production and increasing temperature) was found for all months during the period April 1-October 31).

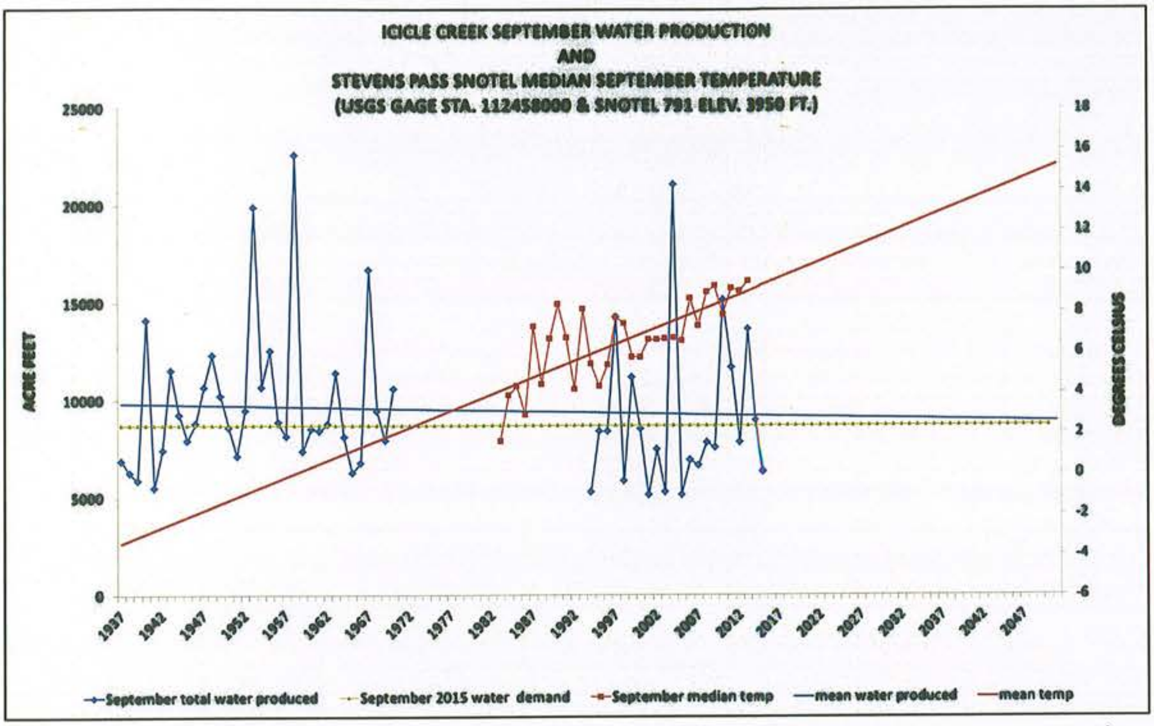

Figure 4. Total volume of water measured at USGS gauge #12458000 decreased and median temperature measured at SNOTEL site #791 increased for the month of September. The same result (decreasing water production and increasing temperature) was found for all months during the period April 1-October 31).

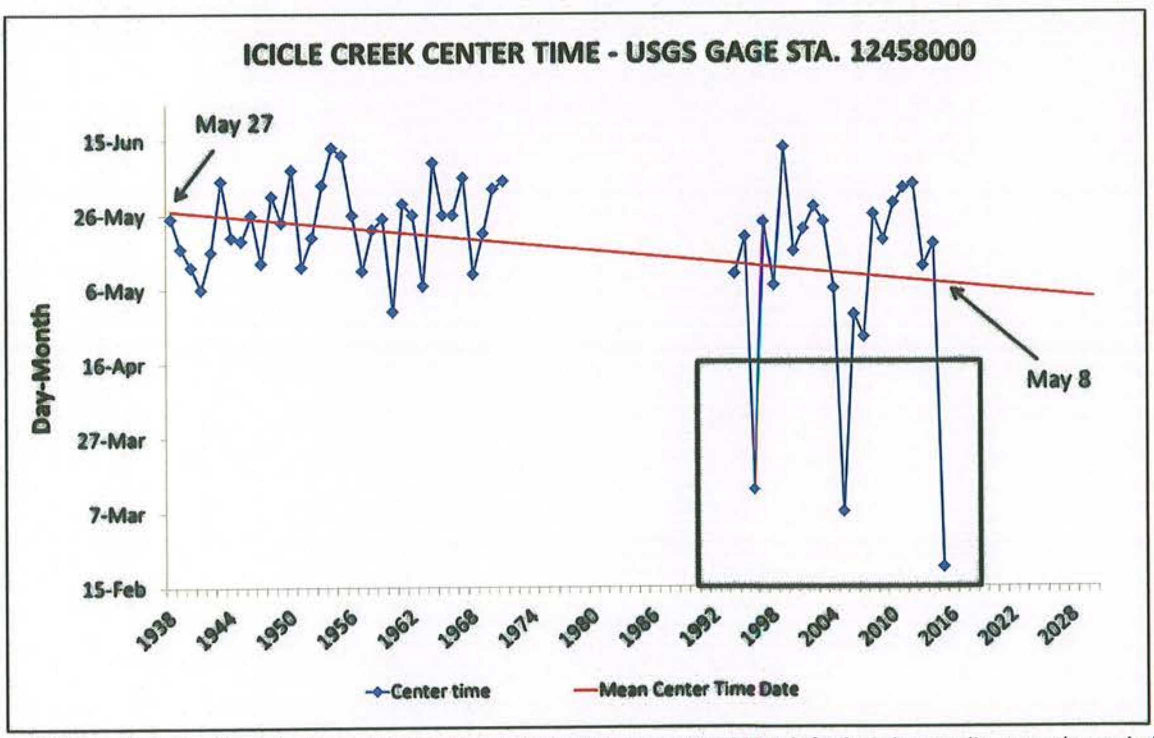

Figure 5. Mean Icicle Creek center time date measured at USGS gauge #12458000 shifted 19 days earlier over the period of record. Note three dates (boxed) occurred on March 13 or earlier 1996-2015.

Historical Data: Temperature

Linear regressions of median temperatures suggested increasing temperatures for all months at SNOTEL site #791 (e.g., Figs. 2, 3, 4). Temperature increases ranged from a minimum of 1.2°C in June to a maximum of 4.8°C in September (Table 1). Average median monthly temperature increase was 3.0°C. SNOTEL data may be biased and this analysis did not research a bias nor apply a bias correction.

Table 1. Median monthly temperatures measured at SNOTEL site #791 (Stevens Pass) increased during the period of record 1984-2013.

Stevens Pass SNOTEL Data: Linear Regression of Median Monthly Temperatures				
Month	**1984 (°C)**	**2013 (°C)**	**Change (°C)**	**Change (Percent)**
Oct	1.7	4.2	2.5	147.1
Nov	-3.0	0.4	3.4	113.3
Dec	-6.0	-2.1	3.9	65.0
Jan	-5.1	-1.2	3.9	76.5
Feb	-5.0	-1.1	3.9	78.0
Mar	-2.7	-0.6	2.1	77.8
Apr	-1.0	0.8	1.8	180.0
May	1.1	3.4	2.3	209.1
Jun	4.8	6.0	1.2	25.0
Jul	7.5	10.2	2.7	36.0
Aug	7.3	11.2	3.9	53.4
Sep	4.3	9.1	4.8	111.6
Mean	0.3	3.4	3.0	97.7

IWG Water Demands and Historical Stream Flow Conditions

Historical mean daily flows at USGS gauge station #12458000 were compared with Icicle Creek July-October IWG water demands for the recent period of gauge operation (1994-2015). Recorded mean daily flows would not have met total instantaneous IWG demands 32.7% of the time (884 of 2706 days) (Table 2). IWG water demand was greater than mean daily flows most often in August (34%) and September (63%). Total monthly water production during the same time period would not have met IWG demands for 27% of the August data (6 of 22 years) and 68% of September data (15 of 22 years) (Figs. 3, 4). Demand deficits ranged from 27-3316 ac-ft (0.5-54 cfs) for August and 165-3563 ac-ft (2.8-60.0 cfs) for September.

Table 2. Number of days when IWG demand would not have been met by mean daily flows in Icicle Creek measured at USGS gauge station #12458000 (deficit days are in red text).

HISTORICAL PERIOD 1994-2015				
Year/Month	**July**	**August**	**September**	**October**
1994	4	29	30	23
1995	0	1	30	0
1996	0	1	19	0
1997	0	0	0	0
1998	0	12	30	26
1999	0	0	2	0
2000	0	16	20	0
2001	6	29	30	10
2002	0	2	21	31
2003	1	16	30	12
2004	0	11	0	0
2005	15	31	29	2
2006	0	19	30	31
2007	0	15	29	0
2008	0	0	23	2
2009	0	9	22	14
2010	0	3	0	0
2011	0	0	0	0
2012	0	0	19	13
2013	0	9	4	0
2014	0	0	15	1
2015	24	30	30	23
Total Days	682	682	660	682
Days Below Demand	50	233	413	188
Pct. Days Below Demand	7%	34%	63%	28%

Future Projections: Snow Water Equivalent

Climatologists predict climate change impacts to the region will include air and water temperature increases, decreased April 1 SWE, and reduced summer base flow conditions (among other effects) (e.g., 2014 USDA Climate Change Vulnerability and Adaptation in the North Cascades Region, Washington). This analysis resampled regional geospatial data to a finer resolution to facilitate visualization at the Icicle Creek watershed scale. Temperature and SWE investigations focused on March-April data as these factors during March-April play a key role in determining runoff timing and water supply availability throughout the arid summer months. CIG data indicate April 1 SWE will decline, with an increase in the portion of the watershed containing snowpack below 800 mm SWE and a much smaller portion of the watershed containing snowpack above 800 mm SWE (Fig. 6). The largest decrease is in Icicle Creek watershed area with more than 1000 mm April SWE, which historically represented 20.86% of the basin but is projected to decline to 2.30% (Table 3).

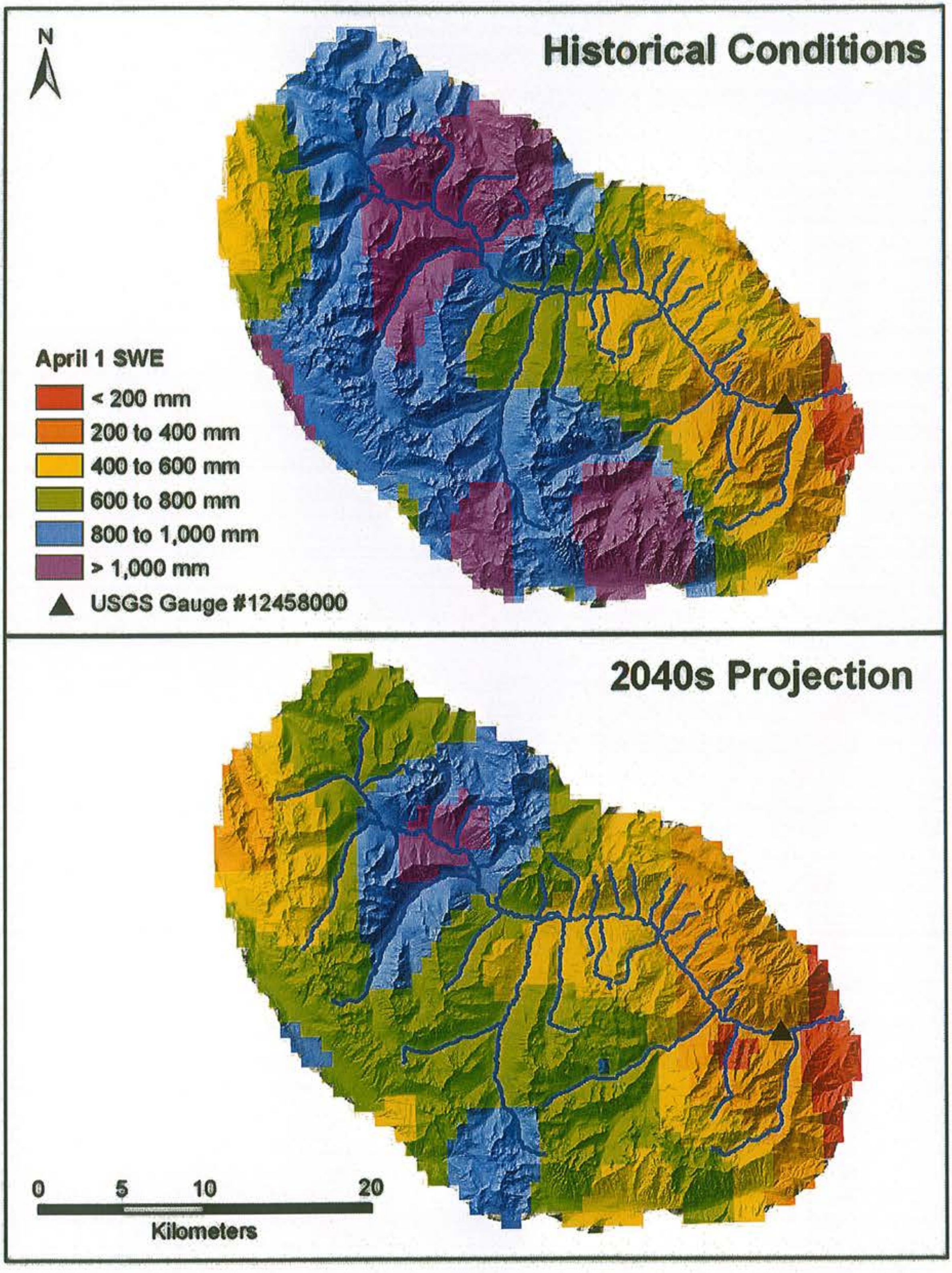

Figure 6. April 1 snow water equivalent (SWE) in the Icicle Creek watershed is projected to decline, with the greatest reductions occurring in the portion of the basin historically comprising snowpack greater than 1000 mm SWE.

Table 3. April 1 snow water equivalent (SWE) less than 800 mm is projected to increase and 800 mm or greater is projected to decrease.

	Historical Conditions		*2040s Projection*		
April 1 SWE (mm)	**Acres**	**Percent of Catchment Area**	**Acres**	**Percent of Catchment Area**	**Percent Change**
< 200	3,665.14	1.73%	7,502.19	3.54%	51.15%
200 to 400	21,045.92	9.91%	35,570.34	16.77%	40.83%
400 to 600	33,227.34	15.65%	45,038.80	21.23%	26.23%
600 to 800	30,935.01	14.57%	87,097.85	41.06%	64.48%
800 to 1000	79,197.45	37.29%	32,025.30	15.10%	-147.30%
> 1000	44,301.18	20.86%	4,872.91	2.30%	-809.13%

Future Projections: Temperature

According to the 2014 United States Department of Agriculture report *Climate Change Vulnerability and Adaptation in the North Cascades Region, Washington* a current warming trend in the Pacific Northwest is expected to continue with mean warming of 2.1°C by the 2040s. This analysis compared COOP historical temperature observations with CIG Western US Hydroclimate Scenarios Project forecasted 2040s mean monthly temperature data. A focus was placed on late winter and spring months (February-May) as this period is critical to dry season water supplies (possible snow accumulations or snow melt, depending on weather/climate). In general, temperatures are predicted to increase for all months analyzed across the Icicle Creek basin. March was used to exemplify the trend as it is a transitional month that can be more like winter or spring depending on variability of inter-annual conditions. Temperatures increased for all locations in the basin. The greatest change was for temperatures below -2°C, which historically comprised 23.16% of the Icicle Creek basin but are projected to comprise just 0.78% of the basin by the 2040s (Table 4, Fig. 7).

Table 4. Temperatures in the Icicle Creek basin are projected to continue a current increasing trend with the largest change for temperatures historically less than -2°C.

	Historical Conditions		*2040s Projection*		
Mean Temperature (°C)	**Acres**	**Percent of Catchment Area**	**Acres**	**Percent of Catchment Area**	**Percent Change**
< -2	49,137.77	23.16%	1,600.68	0.78%	-2,969.82%
-2 to -1	92,833.73	43.76%	47,736.31	23.28%	-94.47%
-1 to 0	53,023.91	25.00%	96,212.80	46.92%	44.89%
0 to 1	10,018.38	4.72%	49,706.30	24.24%	79.84%
1 to 2	4,597.81	2.17%	9,780.28	4.77%	52.99%
> 2	2,517.81	1.19%	7,093.44	3.46%	64.51%

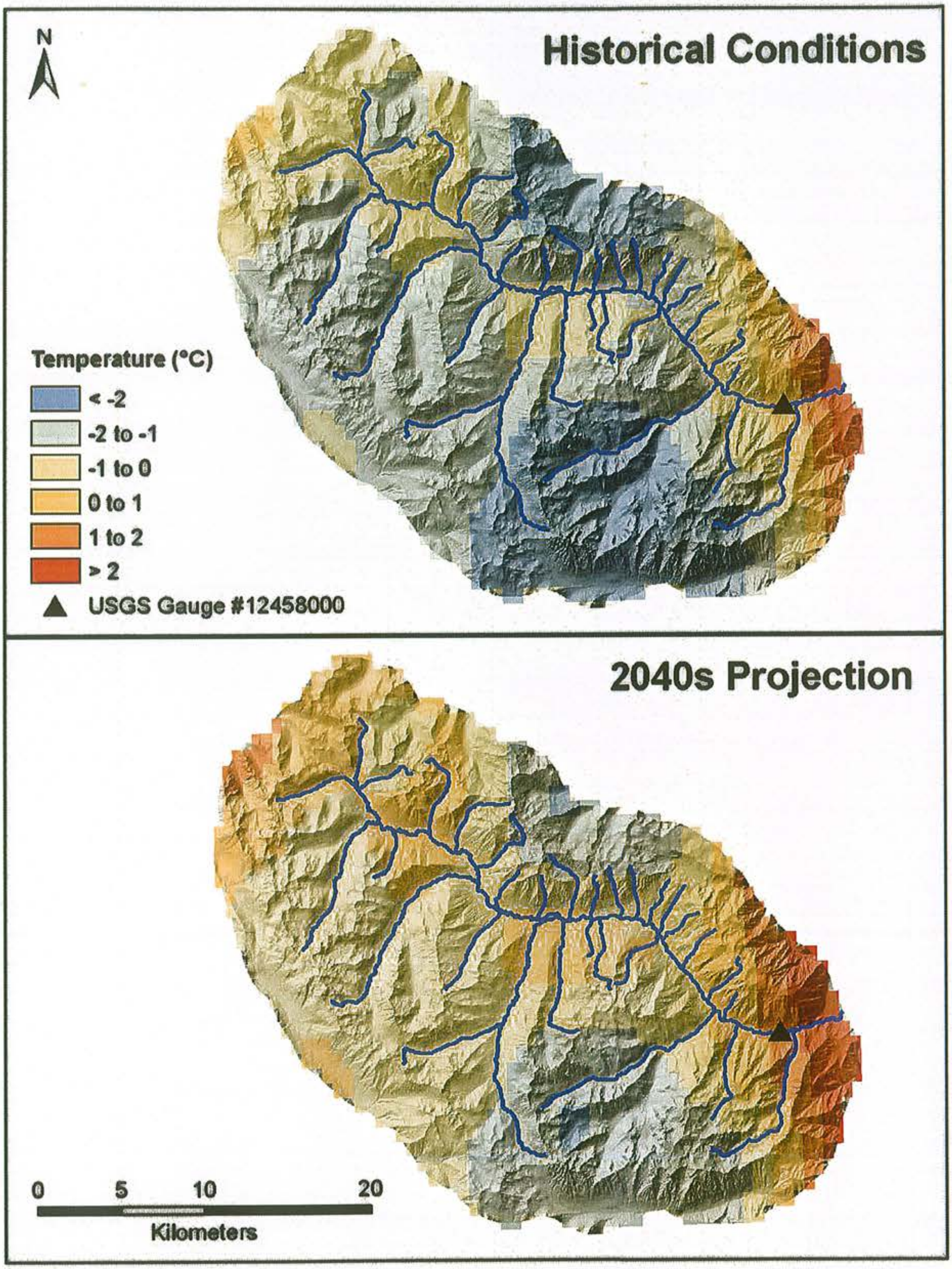

Figure 7. Mean March temperatures in the Icicle Creek basin are projected to increase, with large declines in watershed area historically comprised of mean March temperatures below -1°C.

IWG Water Demands and Future Summer Stream Flow Conditions

In general, climatologists predict reduced summer stream flows as a result of climate change in the region. A review of literature and climate models revealed variable percent of flow reduction from historical conditions. For example, National Stream Internet data indicated a mean summer (June-September) reduction of 39.33% and mean August reduction of 63% in Icicle Creek at the confluence with Snow Creek by the 2040s. The 2014 National Climate Assessment Northwest Regional Report by the United States Global Climate Research Program suggested 40-50% reduction of flows in the Wenatchee River near Icicle Creek. Since no future stream flow data specifically developed for the Icicle Creek basin were available, this analysis considered a 35% reduction in July-October Icicle Creek flows for the historical period 1994-2015 measured at USGS gauge station #12458000. The period July-October was considered because aforementioned evaluations determined historical flows would not have met IWG demands most often during these months. IWG demand was greater than mean daily flows applied with a 35% reduction most often in August (71%) and September (89%) when IWG water demand would not be met for a majority of days (Table 5). Historical Icicle Creek flows applied with a 35% reduction to simulate potential climate change impacts would not have met IWG demand for the entire month of September in 15 of 22 years.

Table 5. Historical Icicle Creek flows measured at USGS gauge station #12458000, when applied with a 35% reduction to simulate potential climate change impacts, would not meet IWG demand for a majority of the typical low-flow period July-October.

35% FLOW REDUCTION				
Year/Month	July	August	September	October
1994	13	31	30	25
1995	1	15	30	0
1996	0	16	30	19
1997	0	11	20	0
1998	7	31	30	31
1999	0	0	23	18
2000	0	25	30	10
2001	17	31	30	16
2002	0	20	30	31
2003	13	31	30	16
2004	10	25	4	0
2005	30	31	30	26
2006	4	31	30	31
2007	6	31	30	11
2008	0	19	30	17
2009	0	27	30	20
2010	0	18	13	4
2011	0	0	27	0
2012	0	10	30	14
2013	6	31	23	0
2014	0	19	28	15
2015	31	31	30	29
Total Days	682	682	660	682
Days Below Demand	138	484	588	333
Pct. Days Below Demand	20%	71%	89%	50%

Interpretation and Conclusions

The purpose of this study was to examine stream flow, temperature, and SWE in the Icicle Creek basin. Investigations yielded a trend of increasing stream flow during the period November 1-March 31 and decreased stream flow during the period April 1-October 31 in Icicle Creek measured at USGS gauge station #12458000. Center time date became earlier through the gauge station period of record. Median monthly temperatures at SNOTEL site #791 at Stevens Pass increased for all months. Icicle Creek basin SWE declined and temperature increased when historic conditions were compared with projected future conditions.

Current IWG materials indicate an instream flow demand of 60/100 cfs and conservation benefit of 47/77 cfs in drought/normal years. This analysis utilized only drought year instream flow demand of 60 cfs. IWG water demand was compared with historical flows measured at the gauge station. Mean daily and mean monthly demand deficits occurred during the period of record, including several instances of deficits greater than the 47 cfs drought year conservation benefit. If the analysis had considered a 100 cfs normal year demand the frequency and quantity of the demand deficit would increase.

A 35% reduction of historical stream gauge mean daily flow data for July-October during the recent period of gauge operation was used to simulate potential future conditions. IWG demand was frequently not met under this scenario, particularly in August, September, and October. Deficits greater than the 47 cfs drought year conservation benefit occurred in each month, with some months exceeding a 47 cfs deficit every day (e.g., September 1998, August 2001, September 2003). Furthermore, there are many October months with large deficits that could not be closed by proposed projects since much of the normal year conservation benefit is associated with irrigation/reservoir management effective only during the irrigation season (ending in September). Note that although this scenario is hypothetical, the authors selected a value for the percent reduction in stream flows based on a review of pertinent literature.

This analysis utilized Icicle Creek stream flow data to evaluate how IWG water demand compared with historical and potential future Icicle Creek flow conditions. Furthermore, the analysis investigated historic temperatures measured near the headwaters of the Icicle Creek basin and also compared historic temperature and SWE data with projected future temperature and SWE conditions across the entire Icicle Creek basin to gain a fundamental understanding of recent and potential future climate conditions. All data utilized were publicly available and the authors encourage interested parties to contact them with questions or data requests.

The study examined data trends and applied straightforward methods such as sums, measures of central tendency, simple linear regressions, and percent changes. No test of statistical significance was applied. Resampling of geospatial data was meant to facilitate visualization and may not be the most appropriate method for analysis. The authors do not claim to be climate experts. Rather, results of this analysis highlighted the need for an expert evaluation of future water supply, instream flow, and climate conditions in the Icicle Creek basin. Such an evaluation has been utilized in other resource planning endeavors and can be a valuable tool when planning projects and making decisions that impact ecosystem health and human communities.

Jordan Sanford

From: Meghan O'Brien
Sent: Tuesday, May 10, 2016 11:38 AM
To: Jordan Sanford
Subject: FW: Icicle Manipulation Comments

Meghan O’Brien | Aspect Consulting LLC | Project Specialist | Direct: 509.895.5261 | Cell: 509.607.0059

-----Original Message-----
From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Tuesday, May 10, 2016 11:38 AM
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: Icicle Manipulation Comments

Meghan and Dan - just for reference, Rob lives off-grid on Eightmile Creek at the Icicle confluence.

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

-----Original Message-----
From: Mike Kaputa
Sent: Tuesday, May 10, 2016 11:26 AM
To: Mary Jo Sanborn
Subject: FW: Icicle Manipulation Comments

-----Original Message-----
From: Mike Kaputa
Sent: Tuesday, May 10, 2016 11:26 AM
To: 'Rob' <rob@boudreauxcellars.com>
Cc: Tim Gartland <timgartland@centurytel.net>; Scot Brower <scotbrower@comcast.net>; harriett@sleepinglady.com
Subject: RE: Icicle Manipulation Comments

Thanks, Rob, good to hear from you. We'll make sure your comments are entered into the record. Interesting observation about the sediment loading and something we will look into.

Mike

-----Original Message-----
From: Rob [mailto:rob@boudreauxcellars.com]
Sent: Monday, May 09, 2016 9:59 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Cc: Tim Gartland <timgartland@centurytel.net>; Scot Brower <scotbrower@comcast.net>; harriett@sleepinglady.com
Subject: Icicle Manipulation Comments

Dear Mike,
Hope all is well. I am glad for the water use study in the Icicle. Two things concern me.
1. Eightmile Creek/ Mountaineer Creek runs right by my back door. Every time extra water is released from Colchuck Lake there is a tremendous sediment load suddenly flowing by. This is a completely unnatural condition for fish and people in late summer.
2. The continued use of helicopter support and further construction of dams in the Alpine Lakes Wilderness Area is blatantly at odds with the spirit of The Wilderness Act. I do not see how we can continue to call this wilderness if we make exceptions for our own over-population and profit.
If you need me I'm here. :)
Best regards,
Rob Newsom
Eightmile Creek
Leavenworth, WA 98826
Cell 509-670-3166

Sent from my iPad

Jordan Sanford

From: Meghan O'Brien
Sent: Tuesday, May 10, 2016 2:55 PM
To: Jordan Sanford
Subject: FW: Alpine Lakes Wilderness Scoping and EIS

Meghan O'Brien | Aspect Consulting LLC | Project Specialist | Direct: 509.895.5261 | Cell: 509.607.0059

From: Mary Jo Sanborn [mailto:MaryJo.Sanborn@CO.CHELAN.WA.US]
Sent: Tuesday, May 10, 2016 2:50 PM
To: Meghan O'Brien <mobrien@aspectconsulting.com>
Cc: Dan Haller <dhaller@aspectconsulting.com>
Subject: FW: Alpine Lakes Wilderness Scoping and EIS

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Tuesday, May 10, 2016 1:55 PM
To: Ruth Dight
Cc: Mary Jo Sanborn
Subject: RE: Alpine Lakes Wilderness Scoping and EIS

Thank you, Ruth, we'll make sure your comments are entered into the record….Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Ruth Dight [mailto:tooruth@earthlink.net]
Sent: Tuesday, May 10, 2016 1:47 PM

To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Alpine Lakes Wilderness Scoping and EIS

Dear Mr. Kaputa:

I attended your presentation in Seattle and find I agree with all of the recommendations outlined on the NAIADS website listed below.

- The EIS must consider a **Wilderness Protection Alternative**. This alternative would promote wilderness values as set forth in the Wilderness Act of 1964, would not allow new water infrastructure or diversions inside the Alpine Lakes Wilderness, and would require all new water supply to be obtained outside the Alpine Lakes Wilderness.
- The EIS must consider a **Water Conservation Alternative**. This alternative would assess using aggressive water conservation measures by Wenatchee Valley cities, including restrictions on lawn watering (as the citizens of Seattle have learned to do). This alternative should also assess transfer of water rights from irrigation districts to cities, where orchards have already been torn out and replaced with residential subdivisions. This alternative should also assess agricultural irrigation efficiency, such as replacing open gravity canals with pipes and pumps and other 21st century concepts.
- The EIS must consider an **Irrigation District Water Right Change Alternative**, which would fix Icicle Creek's low flow problem. This alternative would evaluate moving the Icicle-Peshastin Irrigation District's water right diversion, which presently takes 100 cubic feet per second out of Icicle Creek, to the Wenatchee River downstream about 3 miles. This measure, which would permanently fix Icicle Creek's low flow problem, would convert the IPID diversion from gravity flow to pumping (requiring electrical power). The Icicle Work Group should therefore analyze renewable energy options to supply that power, including solar, wind and in-canal hydroelectric.
- The EIS must consider a **Water Right Relinquishment Alternative**. Removal of water from the Alpine Lakes Wilderness is on the table only because IPID holds water rights that were grandfathered when the Wilderness was created. And – as IPID will tell anyone who will listen – every year they use what they need. When the dam at Eightmile Lake fell down decades ago they didn't fix it because they did not need more water. When a party doesn't use their rights, they lose them. "Use It Or Lose It" – the basic rule of western water law – is controlling. The EIS needs to analyze this.

I feel especially concerned that Chelan County consider the water conservation alternative.

Thank you,

Ruth Dight, AICP
(206) 283 9254
2549 11th Ave W
Seattle, WA 98119

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Tuesday, May 10, 2016 4:32 PM
To: Jordan Sanford; Meghan O'Brien
Cc: Dan Haller
Subject: FW: Objection to EIS - Alpine Lakes Wilderness

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Tuesday, May 10, 2016 4:12 PM
To: W. T. Soeldner
Cc: Mary Jo Sanborn
Subject: RE: Objection to EIS - Alpine Lakes Wilderness

Thank you, we'll make sure your comments are entered into the record....Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: W. T. Soeldner [mailto:waltsoe@allmail.net]
Sent: Sunday, May 08, 2016 7:50 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Objection to EIS - Alpine Lakes Wilderness

Mike Kaputa, Director
Chelan County Natural Resources Department

Dear Mr. Kaputa:

I am writing regarding what I believe to be **serious flaws in the scope of the Alpine Lakes Optimization and Automation Study**. I have hiked the Alpine Lakes Wilderness three times, spending a total of ten days there. I find the proposal to steal water from wilderness when alternative water management options have not been explored is a travesty, and quite likely will be proven to be illegal.

To begin with the Icicle Work Group (IWG), which has made this study has no members who are advocating to protect the Alpine Lakes Wilderness. (I am aware that the Center for Environmental Law and Policy withdrew from the group when the operating procedures were changed to gag CELP's objection to wilderness water projects.) It appears that the IWG is a self appointed conglomerate of groups interested in getting the contracts to do the work the IWG proposes. This is ethically indefensible.

The IWG has not considered a number of alternatives that would protect the Alpine Lakes Wilderness, one of the Northwest's most popular and iconic wilderness areas.

The the EIS proposed by the IWG must consider a **Wilderness Protection Alternative** that would promote the wilderness values set forth in the Wilderness Act of 1964. This would not allow new water infrastructure or diversions inside the Alpine Lakes Wilderness, requiring all new water supply to be obtained outside this wilderness.

The EIS must consider a **Water Conservation Alternative**. This would do an assessment of using aggressive water conservation measures by Wenatchee Valley cities, including restrictions on lawn watering. This should also assess transfer of waster rights from irrigation districts to cities in those places where orchards have already been replaced with residential subdivisions. And it should assess agricultural irrigation efficiency.

The EIS must also consider an **Irrigation District Water Right Change Alternative**, which would fix Icicle Creek's low flow problem. This would involve evaluating a move of the Icicle-Pehastin Irrigation District's (IPID)water right diversion to the Wenatchee River Downstream, permanently fixing Icicle Creek's low flow problem, and converting the IPID's diversion from gravity flow to pumping. Renewable energy options should be able to supply such power.

Finally the EIS should consider a **Water Right Relinquishment Alternative**. When a party doesn't use their rights, they lose them. The IPID says it only uses what it needs, and they have not used all their rights since the dam at Eightmile Lake collapsed decades ago.

For the sake of all that is good about our nation's public lands and especially its wilderness, this plan must be reconsidered with alternatives in mind.

Sincerely,
W. Thomas Soeldner
Valleyford, Washington

Naturam Expellas Furca *Tamen Usque Recurret*

WISE USE MOVEMENT

P.O. Box 17804, Seattle, WA 98127

May 10, 2016

Chelan County Natural Resources Department
Attention: Mike Kaputa, Director
411 Washington Street, Suite 201
Wenatchee, WA 98801
Email: <Mike.Kaputa@CO.CHELAN.WA.US>

RE: SEPA Scoping Comments on the Icicle Creek Water Resource Management Strategy

GENERAL COMMENTS

The Wise Use Movement agrees that the Icicle Creek Water Resource Management Strategy (ICWRMS) would have a significant adverse impact on the environment such that an environmental impact statement must be prepared. However, it would save taxpayers and concerned citizens significant resources if the ICWRMS were withdrawn. The Wise Use Movement <u>strongly opposes</u> the ICWRMS for the following reasons:

- The Department of Ecology used a process taken from the fatally flawed Yakima Work Group to select a small number of participants to prepare the ICWRMS while discouraging public participation. The Yakima Plan is <u>not</u> a national model and neither is the ICWRMS.
- The Icicle Workgroup, like the Yakima Work Group, included the agency conveners as workgroup members. This is unacceptable and introduces an unwarranted level of agency control over what should be an advisory committee.
- The Icicle Workgroup is providing policy direction in an advisory capacity to a number of Federal Agencies, including the Bureau of Reclamation, the US Forest Service, the US Fish and Wildlife Service, and NOAA-Fisheries. Both the Icicle Workgroup and the Yakima Work Group have failed to comply with the Federal Advisory Committee Act.

- The Department of Ecology is asking for scoping on an ICWRMS programmatic EIS under the State Environmental Policy Act (SEPA), Chapter 43.21C Revised Code of Washington (RCW). This allows Ecology to avoid responding to comments on project specific impacts from the ICWRMS, as it did with the Programmatic EIS for the Yakima Plan.

- The ICWRMS has specific adverse environmental impacts to resources located in the Alpine Lakes Wilderness Area, within the Okanogan-Wenatchee National Forest, yet no NEPA environmental impact statement is proposed at this time.
- We also strongly object to the Department of Ecology and Chelan County's continued efforts to hide from the public the impacts that the ICWRMS would have on the Alpine Lakes Wilderness Area. Chelan County gave several PowerPoint presentations of the ICWRMS without showing the Alpine Lakes Wilderness Area on its maps. In addition, the Determination of Significance issued by G. Thomas Tebb (Director, Office of Columbia River) and Mike Kaputa (Director, Chelan County Natural Resource) fails to even mention the Alpine Lakes Wilderness Area. The Chelan County SEPA Environmental Checklist list of environmental information (page 4) fails to list even a single National Forest Service document concerning the Alpine Lakes Wilderness, and the Alpine Lakes Wilderness Area is mentioned only three times in the Applicant's entire Environmental Checklist (pages 7, 13, and 22).

  The Department of Ecology's Office of Columbia River relies on state legislation passed in 2006 to "to aggressively seek out new water supplies for both instream and out-of-stream uses." When the Office of Columbia River assaults our Nation's wilderness areas that belong to all this country's citizens, they have crossed the line. After 10 years of failing to find new water supplies at a cost of $200 million dollars it is time for the Washington Legislature to terminate the Office of Columbia River.

- It appears that the ICWRMS has been rushed out on some sort of artificial timetable. The Environmental Checklist states that the Icicle Strategy is made up of nine Guiding Principles (page 5), but only seven bullets are shown. This is a sloppy presentation. Until Chelan County can provide clear and concise information to the public about the Guiding Principles that form the basis of the ICWRMS, the scoping notice must be withdrawn until Chelan County can get its head out of the beer.

<u>Comments on the Guiding Principles (Environmental Checklist pages 5 and 6)</u>

The Wise Use Movement objects to a small cabal, including members with a direct financial interest, agreeing to an ICWRMS prior to the preparation of environmental review. The Chelan County Natural Resources Department has stated that ALL nine guiding principles must be met. This is completely prejudicial to the SEPA planning process that depends on the presentation and review of alternatives. There is no legal precedent that requires that ALL nine guiding principles be met.

Regarding "Improve Instream Flows in Icicle Creek Historic Channel"-

- The DPEIS must identify and locate the "historic" Icicle Creek channel; identify the historic yearly Icicle Creek streamflows; identify the current yearly Icicle Creek streamflows; identify the source for the proposed 60 cfs minimum flows (drought years); explain why "minimum instream flows" must be reduced during a drought year; identify an alternative that would provide 250 cfs minimum flows during all years; identify an alternative that would provide "optimum instream flows" during all years; identify the yearly maximum Icicle Creek streamflows; identify the environmental impacts from Icicle Creek streamflows from less than 60 cfs and more than 2,600 cfs.

Regarding “Improve sustainability of Leavenworth National Fish Hatchery (LNFH)”-

- The DPEIS must identify and address the following: the location and history of the LNFH; the production output of the LNFH since its construction compared to the historic runs of wild salmon; the amount of water withdrawn from the Icicle Creek or groundwater for the LNFH; impacts to fish production from cutting water withdrawals to the LNFH by half; clarify whether fish passage at Grand Coulee would remove the “obligation” for continued use of the LNFH; include fishery disease and predation morality since the construction of the LNFH; clarify the status of the LNFH NPDES permit.

Regarding “Protect Tribal and Non-Tribal harvest”-

- The DPEIS must identify and address the following: tribal and non-tribal harvest of wild fish spawning in the Icicle Creek and Wentachee River basins since the construction of the LNFH; tribal and non-tribal harvest of LNFH hatchery fish since the construction of the LNFH.

Regarding “Improve Domestic Supply”-

- The DPEIS must explain and address the following: the City of Leavenworth’s 1995 water right change application to Ecology in 1995, and subsequent lawsuit against Ecology to increase their annual water right withdrawal; identify the City of Leavenworth’s current water usage and any City water conservation plan; an explanation of why the City is demanding more water withdrawals and why demand for more water cannot be met by conservation; an estimate of the likely number of new residences through 2050, with and without additional water withdrawals; an estimate of the lawn acreage within the City; and an estimate of the number of groundwater wells and annual withdraw volumes.

Regarding “Agricultural reliability” -

- The DPEIS must explain and address the following: include an alternative that does not rely on any modifications to current withdrawals from lakes within the Alpine Lakes Wilderness area; include an alternative that does not rely on any withdrawals from lakes within the Alpine Lakes Wilderness area; provide detailed crop selection and acreage for each irrigation district with water withdrawal rights in the Alpine Lakes Wilderness Area; clarify whether these water rights withdrawals are specific to the lakes within the Alpine Lakes Wilderness Area or are withdrawals from Icicle Creek: and provide an explanation of why current interruptible agricultural users must be converted to senior water right holders.

Regarding “Enhance Icicle Creek Habitat” -

- The DPEIS must explain and address the following: identify fish passage impediments and projects that would improve fish passage, and explain why such measures have not been previously undertaken; and identify all proposed land acquisition/easements.

Regarding “Comply with State and Federal Law, and Wilderness Acts” -

- The DPEIS must explain and address the following: list how many different Wilderness Acts are under consideration; identify the regulators; review any water rights maintained under the 1976 Alpine Lakes Wilderness Act; disclose all agreements signed by the US Forest Service concerning land exchanges within the Alpine Lakes Wilderness Act; and explain why LNFH, IPID, and COIC withdrawals are not currently appropriately screened.

Specific Comments on Base Package

IPID Irrigation Efficiencies. The DPEIS must evaluate a range of irrigation efficiencies for the IPID, including alternative crop selection, crop insurance, land fallowing, aquifer storage, water delivery costs, and re-reg reservoirs. The DPEIS must include the historic as well as 2015 drought acre-foot usage by the IPID.

COIC Irrigation Efficiencies. The DPEIS must evaluate a range of irrigation efficiencies for the COIC, including alternative crop selection, crop insurance, land fallowing, aquifer storage, water delivery costs, and re-reg reservoirs.

Domestic Conservation Efficiencies. The DPEIS must evaluate a range of domestic conservation efficiencies, including water delivery costs, elimination of leaky water pipes, restrictions on lawn watering; and use of low-flow toilets, clothes washers, and shower heads.

LHFH Conservation and Water Quality Improvements. The DPEIS must evaluate water use savings from a smaller size hatchery. The hydrologic continuity between wellfield and instream withdrawals must be analyzed.

Alpine Lakes optimization, Modernization, and Automation. The DPEIS must evaluate dropping these projects. In addition, the DPEIS must include an alternative of restoring the seven lakes within the Alpine Lakes Wilderness Area to their natural (pre-irrigation use) conditions.

Eightmile Lake Restoration Project. The DPEIS must evaluate dropping this project. In addition, the DPEIS must include an alternative of restoring Eightmile Lake to its natural (pre-irrigation) condition.

Water Markets. The DPEIS must prioritize a water market that makes maintaining optimum instream flows in Icicle Creek as the highest priority.

Habitat Improvements and Land Acquisition. The DPEIS must identify all locations proposed for “engineered logjams.” In addition, the DPEIS must identify all existing impediments blocking fish passage and explain why such blockages or impediments still exist in 2016.

Rehabilitate LNFH Intake, Operational improvements at Structure 2, Icicle Creek Passage, and Tribal Fisheries Improvements. The DPEIS must evaluate a range of alternatives for rehabilitation of the LNFH, including a smaller size hatchery.

Screening Improvements. The DPEIS must identify all faulty diversion screens and explain why such faulty diversion screens still exist in 2016.

Instream Flow Rule Amendment. The DPEIS must explain how the Wenatchee Instream Flow Rule (WC 173-545) meets the purposes of this chapter to retain perennial rivers, streams, and lakes in the Wenatchee River basin with instream flows and levels necessary to protect water quality, wildlife, fish, and other environmental values when instream flows are defined as "minimum flows." The DPEIS must include optimum instream flows that would protect water quality, wildlife, fish and other environmental values more consistent with historic flows.

Specific Comments on the Environmental Checklist

Chelan County's Environmental Checklist is inadequate and has failed to provide the most basic information about the proposal and have failed to answer questions either accurately or carefully, as required by RCW 197-11-960. The following are specific comments on errors and omissions in Chelan County's Environmental Checklist:

A.2. Name of Applicant. The name of the applicant is "Chelan County Department of Natural Resources." However, the proposal purports to benefit irrigation districts, the City of Leavenworth, as well as the Leavenworth National Fish Hatchery. Why are these not listed as co-applicants?

A. 7. The Environmental Checklist states that each individual project proposed under the ICWRMS would have its own environmental review process. The PEIS must clarify that "environmental review" may also lead to Findings of No Significant Impact (FONSI) and that additional environmental impact statements on individual projects may not be prepared.

A.8. We request that environmental information from the US Forest Service regarding the Alpine Lakes Wilderness Area be reviewed and listed. We also request that the following report be added:

U.S. Fish and Wildlife Service (USFWS). 2004. Comprehensive Hatchery Management Plan for the Leavenworth National Fish Hatchery. Planning Report Number ?, U.S. Fish and Wildlife Service, Leavenworth National Fish Hatchery, Leavenworth, Washington. http://www.fws.gov/pacific/fisheries/hatcheryreview/reports/leavenworth/le--002leavenworthhgmp_000.pdf

A. 11. The Environmental Checklist states that the ICWRMS proposes to enhance instream flows, water supplies, and aquatic habitat project that fulfill nine Guiding Principles established by the Icicle Work Group, but, as noted above, only seven bulleted items are listed on page 5 and 6. This only creates confusion as to what the proponents actually intend. In addition, RCW 43.21C.030(b)(iii) requires a detailed statement on alternatives to the proposed action. WAC 197-11-784 defines "Proposal" as including "a particular or preferred course of action or several alternatives." While an applicant may submit an application for a preferred course of action, when it comes to planning, it is not appropriate for government agencies to huddle with a small number of stakeholders, cut deals, and establish a single plan of action. By doing so, government agencies commit themselves, prior to any environmental review, to their selected plan. Any programmatic EIS must, therefore, disclose a range of alternatives, and not a preferred alternative established by the Icicle Work Group.

In addition, the response to Section A. 11 gives figures in both acre-feet and cfs. For consistency purposes, the DPEIS must provide both acre-feet and cfs figures to aid the reviewer in understanding the quantities of water involved.

B.1. Earth - Earthquakes. The DPEIS must identify all known or suspected earthquakes faults in the area.

B.a. 2). Surface Water. The DPEIS must identify all proposed habitat improvement projects, passage barrier removal, and improved diversion screening.

B.3.a. 4). Surface Water. The DPEIS must identify all new proposed surface diversions and alternative locations. The DPEIS must analyze the adverse environmental impacts from new home construction on instream flows.

B.3.b.1). Ground Water. The DPEIS must analyze the amount of projected new rural domestic wells in response to any increase in domestic reserves under the Wenatchee Instream Flow Rule. The DPEIS must provide domestic water conservation measures alternatives in lieu of increasing domestic reserves. The DPEIS must analyze the adverse environmental impacts from new home construction on ground water. The DPEIS must analyze the hydrologic continuity between instream flows and groundwater from any LNFH groundwater augmentation wells.

B.4.b. Plants. The DPEIS must analyze the adverse environmental impacts on vegetation from new home construction.

B.4.c. Plants. The DPEIS must review all US Forest Service information concerning ESA listed plant species within the Alpine Lakes Wilderness Area.

B..5.a and b. Animals. The DPEIS must review all US Forest Service information concerning ESA listed animal species within the Alpine Lakes Wilderness Area.

B.5. d. Animals. The Environmental Checklist claims that the Alpine Lakes Optimization will preserve and enhance wildlife. This is incorrect. Additional development in the Alpine Lakes Wilderness Area would have an unacceptable adverse impacts to fish and wildlife. The DPEIS must not let the Applicant claim that additional Alpine Lakes Wilderness Area development would benefit aquatic wildlife.

B.6.c. Energy and Natural Resources. We again object to any construction projects in the Alpine Lakes Wilderness Area. We again request that an alternative be developed without any such construction projects.

B.7.b.2 Noise. What additional noise levels would be generated by pumps and associated mechanical and electrical equipment within the Alpine Lakes Wilderness Area? Would such noise be covered by “local noise ordinances?”

B.8.a. Land and Shoreline Use. Again, we question why Chelan County would fail to mention the Alpine Lakes Wilderness Area as part of its description of Land and Shoreline use. Chelan

County claims that increasing instream flows would provide beneficial results for natural uses. Chelan County fails to disclose that increasing flows by new construction projects in the Alpine Lakes Wilderness Area would have adverse impacts.

B.8.c. Land and Shoreline Use. Chelan County describes new Alpine Lakes reservoirs in the Alpine Lakes Wilderness Area as an "improvement." Congress designated the Alpine Lakes Wilderness Area, not the Alpine Reservoirs Wilderness Area. The fact that Chelan County has portrayed the Alpine Lakes as "reservoirs" multiple times, demonstrates that Chelan County has little appreciation of and little understanding of wilderness or wilderness values. This is especially ironic, given that that the Applicant is the County's "Natural Resources Department." It appears that this Department is more interested in dismantling and destroying natural resources than preserving, protecting, or enhancing.

B.8.l. Land and Shoreline Use. Chelan County again fails to mention the US Forest Service or the Alpine Lakes Wilderness Area in addressing proposed measures to ensure the proposal is compatible with existing and project land uses and plans. The DPEIS must review US Forest Service planning documents for the Alpine Lakes Wilderness Area.

B.10.b. Aesthetics. Chelan County claims that new construction projects within the Alpine Lakes Wilderness Area would "improve views." Increasing water withdrawals from the Alpine Lakes Wilderness Area would <u>not</u> improve views of these areas and would have adverse impacts on recreational aesthetics. The DPEIS must address these impacts.

B.12.a. and c. Recreation. Again, Chelan County refused to even specifically list the Alpine Lakes Wilderness Area as a recreational opportunity in the vicinity or to list proposed measures to reduce or control impacts on recreation. The DPEIS must include an alternative that does not include construction activities within the Alpine Lakes Wilderness Area. The DPEIS must include recreation usage of the Alpine Lakes Wilderness Area, including day visits.

D.1. Chelan County asserts that implementation of the Guiding Principles is intended to "improve the environment," without addressing impacts from construction activities within the Alpine Lakes Wilderness Area.

D.2. Again, Chelan County asserts that the program would improve instream flow and habitat for fish and benefit terrestrial species, without addressing impacts from construction activities and additional water drawdowns within the Alpine Lakes Wilderness Area or impacts from new home construction. Chelan County again asserts that the Alpine Lakes Optimization, Modernization, and Automation would "benefit aquatic wildlife." Chelan County must not be allowed to describe the proposed program as beneficial while avoiding the purposes of SEPA to disclose to decisionmakers the potential significant adverse impacts.

D.3. Contrary to the assertions of Chelan County, the proposed Alpine Lakes Optimization, Modernization, and Automation would deplete natural resources by increasing water withdrawals from these lakes.

D.4. Contrary to the assertions of Chelan County, the proposed Alpine Lakes Optimization, Modernization, and Automation would result in long-term changes to the environmentally sensitive Alpine Lakes Wilderness Area. Chelan County also asserts that the proposed changed management regime for Alpine Lakes Wilderness Area drawdown "is to improve instream habitat for ESA-listed salmonids and other aquatic species in the Icicle Basin." The DPEIS should clarify whether Alpine Lakes Wilderness Area drawdowns are also intended to provide new water supplies for the City of Leavenworth, the LNFH, and IPID and COIC. The DPEIS must include an alternative that increases instream flows without additional modifications to the Alpine Lakes Wilderness Area.

Additional Specific Comments and Issues

The following are specific comments and issues to be addressed as part of any DPEIS on the ICWRMS. SEPA requires the following elements be included:
(i) the environmental impact of the proposed action,
(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
(iii) alternatives to the proposed action,
(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. *RCW 43.21C.031(2).*

1. Alternatives
* A no-action alternative is the most critical part of any EIS because it avoids all the adverse environmental impacts from the ICWRMS proposed project. The Applicant's Environmental Checklist (page 6) states that the DPEIS will describe both the base package and other alternative projects that could meet Guiding Principles. Again, a slavish attachment to the Guiding Principles, is contrary to SEPA. The DPEIS must include alternatives to the Guiding Principles, including alternatives that do not require more construction within the Alpine Lakes Wilderness Area, and that return the Alpine Lakes Wilderness Area to its pre-irrigation withdrawal condition.
The Department of Ecology refused to provide any alternatives to the Yakima Plan in its PEIS, other than the no-action alternative. Ecology should uphold SEPA and not work to circumvent it. Why would Ecology include alternative projects to meeting the Guiding Principles, when it refused to provide any alternative projects in the Yakima Plan PEIS?

2. Earth Resources
* How will the DPEIS evaluate the project's potential impacts and identify potential mitigation measures for those impacts, such as impacts of filling, soil contamination and erosion; and potential impacts from earthquakes?

3. Air Resources
* How will the DPEIS evaluate the project's potential impacts on existing air quality?
* How will the DPEIS evaluate compliance with the requirements of the Clean Air Act for construction and operation phases?

* What would be the project's contribution to climate change gases?
* What would be the carbon footprint of the proposed projects?
* Will the DPEIS evaluate the impacts on air quality and visibility caused by fugitive and exhaust emissions from construction, traffic, and truck emissions, and all point source emissions? Will the DPEIS analysis include airborne pollutants associated with any built project's day-to-day operations?

4. Water Resources
* Will the DPEIS evaluate the effects of a 100-year and 500-year flood on any project site?
* What water quality monitoring would be proposed?
* Will the DPEIS include a description of the potential for spills of contaminants into waters of the United States and the measures such as an emergency response plan to mitigate impacts?
* What is the scope of the water quality analysis? Will the DPEIS disclose which water bodies may be impacted by the project, the nature of the potential impacts, and the specific pollutants likely to impact those waters? Will it also report those water bodies potentially affected by the project that are listed on the State's current 303(d) list and whether the Washington Department of Ecology has developed a water quality restoration plan (Total Maximum Daily Load) for the water bodies and the pollutants of concern? If a Total Maximum Daily Load (TMDL) has not been established for those water bodies on the 303(d) list, in the interim will the DPEIS demonstrate that there will be no net degradation of water quality to these listed waters?
* Will the DPEIS explain how anti-degradation provisions of the Clean Water Act would be met for any proposed project?
* Will the DPEIS address the effects on water quality from the runoff of pollutants, including fertilizers and pesticides from residential landscaping and from storm water associated with additional impervious surfaces that might result from providing additional water to the City of Leavenworth for new residential construction?

5. Shoreline Habitat
* Will any damage to the Alpine Lakes Wilderness Shoreline result from the proposed projects and associated uses in the area?

* Will the Biological Assessment required for compliance with Section 7 of the Endangered Species Act be a clearly identifiable section?

* Will an assessment of fisheries and benthic impacts specifically address the requirements for an Essential Fish Habitat Assessment per the Magnuson Stevens Act?

* Will studies be carried out of an assessment: 1) species type, life stage, and abundance; based upon existing, publicly available information, 2) potential changes to habitat types and sizes; and 3) the potential for fishery population reductions.
* Will the DPEIS assess potential indirect impacts to fish and wildlife that may result from changes in water movement, sediment transport, and shoreline erosion?
* Will the DPEIS include a Benthic Macroinvertebrate Community Assessment of the nearshore areas of lakes in the Alpine Lakes Wilderness and along Icicle Creek?
* Will the DPEIS comprehensively address the interconnections between the

benthic, fisheries and avian resources?

6. Biological Resources
* Will the DPEIS analyze potential impacts on fish, wildlife and their habitats from every element of the ICWRMS, along with identification of mitigation measures?
* How will the DPEIS consider ecological objectives? Will ecological objectives be designed to protect water quality and to maintain and/or enhance the natural habitats in the Alpine Lakes Wilderness as well as Icicle Creek for the benefit of fish and wildlife resources and the public?
* Will the DPEIS address measures that compensate for the loss of habitats of value to fish and wildlife?
* Will the DPEIS identify the endangered, threatened, and candidate species under the Endangered Species Act (ESA), and other sensitive species within the proposed project area for each alternative? In addition, will the DPEIS describe the critical habitat for these species and identify any impacts the proposed project will have on these species and their critical habitat?
* Will the DPEIS describe the current quality and potential capacity of habitat, its use by fish and wildlife on and near the proposed ICWRMS project area, and identify known fish and wildlife corridors, migration routes, and areas of seasonal fish and wildlife congregation?
* Will the DPEIS evaluate effects on fish and wildlife from any habitat removal and alteration, aquatic and terrestrial habitat fragmentation caused by land use and management activities, and human activity? How will endangered species and habitat, including steelhead or salmon in the Alpine Lakes Wilderness and Icicle Creek be protected?
* How will Ecology ensure that its decision complies with the Migratory Bird Species Act of 1918, as amended?
* What major plant communities are present and affected? Will the DPEIS consider impacts on any sensitive plant species, particularly those endemic to the Alpine Lakes Wilderness and Icicle Creek? How will any sensitive plant species in the vicinity be protected?
* How much new impervious surfaces would be developed?

7. Avian Impacts
* How will the DPEIS describe any avian impacts to the Alpine Lakes Wilderness and Icicle Creek? How will the DPEIS establish a baseline data set? The species, number, type of use, and spatial and temporal patterns of use must be described. Information derived from other studies, which provides a three-year baseline data set, must be included if available. Information must be based on (1) existing, published and unpublished research results, especially research that describes long-term patterns in use, and (2) new field studies undertaken for this DPEIS. Data on use throughout the year, especially in Spring for migratory species, and under a range of conditions must be collected. Data collection must allow a statistically rigorous analysis of results. Issues needing to be addressed include: (1) bird migration, (2) bird flight during storms, foul weather, and/or fog conditions, (3) food availability, (4) predation, and (5) benthic habitat and benthic food sources.
* Will a Biological Assessment be prepared under Section 7 of the Endangered Species Act?

8. Noise and vibrations
* How will the DPEIS include an assessment of the magnitude and frequency of underwater noise and vibrations, and the potential for adversely affecting fish and mammal habitats from construction and operation of any facilities? Will the DPEIS include an assessment of fish and

mammal tolerance to noise and vibrations, with particular emphasis on noise and vibration thresholds that may exist for each of the species? Will the DPEIS also include the potential of noise impacts to human activity?
* How will the DPEIS address identification of existing noise levels and evaluation of the project's potential short-term and long-term noise impacts along with potential mitigation measures?
* Has a noise contours map been developed for any proposed ICWRMS project and does it show day-night average sound level (DNL)? How will any DNL's that are in excess of local ordinance requirements be mitigated?
* Will the DPEIS evaluate noise generating activities associated with construction and ongoing operations, including traffic to and from the project site?

9. <u>Environmental Health</u>
* How will the DPEIS address impacts of any hazardous materials and identification of mitigation measures?

10. <u>Land and Shoreline Use</u>
* How will the DPEIS address compliance with land use laws, plans and policies?
* How will the DPEIS address compliance with the State Shoreline Management Act and the Chelan County and City of Leavenworth Shoreline Master Programs?
* How will the DPEIS address compliance with federal laws governing Wilderness areas?

11. <u>Aesthetics</u>
* How will the visual impacts be mitigated?

12. <u>Recreation</u>
* How will the DPEIS address any ICWRMS project impacts on recreational use of the Alpine Lakes Wilderness Area?

13. <u>Transportation</u>
* How will the DPEIS address the project's potential transportation impacts and identification of mitigation measures?
* How many vehicle trips will be generated, including trips by employees and service and delivery vehicles?
* How will the positive effects of alternative fuels and hybrid cars be factored into trip generation projections?
* Will the DPEIS evaluate the level of service and overall traffic generation from any ICWRMS project activities including: construction traffic; and the level of service and overall traffic generation reasonably expected from project-associated growth in the City of Leavenworth?
* Will the traffic study calculate road maintenance costs attributable to the project?
* What is the scope of mitigation of traffic impacts that will be considered in the DPEIS?
* What is the capacity of surrounding highways, streets, and roads, to accommodate additional traffic associated with any proposed project and additional residential development?

14. Public Services and Utilities
* How will be the need for additional public services, including public safety and emergency services, and for infrastructure improvements be met?
* Will the effects of induced development, including pressure for urban growth expansions, be considered? What will be the scope of such an analysis? i.e., what communities in Chelan County will be included in the analysis?

15. Cultural Resources
* How will the DPEIS address requirements to comply with federal and state laws concerning cultural resources?
* Will the scope of the cultural resources analysis include identifying all historic properties or cultural resources potentially impacted by the project or associated offsite development, including traditional cultural properties, other Native cultural resources, and non-Native historic properties? Will the DPEIS evaluate the impacts to any identified historic properties and cultural resources, i.e., what are the impacts of the project and associated off-site development (e.g., housing, amenities)?
* How will historical tribal uses of this area be factored in, including effects on sacred sites and fishing grounds?
* How will the project affect the cultural heritage of the area?
* Will the DPEIS consider Tribal fishery impacts?
* How will the DPEIS coordinate with the State Historic Preservation Officer?

16. Environmental Justice
* Will the DPEIS consider, based on the experience of such projects elsewhere, effects on levels of poverty?
* Will the DPEIS assess whether low income or people of color communities will be impacted by the proposed project and disclose what efforts were taken to meet environmental justice concerns?

17. Socio-Economics
* Will a comprehensive economic analysis be undertaken to identify potential effects of the proposed project on Chelen County?
* What will be the time frame for the assessment of economic and social impacts; 10, 20, 50 years?
* For comparison purposes, will the socioeconomic effects of other similar projects on other communities in the state be examined?
* How many jobs will be created; at what wage levels? What percentage of work would be reserved for local contractors? Will prevailing wages be paid?
* What will be the consequences on property values and property taxes in Leavenworth and Chelan County?
* How will effects on quality of life, including community character, demographics, and small town atmosphere, be assessed?
* How will the DPEIS address safety considerations during construction of any project?

18. Other Issues
* What tribal consultation would occur with nearby Indian tribes?

* How will Washington communities be consulted with and involved in the SEPA process?
* What consultation with school districts and other service providers will occur?
* What other permits and approvals are required?
* Has a geo-tech study been done for any proposed project site? What extra structural precautions will be taken for potential earthquake liquefaction?
* Will any proposed project be affected by seismic faults or fractures?
* Will the DPEIS address the potential for increased litter?

Please send us a copy of the DPEIS if it becomes available.

Sincerely,

John de Yonge

PRESIDENT

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Tuesday, May 10, 2016 4:34 PM
To: Jordan Sanford; Meghan O'Brien
Cc: Dan Haller
Subject: FW: Public Comment regarding dams and water-level manipulation in Icicle Creek

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Tuesday, May 10, 2016 4:17 PM
To: Tom Walker
Cc: Mary Jo Sanborn
Subject: RE: Public Comment regarding dams and water-level manipulation in Icicle Creek

Thanks, Tom, we'll get your comments into the record…Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Tom Walker [mailto:twalker@nsecomposites.com]
Sent: Sunday, May 08, 2016 4:24 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Public Comment regarding dams and water-level manipulation in Icicle Creek

To whom it may concern:

I'm appalled to read that there is serious consideration being given to building dams and manipulating water levels in lakes within the Icicle Creek drainage. These lakes are located in the Alpine Lakes Wilderness, and it is my opinion that only pre-existing water rights that are being used for the purposes intended, should supersede the importance of Wilderness. Specifically, I agree with the key points of the position taken by the Alpine Lakes Protection Society, i.e.,

- The Alpine Lakes Wilderness is a shared natural resource that must be respected and protected.
- The EIS should include a "Wilderness Protection" alternative, which should include an alternation of public purchase (buy-back) of private water rights in the Alpine Lakes.
- The EIS should include a "Water Right Relinquishment" alternative.
- The EIS should include an alternative that recognizes Icicle Working Group members' water rights are limited to the purposes for which they were initially granted, and cannot be redirected to other purposes.
- The EIS should include a "Water Conservation" alternative that emphasizes aggressive water conservation measures by the local water users. This alternative should evaluate a transfer of water rights for IPID to Leavenworth for properties within the city limits that have now converted from orchards to residential properties. In addition, it should evaluate how IPID spills large quantities of water back into the Wenatchee River at the end of several of its canals.
- The EIS should include a "Water Right Change" alternative.
- The EIS should analyze each proposed action's site-specific impacts, past practices, and the restoration, mitigation, and funding that are needed in the future. At each site, proposed construction activities and proposed water diversions need to be spelled out in detail.
- The EIS should discuss the hydrological and biological impacts of the current drawdown of the lakes, and any proposed changes.
- The EIS should provide a detailed operations, maintenance and environmental monitoring plan for the water infrastructure, and analysis of the wilderness impacts of specific maintenance actions, including helicopter use.
- The IES should fuly explain the purpose and need for the water these projects would provide.
- The EIS should fully explain what human activities caused the degraded conditions that the projects seek to improve.
- The EIS should analyze adequacy of proposed in-stream flows to support spawning, rearing, and migration of steelhead and bull trout.

Again, I strongly urge you to give paramount consideration to the Wilderness aspects of these areas.

Sincerely,

Thomas H. Walker
3815 Bagley Ave N
Seattle, WA 98103

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Tuesday, May 10, 2016 4:34 PM
To: Meghan O'Brien; Jordan Sanford
Cc: Dan Haller
Subject: FW: Icicle Work Group PEIS Environmental Review Comment

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
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-----Original Message-----
From: Mike Kaputa
Sent: Tuesday, May 10, 2016 4:19 PM
To: Carol or Mike Wyant
Cc: Mary Jo Sanborn
Subject: RE: Icicle Work Group PEIS Environmental Review Comment

Thanks, Mike, we'll get these into the record and considered....Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

-----Original Message-----
From: Carol or Mike Wyant [mailto:cmwyant@charter.net]
Sent: Sunday, May 08, 2016 1:19 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Icicle Work Group PEIS Environmental Review Comment

Director Kaputa,

Please consider the following comments concerning the Icicle Work Group suite of proposals for long term improvement of the water management situation on Icicle Creek.

1. The suite of proposals appears to present a viable path to improving water management and increasing the amount of water that stays in Icicle Creek. However, I am concerned that the projections for water savings to reach flow targets are overly optimistic for two reasons. The first concern is that the projections rely on all of the proposed projects being completed. I believe that it is unlikely that some of the projects can be completed to the extent that they will provide the projected water savings. For example, the proposed efficiencies in the Icicle Irrigation District water system seem to be unlikely to be accomplished in my view. I wish that the suite of proposals included additional options so that meeting the target for flows does not rely on completing all of the projects. I am concerned that flow targets and the proposed positive effects of identified water management strategies are overly optimistic given many of the climate change projections for the next 50 years.

2. Though I consider myself a staunch supporter of wilderness, I am in favor of the proposed changes at the lakes in the Alpine Lakes Wilderness that are managed as water storage reservoirs. I support those changes because maintaining the existence of the reservoirs was grandfathered in when the wilderness was established. It makes sense to use the water in those reservoirs as efficiently as possible, even though doing so intrudes and will continue to intrude on the wilderness experience. I support the reconstruction of Eightmile Lake dam to its original height even though doing so will inundate land that has been above lake level for many years. While raising the height of the original Eightmile Lake dam has been taken off the table by the Icicle Work Group, I understand that it is still in mind for folks at the icicle Irrigation District. I oppose raising the height of the original reservoir because that would represent a change to the agreement to keep the existing reservoirs when the wilderness was established.

3. As each individual project comes up for approval I would like to be assured that sufficient scientific study is in place to make it relatively certain that the project will have the positive effects that are proposed and that the possibility that the project will have unintended negative consequences has been thoroughly considered. I would also like to know that each project that has the potential to impact the icicle ecosystem includes a plan and the resources necessary to study the post-project impacts. Too often it seems that projects are completed with the idea that they will improve an ecosystem when there is no post-project evidence that they actually had the intended effects and that they are not, in fact, having a negative or unintended effect.

Thank you for considering these comments.

Michael Wyant
12125 Emig Drive
Leavenworth, WA 98826
(509) 548 7747

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Tuesday, May 10, 2016 4:35 PM
To: Meghan O'Brien; Jordan Sanford
Cc: Dan Haller
Subject: FW: Dam Building and New Water Rights

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
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Cell: (509)-860-2135
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-----Original Message-----
From: Mike Kaputa
Sent: Tuesday, May 10, 2016 4:19 PM
To: winnie becker
Cc: Mary Jo Sanborn
Subject: RE: Dam Building and New Water Rights

Thank you, Winnie, we'll make sure your comments are entered into the record....Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

-----Original Message-----
From: winnie becker [mailto:winnbec@netscape.net]
Sent: Saturday, May 07, 2016 7:57 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Dam Building and New Water Rights

Dear Mike,

Please preserve the Alpine Lakes Wilderness. To build dams and change water rights would not be in keeping with the wilderness.

The EIS should include a "Wilderness Protection" alternative. The increase of water removal from the Alpine Lakes Wilderness is not in keeping with protecting the wilderness which is so very important for generations to come. Water should be obtained from sources outside the Wilderness. The Wilderness Protection alternative should comply with all the provisions in the Forest Service's administrative Alpine Lakes Wilderness Management Plan, including: " Except as provided for in Section 4(D)(4) of the Wilderness Act, watersheds will not be altered or managed to provide increased water quantity, quality or timing of discharge.

The Wilderness Protection alternative should evaluate public purchase (buy-back) of private water rights in the Alpine Lakes, which would allow removal of dams and other structures from the lakes to restore the area to its true natural character.

The EIS should include "Water Right Relinguishment" alternative. The alternative should analyze existing water rights to the Alpine Lakes and acknowledge those rights that have been relinquished or abandoned.

The EIS should include an alternative that recognizes IWG members" water rights are limited to the purposes for which they were initially granted (irrigation is an example) and cannot be redirected to other purposes (such as suburban development).

The EIS should include a "Water Conservation" alternative that emphasizes aggressive water conservation measures by the city of Leavenworth, Icicle-Peshastin Irrigation District, the Leavenworth fish Hatchery and other water users. This alternative should evaluate water markets that facilitate selling and trading of water rights.

The Water Conservation alternative should evaluate a transfer of water rights from IPID to Leavenworth for properties within the city limits that have now converted from orchards to residential properties.
This alternative should analyze how appropriate reductions in water usage (that is, not using agricultural water quantities for lawn irrigation) would save that would then be available for other Leavenworth needs.

The Water Conservation alternative should evaluate how IPID spills large quantities of water back into the Wenatchee River at the end of several of its canals. The alternative should evaluate how this 19th century irrigation practice could be replaced with modern pumping and piping technologies. The EiS should work to reduce water demand as an alternative to water supply.

The EIS should include a "Water Right Change" alternative. This alternative would evaluate improving Icicle Creek flows by moving IPID's point of diversion downstream (to the Wenatchee River). This measure, which would add 100 cfs of water to Icicle Creek every year, would convert the IPID diversion from gravity flow to pumping (requiring electrical power). This alternative should therefore analyze renewable energy options to supply that power, including solar, wind and in-canal hydroelectric.

The EIS should discuss the hydrological and biological impacts of the current drawdowns of the lakes, and any proposed changes. The analysis should include a review of scientific literature on the impacts of water removals upon wildlife, vegetation, soil and wilderness values.

The EIS should analyze each proposed action's site-specific impacts, past practices and the restoration, mitigation and funding that are needed in the future. At each site, proposed construction activities and proposed water diversions need to be spelled out in detail.

The EIS should provide a detailed operations, maintenance and environmental monitoring for the water infrastructure, and analysis of the wilderness impacts of specific maintenance actions including helicopter use.

The EIS should fully explain the purpose and need for water these projects would provide.

The EIS should fully explain what human activities caused the degraded conditions (such as low instream flows in Icicle Creek) that the projects seek to improve.

The EIS should analyze adequacy of proposed instream flows to support spawning, rearing and migration of steelhead and bull trout.

Thank you for your attention.

Sincerely,

Winnie Becker

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Wednesday, May 11, 2016 10:42 AM
To: Jordan Sanford; Meghan O'Brien
Subject: FW: Alpine Lake Wilderness in Washington

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

-----Original Message-----
From: Mike Kaputa
Sent: Tuesday, May 10, 2016 5:35 PM
To: Dean Effler
Cc: Mary Jo Sanborn
Subject: RE: Alpine Lake Wilderness in Washington

Thank you both for your comments, we'll make sure they are entered into the record and considered during the scoping process.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

-----Original Message-----
From: Dean Effler [mailto:efflerbiz@gmail.com]
Sent: Thursday, May 05, 2016 8:07 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Alpine Lake Wilderness in Washington

Please do not allow any agreement to provide water to commercial or residential users that would impact the hydrology and natural beauty of the Alpine Lakes Wilderness. A wilderness no longer is a wilderness when you drain it's natural resource or flood it's land. Only allow growth in local cities and counties based on water conservation methods rather than tapping into the waters of a protected wilderness.

Sent from my iPad
Dean and Martha Effler

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Wednesday, May 11, 2016 10:41 AM
To: Meghan O'Brien; Jordan Sanford
Cc: Dan Haller
Subject: FW: Scoping Comments - Icicle Work Group's "Icicle Strategy" Scoping Request

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
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From: Mike Kaputa
Sent: Tuesday, May 10, 2016 5:33 PM
To: Jena Gilman
Cc: maib461@ecy.wa.gov; Mary Jo Sanborn; (GTEB461@ecy.wa.gov)
Subject: RE: Scoping Comments - Icicle Work Group's "Icicle Strategy" Scoping Request

Jena, thank you for the comments. They will be entered into the record and considered as part of the scoping process.

On your last point, I wanted you to know that we have had and will continue to have meetings in the Seattle area (so far, two at Good Shepherd Center in Wallingford and one at Phinney Neighborhood Association in Phinney Ridge) to broaden our engagement. I will add you to that distribution list.

We are also planning a field visit with the conservation community to Eightmile Lake in late summer, probably September, to view the lakes after they have been drawn down for the irrigation season.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Jena Gilman [mailto:jena.gilman1@gmail.com]
Sent: Thursday, May 05, 2016 11:50 AM

To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Cc: maib461@ecy.wa.gov
Subject: Scoping Comments - Icicle Work Group's "Icicle Strategy" Scoping Request

Dear Mike:
The Icicle Work Group's "Icicle Strategy" is a recipe for serious degradation of Alpine Lakes Wilderness lands and waters that are becoming increasingly important to the exploding numbers of hikers and other outdoorspeople throughout our State. Instead of honoring these wilderness values, the "Icicle Strategy" instead celebrates the banality of suburban sprawl and the enshrinement of golf courses as our society's vision of the highest and best use of our water resources.
Any environmental impact statement (EIS) for the water theft and attack on wilderness that the promotors champion in the "Icicle Strategy" must consider the following at minimum:

- The EIS should fully explain the purpose and need for each of the water projects outlined in the "Icicle Strategy".
- The EIS should analyze each of the proposed action's site-specific impacts, past practices, and the restoration, mitigation and funding needed in the future. At each site, proposed construction activities need to be explained and illustrated in detail as well as how wilderness and habitat values will be maintained throughout the period of construction for Wilderness users and the complete array of fauna and flora that inhabit these areas.
- The EIS should discuss the hydrological and biological impacts of the current drawdowns of the lakes within the Wilderness and the incremental impacts of any proposed changes. The analysis should include the impacts of water removals upon all wildlife, vegetation, soil and wilderness values.
- The EIS should provide detailed operations and maintenance plans for proposed infrastructure and an analysis of the impacts on the wilderness experience of specific maintenance actions, including helicopter operations.
- The EIS should consider a Wilderness Protection Alternative. This alternative would promote wilderness values as set forth in the Wilderness Act of 1964, would not allow new water infrastructure or diversions inside the Alpine Lakes Wilderness, and would require all new water supply to be obtained outside the Alpine Lakes Wilderness.
- The EIS should consider a serious Water Conservation Alternative. This alternative would assess using aggressive water conservation measures by area cities, including restrictions on lawn watering and provision for landscaping that is suited to the climate without irrigation for any new development. This alternative should also assess transfer of water rights from irrigation districts to cities, where orchards have already been torn out and replaced with residential subdivisions. This alternative should also assess agricultural irrigation efficiency, such as replacing open gravity canals with pipes and pumps. This Alternative should also consider water re-use technologies.

- The EIS should consider an Irrigation District Water Right Change Alternative, which would fix Icicle Creek's low flow problem. This alternative would evaluate moving the Icicle-Peshastin Irrigation District's water right diversion, which presently takes 100 cubic feet per second out of Icicle Creek, to the Wenatchee River downstream.

- The EIS should consider a Water Right Relinquishment Alternative. Removal of water from the Alpine Lakes Wilderness is an issue only because the Icicle-Peshastin Irrigation Distirct holds water rights that were grandfathered when the Wilderness was created. When the dam at Eightmile Lake failed the Irrigation District did not fix it because they did not need the water. When a party doesn't use their rights, they lose them. The "Use It Or Lose It" doctrine should govern. The EIS needs to acknowledge this issue.

Please use some common sense in the scoping process. Anything in the "Icicle Strategy" that affects and detracts from the wilderness character of the Alpines Lakes Wilderness on a long-term, short-term, or cumulative basis needs to be fully vetted.

Finally, the Alpine Lakes Wilderness, and particularly the Enchantment Lakes area, is a national asset, important to people far beyond Chelan County. Therefore, public meetings and notices limited to Chelan County will be inadequate to the public's inquiry into the "Icicle Strategy" and its proposed actions within the Wilderness.

Thank you for your attention,

Sincerely,
Jena F. Gilman, P.E. (WA 23673)
1480 SW 10th Street
North Bend, WA 98045

- Born in Yakima 1952
- Raised in Moses Lake (MLHS Class of 1971)
- First sight of Nada and Snow Lakes: July 25-26, 1969

State of Washington
Department of Fish and Wildlife
Mailing Address: 1550 Alder St NW, Ephrata, WA 98823, (509) 754-4624, TDD (360) 902-2207
Main Office Location: Natural Resources Building, 1111 Washington Street SE, Olympia WA

May 6, 2016

Tom Tebb, Director
Office of Columbia River
Washington State Department of Ecology
1250 W. Alder St.
Union Gap, WA 98903

Mike Kaputa, Director
Chelan County Natural Resources Department
411 Washington Street, Suite 201
Wenatchee, WA 98801

RE: WDFW Scoping Comments – Determination of Significance (DS) and Request for Comments on Scope of State Environmental Policy Act (SEPA) Nonproject Programmatic Environmental Impact Statement (PEIS) for the *Icicle Creek Water Resource Management Strategy* (ICWRMS)

Dear Mr. Tebb and Mr. Kaputa,

The Chelan County Natural Resources Department (CCNRD) has been contracted by the Washington Department of Ecology (Ecology), through the Office of Columbia River (OCR) to develop a Final ICWRMS SEPA PEIS. Since 2007, the Washington Department of Fish and Wildlife (WDFW) has supported Ecology's efforts to fulfill its legislative mandate to, *"aggressively pursue development of new water supplies for instream and out-of-stream uses."* Our agency is a collaborative partner to ensure natural resource values are adequately reflected in decision-making. Thus, WDFW appreciates the opportunity to provide comments during the public scoping[1] period to assist with the development of the Draft PEIS.

As stated in the DS, the SEPA *Non Project*[2] PEIS is being prepared to *generally* address impacts associated with collectively implementing a suite of projects within the Icicle Creek basin. These projects aim to improve instream flows to protect fish and aquatic habitat, improve water storage and operational flexibility within the Alpine Lakes Wilderness, and reinstate water

[1] WAC 197-11-455

[2] "Nonproject actions are governmental actions involving decisions on policies, plans, or programs that contain standards controlling use or modification of the environment, or that will govern a series of connected actions. Nonproject review allows agencies to consider the "big picture" by conducting comprehensive analysis, addressing cumulative impacts, possible alternatives, and mitigation measures". SEPA Online Handbook, Ecology.

reserves[3] to accommodate growth within Chelan County. WDFW staff has been involved with the planning process since the Icicle Work Group (IWG) convened in 2012. WDFW Region 2 Director Jim Brown currently serves as the Chair for the IWG Steering Committee to help facilitate the collaborative process and to promote WDFW's interests to protect fish, wildlife, and their habitats in the Icicle Creek basin.

WDFW appreciates the value Ecology and CCRND bring to managing water resources in Icicle Creek for both in-stream and out-of-stream uses. WDFW promotes[4] developing the PEIS in such a way that adequately assesses impacts (beneficial and adverse) for the following suite of projects in Icicle Creek:

- Icicle Peshastin Irrigation District (IPID) Irrigation Efficiency Upgrades
- Cascade Orchards Irrigation Company (COIC) Irrigation Efficiency Upgrades
- Domestic Conservation Efficiency Upgrades
- Alpine Lakes Optimization, Modernization, and Automation
- Leavenworth National Fish Hatchery (LNFH) Conservation and Water Quality Improvements (e.g. Rehabilitate LNFH Intake, Operational Improvements at Structure 2
- Eightmile Lake Restoration Project
- Water Markets
- Habitat Improvements between RM 2.7-4.5 and Land Acquisitions
- Icicle Creek Passage, Tribal Fisheries Improvements
- LNFH/COIC, IPID, and City of Leavenworth Diversion Screening Upgrades
- Instream Flow Rule Amendment (WAC 173-545)

WDFW General Scoping Comments

1) It is essential the PEIS describes the sequencing and timing of permittable projects and identifies the beneficiaries of in-stream and out-of-stream flow improvements. WDFW is concerned that water will be allocated for out-of-stream uses before an adequate amount of flow improvements are made in Icicle Creek.
2) At the public scoping meeting held in Leavenworth it was stated by Aspect Consulting that the timeframe associated with implementing projects ranged from 5-20 years. In order to "track" flow improvements that may occur over the next 5-20 years, a project implementation schedule should be included in the PEIS so readers can adequately provide comments, mitigation recommendations, and resource protection expectations within the context of "real water" in "real time".
3) Please describe the "Alternative Projects" being contemplated for replacing project that may not be feasible. WDFW expectations are that alternative projects would be identified through a collaborative process to replace those benefits and functions intended by the project determined to be infeasible.

[3] Senate Bill 6513

[4] Per November 19, 2015 WDFW Support Letter to Ecology and CCNRD

4) As fisheries co-managers for the state of Washington, WDFW does not support waiting 5-20 years to upgrade the Leavenworth Hatchery. We respect Ecology and CCNRD's efforts to find non-litigious solutions to upgrading the hatchery to meet state and federal laws. However, we also want to be clear that though our agency is an active member of the IWG, we are in no way advocating delaying compliance-related upgrades at the hatchery as a result of being a project element of the PEIS. We suggest providing details within the PEIS that "cross-walks" your efforts to solve hatchery issues with the U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service's efforts.
5) It is essential that long-term climate change scenarios serve as the "backbone" to developing the PEIS. Refill scenarios for the Alpine Lakes remain uncertain, as do in-stream flows influenced from timing and quantity of annual precipitation. WDFW urges Ecology not to over-commit water for out-of-stream uses made "available" as a result of implementing any of the projects. We would not be doing our job as a resource agency if we did not safeguard stream flows to protect fish and their habitat throughout this PEIS process. We assume the same level of safeguarding will occur from Ecology to protect senior water right holders from harm or avoid project actions that may cause adverse impacts to stream flows or water quality. WDFW expects to see a robust section in the PEIS that evaluates climate change effects on project operational scenarios (e.g. new water management of the Alpine Lakes) and then illustrates how stream flow improvements will be achieved while simultaneously providing additional water for out-of-stream uses (i.e. show the math).
6) Ecology and CCNRD have indicated that some of the projects listed above may be described with a higher level of detail within the PEIS than the broader ICWRMS projects, making some projects ready for early implementation. Evaluation of projects considered for early implementation should include an assessment of natural resource costs and benefits as a function of project sequencing/early implementation within a subsequent project-level EIS, as necessary.
7) As you are aware, WDFW is actively working on several fish screen and diversion replacement projects in Icicle and Peshastin Creeks[5] to protect fish life; these projects are slated to occur in the near future. WDFW staff will continue to manage these projects and our own environmental compliance process, associated grant awards, and partnerships independent of the Icicle Strategy. However, our WDFW team is always available to assist with project planning and/or provide expertise to support PEIS development.
8) Please provide a hardy, water conservation and reduction section in the PEIS. For example, what are some ways CCNRD and Ecology will reduce the current gallon per capita per day as a tool to provide water for future growth and respond to drought effects? How will those endeavors be coordinated with investigating new water supply in the Alpine Lakes? WDFW recommends including a plan in the PEIS by which (1) CCNRD and Ecology will partner with utility providers to offer rebates for using less water, (2) to update local regulations and/or develop ordinances to promote and/or require water savings wherever possible, and (3) to develop water conservation and reduction incentive programs.

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[5] Icicle Irrigation Diversion and City of Leavenworth Diversion as examples.

9) WDFW still isn't clear how the Upper Wenatchee Community Lands Plan[6] is linked to the ICWMRS. WDFW habitat and wildlife staff have communicated with CCNRD that parcels identified in the Upper Wenatchee Community Lands Plan for acquisition may modestly add habitat value for wildlife or watershed protection in of itself. WDFW doubts these lands will be sufficient to provide "commensurate compensation for impacts to fish and wildlife resources" in the Icicle Creek basin. In addition to low habitat value, the scope of the Upper Wenatchee Community Plan includes Cashmere to Stevens Pass, with three sub-areas not located in the Icicle Creek Basin including: 1) Blewett Pass/Peshastin, 2) Chumstick Valley, and 3) Nason & Coulter Creek. The Wenatchee Community Lands Plan webpage makes no clear reference to how these "out-of-basin lands" are linked to the ICWRMS. WDFW recommends Ecology and CCNRD work with resource experts to assess lands for acquisition and/or enhancement within the Icicle Creek basin that can provide valuable fish and wildlife habitat. As you are aware, mitigation should be similar to the resource values lost through project development; out-of-place and/or out-of-kind mitigation is only appropriate when all other in-place mitigation opportunities have been exhausted[7].

10) WDFW encourages Ecology and CCNRD to identify a lead federal agency to undertake the NEPA process as soon as possible. WDFW is unclear if federal participation on the IWG and dedication of time and personnel constitutes a "major federal action" within the meaning of NEPA. WDFW suggests delineating projects in the PEIS that cannot proceed until NEPA has been fulfilled. This will ensure local, state, and federal agencies, tribes, and other stakeholder groups have a clear understanding of project implementation timelines and associated in-stream flow benefits for each project (i.e. when will the water be in Icicle Creek and how much).

Fish, Wildlife, and Habitat Resource Considerations and Information Needs

Wildlife

- The WDFW Priority Habitat and Species (PHS) data layers are a tool for planning purposes. These data sources cannot be assumed complete or exhaustive in expanses of wilderness considered in the PEIS. Lack of information for any species does not indicate a lack of presence. If the U.S. Forest Service (USFS) does not have species presence/absence surveys, WDFW recommends terrestrial surveys be completed for species likely to occur within the project footprint.
- Project activities requiring the use of helicopters pose a significant disturbance threat to mountain goats in the Alpine Lakes Wilderness - flying over mountain goats is considered to be a direct disturbance. WDFW recommends conducting surveys for concentrations of mountain goats for PEIS development. Specific consideration should be made for the timing of helicopter use to avoid the period when females are giving birth and following weeks when raising young.

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[6] Upper Wenatchee Community Lands Plan, CCNRD, Trust for Public Lands, the Nature Conservancy, and the Chelan-Douglas Land Trust (2015), funded through OCR.

[7] WDFW Mitigation Policy M5002[7] guides our agency to "achieve no net loss of habitat functions and values" when reviewing or permitting projects. WDFW preferred alternative is to mitigate for natural resource impacts within the Icicle Creek basin by implementing habitat protection, conservation, and restoration actions in-place and in-kind or secondarily in-place and out-of-kind.

- Golden eagles, peregrine falcons, northern goshawks, and northern spotted owls all occupy, nest, and rear young in associated habitats in the wilderness and may be located within the project footprint. WDFW recommends conducting surveys within the project footprint so a plan can be developed to avoid disturbing nest sites, particularly until young have fledged. The high elevation and colder conditions of the wilderness will extend fledging dates into the summer later than warmer low elevation habitats.
- WDFW recommends conducting surveys for pika within the project footprint and to work closely with WDFW and the USFS to avoid impacts to this species at the project planning stage.
- Any open water habitat included within the project footprint should be surveyed for common loon nesting. The potential for direct impacts to loon nests is high for any project activities that would result in a rise of water elevation on any lakes.
- The USFS and WDFW are coordinating in summer of 2016 to conduct amphibian and reptile surveys at wetlands, lakes, ponds or streams located within and whereas water-levels or flows are impacted by the package of projects in the PEIS. Data collected and information in the final report should be used to develop the Final PEIS and for future, subsequent EISs.

Habitat

- Installation of a flow meter, with access to the data should be made publicly available to confirm proposed minimum instream flows designated for the Historic Channel in Icicle Creek are being met.
- WDFW support CCNRDs efforts to fund and install meters on all diversions.
- The water market being developed for Icicle Creek will need to be coordinated annually with fisheries co-managers to avoid seasonal harm to instream flows, including winter flows to protect fish life.

Fish

- Fish passage improvements should include flow as an important component to ensure riffles are passable to upstream migrating salmonids.
- WDFW can provide fish stocking data for the Alpine Lakes if requested. Our agency has a vested interest in ensuring changes in operations at the lakes do not adversely impact fish
- Modeling flow scenarios out of each and/or all of the Alpine Lakes being contemplated in the PEIS will help prioritize flows scenarios that maximize benefits to fish at each relevant life stage. Focal species and relevant life stages include Steelhead (adult, rearing), Rainbow trout (adult, rearing), Bull Trout (adult/sub-adult, rearing), Cutthroat Trout (adult, rearing), and Lamprey (adult).
- Bringing fish screening associated with diversions into compliance with state and federal requirements should be a nondiscretionary “early action” item of the PEIS; this action should be funded and pursued in the immediate future as a priority of the ICWRMS.

Closing Remarks

Flows in Icicle Creek need to be restored to avoid extinction of trout and steelhead populations. Withdrawing additional water from Icicle Creek cannot occur until fisheries experts agree that flow is sufficient to protect fish at all life stages and there is “wiggle” room to allocate water for out-of-stream uses. WDFW looks forward to working toward water resource solutions that embody a balance of public interests with natural resource protection for the benefit of all! If you have questions or concerns regarding our comments, please feel free to contact me directly by email at carmen.andonaegui@dfw.wa.gov or by phone at (509) 754-4624 ext. 212.

Sincerely,

Carmen Andonaegui
WDFW, Region 2 Habitat Program Manager

cc: Jim Brown, WDFW Region 2 Director
Amy Windrope, WDFW Ecosystem Services Division Manager
Jeff Korth, WDFW Region 2 Fish Program Manager
Matt Monday, WDFW Region 2 Wildlife Program Manager
Charity Davidson, WDFW Environmental Planning Coordinator

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Wednesday, May 11, 2016 10:43 AM
To: Meghan O'Brien; Jordan Sanford
Cc: Dan Haller
Subject: FW: Formal Comment: Icicle Work Group's "Icicle Strategy."

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Tuesday, May 10, 2016 5:55 PM
To: Doug Scott
Cc: George Nickas; John Gilroy; Mary Jo Sanborn
Subject: RE: Formal Comment: Icicle Work Group's "Icicle Strategy."

Doug, thank you for your comments. We will make sure they are entered into the record and considered during scoping.

I did recently talk with Rep. McCormack about the "in-holders" in the wilderness area who held ownership rights prior to the wilderness being established. By "in-holders" I am referring to Pack River, Icicle Irrigation District and Burlington Northern Santa Fe Railways. Given your role in establishing the wilderness, any input you could provide on how those "in-holders" were to be addressed post-wilderness designation would be appreciated.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Doug Scott [mailto:scottdoug959@gmail.com]
Sent: Friday, May 06, 2016 1:11 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>

Cc: George Nickas <gnickas@wildernesswatch.org>; John Gilroy <jgilroy@pewtrusts.org>
Subject: Formal Comment: Icicle Work Group's "Icicle Strategy."

Mr. Kapula --

On behalf of my company, Doug Scott Wilderness Consulting, I wish to comment on your proposed Icicle Work Group's Icicle Strategy.

As background, in the mid-1970s I was the Northwest Representative of the Sierra Club based in Seattle. As such, I represented the large coalition of organizations (local, state, and national) which sought the designation of the Alpine Lakes Wilderness Area. I testified at the U.S. Forest Service hearings in Seattle and Wenatchee, at the congressional field hearings, and at the hearings before both the Senate and House committees in Washington, DC.

I worked closely with the sponsors of the legislation that designated the wilderness area, notably Representatives Lloyd Meeds, Joel Pritchard, and Mike McCormack, who represented the Wenatchee side of the wilderness area, and with Senators Henry M. Jackson and Warren Magnuson, as well as the many congressional committee members involved. I worked closely with leaders of the U.S. Forest Service, including the chief, and with officials in the Department of Agriculture and the White House.

I attended and was recognized at the Forest Service's celebration of the new wilderness area in 1976 at Snoqualmie Pass.

I have often visited the Icicle, including the hike up the Snow Lake Trail to the Enchantments area at the eastern end of the wilderness area. I was involved in the enactment of the amendment which added 22,172 acres in the lower valley of the Middle Fork, Snolqualmie River sponsored by Representative Xxxxx Xxxxx and Senators Xxxxx Xxxxx and Maria Cantrell. I attended and was recognized at the celebration of this addition held near the new boundary.

The Alpine Lakes Wilderness Area is a beloved part of America's National Wilderness Preservation System:

> The wilderness area--every acre of it -- is protected with the full strength of the 1964 Wilderness Act.
>
> The building of new dams or water diversions, however “minor” you may think they would be, is illegal.
>
> Were your proposal to succeed, it would constitute a very serious and unacceptable precedent.

I can assure you that any such final decision will, on the day it is issue, bring you before a federal judge and will be prosecuted with the full resources of the national wilderness movement and with the well-regarded legal skills of the top environmental attorneys practicing today.

Prior to that, you are obligated legally to produce and reveal a complete and thorough environmental impact statement to cover your proposal and -- as you have indicated you will do -- to include the mandatory full range of alternatives to your proposed action.

This include the non-action alternative -- leaving well enough alone without violating the wilderness area.

Every alternative -- every -- that would achieve your goal without violating the wilderness area.

Three notable facts:

> The father of the Alpine Lakes Wilderness Area in the U.S. Senate was Senator Henry M. Jackson who was also chairman of the committee which produced the area. Senator Jackson was also the

> father of the National Environmental Policy Act. It would be a slur on his memory for you to cut corners in any way in meeting your obligations under his statute. A lawsuit is certain.
>
> Senator Jackson chaired the meeting of the entire Washington congressional delegation in which final issues of the boundaries and wording of the Alpine Lakes Area Management Act of 1976.
>
> I represented the coalition of supporting organizations in presenting to this private meeting the results of final negotiations which I carried out with Bill Ruckelshaus, then of Weyerhaeuser Company, who acted on behalf of the timber industry coalition, including local governments -- including Wenatchee County. Mr. Ruckelshaus was, of course, the first administrator of the U.S. Environmental Protection Agency which oversees the environmental impact statement process.

You have similar but separate obligations under statutes of the State of Washington.

Issues of impacts on the interests and needs of Native American Tribes and on anadromous fisheries are mandatory topics you must cover in complete detail.

You are on notice. Your agency and its constituents are apparently not aware of what you are doing, for you court an enormous waste of your time, the time of many other agencies, organizations, and individuals, and the money the taxpayers who pay for your efforts. And it will be for naught. You will learn this as have those who attempted much smaller dams and diversions within the Selway-Bitterroot Wilderness Area, Montana.

You will end up empty handed and ... with our thanks, the author of yet another strong pro-wilderness precedent.

Think again!

Doug Scott
Principle

Doug Scott Wilderness Consulting
1723 18th Avenue, Suite 25
Seattle, WA 98122
www.wilderness-reources.net

Doug Scott, a forester by training, is recipient of the highest honor of the national Sierra Club, the John Muir Award.

cc:

George Nickas, Executive Director, Wilderness Watch
John Gilroy, Assistant Director, Campaign for America's Wilderness, U.S. Lands, The Pew Charitable Trusts

Alpine Lakes Protection Society ● Alpine Lakes Foundation
Alliance for the Wild Rockies ● American Whitewater ● Aqua Permanente
Center for Environmental Law & Policy ● Conservation Congress
El Sendero ● Endangered Species Coalition ● Federation of Western Outdoor Clubs
Friends of the Bitterroot ● Friends of Bumping Lake ● Friends of the Clearwater
Friends of the Enchantments ● Friends of Lake Kachess ● Friends of Wild Sky
Great Old Broads for Wilderness ● Issaquah Alps Trails Club
Kachess Homeowners Association ● Kachess Ridge Maintenance Association
Kittitas Audubon Society ● Kittitas County Fire District #8 ● The Mazamas
Middle Fork Recreation Coalition ● North Cascades Conservation Council
North Central Washington Audubon Society ● Olympic Forest Coalition
River Runners For Wilderness ● Save Our Sky Blue Waters ● Seattle Audubon Society
Sierra Club ● Spokane Mountaineers ● Spring Family Trust for Trails
Washington Native Plant Society ● Washington Wild ● Western Lands Project
Wilderness Watch ● Wild Fish Conservancy

May 11, 2016

Via email to: mike.kaputa@co.chelan.wa.us

Chelan County Natural Resources Department
Attention: Mike Kaputa, Director
411 Washington Street, Suite 201
Wenatchee, WA 98801

RE: **Icicle Creek Water Resource Management Strategy – SEPA scoping**

Dear Director Kaputa:

Thank you for the opportunity to provide scoping comments on the Icicle Creek Water Resource Management Strategy. As non-profit organizations focused on conservation and recreation with members who live, work and play in the project area, we have a strong interest in current and future management activities in the Icicle Creek watershed and the Alpine Lakes Wilderness. Many of our organizations attended the informational and scoping meetings held in 2013-2016 regarding this proposal, and some of us have participated in Icicle Work Group meetings and have submitted comment letters previously. We appreciate the difficult challenge to provide instream flows and supply water for historic agricultural uses. There are impacts inherent in this, and Chelan County should work to minimize such impacts by prioritizing water conservation measures that are not detrimental to wilderness values. We are willing to work towards a solution. We support the tribes' insistence that any solution ensure adequate instream flows for fish. However, we are very concerned about the substantial impact of current and proposed water management activities on the lakes in the Wilderness, and the proposal to increase water diversions from seven lakes in the Alpine Lakes Wilderness that flow into Icicle Creek: Colchuck, Eightmile, Upper and Lower Snow, Nada, Lower Klonaqua and Square Lakes.

Chelan County and the Washington State Department of Ecology jointly issued a SEPA Determination of Significance, determining that a Programmatic Environmental Impact Statement (PEIS) is required, due to the proposal's probable significant environmental impacts. We agree with that determination, and we support the decision to prepare an EIS, given the scope and severity of the potential environmental impacts associated with the proposal.

After reading through the materials you published online, we offer the following comments:

Full range of alternatives

Key to the effectiveness of the EIS is presenting a full range of alternatives. "The range of alternatives considered in an EIS must be sufficient to permit a reasoned choice."[1] The proposed action and a "No Action" alternative do not present a sufficient range of alternatives, especially given the large scope of the overall proposal. Furthermore, the EIS cannot be constrained solely by the set of principles agreed to by the Icicle Work Group, as that would be contrary to law. "[A]n agency violates SEPA by shaping the details of a project before completing an EIS, effectively turning administrative approval into a 'yes or no' vote on that project as detailed, rather than allowing for the development and consideration of alternatives after the EIS is completed."[2] The large amounts of money that the Work Group has expended on the proposed action cannot be used to justify foreclosure of other reasonable alternatives.[3]

We suggest several other reasonable alternatives below to fully evaluate the project opportunities, impacts and needed mitigation. We believe that the alternatives below are reasonable and can "feasibly attain or approximate a proposal's objectives, but at a lower environmental cost or decreased level of environmental degradation."[4]

Wilderness Protection alternative

The Alpine Lakes Wilderness is a shared natural resource that many people use and care about; it must be respected and protected. It is the Wilderness area nearest to the millions of people who live in the Puget Sound metropolitan area, and is one of the most popular Wilderness areas in the United States. Alpine Lakes Wilderness has operated under a permit system for decades because of the popularity of this Wilderness with the people of Washington State. It has national importance as part of the National Wilderness Preservation System, and it is owned and visited by people from all over the country. It took many years of struggle and hard work by members of our non-profit organizations to establish the Wilderness.

The EIS should include a "Wilderness Protection" alternative. This alternative should promote Wilderness values in keeping with the Wilderness classification of the Alpine Lakes Wilderness area, while simultaneously meeting the objectives of the proposal. This alternative should not increase the amount of water removed from the Alpine Lakes Wilderness; not expand easements; not encroach on wilderness lands; not use mechanical transport; and not build any structure or

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[1] *Solid Waste Alternative Proponents v. Okanogan County*, 66 Wn.App. 439, 445, 832 P.2d 503 (1992).
[2] *Columbia Riverkeeper v. Port of Vancouver USA*, 189 Wn.App. 800, 818-19, 357 P.3d 710 (2015).
[3] *Id.*
[4] WAC 197-11-440(5)(b).

installation in the Wilderness. Rather, under the Wilderness Protection alternative, any new water supplies should be obtained from application of conservation measures and from sources outside the Wilderness, and use non-Wilderness options for improving instream flows (for example, the Icicle-Peshastin Irrigation District change in diversion point discussed below). The Wilderness Protection alternative should comply with all provisions in the Forest Service's administrative Alpine Lakes Area Land Management Plan, including: "Except as provided for in Section 4(d)(4) of the Wilderness Act, watersheds will not be altered or managed to provide increased water quantity, quality or timing of discharge."

The EIS list of relevant laws, rules and plans should include the Wilderness Act of 1964; the Alpine Lakes Area Management Act of 1976, the Alpine Lakes Area Land Management Plan (1981), and the Wenatchee NF Forest Plan (1990) as amended.

The Wilderness Protection alternative should evaluate public purchase (buy-back) of private water rights in the Alpine Lakes, which would allow removal of dams and other structures from the lakes to restore the Wilderness area to its true natural character.

The Icicle Work Group's guiding principle on Wilderness should be stated as a separate principle, and not subsumed or merged or blended into the other principles. Most of the Icicle Creek watershed is within the Alpine Lakes Wilderness.

Water Right Relinquishment alternative

We appreciate the irrigators' need for water to irrigate their orchards and keep them productive. We do not object to the exercise of valid, existing water rights of the Icicle-Peshastin Irrigation District, but we question any assertion of water rights that have been relinquished or are otherwise invalid.

The EIS should include a "Water Right Relinquishment" alternative. This alternative should analyze existing water rights to the Alpine Lakes and acknowledge those rights that have been relinquished or abandoned. Further, to the extent that relinquishment of water rights affects the basis of other alternatives, a relinquishment analysis should be part of each alternative considered. For example, has the Icicle-Peshastin Irrigation District (IPID) relinquished through non-use any part of the Eightmile Lake water right on which the dam rebuilding scheme is predicated? If so, it would be improper to analyze an alternative that is based upon the invalid assumption that IPID has valid water rights that would be needed to pursue the project.

The EIS should include an alternative that recognizes Icicle Work Group members' water rights are limited to the purposes for which they were initially granted (for example, agricultural irrigation) and cannot be redirected to other purposes (such as suburban development). Furthermore, all alternatives should be assessed for compliance with all applicable provisions of the Water Code, RCW 90.03.

Water Conservation alternative

The EIS should include a "Water Conservation" alternative that emphasizes aggressive water conservation measures by the City of Leavenworth, Icicle-Peshastin Irrigation District, the Leavenworth Fish Hatchery and other water users as a means to achieve the proposal's objectives. This alternative should consider the adoption of conservation measures (such as restrictions on watering lawns) that have been implemented in the Seattle area, where water consumption actually declined while the population increased. This alternative should also evaluate water markets that facilitate selling and trading of water rights.

The Water Conservation alternative should evaluate a transfer of water rights from IPID to Leavenworth for properties within the city limits that have now converted from orchards to residential properties. This alternative should analyze how appropriate reductions in water usage (that is, not using agricultural water quantities for lawn irrigation) would save water that would then be available for other Leavenworth needs.

The Water Conservation alternative should evaluate how IPID spills large quantities of water back into the Wenatchee River at the end of several of its canals. This alternative should evaluate how this 19th century irrigation practice (which was required to ensure water made it to the furthermost customers) could be replaced with modern pumping and piping technologies constructed outside of the Wilderness Area. The EIS should consider the resulting reduction in water demand as an alternative water supply.

A strong water conservation program can and should be a part of all the action alternatives, and should be compared to current practices (the No Action alternative).

Water Right Change alternative

The EIS should include a "Water Right Change" alternative. This alternative would evaluate improving Icicle Creek flows by moving IPID's point of diversion downstream (to the Wenatchee River). This measure, which would add 100 cfs of water to Icicle Creek every year, would convert the IPID diversion from gravity flow to pumping (requiring electrical power). This alternative should therefore analyze renewable energy options to supply that power, including solar, wind and in-canal hydroelectric. Options for changing the point of diversion have already been studied and information on their feasibility and costs is available.

Relationship Between NEPA & SEPA Review

The involvement of several federal agencies and the likelihood of significant environmental impacts justify a finding of significance under NEPA.[5] Therefore, it is imperative that the Forest Service, as the federal land manager of the Wilderness, take a hard look at the Wilderness impacts associated with the proposed projects.[6] If the proposed SEPA EIS is "programmatic" and contains no federal decisions, the SEPA EIS should say so explicitly and note that any project that requires a federal decision will require NEPA analysis and cannot rely solely on this

[5] 42 U.S.C. § 4332.
[6] *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).

SEPA EIS. It is unclear, from the documents produced thus far, how the SEPA and NEPA analyses will be related, if at all. Given the fact that the Wilderness Area is federally managed, the relationship between these two different review processes should be disclosed.

Climate Change Impacts Must Be Considered

The impact of each alternative on Icicle Creek's resilience to climate change, particularly with regard to changes in amount or timing of precipitation and instream flow, should be evaluated.[7] According to Ecology:

> *Climate Change will increase the variability – widening the range – of future supply and demand of water. As climate change shifts the timing and volume of streamflow and reduces snowpack , lower flows during the summer will make it more difficult to maintain an adequate supply of water for communities, agriculture, and fish and wildlife. Lower summer flows and higher stream temperatures will continue to degrade our water quality and place stress on salmon*.[8]

These impacts are foreseeable and must be assessed as part of the EIS.

Impacts of Water Withdrawal Must Be Analyzed

The EIS should discuss the hydrological and biological impacts of the current drawdowns of the lakes, and how the proposed changes will affect the current situation. The analysis should include a review of scientific literature on the impacts of water removals upon wildlife, vegetation, soil and wilderness values.

Operations, Maintenance & Environmental Monitoring Analysis

The EIS should provide a detailed operations, maintenance and environmental monitoring plan for the water infrastructure, and analysis of the wilderness impacts of specific maintenance actions, including helicopter use. The EIS should also provide a detailed accounting of budgets and funding sources for these items.

The Purpose & Need of the Project Should Be Identified

The EIS should fully explain the purpose and need for the water these projects would provide. We understand the need to increase instream flows in Icicle Creek, but what are the additional

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[7] RCW 43.21C.030(f) (SEPA is to be implemented in a fashion that "recognize[s] the worldwide and long-range character of environmental problems and, where consistent with state policy, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of the world environment."); WAC 197-11-444; *Rech v. San Juan Cnty*, 2008 WL 5510438 (Wash. Shorelines Hearings Bd.) (June 12, 2008) at *12 n.8 ("We further note an emerging trend in the case law under the National Environmental Policy Act ("NEPA") and state NEPA analogues in which courts are increasingly requiring agencies to analyze climate change impacts during environmental assessments.").

[8] Ecology, Preparing for a Changing Climate: Washington State's Integrated Climate Response Strategy (April 2012) at 101-102; *id.* at 103 (stating that climate change will lead to "increases in winter precipitation, posing additional challenges for managing reservoirs for flood control, fish, and hydropower.").

out-of-stream uses to be served by these projects? To what beneficial use will the additional water be put?

The EIS should fully explain what human activities caused the degraded conditions (such as low instream flows in Icicle Creek) that the projects seek to improve. We should not be repeating the mistakes of the past and this information is highly relevant as to the purpose and need of the projects in the first place.

Direct, Indirect & Cumulative Impacts Must Be Assessed

The EIS should analyze each proposed action's site-specific impacts, past practices, and the restoration, mitigation, and funding that would be needed in the future. At each site, proposed construction activities and proposed water diversions need to be spelled out in detail.

The direct, indirect and cumulative impacts of all proposed projects must be assessed.[9] Cumulative impacts include "the impact from the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions."[10] "A cumulative impact analysis need only occur when there is some evidence that the project under review will facilitate future action that will result in additional impacts."[11] Here, all of the projects are being analyzed in one EIS, are not speculative, and thus must be assessed in a holistic fashion. In addition, if the projects are going to be implemented in phases, that must be described and done in a manner that does not improperly segment the environmental impacts of all proposed projects.

Instream Flow Impacts on Fish and ESA Consultation

The EIS should analyze the adequacy of proposed instream flows to support spawning, rearing and migration of steelhead, salmon and bull trout. Each project's impacts on instream flows and the species likely to be affected should be identified. Under the Endangered Species Act, the Upper Columbia River distinct population segment of steelhead is listed as a threatened species, and the Upper Columbia River spring-run Chinook salmon evolutionary significant unit is listed as endangered. Therefore, consultation under the Endangered Species Act must be required. Icicle Creek contains some of the last remaining nearly pristine habitat available to these fish. Icicle Creek is designated critical habitat for the Upper Columbia River steelhead and contains spawning, rearing, and migration habitat for this species. Upper Columbia River spring-run Chinook salmon also spawn in Icicle Creek. However, human activities have lowered instream flows and devastated these fish in Icicle Creek.

Information on Existing Diversions Is Needed

The EIS should include maps, diagrams and photos to clearly show the current situation (including the place of diversion and amount of water diverted) at each of the lakes and other project locations and how that would change under the proposed action(s) under each alternative.

[9] WAC 193-11-060(4).
[10] 40 C.F.R. § 1508.7.
[11] *Boehm v. City of Vancouver*, 111 Wn.App. 711, 720, 47 P.3d 137 (2002).

Thank you for considering these comments.

Sincerely,

Karl Forsgaard, President
Alpine Lakes Protection Society (ALPS)

Trish Rolfe, Executive Director
Center for Environmental Law & Policy

Harry Romberg, National Forests Chair
Washington State Chapter
Sierra Club

Mark Boyar, President
Middle Fork Recreation Coalition (MidFORC)

John Spring, Manager
Spring Family Trust for Trails

Brock Evans, President
Endangered Species Coalition

Dave Kappler, President
Issaquah Alps Trails Club

Shelley Spalding, Climate Action Liaison
Great Old Broads for Wilderness

Kathi & Greg Shannon, Steering Comm members
Friends of the Enchantments

Mike Garrity, Executive Director
Alliance for the Wild Rockies

Denise Boggs, Executive Director
Conservation Congress

Gary Macfarlane, Ecosystem Defense Director
Friends of the Clearwater

Lee Davis, Executive Director
The Mazamas

Tom Uniack, Executive Director
Washington Wild

Rachael Osborn
former member, Icicle Work Group

Gus Bekker, President
El Sendero
Backcountry Ski and Snowshoe Club

Mike Town, President
Friends of Wild Sky

Tom Hammond, President
North Cascades Conservation Council

Chris Maykut, President
Friends of Bumping Lake

William Beyers, President
Alpine Lakes Foundation

George Nickas, Executive Director
Wilderness Watch

George Milne, President
Federation of Western Outdoor Clubs

Tom Martin, Council Member
River Runners For Wilderness

Larry Campbell, Conservation Director
Friends of the Bitterroot

Kurt Beardslee, Executive Director
Wild Fish Conservancy

Tom Gauron, President
Kittitas Audubon Society

Janine Blaeloch, Executive Director
Western Lands Project

Doug Scott, Principal
Doug Scott Wilderness Consulting

Lori Andresen, President
Save Our Sky Blue Waters

Robert Angrisano, President
Kachess Homeowners Association

Terry Montoya, President
Kachess Ridge Maintenance Association

Thomas O'Keefe, PhD
Pacific Northwest Stewardship Director
American Whitewater

Melissa Bates, President
Aqua Permanente

Art Campbell, President
North Central Washington Audubon Society

Bill Campbell, President
Friends of Lake Kachess

Jerry Watts, Chair
Board of Fire Commissioners
Kittitas County Fire District #8

Brian Hoots, President
Spokane Mountaineers

Clay Antieau, President
Washington Native Plant Society

John Brosnan, Executive Director
Seattle Audubon Society

Connie Gallant, President
Olympic Forest Coalition

Cc: Tom Tebb, Department of Ecology
other Icicle Work Group members
Governor Jay Inslee
U.S. Senator Patty Murray
U.S. Senator Maria Cantwell
U.S. Representative Dave Reichert
U.S. Interior Secretary Sally Jewell
U.S. Bureau of Reclamation Commissioner Michael Connor
U.S. Forest Service, Regional Forester Jim Pena
Okanogan-Wenatchee National Forest Supervisor Mike Williams
Wenatchee River District Ranger Jeff Rivera

WASHINGTON STATE DEPARTMENT OF
Natural Resources

PETER GOLDMARK
Commissioner of Public Lands

May 11, 2016

Mike Kaputa
Chelan County Natural Resource Dept.
411 Washington Street, Suite 201
Wenatchee, WA 98801

SUBJECT: Icicle Creek Water Resource Management Strategy

We've searched the Natural Heritage Information System for information on rare plants or rare and/or high quality ecological communities in the vicinity of your project. A summary of this information accompanies this letter (Excel file; GIS shapefile). In your planning, please consider protection of these significant natural features, and feel free to contact us for consultation.

The information provided by the Washington Natural Heritage Program is based solely on existing information in the database. There may be significant natural features in your study area of which we are not aware. These data are being provided to you for informational and planning purposes only - the Natural Heritage Program has no regulatory authority. This information is for your use only for environmental assessment and is not to be redistributed. Others interested in this information should be directed to contact the Natural Heritage Program.

The Washington Natural Heritage Program is responsible for information on the state's rare plants as well as high quality ecosystems. For information on animal species of concern, please contact Priority Habitats and Species, Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia WA 98501-1091, or by phone (360) 902-2543.

For more information on the Natural Heritage Program, please visit our website at http://www.dnr.wa.gov/natural-heritage-program. Species lists and fact sheets, as well as rare plant survey guidelines are available for download from the site. For the self-service system, please follow the Reference Desk link to Location Search. Please feel free to call us at (360) 902-1667 if you have any questions, or e-mail us at natural_heritage_program@dnr.wa.gov.

Sincerely,

Jasa Holt, Data Specialist

Washington Natural Heritage Program
Forest Resources and Conservation Division

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
Central Washington Field Office
215 Melody Lane, Suite 103
Wenatchee, Washington 98801

May 11, 2016

In Reply Refer To:
USFWS Reference: 01EWFW00-2016-TA-0800
Hydrologic Unit Codes: 17-02-00-11-04

Tom Tebb
Director, Office of Columbia River
Washington State Department of Ecology
1250 West Alder Street
Union Gap, WA 98903-0009

Mike Kaputa
Director, Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801

RE: Scoping Comments on the Programmatic Environmental Impact Statement (PEIS) for the Icicle Creek Water Resource Management Strategy

Dear Mr. Tebb and Mr. Kaputa:

This responds to your request for scoping comments to assist with the development of a Draft State Environmental Policy Act (SEPA) PEIS for the Icicle Creek Water Resource Management Strategy (ICWRMS). The U.S. Fish and Wildlife Service's (Service) Central Washington Field Office has participated periodically in the Icicle Work Group (IWG) meetings with a focus on implementation, consultation, and recovery planning issues surrounding the ICWRMS. The Service supports developing the PEIS to assess projects that could provide a more secure water supply for agricultural and municipal uses as well as advancing the conservation of species. The Service encourages continued coordination and collaboration with federal stakeholders as site-specific projects are developed and packaged for National Environmental Policy Act (NEPA) review, consultation in accordance with Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*), and for the implementation of priority recovery actions associated with Section 7(a)(1) of the ESA.

General Comments

1. Many of these proposed actions appear to be a "water resource development" as defined by the Fish and Wildlife Coordination Act (FWCA), as amended (16 U.S.C. 661 *et seq.*). The FWCA was developed to ensure that fish and wildlife resources receive equal consideration as other aspects of a water resource development project. The FWCA requires the federal agencies involved to consult with the Service and the state fish and wildlife agency (Washington Department of Fish and Wildlife, WDFW) to request a Coordination Act Report (CAR). The CAR assesses the effects of the action, considers the fish and wildlife resources at risk, and recommends measures to protect, develop, and improve these habitats. Although not binding, the federal agency must strongly consider the recommendations of the CAR to prevent loss or damage to fish and wildlife resources and to mitigate any unavoidable impacts.

   Although the ICWRMS is a non-federal effort not directly bound by the FWCA, many or perhaps all of the subsequent steps of implementation appear to have at least one federal agency involved. Rather than conducting several individual CARs for each successive step implementing the ICWRMS, the Service recommends a more comprehensive and efficient approach. The Service recommends a single CAR be produced for the entire ICWRMS in collaboration with the Department of Ecology, Chelan County Natural Resources Department, WDFW, and the Service. We look forward to future discussions regarding this possibility.

2. Please describe the sequencing and timing of projects, and how increased instream flows will be metered out among the beneficiaries of flow increases, as projects are implemented. This will ensure that all stakeholder groups have a clear understanding of project implementation timelines and associated instream benefits for each projects (i.e. when and how much water will be in Icicle Creek and over what timeframe). Similarly, develop a phased implementation schedule to facilitate Section 7(a)(2) consultation with the Service to assess individual and cumulative impacts of implementing projects under the ICWRMS.

3. To improve and expedite any Section 7(a)(2) consultation for individual ICWRMS projects, please insure appropriate coordination with the Service's Central Washington Field Office and federal partners (especially land management agencies such as the Forest Service) occurs early in the planning and implementation schedule. Early and often coordination and engagement with the Service is the single best way to foster an efficient consultation environment.

4. The Service encourages the Department of Ecology and Chelan County Department of Natural Resources to identify a single federal agency to lead the Section 7(a)(2) consultation and NEPA processes. At the April 20, 2016, ICWRMS open house, it appeared that some individual projects could have several federal agencies involved. In these cases, we recommend that the federal agency with the higher NEPA standards be the lead action agency (i.e., so one NEPA document can meet both agencies standards).

5. We have also reviewed scoping comments prepared by the WDFW on the ICWRMS. We find the WDFW comments to be very thoughtful and detailed, and we hope they are carefully considered. Although the WDFW comments extend to areas outside of the Service's purview, we endorse the spirit and content of their comments that all reflect a clear desire to protect fish and wildlife resources.

Thank you for your assistance in the conservation of listed species. If you have any questions or comments regarding this letter, please contact Jeff Krupka at the Central Washington Field Office in Wenatchee at (509)665-3508, extension 2008, or via e-mail at jeff_krupka@fws.gov.

Sincerely,

Steve Cloa for

Eric V. Rickerson, State Supervisor
Washington Fish and Wildlife Office

cc: Via e-mail;
Carmen Andonaegui, WDFW, Region 2 Habitat Program Manager
Charity Davidson, WDFW Environmental Planning Coordinator
Dave Irving, USFWS, Leavenworth Fisheries Complex
Jeff Rivera, OWNF, Wenatchee River Ranger District

American Rivers | The Wilderness Society
Washington Trails Association

May 11, 2016

Tom Tebb
Director, Office of Columbia River
Washington Department of Ecology
1250 Alder Street
Union Gap, WA 98903

Mike Kaputa
Director, Chelan County Natural Resources Department
411 Washington Street, Suite 201
Wenatchee, WA 98801

Submitted electronically on May 11, 2016 to Mike Kaputa.

RE: Request for Comments on the Scope of the Programmatic Environmental Impact Statement (PEIS) for the Icicle Creek Water Resource Management Strategy (Icicle Strategy)

Dear Directors Tebb and Kaputa:

Thank you for the opportunity to provide scoping comments on the Icicle Creek Water Resource Management Strategy (Icicle Strategy). The Washington State Department of Ecology (Ecology) directed the Chelan County Natural Resource Department (CCNRD) to develop a PEIS for the Icicle Strategy. Scoping comments gathered on the potential project package established by the Icicle Work Group (IWG) will be used to inform a draft State Environmental Policy Act (SEPA) PEIS for the Icicle Strategy. Our organizations appreciate the opportunity to provide feedback on the current proposal.

The project area of the Icicle Strategy proposal encompasses one of the most iconic - and treasured - wilderness areas and one of the most visited valleys in the state. Thousands of hikers and adventurers explore the Alpine Lakes Wilderness each year, and the Enchantments Lakes Region specifically. Our organizations and members have great interest in the management and stewardship of these lands, and are committed to working to ensure wilderness, recreation, and scenic values are protected into the future.

SEPA Purpose

The purpose of the SEPA PEIS is to address probable significant adverse impacts associated with implementation of a suite of projects within the Icicle Creek basin aimed at enhancing streamflow and habitat conditions for fisheries and other aquatic organisms, improving operational flexibility and water storage at high-alpine lakes within the Alpine Lakes Wilderness, maintaining water security and supply reliability for out-of-stream users of Icicle Creek water, and reinstating water reserves that will facilitate growth and development in Chelan County. The primary purpose of the SEPA PEIS is to help clarify resources and information that will inform programmatic environmental review for the Icicle Strategy as well as individual environmental review processes for each project.

The undersigned organizations understand that current suite of projects proposed by the IWG for public comment does not necessarily represent the final project package nor approval of individual projects in the PEIS. We do hope the concerns and comments provided below will inform further refinement of the current suite of projects.

Concerns and Comments

The undersigned organizations are pleased to share the following concerns and comments that should be addressed during the SEPA review and PEIS development.

1. Alpine Lakes Wilderness Area Compliance and Impacts

Icicle Creek is a major tributary to the Wenatchee River in Chelan County, and the Icicle Creek watershed encompasses an area of approximately 212 square miles, most of which is designated as the Alpine Lakes Wilderness (ALW) and currently managed by the U.S. Forest Service. The 920,000-acre ALW was designated in 1976 to protect some of the most wild, rugged, scenic, and beloved lands in the Central Cascade Mountains.

One of the seven guiding principles cited in the Icicle Strategy is to "comply with State and Federal Law, and Wilderness Acts." Several layers of law are relevant to the projects and actions proposed in the Icicle Strategy, and in many ways, the interpretation of those laws will determine the viability of the projects proposed at the wilderness lakes, specifically the restoration/repair at Eightmile Lake as well as automation and optimization efforts. It is our understanding that the U.S. Forest Service has participated in the IWG, but has not provided any specific guidance on the projects proposed and how such proposals comply with current management agreements with the Icicle-Peshastin Irrigation District or the suite of wilderness laws relevant in this situation, including the 1964 Wilderness Act, 1976 Alpine Lakes Area Management Act, and the 1981 Alpine Lakes Wilderness Management Plan (ALWMP). Such interpretation and guidance from the U.S. Forest Service is imperative, and should happen as a part of the SEPA process. Relevant direction from these laws is cited below and requires federal interpretation and development of guidance for federal actions in relation to the Icicle Strategy.

From the 1964 Wilderness Act, Section 4(d)(4), related to the requirement of Presidential approval of facilities, including water resources, that are not compliant with wilderness regulations:

> *Within Wilderness areas in the national forests designated by this Act, (1) the President may, within a specific area and in accordance with such regulations as he may deem desirable, authorize prospecting for water resources, the establishment and maintenance of reservoirs, water-conservation works, power projects, transmission lines, and other facilities needed in the public interest . . . upon his determination that such use or uses in the specific area will better service the interests of the United States and the people thereof than will its denial…* [emphasis added]

From the 1964 Wilderness Act, Section 4(c), related to the concept of Minimum Requirements, and applicable to activities related to special provisions mandated by the Wilderness Act such as access to inholdings and maintenance of water developments:

> *Except as specifically provided for in this Act, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this Act and except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area.* [emphasis added]

From the 1981 ALWMP, related to specific management guidance for water resources:

> *Management Objective: to preserve water bodies and stream courses in a natural state with minimal modification or human-caused contaminants. . .*
>
> *Management Direction: (1) except as provided for in Section 4(d)(4) of the Wilderness Act, watershed will not be altered or managed to provide increased water quantity, quality or timing of discharge. . . (2) . . . long-term weather modification programs producing repeated or prolonged changes in the weather during any part of success years and having substantial impacts on the Wilderness resource will not be permitted. Prior to any weather management modification activity within the Alpine Lakes Wilderness, formal application must be filed and approved by the Chief of the Forest Service. The proponents must, through an environmental analysis accompanying their applications, provide reasonable, scientifically supportable assurance that their activities will not produce permanent or substantial changes in natural conditions, nor will they include any feature that might reasonably be expected to produce conditions incompatible in appearance with the environment or reduce the values for with the Wilderness was created.* [emphasis added]

Because of the constraints related to water resource management in wilderness established by federal law, our organizations recommend the IWG explore non-Wilderness options for improving instream flows (for example, the IPID change in diversion point discussed below).

2. Recreation Impacts
The Alpine Lakes Wilderness and the lands surrounding the wilderness are one of the most popular recreation destinations in the state for hikers, climbers, backcountry skiers, snowshoers and others who enjoy getting out on our public lands. The Enchantment Lakes region is considered one of Washington's iconic areas, filled with crystal-clear blue lakes, subalpine meadows and rocky spires. Thousands of people come from all over the world to visit this area. The Enchantment Lakes region is so popular and fragile due to its higher elevation that the Forest Service instigated a backcountry camping permit system years ago, and has since expanded the season during which permits are required. Now, the Enchantment Lakes sees hundreds of people visiting for a day hike, alpine climb or week-long backpacking trip each summer.

We are very concerned by the potential negative impacts to recreation in the Enchantment Lakes region. These impacts should be identified through the PEIS and alternatives should be provided that avoid all negative impacts to this fragile and beloved area. Impacts to aesthetics, user experience, trails, access and camping should be included in the analysis and alternatives provided that result in no net loss of recreational access and experience.

3. Water Rights Issues
Our organizations understand and appreciate the need for water to irrigate orchards and keep them productive. We do not object to the use of valid, existing water rights in the Icicle-Peshastin Irrigation District. However, we are concerned that the scope of the Icicle Strategy may extend beyond the valid, existing water rights as limited by relinquishment and recorded agreements. We recommend that all water rights be analyzed for valid use.

4. Water Right Change
As part of the PEIS, our organizations recommend the evaluation of improving Icicle Creek flows by moving the Icicle-Peshastin Irrigation District's point of diversion downstream to the Wenatchee River. Our organizations support the alternatives analysis provided by Trout Unlimited for moving the IPID downstream.

5. National Environmental Policy Act
Our organizations understand that the National Environmental Policy (NEPA) process must be undertaken by a lead federal agency. At this time no lead agency has been identified. We recommend identification of a federal agency that will serve as the lead during NEPA processes. If any of the proposed projects cannot proceed until NEPA is completed, we recommend that these projects be identified so that interested stakeholders understand the timelines associated with project implementation.

6. Range of Projects
We understand that the success of the Icicle Strategy hinges on implementation of the full suite of proposed projects. However, it is unclear what projects have been identified to replace those in the proposed package should any one become unattainable due to logistics, lack of public support,

unanticipated expenses, or other reason(s). Our organizations recommend the development of a list of proposed project alternatives that will meet the Guiding Principles established by the IWG and that are practical, feasible and implementable. In addition to identifying potential replacement projects should one of the proposed projects drop from the final package, a comprehensive list of project alternatives will also demonstrate that the final package contains projects that have the greatest conservation benefit for the most effective cost.

Thank you for the opportunity to provide scoping comments on the Icicle Strategy. Our organizations support collaborative efforts to develop innovative and sound approaches to water and natural resource management for Icicle Creek and the greater Wenatchee basin and appreciate the commitment of member organizations, tribes, agencies, and individuals to this important endeavor. As we face a certain future of increased demands on limited water resources, such collaborative efforts will be required to balance the range of competing needs. Broad-based community involvement and support as well as transparency and trust are critical ingredients for success. Please feel free to contact representatives from the organizations listed below for further comments or questions.

Sincerely,

Andrea Imler Advocacy Director Washington Trails Association	Kitty Craig Washington State Deputy Director The Wilderness Society
John Seebach Vice President for River Basin Conservation American Rivers	Katherine Hollis Conservation and Advocacy Director The Mountaineers

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Thursday, May 12, 2016 8:59 AM
To: Jordan Sanford; Meghan O'Brien
Subject: FW: Public comment

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Wednesday, May 11, 2016 4:56 PM
To: Robert Welsh
Cc: Mary Jo Sanborn
Subject: RE: Public comment

Thank you, Bob and Linda. We'll get your comments into the record and considered during scoping. Appreciate the input…..Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Robert Welsh [mailto:welshrp@comcast.net]
Sent: Monday, May 09, 2016 9:29 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Public comment

Please be aware the Alpine Lakes Wilderness is a shared natural resource that must be respected and protected. Please do not seedk any increase in the amount of water removed from the Alpine Lakes Wilderness area. The Wilderness protection alternative should comply with all provisions in the Forest Service's administrative Aalpine Lakes Wilderness Management Plan, icluding: "except as provided for in Section 4 (d))4) of the Wilderness Act, watersheds will not be altered or managed to provide increased water quntitn, lquality or timing of discharge. The Water Conservation alternative should evaluate how IPID spills large quantities of water back into the Wenatchee River at eh end of several of its canals. The EIS should include a Water Right Change alternative . This would evaluate improving Icicle Creek flows by m9ving IPIDs point of divethe EIS should discuss the hydrological and biological impacts of the current drawdowns of thelakes, land any proposed changes actionss downstream . The EIS should analyze each proposed anction's site-specific inpacts, past practices, and the restoration, mitigation, and funding that are needed in the future. The EIS should provide a detiled operationds maintenance and envioronmental monitorins plan for the water insfrastructure, and analysis of the wilderness impacts of the specific maintenancae actions including helicoter use. The EIS should fully explain the prupose and need for the water these projects would provide. The EIS shold fully explain what human activities caused the degraded conditions that the projets seek to improve. WE SHOULD NOT BE REPEATING THE MISTAKES OF THE PAST.   Thank You. Bob and Linda Welsh

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Thursday, May 12, 2016 9:08 AM
To: Jordan Sanford; Meghan O'Brien
Subject: FW: comments concerning the Icicle Work Group's "Icicle Strategy"

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Wednesday, May 11, 2016 5:01 PM
To: Chester Marler
Cc: Mary Jo Sanborn
Subject: RE: comments concerning the Icicle Work Group's "Icicle Strategy"

Thanks, Chester, we'll get your comments into the record and considered during scoping. Much appreciated.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Chester Marler [mailto:northfork@nwi.net]
Sent: Wednesday, May 11, 2016 4:18 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: comments concerning the Icicle Work Group's "Icicle Strategy"

Hello Mike—pleased to see Chelan County and DOE initiating this collaborative effort. A few comments follow:

? Eightmile Lake restoration—would like to have the PEIS uncover the documentation that establishes the historic high water line. I was unaware it was so high, rather surprised. Also I assume some adverse affects to recreation values from both the raising of the lake in the spring and lowering to levels below current drawdown. Mitigation might include some trail re-routing around the lake, constructing new campsites on higher ground, softening the appearance of vegetation removal for the higher reservoir, etc. PEIS need to acknowledge the goal of protecting Wilderness values, not simply meet the letter of the law—acknowledge the feelings of Wilderness enthusiasts.

? Optimization and modernization of the flow from the lakes are great—should have been accomplished long ago.

? Water conservation by IPID and COIC does not appear as robust as it could. This should be more specific—not so many “mays” or “coulds”. Both districts need to address the non-agricultural use of a significant portion of their water—watering of extravagant and very large “lawns”. This tends to lessen the public image of the districts, and makes one wonder if legislative changes to the state’s water rights laws are in order. Better to address the issue without regulation and use common sense ethics instead. As we all know water will be increasingly precious in the decades to come.

At some point in the future the pressure on water resources will be much greater and I would not be surprised to see many responsible citizens asking for fundamental changes to water law. This could include reducing water rights when lands change from agricultural use to suburban. A time will come in the NW when agriculture will need to use water much more sparingly—not more open canals and watering on windy, hot daytime periods. Perhaps the PEIS could look ahead and at least discuss how some of these issues will require being more flexible and creative in finding solutions.

Chester Marler
Leavenworth

May 11, 2016

Chelan County Natural Resources Department
Attention: Mike Kaputa, Director
411 Washington Street, Suite 201
Wenatchee, WA 98801

Via email to: *mike.kaputa@co.chelan.wa.us*

RE: **Icicle Creek Water Resource Management Strategy – SEPA scoping**

Dear Mr. Kaputa:

I have visited the Alpine Lakes multiple times every year since 1969. In the 70s and early 80s my activity was primarily in the Icicle Creek drainage. This is a captivating place. I found that there were a lot of people who shared my attraction. Over time I spread my attention to other parts of the Alpine Lakes making room for others in the increasing popular Icicle. Overall, my visits to the Wilderness have been a highly meaningful part of my life.

For the most part I would consider myself an outdoor recreationist (climbing, backcountry skiing, hiking, kayaking among others). Occasionally, I have been motivated toward an activist role interacting with the USFS concerning their management of the Alpine Lakes Wilderness and surrounding areas. The "Icicle Creek Water Resource Management Strategy" generated by the Icicle Creek Working Group (ICWG) now draws my attention because of its significance locally for the Alpine Lakes Wilderness and potentially nationally for precedence with regard to the National Wilderness Act. I agree that a PEIS is needed and here respond to the request for comments on its scope.

My comments that follow are based on the public information at:
http://www.co.chelan.wa.us/ natural-resources/pages/icicle- work-group

Range of Alternatives. The PEIS needs to present a range of alternatives with significantly more extensive analysis than given in the present information for scoping. The issues are complex and significant. A single preferred-action proposal from a consensus group of stakeholders is inadequate.

Recognition of Wilderness values. All alternatives need to account for the special circumstances for construction and maintenance of structures in Wilderness Areas. The "SEPA Determination of Significance" does not even mention the Alpine Lakes Wilderness Area even though the "Primary Development Area" involved with the "Base Package of Projects" involves a significant footprint in the Wilderness. PEIS must recognize that the Alpine Lakes Wilderness is a community natural resource that must be respected and protected. Correspondingly, historical management of the the seven natural lakes that have served as storage reservoirs and associated legally-standing water rights must also be respected as important to the identity and economic well-being of the local community. However, that does not justify nor does the Wilderness Act allow expansion of storage facilities beyond actual traditional use without highest level decisions at the National level. Environmental analysis must include the direct biological and hydrological effects on lakes, surrounding terrain and outlet streams associated with management of the lakes in the past and and future for all alternatives. The PEIS list of relevant laws, rules and plans should include the Wilderness Act of 1964; the Alpine Lakes Area Management Act of 1976, the Alpine Lakes Area Land Management Plan (1981), and the Wenatchee NF Forest Plan (1990) as amended.

Reduction of Wilderness footprint. The 7 managed lakes encompass the largest lakes and a significant fraction of the total lake area in the Icicle Creek drainage. That is a lot of impact for an area in the Cascades named for its unique lakes. Some alternatives (at least one and perhaps all) should include the aim to enhance Wilderness values through reduction in footprint, appearance of structures and the mode of maintaining them. What is the cost benefit ratio for each of the 7 managed lakes? Could one or more of them be returned to a natural condition without significant loss of flexibility or dependability? Could there be public buyback of associated water right to enable compensating adjustment on the user end? An alternative should explore this possibility.

Clarity about water rights and priority for in-stream flow. The PEIS needs to give historical background on actual water withdrawal and use and a clear explanation of corresponding water rights including identification of purposes for which they were granted. This background is needed for understanding the strategy (a preferred alternative?) presented by the ICWG. "The Projects" page for the present SEPA scoping proposes "the adoption of an integrated package of projects to meet agricultural and domestic water supply needs while increasing the amount of in-stream flow required to maintain healthy fish populations." The stated "Metrics" indicate significant gains for in-stream flow. Sounds good, but what is the actual priority when the inevitable water-availability crunches occur. In-stream water flow has generally been on the losing end. Given that the total water rights at times exceed the total flow, there must be some sort of relinquishment of priority to in-stream flows to make this work. This issue is especially important since increases in releasable water storage in the ICWG plan are associated with a specific water right holder (IPID) and corresponding specific use. Please make this explicit and more clear in the PEIS for the ICWG strategy and other alternatives, including one that does not increase storage in the Alpine Lakes.

Alternative diversion points. A pivotal issue for Icicle Creek in-stream flow appears to be the Boulder Field and the traditional stream bed downstream from the Irrigation Districts' diversion points. The most direct approach to enhancing in-stream flow in these sections would be to have diversion points farther downstream, possibly from the Wenatchee River and at multiple places. This is obviously unattractive since new infrastructure and pumping would be required. In order to minimize these requirements, this (these) diversion point(s) could be active only during drought conditions and withdraw only the amount needed to support the in-stream flow in the critical reaches between it and the normal-continuously operating, gravity flow diversion point upstream. Perhaps there would be a mechanism for in-stream flow to buy the gravity flow loss that the IPID would incur. (This raises a question in my mind: Does the IPID have a right to the potential energy of the water that it withdraws?)

Aggressive Conservation. Conservation is the only way to achieve a sustainable future. There is not more water. The ICWG discussion concerns manipulation of the timing of run off to maintain availability during the dry part of the year. This becomes more true with the disappearance of perennial snow and ice from the watershed. Some alternative(s) should put heavy emphasis on conservation and multiple (recycled) use.

Thank you for considering these comments.

Sincerely,

Charles Raymond
3798 NE 97th St.
Seattle, WA 98115

(206) 522-3798
cfr98115@gmail.com

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Thursday, May 12, 2016 9:16 AM
To: Jordan Sanford; Meghan O'Brien
Subject: FW: Alpine Lakes Wilderness comment

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Wednesday, May 11, 2016 9:53 PM
To: Patty D
Cc: Mary Jo Sanborn
Subject: RE: Alpine Lakes Wilderness comment

Thank you, Patty, we'll get your comments into the scoping process. I appreciate what you are saying.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Patty D [mailto:pattyd777@gmail.com]
Sent: Wednesday, May 11, 2016 8:35 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Alpine Lakes Wilderness comment

Dear Mr. Kaputa,

Alpine Lakes Wilderness provides a majestic, peaceful, and awe inspiring place for humans to be with nature. It provides a relatively undisturbed and pristine habitat for wild animals. Wilderness areas need to remain WILD. The short sighted efforts of some people to encroach on these shrinking areas of wilderness baffles me. We need to protect the area AND its water for the health of the earth, which provides for the health of the animals and the health of the humans. If we are to leave anything kind of habitable earth left for future generations, we must start protecting our environment and wild places NOW, not selling them out to the highest bidder.

I am sure that you will receive many letters with all the more technical points of concern highlighted about this proposed plan to dam and drain the alpine lakes, so I don't need to repeat all that. This appeal comes from the heart. Please, please, please use your position and ability to protect this gem of a wilderness area. The process must also include input from environmentalists and the people who value and visit softly this beautiful land. The time has come to limit human impact on these places. If there is not enough water for the humans, then limit the human expansion in the area. Don't drain and destroy the wilderness!

Thank you!

Sincerely,
Patricia Danner
Spokane County and Washington State lifelong resident and registered voter
Alpine Lakes Wilderness Hiker

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Thursday, May 12, 2016 9:17 AM
To: Jordan Sanford; Meghan O'Brien
Subject: FW: Icicle Basin water plan

Mary Jo Sanborn
Water Resource Manager
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411 Washington St., Suite 201
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From: Mike Kaputa
Sent: Wednesday, May 11, 2016 9:56 PM
To: Andy Zahn
Cc: Mary Jo Sanborn
Subject: RE: Icicle Basin water plan

Thanks, Andy, we'll consider your comments during the scoping process. I appreciate that you took the time to put these together.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Andy Zahn [mailto:cmotdibbler5@gmail.com]
Sent: Wednesday, May 11, 2016 1:26 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Icicle Basin water plan

Hello,

I am writing to comment on the Icicle basin water plan. I am especially opposed to the reconstruction of the Eightmile lake dam and any new construction on Klonaqua lakes.The Eightmile dam was destroyed so long ago that to rebuild the dam would be equivalent to constructing a dam on a lake where a dam has never existed before. This is a popular hiking destination, and the destruction of the shoreline would make it an unattractive place to visit. It would also be disruptive to the ecosystem, and overall a severe detriment to one of Washington's finest natural treasures. I feel the same regarding the proposed actions at Klonaqua lakes. Such projects are not compatible with the primeval character of wilderness. These are the two parts of the proposal with which I take the most issue, but I would like to express my disapproval of most everything else it contains. I would see all the Icicle Basin dams on alpine lakes removed and the region restored to its natural state. These structures are an ugly blemish on an otherwise pristine and spectacular region. Please explore other options such as water conservation rather than cause further degradation of the Alpine Lakes Wilderness.

Sincerely,
Andy Zahn,
Toutle, WA

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Thursday, May 12, 2016 9:17 AM
To: Jordan Sanford; Meghan O'Brien
Subject: FW: Icicle Creek Water Resource Management Strategy – SEPA scoping

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
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From: Mike Kaputa
Sent: Wednesday, May 11, 2016 9:57 PM
To: Laurel Schandelmier
Cc: Mary Jo Sanborn
Subject: RE: Icicle Creek Water Resource Management Strategy – SEPA scoping

Thanks, Laurel, received and will be considered during the scoping process.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Laurel Schandelmier [mailto:lschandelmier@gmail.com]
Sent: Tuesday, May 10, 2016 10:20 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Icicle Creek Water Resource Management Strategy – SEPA scoping

To whom it may concern,

Thank you for the opportunity to provide scoping comments on the Icicle Creek Water Resource Management Strategy. I am a concerned citizen who enjoys the fact that our Washington wilderness area and its natural resources are able to be shared by all. I understand that managing the resources in a fair and equitable way can be challenging, but I'd like to share my thoughts on this proposed plan.

I think the public would appreciate a better understanding of the purpose and intent of making these proposed changes to improve instream flows. Is the intent primarily to address current water rights that are not being satisfied? Are new water rights being issued? Who primarily stands to benefit from these increased flows? I would ask that other alternatives be considered in an effort to minimize, or even reverse damage to existing wilderness area.

A "Wilderness Protection" alternative that would not increase the amount of water removed from the Alpine Lakes Wilderness, not create a disturbance or encroach on wilderness lands, and not expand easements should be considered. Any new water supplies would ideally be obtained from non-wilderness sources and use non-wilderness options for improving instream flows. Additionally, evaluating the feasibility of purchasing back private water rights to the Alpine Lakes to allow removal of dams and other structures to restore the wilderness to its pre-developed state would be most preferred. If this is not possible, I agree that installing remotely controllable valves to allow for the controlled drawdown of lake levels over a season, responding to current weather patterns and water needs, would add flexibility and robustness to the system.

Alternatively, a "Water Right Relinquishment" option could analyze existing water rights to the Alpine Lakes if any have been relinquished or abandoned. Water rights should be limited to the purposes for which they were originally granted, such as for irrigation, and should not be redirected for other purposes, including suburban development. A "Water Conservation" option emphasizing aggressive water conservation measures by the City of Leavenworth and other water uses could analyze markets available for selling and trading water rights. For example, if some properties have been converted from orchards to residential properties, the water rights could be sold or traded accordingly. This option would have an "efficiency first" mentality: first, reduce the sources of water demand before looking to bringing in additional capacity. Aggressive reductions in water usage for non-agricultural purposes, such as watering lawns, could be encouraged through such measures as low-flow fixtures, drip irrigation, planting native species in gardens that require no or little irrigation, greywater recycling, and rainwater harvesting.

Additionally, the EIS should analyze each proposed action's site-specific impacts, past practices, and any restoration, mitigation, or funding needed in the future. For each site, proposed construction activities and water diversions should be laid out in detail. The EIS should discuss the hydrological and biological impacts of the current level of lake drawdown, as well as any proposed future changes. The analysis should include a review of scientific literature on how water removals impact wildlife, vegetation, soil, and overall ecosystems. A detailed operations, maintenance, and environmental monitoring plan for the water infrastructure alongside an analysis of wilderness impacts of specific maintenance actions should be included. The EIS should include maps, diagrams and photos to clearly show the current situation at each of the lakes and other project locations and how that would change under the proposed actions. The EIS should fully and completely explain the need for the water these projects would provide. What human activities caused the degraded conditions - i.e., low instream flows in Icicle Creek - should be identified, avoided in future, and ideally mitigated.

Thank you for considering these comments.

Regards,

Laurel Schandelmier

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Thursday, May 12, 2016 9:17 AM
To: Jordan Sanford; Meghan O'Brien
Subject: FW: Icicle strategy comment

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
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-----Original Message-----
From: Mike Kaputa
Sent: Wednesday, May 11, 2016 10:00 PM
To: Philip Fenner
Cc: Mary Jo Sanborn
Subject: RE: Icicle strategy comment

Thank you, Philip, comments received and will be considered during scoping.

We will have another Seattle meeting this summer and possibly a hike to Eightmile in September so hope you can continue participate.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

-----Original Message-----
From: Philip Fenner [mailto:pfitech.seanet.com@gmail.com]
Sent: Tuesday, May 10, 2016 8:18 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>

Subject: Icicle strategy comment

I attended your meeting in Seattle and wanted to thank you for coming here to tell us what you'd like to do in Alpine Lakes Wilderness.

I understand the rationale behind your proposal to revive the old dams on some of the lakes there. I can see why you would like to do it. But I don't think you should. Doing that ought to be the absolute LAST thing you consider if water in the Wenatchee basin runs low. And here's why: Alpine Lakes Wilderness is a sacred place, in many ways to many people. It should not be subjected to artificial manipulation - period. Just because it was manipulated in the past is no reason to start manipulating it again now.

Those old decrepit dams should be left to deteriorate naturally as they have been, to keep the current lake levels as unchanged as nature allows. Just the sheer amount of motorized incursions into Wilderness there to rebuild those dams and associated infrastructure is in itself anathema to what Wilderness is and represents - the last enclave of natural processes "untrammeled by man." Choppering-in concrete and construction equipment would be as appropriate there as in the Sistine Chapel! No, come to your senses and if you're short on water do EVERYTHING else first, starting with a ban on lawn watering and taking other such water conservation measures. And the fish hatchery is a big water waster, fix that first. It just makes NO sense to damage a natural area if anything else could be done beforehand to see if the water equation could work without damaging Wilderness.

We're in the Age of Elwha now, we're looking at taking out dams and restoring natural waters. The last thing we should be doing (literally) is building up old dams anywhere.

You started your talk by saying you didn't understand why you hadn't made any progress getting this Icicle Creek watershed management plan done for so long.... Maybe it's because so many people don't want you to touch Wilderness. It's probably as simple as that.

Philip Fenner
Seattle

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Thursday, May 12, 2016 9:18 AM
To: Meghan O'Brien; Jordan Sanford
Subject: FW: IWG comments from public on PEIS

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
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www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Wednesday, May 11, 2016 10:04 PM
To: GW Shannon
Cc: Mary Jo Sanborn
Subject: RE: IWG comments from public on PEIS

Thanks, Greg, we'll get these comments into the record.

Are you related to Kathi Rivers-Shannon? I wanted to reach out to her and discuss the effort to look at recreation impacts and how the Icicle Work Group efforts might be integrated with that one.

Thanks.

Mike

From: GW Shannon [mailto:gwshannon@gmail.com]
Sent: Tuesday, May 10, 2016 6:10 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: IWG comments from public on PEIS

Mike Kaputa, Director

Mike.kaputa@co.chelan.wa.us

Chelan County

411 Washington Street, Ste. 201

Wenatchee, WA 98801

Re: Icicle Work Group; Comments on the scope of the PEIS

Dear Mr. Kaputa:

I have concerns about the collaborative efforts by members of the Icicle Working Group and the agency participation in the study. It seems awkward or unprofessional to have agencies commit to a number of projects with either a yes or no in advance of public and environmental review on specific projects. The premise the IWG has in regards to the project goals, second paragraph, also seems flawed *"If a project is determined to be fatally flawed, it must be replaced or modified to ensure all guiding principles are met."* How can IWG be realistically committed to that goal without specific project and environmental assessments. It sounds as if successful projects with proper funding and meeting public and environmental review could be jeopardized or delayed because other projects were cancelled.

The process feels to me like backroom politics, especially with a $2,885,000 budget since 2012. For example, Icicle-Peshastin Irrigation District's manager said to me in person at the meeting that if they accessed water (either tunnel or pipe) from Upper Klonaqua Lake, they would give that water to the Department of Ecology for fish purposes. I wonder what the Irrigation District will get in return from the Department of Ecology? I am under the impression that water the irrigation district utilizes shall only be used for irrigation purposes.

I also have a concern about increasing water for development (transfer of water rights) without having a detailed PEIS alternative to look at major conservation of water by all users. Even though the amount seems minimal, is the water coming from Icicle-Peshastin Irrigation District's increased flow through optimization or from reduced use of water by the Leavenworth Fish Hatchery, or other source? Why is the hatchery's participation even needed in the working group as they already have federal mandates to reduce water usage and their funding will come from federal sources?

Is it true that the US Forest Service is not a voting member of the IWG? If they aren't a voting member, it seems that they should be to represent the Alpine Lakes Wilderness. Many of the projects take place in wilderness and those wilderness impacts and considerations are not being considered. The Alpine Lakes Wilderness is more than a reservoir. It is a unique wilderness with many shared natural resources used by the public. The Forest Service has a mandate to protect wilderness resources even though Icicle-Peshastin Irrigation District has water rights for irrigation purposes. As stated in the Forest Service's policy:

> *In wildernesses where the establishing legislation permits resource uses and activities that are nonconforming exceptions to the definition of wilderness as described in the Wilderness Act, manage these nonconforming uses and activities in such a manner as to minimize their effect on the wilderness resource.*

In fact, are there not water right issues that are involved at Eight-Mile Lake that have not be resolved or will need to be resolved in the courts? Any impacts in the Alpine Lakes Wilderness should be addressed in a specific alternative. In looking at the estimated cost of optimization at the seven lakes (reservoirs) which is estimated at $680,000.00, has the IWG looked at the Alpine Lakes Wilderness Management Plan in that regard? In Section 4(d)(4) of that plan, it states "*watersheds will not be altered or managed to provide increased water quantity, quality or timing of discharge."*

Why are the releases set infrequently under current management? It seems you could hire a couple high school graduates to camp out part of the summer with a radio at different lakes to gain a level optimization close to what the irrigation district is to trying to achieve at a much lower cost. The irrigation district would still have maintenance and monitoring costs associated with any optimization of the dams.

Thank you for this opportunity to comment on the Icicle Work Group's anaylsis.

Greg Shannon

313 Olive Street

Cashmere, WA 98815

c. Governor Jay Inslee

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Thursday, May 12, 2016 9:19 AM
To: Meghan O'Brien; Jordan Sanford
Subject: FW: Uphold the water rights of Icicle-Peshastin Irrigation District

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
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From: Mike Kaputa
Sent: Wednesday, May 11, 2016 10:05 PM
To: Mary Jo Sanborn
Subject: FW: Uphold the water rights of Icicle-Peshastin Irrigation District

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From: rmullins3316@frontier.com [mailto:rmullins3316@frontier.com]
Sent: Friday, May 06, 2016 1:22 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Uphold the water rights of Icicle-Peshastin Irrigation District

Chelan County Natural Resources Department
Attention: Mike Kaputa, Director

cc: Alpine Lakes Protection Society, El Sendero, Wilderness Watch.

My name is Robert Mullins. I am a resident and property owner in Leavenworth, WA. I have resided in Leavenworth and Chelan County since 1980.

This email is to comment in re the SEPA and any other consideration involving the rights of Icicle-Peshastin Irrigation District water rights and resultant uses in the areas overlaid by Alpine Lakes Wilderness.

I support, actually I demand, that Icicle-Peshastin Irrigation District will fully and completely use its water rights including any related construction, transportation, use of aircraft, use of power equipment, use of all legitimate activity, equipment, and construction related to full implementation of Icicle-Peshastin Irrigation District water rights and resultant uses in the Alpine Lakes Wilderness as existed before the creation of the Alpine Lakes Wilderness. These rights pre-exist- by many decades (!) - and are more important than the Alpine Lakes Wilderness and any uses of any visitors to the Alpine Lakes Wilderness.

Of interest, I have worked in advocacy in protection of Wilderness with those organizations copied above. I am a user of Wilderness. In advocacy, along with the above mentioned, in the cause of Wilderness Protection.

Specifically in the Alpine Lakes Wilderness, we have vigorously implored the protection of the Alpine Lakes Wilderness according to the 1964 Wilderness Act.

According to Law, per the 1964 Wilderness Act, the water rights of Icicle-Peshastin Irrigation District and all related equipment and activity are established. These organizations opposing complete and full implementation of the water rights of icicle-Peshastin Irrigation District are making demands contrary to Law, specifically contrary to the 1964 Wilderness Act.

I have hiked, camped, fished, skied, climbed throughout the lakes and areas surrounding the reservoir high lakes of the Icicle-Peshastin Irrigation District. I understand the water rights, my family and I are dependent on that water. I will point out that the negative impacts to be defined correctly are from the Wilderness tourists that enter the area or advocates who attempt to reduce or diminish the water rights of Icicle-Peshastin Irrigation District and all related equipment and activity. In other words. users of the Alpine Lakes Wilderness have been allowed to travel into the areas of the water rights of Icicle-Peshastin Irrigation District, Wilderness is an overlay of pre-existing water rights. Numerous examples exist of watersheds being closed to public entry in order to protect the resource.

I would invite the Wilderness users and advocates offended by this more important lawful water right to please stay near their own home and do not enter the area of the Alpine Lakes Wilderness that was overlaid on the the water rights of Icicle-Peshastin Irrigation District. If there is any conflict, the pre-existing entity, the water rights of Icicle-Peshastin Irrigation District and all related equipment and activity , must be protected, and therefore any unauthorized visitors to these areas must be prohibited from entry.

Sincerely,

Robert Mullins
234 Mine St.
Leavenworth, WA

Ann Fink
201 Mine Street
Leavenworth, WA 98826
northfork@nwi.net
May 11, 2016

Mike Kaputa
411 Washington Street, Suite 201
Wenatchee, WA 98801

RE: Icicle Working Group Proposals

Dear Mr. Kaputa:

Impacts to Recreational Use at Eightmile Lakes and other Lakes.

The Irrigation districts has easements on only 2 of the 4 sections that underlie Eightmile Lake. The other two sections are wilderness and don't appear to have "easements". Please explain how the IWG can flood congressionally designated wilderness lands without involving the U.S. Forest Service in these discussions. I do not see any consultation with the Forest Service listed in section 9 of your SEPA checklist until the point of obtaining permits is reached. Now is the time to address these issues.

I see that the question of water rights has been raised within the working groups. It has been suggested that since the district did not use all their rights in the Eightmile drainage that they might be forfeit. I do know that in the last 40 years of my activities in the Alpine Lakes Wilderness, I have never seen any drawdown of the reservoir. Admittedly, this anecdotal observation is highly sporadic, but, the question needs to be addressed. The Icicle Irrigation District should provide its records regarding its use of water from this lake.

Eightmile Lake is a very popular destination in the Alpine Lakes Wilderness Area. While Icicle Irrigation has rights to its existing dam and reservoir, the operation of these facilities will greatly impact the experiences of many, many wilderness users who use this area. I would like to see a discussion of how the Irrigation District and its partners will mitigate some of the ugly visual effects of raising the level of the lake and then lowering well below current levels. The effects to plants and wildlife need to also be addressed. Improvements at other lakes also need to consider the visual and ecological effects to

Remote monitoring and control of existing facilities appear to be a good modern option if the equipment needed for this activity can be blended into the surroundings without intruding on wilderness values.

Conservation:
The proposal includes many possible projects that include water conservation principals. But these projects are not definite and are described as might occur and maybes. Water conservation for the Leavenworth City Area is proposed but other water district users need to reduce their consumption of water. Agricultural practices need to be more efficient and reduce their water intake. The most egregious cases in point the emerald green lawns in the Ski Hill Area and Icicle Valley. While the Fish Hatchery has a legal mandate, it too needs to produce a

water savings with more efficient equipment and fish rearing techniques. These need to be “will happen” projects and not “mights” and “maybes”.

As we are all aware, the world of water availability is changing and we can no longer continue to be efficient under existing water laws. While these laws will not change for this project, the Icicle Working Groups needs to champion conservation measures and improved facilities (non-leaky) water distribution systems) for rational and equitable water distribution.

Sincerely,

Ann L. Fink

May 11, 2016

Chelan County Natural Resources Department
Attention: Mike Kaputa, Director
411 Washington Street, Suite 201
Wenatchee, WA 98801

Dear Mr. Kaputa,

I am writing to express my concerns about the proposed Icicle Creek Water Resource Management Strategy.

My first concern is that this project is being segmented to avoid a full environmental review under the National Environmental Policy Act (NEPA). The proposed project will affect an immense area and will require federal approval in the form of permits such as Clean Water Act National Pollutant Discharge Elimination System and § 404 permits and a special use permit from the Forest Service. To comply with NEPA, the environmental impacts of large projects requiring federal approval or using federal funding must be analyzed before the project begins.

My second concern is with the County's approach to tiered environmental review. During the public meeting in Seattle, you explained that Chelan County is not planning to conduct a programmatic NEPA analysis because it is conducting a programmatic State Environmental Policy Act (SEPA) review. Both the federal and state laws anticipate a tiered review for large and complex proposals such as the Icicle Creek Water Resource Management Strategy. To comply with NEPA the County must conduct a programmatic environmental review in addition to project specific analysis. Analysis under state law is a separate requirement and does not substitute for NEPA analysis. To comply with SEPA the County must also conduct a programmatic environmental review and project specific analysis.

My third and final concern is that the County has not adequately considered the federally designated wilderness that would be affected by the proposed project. The Wilderness Act restricts the activities that can occur, the structures that can be built, and the tolerable impacts in wilderness areas. It is troubling that the proposal and the public presentations contained no explanation of how the County intends to comply with the Wilderness Act. The public presentations implied that the County is trying to balance the need for water with the need for wilderness when Congress struck that balance over fifty years ago and established non-negotiable limits on wilderness use. When discussing compliance with the Wilderness Act the proposal is only to "identify and engage regulators in the process." The proposal would violate the Wilderness Act because it would install permanent fixtures in a designated wilderness. Simply engaging regulators does not remedy such a blatant violation of the Wilderness Act. The lack of consideration for required wilderness protection is a fatal flaw in the proposed Icicle Creek Water Resource Management Strategy.

I urge the county to consult the applicable federal laws, including NEPA, the Wilderness Act, and the Endangered Species Act, and to reconsider the proposed project before proceeding to violate them.

Sincerely,

Kimberly Wells

Jordan Sanford

From: Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent: Tuesday, May 10, 2016 4:31 PM
To: Jordan Sanford; Meghan O'Brien
Cc: Dan Haller
Subject: FW: Subject: Comments on Damming and Water Rights in Alpine Lakes Wilderness

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
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www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Tuesday, May 10, 2016 4:07 PM
To: Jerry Bodine
Cc: Mary Jo Sanborn
Subject: RE: Subject: Comments on Damming and Water Rights in Alpine Lakes Wilderness

Thanks, Jerry, we'll make sure your comments are entered in to the record. We plan on having another Seattle-area meeting and tour of Eightmile Lake so hope that you will be able to join us.

Mike

Mike Kaputa, Director
Chelan County Natural Resource Department
411 Washington Street, Suite 201
Wenatchee, WA 98801
Phone: (509) 670-6935

From: Jerry Bodine [mailto:jbodine.bwphotog@yahoo.com]
Sent: Monday, May 09, 2016 3:01 PM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Subject: Comments on Damming and Water Rights in Alpine Lakes Wilderness

Dear Mr. Kaputa,

I want to provide my input to the subject issues. As a member of the Alpine Lakes Protection Society (ALPS) for decades, I have very strong feelings about these proposed activities; I expended a great deal of effort in supporting ALPS' activities leading to the Wilderness designation for this area in the first place. My personal attitude, without delving deeply into the politics of policing the requirements of the Wilderness Act of 1964, is that those requirements are NON-DEBATABLE. PERIOD. Now, we are faced with a designated working group (IWG) that seems oblivious to those requirements and refuses to recognize them. For example, re-naming our beloved lakes as "reservoirs" really raised the hair on my neck, as well as other indications of their lack of caring about the preservation of Nature's "systems." Therefore, lacking a legal background or knowledge of the history of amendments to the "ACT" since its inception, I can only offer my support of ALPS' effort to resist IWG's proposals. With all this in mind, then, I offer a number of comments:

The Alpine Lakes Wilderness is a shared natural resource that must be respected and protected.

The EIS should include a "Wilderness Protection" alternative. This alternative should promote Wilderness values by not seeking any increase in the amount of water removed from the Alpine Lakes Wilderness; not expanding easements; not encroaching on wilderness lands; not using mechanical transport; and not building any structure or installation in the Wilderness. Under the Wilderness Protection alternative, any new water supplies should be obtained from sources outside the Wilderness, and use non-Wilderness options for improving instream flows (for example, the IPID change in diversion point discussed below). The Wilderness Protection alternative should comply with all provisions in the Forest Service's administrative Alpine Lakes Wilderness Management Plan, including: "Except as provided for in Section 4(d)(4) of the Wilderness Act, watersheds will not be altered or managed to provide increased water quantity, quality or timing of discharge."

The Wilderness Protection alternative should evaluate public purchase (buy-back) of private water rights in the Alpine Lakes, which would allow removal of dams and other structures from the lakes to restore the Wilderness area to its true natural character.

The EIS should include a "Water Right Relinquishment" alternative. This alternative should analyze existing water rights to the Alpine Lakes and acknowledge those rights that have been relinquished or abandoned.

The EIS should include an alternative that recognizes IWG members' water rights are limited to the purposes for which they were initially granted (for example, irrigation) and cannot be redirected to other purposes (such as suburban development).

The EIS should include a "Water Conservation" alternative that emphasizes aggressive water conservation measures by the City of Leavenworth, Icicle-Peshastin Irrigation District, the Leavenworth Fish Hatchery and other water users. This alternative should evaluate water markets that facilitate selling and trading of water rights.

The Water Conservation alternative should evaluate a transfer of water rights from IPID to Leavenworth for properties within the city limits that have now converted from orchards to residential properties. This alternative should analyze how appropriate reductions in water usage (that is, not using agricultural water quantities for lawn irrigation) would save water that would then be available for other Leavenworth needs.

The Water Conservation alternative should evaluate how IPID spills large quantities of water back into the Wenatchee River at the end of several of its canals. This alternative should evaluate how this 19th century irrigation practice (which was required to ensure water made it to the furthermost customers) could be replaced with modern pumping and piping technologies. The EIS should consider the resulting reduction in water demand as an alternative water supply.

The EIS should include a "Water Right Change" alternative. This alternative would evaluate improving Icicle Creek flows by moving IPID's point of diversion downstream (to the Wenatchee River). This measure, which would add 100 cfs of water to Icicle Creek every year, would convert the IPID diversion from gravity flow to pumping (requiring electrical power). This alternative should therefore analyze renewable energy options to supply that power, including solar, wind and in-canal hydroelectric.

The EIS should analyze each proposed action's site-specific impacts, past practices, and the restoration, mitigation and funding that are needed in the future. At each site, proposed construction activities and proposed water diversions need to be spelled out in detail.

The EIS should discuss the hydrological and biological impacts of the current drawdowns of the lakes, and any proposed changes. The analysis should include a review of scientific literature on the impacts of water removals upon wildlife, vegetation, soil and wilderness values.

The EIS should provide a detailed operations, maintenance and environmental monitoring plan for the water infrastructure, and analysis of the wilderness impacts of specific maintenance actions, including helicopter use.

The EIS should fully explain the purpose and need for the water these projects would provide.

The EIS should fully explain what human activities caused the degraded conditions (such as low instream flows in Icicle Creek) that the projects seek to improve. We should not be repeating the mistakes of the past.

The EIS should analyze adequacy of proposed instream flows to support spawning, rearing and migration of steelhead and bull trout.

Sincerely,
Jerry Bodine
585 SW Mt. Cedar Dr.
Issaquah, WA 98027

Californians for Western Wilderness

A project of Resource Renewal Institute

Coordinator
Michael J. Painter
(415) 752-3911

P.O. Box 210474
San Francisco
CA 94121-0474

e-mail:
info@caluwild.org

May 17, 2016

Mr. Mike Kaputa, Director
Chelan County Natural Resources Department
411 Washington Street, Suite 201
Wenatchee, WA 98801

Re: Icicle Creek Water Resource Management Strategy – SEPA scoping

Dear Mr. Kaputa:

I am writing on behalf of the more than 830 members and supporters of Californians for Western Wilderness (CalUWild), a citizens organization dedicated to encouraging and facilitating citizen participation in legislative and administrative actions affecting wilderness and other public lands in the West. Our members use and enjoy the public lands all over the West.

Although the formal deadline for submitting scoping comments has passed, CalUWild fully endorses the comments submitted by the Alpine Lakes Protection Society and 39 other organizations, dated May 11, 2016.

Thank you for your positive consideration.

Sincerely,

Michael J. Painter
Coordinator

Meghan O'Brien

From:	Mary Jo Sanborn <MaryJo.Sanborn@CO.CHELAN.WA.US>
Sent:	Tuesday, May 17, 2016 8:53 AM
To:	Jordan Sanford; Meghan O'Brien
Cc:	Dan Haller
Subject:	FW: Icicle watershed

This one came in after the 11th...

Mary Jo Sanborn
Water Resource Manager
Chelan County Natural Resource Department
411 Washington St., Suite 201
Wenatchee, WA 98801
Desk: (509)-667-6532
Cell: (509)-860-2135
www.co.chelan.wa.us/nr

From: Mike Kaputa
Sent: Monday, May 16, 2016 9:29 AM
To: Mary Jo Sanborn; dhaller@aspectconsulting.com
Subject: FW: Icicle watershed

One more comment.

From: Kayt Hoch [mailto:kayt@kaythoch.com]
Sent: Monday, May 16, 2016 9:15 AM
To: Mike Kaputa <Mike.Kaputa@CO.CHELAN.WA.US>
Subject: Icicle watershed

Hi Mike,

Anne and I both read the watershed working group information and had meant to write earlier. The proposed plan looks like a good approach to us as it seems to have minimal impact for a great benefit to the region. After reading the Sunday paper, I certainly hope there isn't going to be negative fall-out from the Puget Sound group.

The only curiosity I have is if you all have some construction impact estimations/projections re the dam rebuild at Eight Mile lake that you could share. After our personal experience with the quick recovery of our own property after the impacts from the bridge project I'm not concerned, just curious if you have any info.

Thanks for all the great work you and your department is doing!

Best always,
Kayt

APPENDIX B

Eightmile Lake Storage Restoration Feasibility Study

April 2018
Icicle Creek Water Resource Management Strategy

Eightmile Lake Storage Restoration Feasibility Study

Prepared for:
Icicle and Peshastin Irrigation Districts
Chelan County Natural Resources Department

Ecology Grant No. WROCR-VER1-ChCoNR-00002

April 2018
Icicle Creek Water Resource Management Strategy

Eightmile Lake Storage Restoration Feasibility Study

Prepared for
Icicle and Peshastin Irrigation Districts
P.O. Box 371
5594 Wescott Drive
Cashmere, Washington 98815

Chelan County Natural Resources Dept.
411 Washington Street, Suite 201
Wenatchee, Washington 98801

Prepared by
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, Washington 98101

Aspect Consulting, LLC
23 South Mission St.
Wenatchee, Washington 98801

Project Number: 140204-02
K:\Projects\Chelan_County\Icicle_Creek_Comp_Water_Mgt_Plan_(140204-02)\2016-2017 Work\Task 04A - Eightmile Lake Restoration Feasibility\Reports\Eightmile Lake - Feasibility Study - FINAL_2018-04-30.docx

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ABBREVIATIONS

AEP	Annual Exceedance Probability
Anchor QEA/Aspect	Anchor QEA, LLC, and Aspect Consulting, LLC
BGS	below ground surface
CCNRD	Chelan County Natural Resources Department
cfs	cubic feet per second
CMP	Corrugated Metal Pipe
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
DAHP	Washington State Department of Archaeology and Historic Preservation
DC	direct current
DEM	Digital elevation model
DF	design factor
DSO	Washington State Department of Ecology Dam Safety Office
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
GIS	Geographic information system
H:V	Horizontal to vertical
HDPE	High-density polyethylene
HEC-HMS	Hydrologic Modeling System
IDA	Incremental damage analysis
IDF	Inflow Design Flood
IID	Icicle Irrigation District
IPID	Icicle and Peshastin Irrigation Districts
IWG	Icicle Work Group
JARPA	Joint Aquatic Resource Application
L-Cv	Site-specific coefficient used in Dam Safety Office spreadsheet to calculate At-site Mean Precipitation.
L-Skew	Site-specific skew value used in DSO spreadsheet to calculate At-site Mean Precipitation
LNFH	Leavenworth Fish Hatchery
NAVD 88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service

NRHP	National Register of Historic Places
P_{gds}	Estimated 2-, 6-, or 24-hour precipitation for selected frequency
P_{sd}	Scaling precipitation for 2-, 6- or 24-hour index period
PEIS	Programmatic Environmental Impact Statement
Q	flow rate
Q_{min}	minimum flow rate
SEPA	State Environmental Policy Act
SNOTEL	Snow Telemetry
USGS	U.S. Geologic Survey
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
RCW	Revised Code of Washington
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WSEL	Water Surface Elevation

Executive Summary

Eightmile Lake is one of four lakes in the Alpine Lakes Wilderness Area managed by Icicle and Peshastin Irrigation Districts (IPID) to provide water storage for irrigation. A small dam, low-level outlet pipeline, and slide gate at the outlet of Eightmile Lake allow for controlled releases of stored water to supplement flows in Icicle Creek to increase water supply available for irrigation during low flow periods, which typically occur during the late summer. IPID has relied on Eightmile Lake and the other Alpine Lakes they manage for nearly 80 years. Eightmile Lake captures runoff from a 3,822-acre drainage basin. Due to the large size of the drainage basin relative to the storage volume in the lake, Eightmile Lake has a high potential for refill, even during dry years. Because the storage is so reliable and the lake is more accessible than the other Alpine Lakes that IPID manages, the lake is a critical piece of IPID's water supply infrastructure.

The infrastructure at Eightmile Lake is aging and will require improvement to continue to operate in a way that meets IPID's needs. The most urgent issue identified by IPID is that the low-level outlet pipe has collapsed in multiple locations, which has recently reduced the capacity of the pipeline and limits the rate at which IPID can release water to Icicle Creek. If the pipe is not replaced or repaired before the next big drought cycle, IPID will likely not be in a position to meet the irrigation water supply needs of the IPID water users. The gate that controls flow to the low-level outlet pipe also needs to be replaced. It was damaged by ice or debris and is now very difficult to open and close. In addition, the dam structure that allows IPID to store water has deteriorated. Erosion of the earthen embankment portion of the dam structure has reduced the active storage available for release by gravity without pumping or siphoning to less than 1,400 acre-feet. Some additional storage is released via seepage. Due to these limitations, improvements are needed to restore the useable storage capacity of Eightmile Lake to 2,500 acre-feet, which is the volume allowed for storage and release by IPID's water right for the lake. Improvements are also needed to ensure efficient control and release of water stored in the lake to meet downstream water supply and instream flow needs.

In addition, the Jack Creek Fire burned to the shoreline of Eightmile Lake in August of 2017. A large percentage of the Eightmile Lake watershed was damaged by the fire. The potential change in runoff resulting from the fire combined with deficiencies at the dam has caused concern on the part IPID, the Washington State Department of Ecology Dam Safety Office (DSO), and local emergency responders about the potential for a large runoff event to damage the dam or cause it to fail.

This Feasibility Study identified and evaluated the follow improvements for restoring the storage at Eightmile Lake and improving the control and release of water from the lake:

- Replacement of the dam with a reinforced concrete and earthen embankment structure that would have a primary spillway elevation of 4,671 feet, which would match the historical high water surface elevation (WSEL) in the lake and restore the useable storage capacity to 2,500 acre-feet.

- Construction of an embankment and secondary spillway structure in a low spot south of the existing dam to provide additional spillway capacity to meet Washington State Department of Ecology Dam Safety Office requirements.
- Replacement of the existing low-level outlet facilities with a new pipeline that would allow for greater flexibility in drawing down the lake. Flow through the new low-level outlet would be controlled by an automated valve. Telemetry would allow for remote access from IPID's office to operate the valve and optimize releases. The low-level outlet would operate by gravity when the lake is full and transition to siphon operation as the lake is drawn down.

The hydrology and hydraulics of the proposed lake operation under improved conditions was evaluated to inform the design, as required by Ecology's DSO. Consultation was initiated with DSO as part of this Feasibility Study to better understand their requirements for permitting construction of improvements to the dam and outlet facilities. DSO reviewed the draft Feasibility Study and provided general comments regarding the analysis and geotechnical evaluation of the proposed facilities that will be applied to the detailed design of the improvements. No changes were made to this report to reflect DSO comments regarding the detailed design of the proposed project. Those comments will be addressed through detailed design of the project. This study reflects the concept and feasibility-level analysis completed through the end of 2017 and does not include additional analysis requested by DSO in response to the Jack Creek Fire or recent emergency declaration by IPID. Consultation with DSO is ongoing and will continue through the design and construction of the proposed improvements. The calculations and sizing of facilities provided in this feasibility are based on conservative assumptions for hydrology and the impact that a dam breach would have on downstream properties. Additional analysis completed during detailed design may allow for some optimization of the size and configuration of dam and spillway facilities to reduce the cost and complexity of the project as much as possible.

Eightmile Lake Storage Restoration is one of several projects being evaluated under the direction of the Icicle Work Group. The multi-stakeholder group is working together to identify and evaluate projects that will improve management of water in the Icicle Creek Sub-basin. The group has adopted Guiding Principles that represent the collective goals established by the group for improving water management in the Icicle Creek Sub-basin. The proposed Eightmile Lake Storage Restoration project helps meet multiple prongs of the Guiding Principles, including augmentation of streamflow in Icicle Creek, providing additional water to meet municipal demands, improving agricultural reliability by increasing water supply available in the late summer, creating additional streamflow to meet fish passage and habitat goals, improving treaty and non-treaty harvest rights, and potentially making more water available to Leavenworth National Fish Hatchery.

The primary challenge to implementing this improvement project will be determining how to construct the project at a remote location within the Alpine Lakes Wilderness. IPID has an easement agreement with the USFS that was established when the property was transferred to the USFS for management as part of the Alpine Lakes Wilderness Area. The easement agreement allows IPID to continue to have access to the site, including with mechanized equipment, to maintain the facilities and to make full use of IPID's water right. However, the site is not accessible by roads. The Alpine Lakes are often accessed by IPID by helicopter for maintenance, but even the largest helicopters have payload limitations that will make mobilization of large equipment to the site a challenge. Options that were identified are transport of a smaller excavator by large helicopter, overland transport of a larger tracked excavator, or overland transport of a spider excavator. The approach will likely be dictated by funding, the equipment available, and permit approval constraints.

Another challenge to implementing this project that is closely related to the challenge of mobilizing equipment will be the narrow window available for construction. The lake will need to be drawn down to construct the project, which typically does not happen until late in the summer. IPID might be able to facilitate early drawdown of the lake for construction, but will be constrained by weather and runoff conditions in the early summer. Construction will need to be complete before significant snowfall and consistent freezing temperatures occur. Due to the elevation of the site, snowfall and consistent freezing temperatures are likely to occur in October or early November.

The estimated implementation cost of a project that would rely on helicopters to transport and mobilize equipment to the site is approximately $2.62 to $2.97 million. Based on the estimated useable storage that could be restored by the project (1,125 acre feet), the cost would be $2,329 to $2,644 per acre-foot of additional storage created.

1 Introduction

Eightmile Lake is one of four lakes in the Alpine Lakes Wilderness Area managed by Icicle and Peshastin Irrigation Districts (IPID) to provide water storage for irrigation. A small dam, low-level outlet pipeline, and slide gate at the outlet of Eightmile Lake allow for controlled releases of stored water to supplement flows in Icicle Creek to increase water supply available for irrigation during low flow periods, which typically occur during the late summer. The proposed Eightmile Lake Storage Restoration Project would replace the existing dam structure, low-level outlet pipeline, gate, and controls to restore the usable storage capacity of the lake and allow for automation and optimization of releases from the lake. This Feasibility Study summarizes the preliminary design analysis of proposed improvements that would restore the available storage capacity in Eightmile Lake to the volume that was historically available to IPID.

1.1 Compatibility with Icicle Strategy

The Eightmile Lake Storage Restoration Project is one of several potential projects currently being evaluated under the direction of the Icicle Work Group (IWG). The IWG is a multi-stakeholder group that was convened by Chelan County Natural Resources Department (CCNRD) and the Washington State Department of Ecology (Ecology) to take a comprehensive look at water resource management in the Icicle Creek Sub-basin. The IWG consists of federal, state, and local agencies; irrigation districts, including IPID; the City of Leavenworth; the Leavenworth National Fish Hatchery (LNFH); non-profit organizations; environmental groups; and other stakeholders. The IWG is working together to identify and evaluate projects that will improve management of water in the Icicle Creek Sub-basin and improve instream flow conditions in lower Icicle Creek. CCNRD retained Anchor QEA, LLC, and Aspect Consulting, LLC (Anchor QEA/Aspect), to complete this Feasibility Study. The study was funded under a grant from Ecology's Office of the Columbia River.

Projects endorsed by the IWG are collectively intended to meet the following nine Guiding Principles:

1. Streamflow that:
    a. Provides passage
    b. Provides healthy habitat
    c. Serves channel formation function
    d. Meets aesthetic and water quality objectives
    e. Is resilient to climate change
2. Sustainable hatchery that:
    a. Provides healthy fish in adequate numbers
    b. Is resource efficient
    c. Significantly reduces phosphorus loading
    d. Has appropriately screened diversion(s)

    e. Does not impede fish passage
3. Tribal Treaty and federally protected fishing/harvest rights are met at all times.
4. Provide additional water to meet municipal and domestic demand.
5. Improve agricultural reliability that:
    a. Is operational
    b. Is flexible
    c. Decreases risk of drought impacts
    d. Is economically sustainable
6. Improve ecosystem health including protection and enhancement of aquatic and terrestrial habitat.
7. Comply with state and federal law.
8. Protect Non-Treaty Harvest.
9. Comply with the Wilderness Act of 1964, the Alpine Lakes Wilderness Act of 1976, and the Alpine Lakes Wilderness Management Plan.

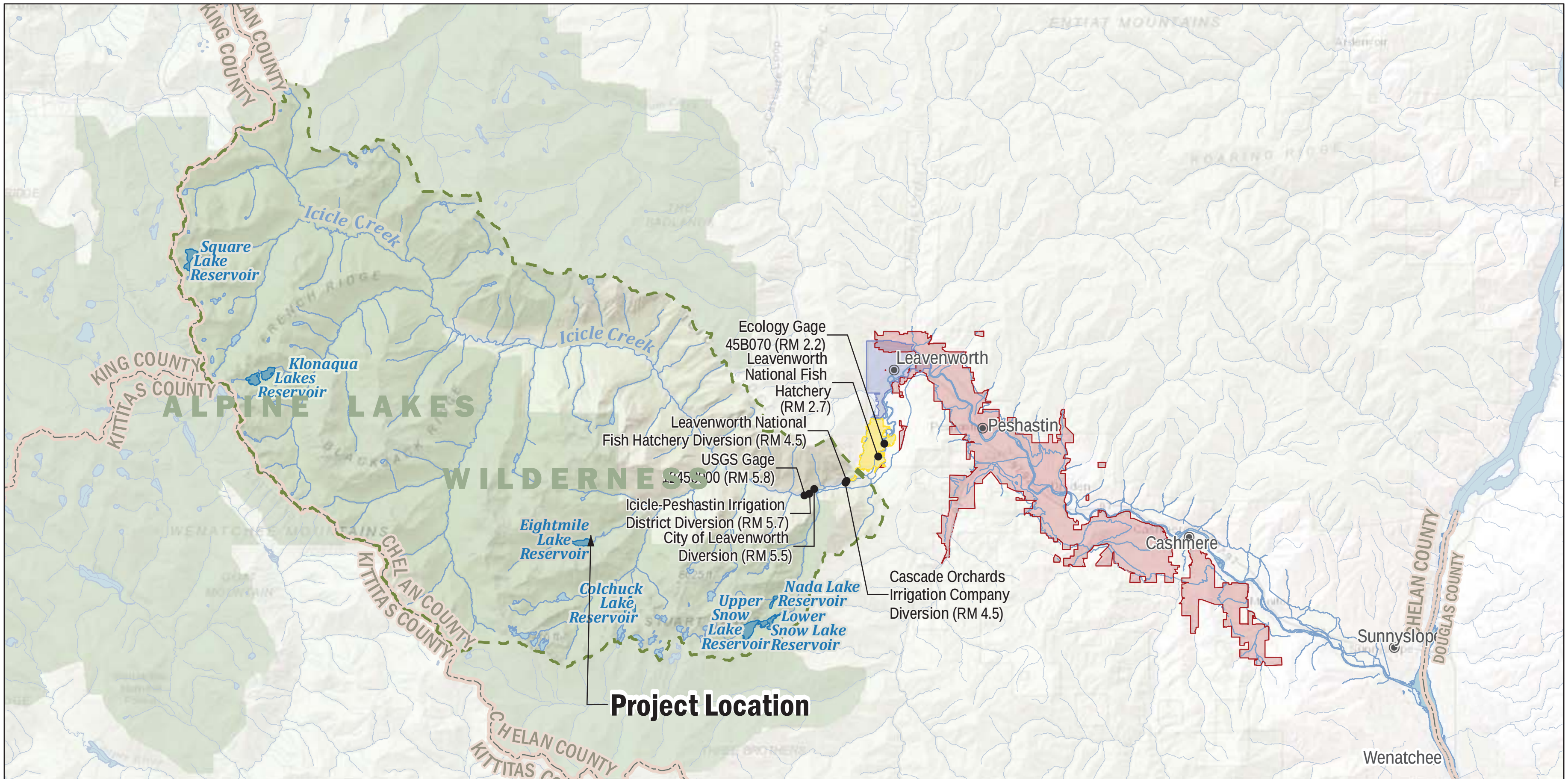
The intent of the Eightmile Lake Storage Restoration Project is to meet multiple prongs of the Guiding Principles. This project has the potential to achieve the following:

- Augment streamflow in Icicle Creek (Guiding Principle No. 1)
- Provide additional water to meet municipal demands (Guiding Principle No. 4)
- Improve agricultural reliability by increasing water supply available in the late summer to meet IPID's diversion needs (Guiding Principle No. 5)
- Benefit fish passage and habitat (Guiding Principle No. 6) and Treaty and Non-Treaty Harvest (Guiding Principles No. 3 and No. 8)

Relative to Guiding Principle 2, maintaining a sustainable hatchery, it should be noted that the project could also be operated to allow for the release of additional water during the winter low flow period, which would benefit LNFH water supply needs. Low flow conditions in the Icicle Creek Sub-basin typically occur in late-summer and again during the winter when a hard freeze occurs. The Hatchery Canal is dewatered from mid-summer through early spring to meet instream flow needs in Icicle Creek. Releases from Eightmile Lake have not historically occurred during the winter low-flow period, but the improvements discussed in this report could potentially allow for management of releases to benefit LNFH.

1.2 Project Background

Eightmile Lake is located in the Alpine Lakes Wilderness Area of Okanogan-Wenatchee National Forest approximately 10 miles west of the City of Leavenworth, as shown in Figure 1-1. It is one of four lakes in the Alpine Lakes Wilderness Area managed by IPID.



LEGEND:

- Points of Interest
- Leavenworth Urban Growth Area
- Cascade Orchards Irrigation
- IPID Service Area
- County
- Icicle Creek Watershed

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Miles

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Figure 1-1
Location Map
Eightmile Lake Restoration Feasibility Study
Icicle and Peshastin Irrigation Districts

A small dam with a low-level outlet pipeline or tunnel and control gate was installed at the outlet of each of the lakes in the early part of the twentieth century to allow IPID to capture and store runoff during the winter and spring for release during the late summer low flow period. The supplemental flows allow IPID to maintain irrigation diversions and meet instream flow obligations.

The dam, outlet, and control gate at Eightmile Lake are aging and in need of repair. The dam consists of a rock-masonry/concrete structure with stop logs and an earthen embankment section that extends from the rock-masonry/concrete structure to the hillside north of the dam. Stop logs were historically placed in a notch in the concrete portion of the dam up to the spillway crest (elevation ~4,671 feet North American Vertical Datum of 1988 [NAVD 88]) to allow the lake to fill to that elevation. The earthen embankment portion of the dam has eroded around the left side (looking downstream) of the rock-masonry/concrete structure. Consequently, the dam is not currently capable of impounding water to the full level for which it was designed and at which it historically operated. IPID can now only raise the water to an elevation of approximately 4,667 feet. This has reduced the storage capacity annually available for release by gravity without pumping or siphoning to less than 1,400 acre-feet. Some additional storage is released via seepage. Storage can also be accessed up to IPID's water right (2,500 acre-feet) using pumps or siphons.

The rock masonry/concrete portion of the dam is also deteriorating. The guides and logs used to check the flow of water from the lake through the notch in the concrete portion of the dam no longer function as designed. The slide gate that controls flow from the lake to the low-level outlet pipeline is also very difficult to operate and needs to be refurbished or replaced.

This Feasibility Study summarizes analysis of facilities that would be needed to replace the existing dam, low-level outlet pipeline, and control gate and enable releases from the dam to be automated and optimized to better manage releases. The *Feasibility Study, Alpine Lakes Optimization and Automation* (Aspect 2017) prepared concurrent with this report outlines the feasibility of automating and optimizing the releases from all of the IPID-managed reservoirs to improve late-summer flows in Icicle Creek. The improvements would restore IPID's ability to capture and release up to 2,500 acre-feet, as permitted by their water right for the lake.

1.2.1 Prior Studies and Related Documents

Table 1-1 provides a list of existing key studies and documentation related to the restoration of storage at Eightmile Lake.

Table 1-1
Prior Studies and Related Documents

Date	Study and Relevance	Author
April 1981	*Icicle Irrigation District Helicopter Access Environmental Assessment* This environmental assessment was completed by the U.S. Forest Service to evaluate Icicle Irrigation District's use of helicopters to access the lakes they manage in the Alpine Lakes Wilderness Area for operations and maintenance. The document recommended use of helicopters for transportation to and from the lakes and found that helicopter access "provides for health and safety as well as protection of wilderness resources and trail systems."	U.S. Forest Service
December 1989 May 1990	*Easement Termination Agreement* and *Special Warranty Deed* These include legal documents deeding the property around Eightmile Lake and other Alpine Lakes held historically by IPID to the U.S. Forest Service, with language that preserves IPID's right to operate and maintain the lakes, access the lakes for maintenance, and make full use of water storage rights for the lakes.	U.S. Forest Service and Icicle Irrigation District
December 1995	*Reconnaissance Inspection of Eightmile Lake Dam; File No. CH45-228* This letter was prepared by Ecology's Dam Safety Office following a reconnaissance visit to the site to evaluate and inspect the dam facilities at Eightmile Lake. The letter noted the breach or erosion of the embankment portion of the dam adjacent to the rock masonry structure and concluded that the breach had cut a channel down to a hardened surface that had potential to widen further with subsequent flood events, but that the configuration of the dam did "not pose a sufficient incremental damage threat to warrant mandating a retrofit of the spillway."	Ecology Dam Safety Office; Mel Schaefer Jerald LaVassar Doug Johnson
June 2006	*Multi-purpose Water Storage Assessment in the Wenatchee River Watershed* This report, prepared under the direction of IWG member CCNRD, identified and evaluated a wide range of potential opportunities for increasing storage in the watershed, including automating and optimizing releases from the IPID-managed Alpine Lakes (Eightmile, Colchuck, Klonaqua, and Square Lakes)	Montgomery Water Group, Inc. (Now Anchor QEA, LLC)
November 2013	*Eightmile Lake Surveys Technical Memorandum* The memorandum summarized topographic and bathymetric survey data collected by Gravity Consulting, LLC, at Eightmile Lake in October of 2013. The survey was collected under the direction of IWG Member Trout Unlimited.	Gravity Consulting, LLC

Date	Study and Relevance	Author
July 2014	*Draft Icicle Irrigation District Instream Flow Improvement Options Analysis Study* This study, prepared under the direction of IWG Member Trout Unlimited, included an evaluation of storage volumes and available storage at Eightmile Lake based on the survey that was completed by Gravity Consulting, LLC.	Forsgren Associates, Inc.
March 2015	*Appraisal Study, Eightmile Lake Storage Restoration* This study, prepared under the direction of IWG Member CCNRD, provided an appraisal-level assessment of existing storage conditions and lake operations, identified four alternatives for increasing the useable storage in Eightmile Lake, identified options for optimizing and automating releases from the lake, summarized potential uses and benefits of the water that would be made available, and provided a preliminary review of environmental impacts and permitting.	Anchor QEA, LLC, and Aspect Consulting, LLC
March 2015	*Appraisal Study, Alpine Lakes Optimization and Automation* This study, prepared under the direction of IWG Member CCNRD, provided an appraisal-level assessment of existing control facilities at each of the managed Alpine Lakes, including Eightmile Lake, and provided recommendations for potential equipment and improvements that would be needed to optimize and automate releases from the lakes.	Aspect Consulting, LLC, and Anchor QEA, LLC

Notes:
CCNRD: Chelan County Natural Resources Department
IPID: Icicle and Peshastin Irrigation Districts
IWG: Icicle Work Group

Several additional studies are being prepared under the direction of the IWG, concurrent with this Feasibility Study, to evaluate the projects being evaluated by the IWG. The two that are most related to this feasibility study include the following:

- *Icicle Strategy Programmatic Environmental Impact Statement* (Aspect pending) – The IWG is currently developing a programmatic environmental impact statement (PEIS) for the strategy that has been developed by the IWG to improve the management of water in the Icicle Creek Sub-basin. The Icicle Strategy PEIS will evaluate four alternatives and a no-action alternative. The alternatives each include a suite of projects that are collectively intended to meet the guiding principles listed above. The Eightmile Lake Storage Restoration Project will be included as a component of three of the four action alternatives evaluated by the PEIS.
- *Feasibility Study; Alpine Lakes Optimization and Automation* (Aspect 2017) – This study, prepared under the direction of IWG member CCNRD, will include a feasibility-level evaluation and design recommendations for implementing improvements that will allow IPID and the U.S. Fish and Wildlife Service to optimize and automate releases from the managed lakes in the Alpine Lakes Wilderness Area, including Eightmile Lake.

1.3 Feasibility Study Description

This study provides a feasibility-level evaluation and design recommendations for a project that would replace the existing dam, low-level outlet pipeline, and control gate facilities at Eightmile Lake with facilities that are designed to restore the useable storage at Eightmile Lake to 2,500 acre-feet and allow for automated releases from the lake.

Consultation was initiated with DSO as part of this Feasibility Study to better understand their requirements for permitting construction of improvements to the dam and outlet facilities. DSO reviewed the draft Feasibility Study and provided general comments regarding the analysis and geotechnical evaluation of the proposed facilities that will be applied to the detailed design of the improvements. No changes were made to this report to reflect DSO comments regarding the detailed design of the proposed project. Those comments will be addressed through detailed design of the project. This study reflects the concept and feasibility-level analysis completed through the end of 2017 and does not include additional analysis requested by DSO in response to the Jack Creek Fire or recent emergency declaration by IPID. Consultation with DSO is ongoing and will continue through the design and construction of the proposed improvements.

1.3.1 Scope of Work

The scope of work for this Feasibility Study included the following work:

- The Anchor QEA/Aspect team worked with IPID and Chelan County to identify key components and characteristics of the preferred design concept, based on additional data and observations made during the Summer of 2015, when water was drawn down below the existing outlet, and the outlet pipe condition was determined to be significantly different than assumed in the *Appraisal Study, Eightmile Lake Storage Restoration* (Anchor QEA 2015)
- The Anchor QEA/Aspect team worked with IPID and Chelan County to evaluate potential approaches to constructing the proposed improvements to Eightmile Lake.
- The Anchor QEA/Aspect team provided preliminary sketches showing key components of the preferred design concept to confirm the preferred concept with IPID and Chelan County.
- The Anchor QEA/Aspect team developed a draft construction work plan for IPID use in coordinating with the United States Forest Service (USFS).
- The Anchor QEA/Aspect team reviewed the potential improvements with Ecology's Dam Safety Office (DSO) to identify likely requirements for securing a DSO dam construction permit. This report summarizes the design reports, application forms, and supporting documentation that would be required for DSO review and approval of dam modifications.
- The Anchor QEA/Aspect team refined the evaluation of hydrology, lake levels, and refill, based on work completed during the summer of 2016.
- The team analyzed peak inflow hydrology and hydraulics of the low-level outlet, spillway, and dam improvements as a basis for sizing the facilities to meet DSO requirements.

- The Anchor QEA/Aspect team also developed conceptual design drawings showing proposed improvements in plan and section view, identifying key materials and dimensions.
- The Anchor QEA/Aspect team prepared an opinion of probable costs.
- The Anchor QEA/Aspect team developed a photographic rendering illustrating what the proposed reservoir modifications might look like following construction.
- The Anchor QEA/Aspect team prepared this report to summarize the findings of the Feasibility Study.

1.3.2 Purpose and Objectives

The following are the goals of the Feasibility Study:

- Review and provide a more complete understanding of the existing conditions, constraints, and design requirements for proposed improvements at Eightmile Lake.
- Evaluate the preferred improvement option in enough detail to provide IPID and the IWG with the information needed to determine whether additional resources can be allocated to complete the design and implement the project and identify those resources.

The overall goal of the Eightmile Lake Restoration project is to restore storage capacity at Eightmile Lake and improve control of releases from the lake to improve the water supply available in Icicle Creek to meet instream flow and out-of-stream water supply needs.

1.4 Report Organization

This report is organized into the following sections:

- **Existing Reservoir Conditions** provides a summary of existing conditions and deficiencies at Eightmile Lake based on recent work done by Anchor QEA, Aspect, Gravity Consulting, LLC, and Forsgren Associates, Inc.; input from IPID; and conditions documented during a site visit to the lake.
- **Eightmile Lake Hydrology** summarizes the results of hydrologic analyses including watershed yield, a downstream hazard analysis, and design storm calculations and analysis.
- **Eightmile Lake Storage Restoration Design** summarizes proposed hydraulic analysis, design calculations, and improvements.
- **Construction Approach** provides a summary of construction access and sequencing options and anticipated limitations to implementing the proposed project.
- **Cost Analysis** includes a summary of preliminary opinions of probable project costs associated with the proposed restoration design.
- **Water Rights** summarizes the existing water rights associated with storage and release of water from Eightmile Lake.
- **Environmental and Permitting Strategy** includes a summary of likely environmental impacts and permitting requirements, and recommends a strategy for securing permit approvals.

- **Summary and Recommendations** provides an overall summary of the Feasibility Study and recommendations for future study and implementation.

Tables and figures are included throughout the report. Appendices, including design drawings, photographs, calculations, and other information, are included at the back of the report.

1.5 Feasibility-level Design Drawings

Feasibility level design drawings have been prepared and are included in Appendix A. In addition, a rendering was developed to illustrate what the finished project might look like from an aerial perspective. The rendering is show in Figure 1-2.

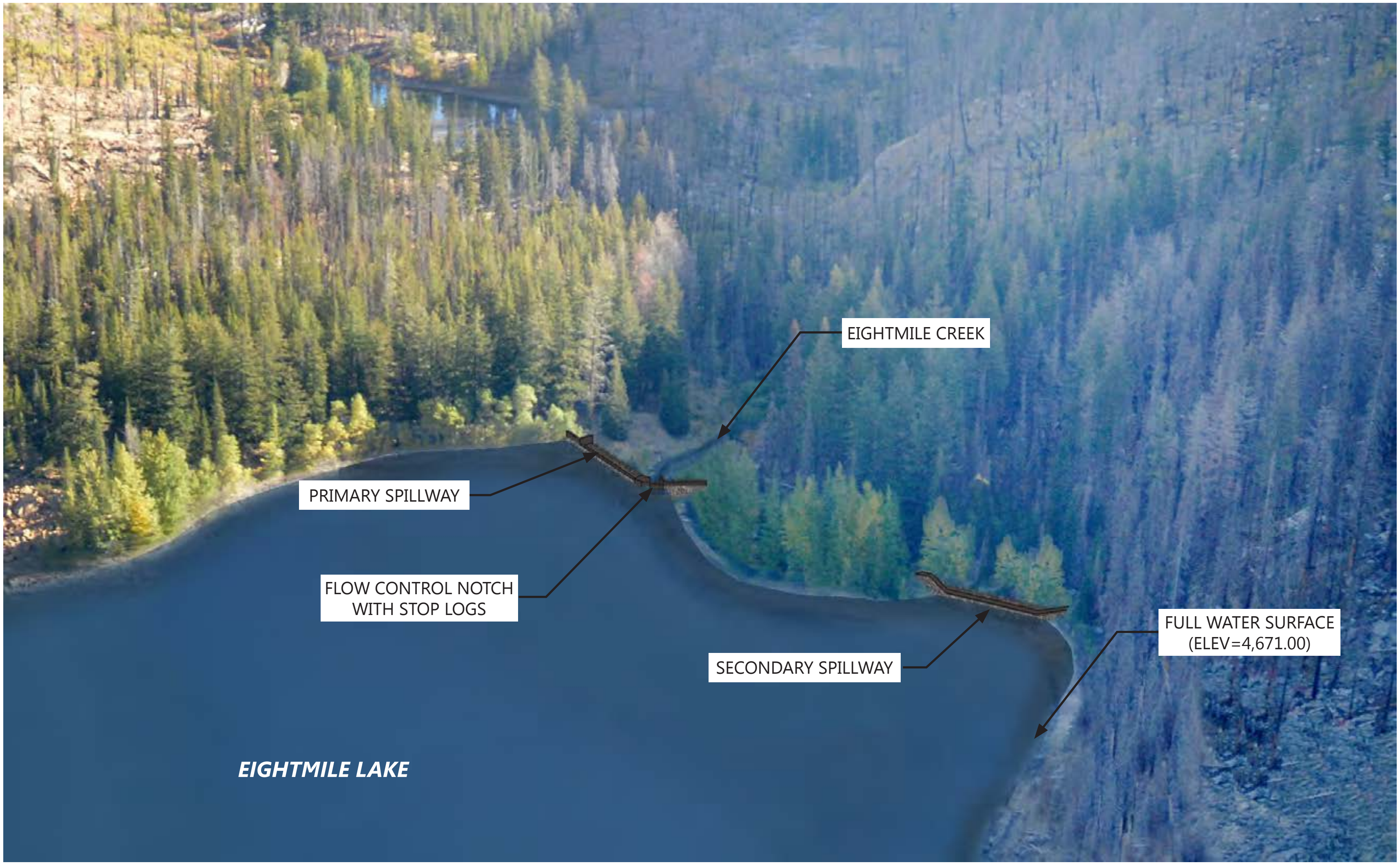

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Figure 1-2
Photo-realistic Rendering of Proposed Eightmile Lake Improvements
Eightmile Lake Storage Restoration Feasibility Study
Icicle and Peshastin Irrigation District

2 Existing Reservoir Conditions

Eightmile Lake is located in the Icicle Creek Sub-basin on the east slopes of the Cascade Mountains approximately 10 miles west of the City of Leavenworth, Washington (See Figure 1-1). The lake is situated within Sections 32 and 33, T24N, R16E, and currently has a full water surface area of approximately 76.6 acres. Eightmile Lake captures water from a 3,822-acre drainage basin and discharges surface water to Eightmile Creek, which is a tributary to Icicle Creek. The Eightmile Lake drainage basin is delineated in Figure 2-1.

The lake can be accessed on foot via the Eightmile Lake Trail (USFS Trail No. 1552). The trailhead is accessible from Leavenworth by vehicle following Icicle Road, USFS Road 7600, and USFS Road 7601. The trail generally follows Eightmile Creek from U.S. Geologic Survey (USGS) Road 7601 to Eightmile Lake. The distance from the trailhead to the lake is approximately 4 miles. Because of its relative accessibility, the lake is a popular destination for hikers and campers. Because of its proximity to Icicle Creek and relative ease of access, IPID visits Eightmile Lake and operates the gate to release water from the lake more frequently than at the more remote lakes it operates. Consequently, it is a critical piece of IPID's water supply infrastructure.

The existing facilities that control flow from Eightmile Lake to Eightmile Creek consist of a dam and embankment structure, a low-level outlet pipeline, and a slide gate. The configuration of these facilities is shown on the existing conditions plan of the feasibility-level design drawings (See Drawing G-04, Appendix A). Additional survey data was collected on the dam structure and low-level outlet pipeline during a site visit on September 30, 2016, to provide better definition for development of the feasibility-level design.

2.1 Dam and Embankment

The existing dam consists of a rock masonry and concrete wall structure with an earthen embankment section. Photographs 1 and 2 (Appendix B) show the dam and spillway structures. Pieces of the masonry rock and concrete wall structure have deteriorated and fallen down, but most of the structure is still intact. The rock masonry and concrete structure spans approximately 43 feet across the outlet of the lake and features the following:

- **Flow Control Notch** – A 5-foot 9-inch-wide notch near the center of structure, has a crest elevation of 4,661.6 to 4,661.8 feet. Guides were originally included in the notch so that stop logs could be placed to control the level at which the lake spills to the downstream channel through the notch. The stop log guides have deteriorated and no longer function as designed; however, IPID still places logs in the notch and drapes plastic over the logs to control the high water surface elevation in the lake.

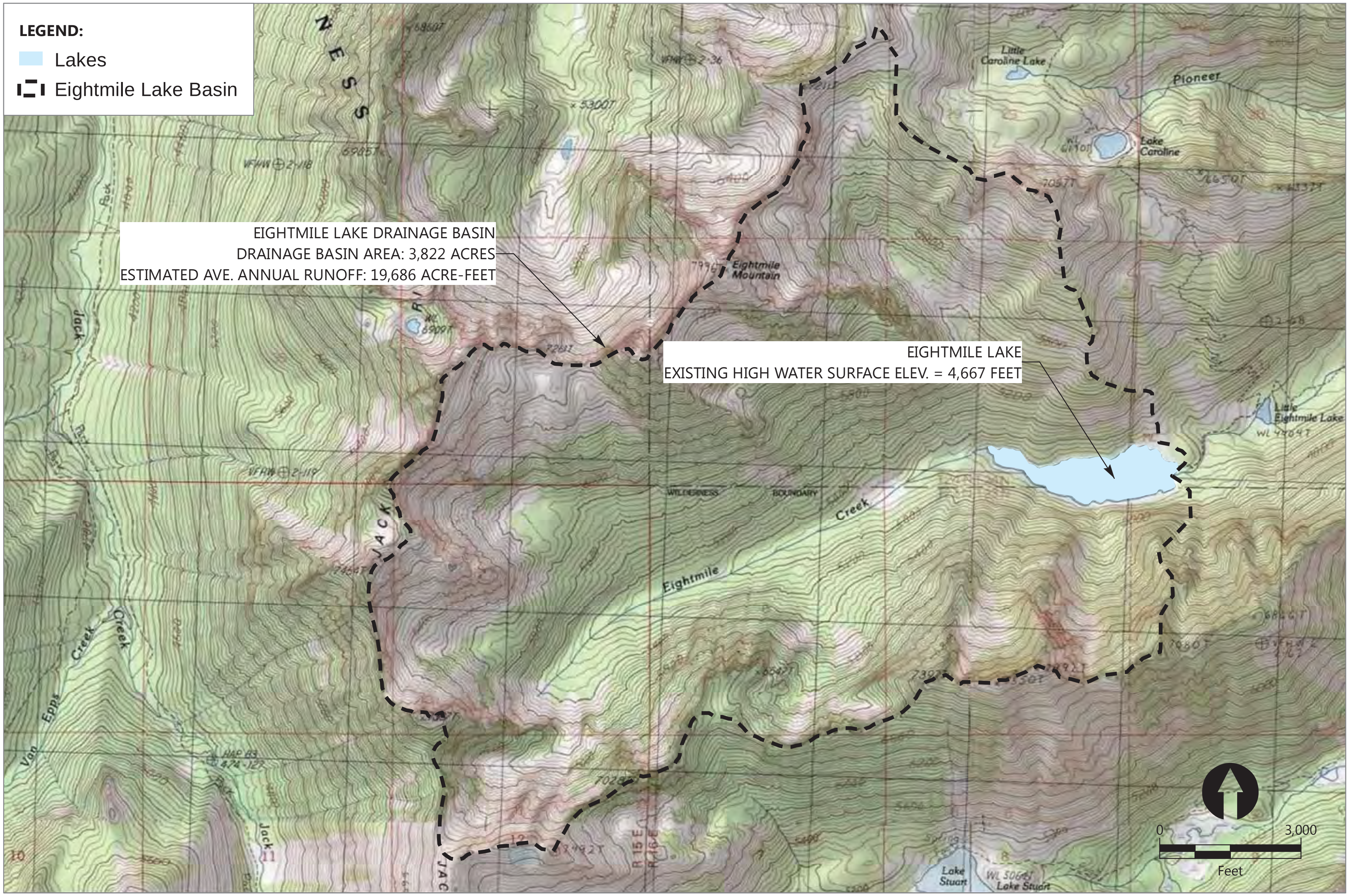

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Figure 2-1
Eightmile Lake Drainage Basin
Eightmile Lake Storage Restoration Feasibility Study
Icicle and Peshastin Irrigation Districts

- **Spillway** – The wall south of the notch comprises the historical spillway, with a crest elevation that varies from 4,671.3 to 4,671.4. The spillway crest length is approximately 6 feet. Historically, stop logs were placed in the notch during the spring or early summer to capture runoff and raise the lake level to the spillway elevation (~4,671 feet).
- **South Wing Wall** – A rock masonry wall extends from the spillway to the hillside south of the structure. The high point on the south wing wall is just over 4,673 feet.
- **North Wing Wall** – A rock masonry wall also extends from the notch north of the dam. The highest portion of the north wing wall is also just over 4,673 feet. The earthen embankment portion of the dam was historically connected to the north wing wall and likely matched the elevation at the top of the wing wall.
- **Stilling Basin and Cutoff Wall** – When the gate on the low-level outlet is closed and the lake is full to the top of the stop logs in the flow control notch, water spills over the stop logs into a concrete basin on the downstream side of the structure. It is not clear what the design function of the basin was intended to be, but it appears to have been the original location of the control gate and may have provided access to the low-level outlet pipeline. The basin extends down to within a few feet of the top of the low-level outlet pipe, but it is typically filled with rock, logs, and debris. The basin was cleaned out in 2015 by IPID in an effort to determine the connection between the basin and the low-level outlet pipeline. A concrete cutoff wall forms the downstream edge of the basin and extends down to the low-level outlet pipeline. IPID has observed that water flowing into the basin disappears through the debris into the low-level outlet pipeline. During high flow periods, the basin fills completely with water and excess water discharges over the cutoff wall and to the rock-lined Eightmile Creek channel. The IPID Manager indicated that under current operation, water overtops the cutoff wall on the downstream side of the basin during the spring and early summer.

The earthen embankment section of the dam extends more than 120 feet from the hillside north of the dam to the north wing wall. The portion of the earthen embankment closest to the north wing wall has eroded to an elevation that is more than 4 feet below the crest of the spillway. No historical information has been found to indicate exactly how or when the embankment was eroded. It likely occurred during a large storm event when no one was at the site to observe. The erosion suggests that the spillway is not large enough to accommodate flow rates during peak storm events. The width of the eroded portion of the embankment is approximately 25 feet. The upper (west) portion of the embankment appears to be intact and is covered with large rock.

Three engineers from Ecology DSO completed a reconnaissance inspection of the dam in September 1995. A letter prepared following the inspection (Ecology 1995) summarized their observations and conclusions. They observed both the earthen embankment and the rock masonry/concrete structure. They noted that the portion of the embankment adjacent to the rock masonry/concrete structure had eroded and the cut was roughly 25 feet wide and 5 feet deep. They concluded that this “past breach of the embankment has cut a channel across the embankment down to a “hardened” or stable floor. In the event of another major flood, it is likely that the breach section would widen further.” Although this widening during a major flood would likely result in surges of flood releases, DSO suggested that the spillway might actually “function, to a limited degree, as a false plug spillway – cutting laterally rather than vertically.” They concluded that the “possibility of surges and on-going flood releases from a 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 by widening and hardening the channel now.” However, in the judgement of the DSO Engineers that did the inspection, the dam configuration at the time of the inspection did not pose a “sufficient incremental damage threat to warrant mandating a retrofit of the spillway”.

2.2 Low-Level Outlet Pipeline and Gate

A slide gate and low-level outlet pipeline control releases from Eightmile Lake to Eightmile Creek. The gate is a 30-inch-diameter, round, cast iron slide gate and was originally equipped with a hand-wheel operator. The gate is typically submerged in the lake just upstream of the dam, but can be opened to release water through the low-level outlet pipeline to Eightmile Creek. It appears that a rock-masonry/concrete gate tower was originally constructed to support the gate stem and manual hand-wheel operator, which was mounted above the water surface of the lake. The tower appears to have been completely destroyed and the manual gate operator has been removed. The IPID Manager indicated that the gate and tower were likely damaged by ice or debris. The gate currently has to be operated by attaching a log as a come-along to a square metal loop welded to the top of the remaining gate stem below the water surface. This makes gate operation very challenging. The IPID Manager also indicated that rock settles above and against the gate, preventing the gate from closing completely. IPID removed the rock that was piled against the gate and cleaned out the channel leading to the gate from the lake when the lake was drawn down at the end of the summer of 2015. Photograph 3 (Appendix B) shows the exposed gate.

The existing low-level outlet pipeline is nearly 300 feet long and consists of pipe that varies in size and composition. IPID personnel inspected the pipe from the inside late in the summer of 2015 when the lake was drawn down to document the condition and configuration. The existing conditions map in the feasibility-level drawing set shows the observed pipe configuration (See Drawing G-04, Appendix A). The following segments of pipe were observed by IPID:

- **30-inch Corrugated Metal Pipe (CMP), Gate to Dam Structure** – This segment of pipe is in relatively good condition and includes two bends.
- **30-inch Wood Stave Pipe, Under Dam Structure** – Under the stilling basin on the downstream side of the dam structure, the pipe transitions to wood stave pipe.
- **Open Chamber with Log Ceiling** – At the cutoff wall on the downstream side of the stilling basin, the pipe transitions into a more open chamber with a log ceiling. The chamber varies in

height and width. An opening has eroded at the base of the cutoff wall that allows water in the stilling basin to flow into the chamber from above and down the low-level outlet pipe.

- **30-inch Log Stave Pipe** – A log stave pipe, formed by banding raw, round logs together with steel bands, extends from the open chamber on the downstream side of the first cutoff wall to an open chamber on the upstream side of the second cutoff wall. The log stave pipe has collapsed mid-way between the cutoff walls. IPID has indicated that capacity of the pipeline has declined significantly due to blockage caused by this collapse and is a major concern for IPID.
- **Open Chamber with Log Ceiling** – A second chamber is located at the second cutoff wall, approximately 48 feet downstream of the first cutoff wall.
- **30-inch CMP, Downstream of Cutoff Wall** – A segment of 30-inch CMP extends downstream of the second cutoff wall and includes a bend.
- **30-inch Wood Stave Pipe** – The 30-inch CMP transitions to Wood Stave Pipe again downstream of the bend.
- **30-inch CMP, Wood Stave Pipe to Outlet** – A final segment of 30-inch CMP extends from the Wood Stave Pipe to the outlet to the Eightmile Creek channel. The CMP pipe has a couple of large deformations.

Photographs of the pipe interior are included as Photographs 8 through 11 in Appendix B. Most of the pipe is buried under large rock. The pipe outlet is typically submerged in the spring and early summer. A large rock that had been naturally deposited in the channel immediately downstream of the outlet was removed by IPID as part of the maintenance and inspection done late in the summer of 2015. The IPID Manager indicated that when the gate is open and the reservoir is releasing water, conditions at the pipe outlet are turbulent.

2.3 Overflow Channel to Eightmile Creek

An overflow or spillway channel extends from the dam above the buried low-level outlet pipeline to the pipe outlet. The channel is filled with large rock. At least some of the rock appears to have been deposited in the channel naturally since it was first constructed. The channel is typically filled with water during the spring and early summer when the lake is spilling. During the late summer, when the gate is open and controlled releases are occurring, the channel runs dry down to the low-level pipeline outlet.

2.4 Useable Storage Capacity

A survey and lake volume evaluation was completed by Gravity Consulting, LLC, and Forsgren Associates, Inc. (Forsgren 2014), to estimate the volume of the lake at key water surface elevations. The volumes estimated in that report are summarized in Table 2-1. Elevations were surveyed by Gravity Consulting, LLC, relative to the NAVD 88. All elevations reported in this Feasibility Study are based on that datum. Gravity Consulting, LLC, estimated that the current high water surface elevation was approximately 4,667 feet, based on the current configuration of the dam and input from IPID about placement of stop logs. If IPID attempts to raise the water level higher than that by adding more stop logs to the notch, water spills through the embankment breach around the north wing wall of the dam. The total estimated volume of the lake at that elevation is estimated to be approximately 2,706 acre-feet. The current useable storage in the lake is the volume of water storage between the minimum drawdown level, which was estimated by Gravity Consulting, LLC, and Forsgren Associates, Inc., to be approximately 4,644 feet, and the current high water surface elevation, 4,667 feet. The current usable storage volume, or storage available for release by gravity without pumping or siphoning, was estimated to be approximately 1,375 acre-feet.

Table 2-1
Lake Volume Summary (From 2014 Forsgren Associates, Inc./Gravity Consulting, LLC Study)

Description	Water Surface Elevation (Feet)	Water Surface Area (Acres)	Total Volume (Acre-feet)	Usable Storage Volume[1] (Acre-feet)
1) Existing Low-Level Outlet (Max Drawdown)	4,644	44.1	1,331	↑
2) Existing Top of Weir at Flow Control Notch	4,664	73.5	2,486	1,375
3) Existing High Water Surface	4,667	76.6	2,706	↓
4) Existing Spillway Crest/Historical High Water Surface	4,671	80.8	2,998	

Note:

1. Icicle and Peshastin Irrigation Districts estimates that additional seepage below the low-level outlet draws the lake down below elevation 4,644 and that the total useable storage, or total volume that can be released from the lake during the late summer, with the additional seepage that occurs after the lake has been drawn down to the low-level outlet, is approximately 1,600 acre-feet.

Additional topographic survey data was collected as part of this analysis to provide better definition of the embankment, rock masonry/concrete structure, and low-level outlet. Table 2-2 summarizes the key elevations and existing stage-storage-area relationship in the lake, based on a refined analysis with the new data collected. When the original analysis was done by Gravity Consulting, LLC, and Forsgren Associates, Inc., the inlet to the low-level outlet pipeline was submerged and likely buried by rock and debris. The additional survey data gathered in 2016 was collected when the lake was drawn down to the low-level outlet elevation. The surveyed elevation at the invert of the low-level outlet is more than 4 feet higher than what was originally estimated as the maximum drawdown elevation. The useable storage volume between the estimated high water surface elevation and the surveyed invert of the low-level outlet is actually only 1,151 acre-feet. However, the lake continues to draw down below the low-level outlet during the late summer due to seepage. For example, the water surface level of the lake during September 2015 was observed at least 3 feet below the low-level outlet invert. So, it is likely that the lake can be drawn down to an elevation beyond the 4,644 feet estimated by Gravity Consulting, LLC, and Forsgren Associates, Inc., through seepage at the end of the summer. IPID estimates that the total volume that can currently be released by gravity in the late summer without pumping or siphoning, when considering the volume that drains via seepage below the low-level outlet, is approximately 1,600 acre-feet.

Table 2-2
Lake Volume Summary (Based on Additional Data Collection)

<table>
<tr><th>Description</th><th>Water Surface Elevation (Feet)</th><th>Water Surface Area (Acres)</th><th>Total Volume (Acre-feet)</th><th colspan="2">Usable Storage Volume[2] (Acre-feet)</th></tr>
<tr><td>0) Existing Low Lake Level (Max Drawdown)[1, 2]</td><td>4,644.0±</td><td>44.1</td><td>1,331</td><td rowspan="4">↑ 1,367 ↓</td><td></td></tr>
<tr><td>1) Existing Low-level Outlet Invert</td><td>4,648.7</td><td>47.9</td><td>1,547</td><td rowspan="3">↑ 1,151 ↓</td></tr>
<tr><td>2) Existing Top of Weir at Flow Control Notch</td><td>4,664.6</td><td>73.7</td><td>2,514</td></tr>
<tr><td>3) Existing High Water Surface[2]</td><td>4,667.0±</td><td>76.6</td><td>2,698</td></tr>
<tr><td>4) Existing Spillway Crest/Historical High Water Surface</td><td>4,671.3</td><td>81.7</td><td>3,035</td><td></td><td></td></tr>
</table>

Notes:

1. Existing low lake level was not surveyed in fall 2016, but is based on original analysis by Gravity Consulting, LLC, and Forsgren Associates, Inc. The low lake level has been observed a few feet below the invert of the existing low-level outlet invert. The lake continues to draw down water below the low-level outlet through seepage during the late summer.
2. IPID estimates that additional seepage below the low-level outlet draws the lake down below elevation 4,644 and that the total useable storage, or total volume that can be released from the lake during the late summer, with the additional seepage that occurs after the lake has been drawn down to the low-level outlet, is approximately 1,600 acre-feet.
3. Existing high water surface not surveyed in fall 2016, but is based on original analysis by Gravity Consulting, LLC, and Forsgren Associates, Inc.

2.5 Topography

Eightmile Lake captures runoff from a 3,822-acre drainage basin on the east slopes of the Cascade Range. The general topography of the basin is very rugged and comprises steep craggy peaks and a deep glacial valley. Elevations in the basin range from approximately 7,980 feet to the outlet of Eightmile Lake, at approximately 4,661 feet. The mean basin slope, calculated from a 30-meter USGS digital elevation model (DEM), is 62%.

2.6 Geology

A geotechnical investigation has not been completed as a basis for the design of the improvements to Eightmile Lake; however, general data on soil types and geology was collected from USGS and Natural Resources Conservation Service (NRCS). The geology of the Eightmile Lake basin is dominated by rocky soils and tonalite geology. According to the NRCS Web Soil Survey database, approximately 79% of the soils within the basin are designated as rock outcrop or rock outcrop complex, with bedrock at or within 3 feet of the surface. The valley bottom is composed primarily of very rocky, sandy loam with boulders and comprises approximately 19% of the basin terminating at the outlet of the lake. The underlying geology is dominated by tonalite, which is classified as an igneous, intrusive rock of felsic composition, with phaneritic texture. Less abundant geologic components include ultrabasic (ultramafic) rock, talus deposits, alluvium, and mass-wasting deposits.

A geology map, showing geologic units mapped by the USGS, is included in Figure 2-2. The map shows that there is a large landslide area with mass-wasting deposits just north and east of the lake. This landslide area and the associated rock and boulders deposited at the base of it are visible on aerial photographs of the lake (See Drawing G-03, Appendix A).

2.7 Existing Reservoir Operations

Eightmile Lake is one of four storage sites in the Alpine Lakes Wilderness managed by IPID. The operation of Eightmile Lake was last reviewed with the IPID Manager during a site visit in September 2016. During a typical year, the storage from only one or two of the IPID-managed lakes is actively managed. Typically, releases from the lakes are rotated from year to year to ensure that the lakes refill between releases. However, because of its proximity to Icicle Creek, relative ease of access, and high probability of refill, the useable storage at Eightmile Lake is released more frequently than the storage at the more remote lakes.

The lake typically fills to the crest elevation of the notch in the rock masonry/concrete portion of the dam during the winter and spring. IPID personnel go to the lake when the snow melts enough to provide access late in the spring or early in the summer to place stop logs and plastic to capture the last few feet of additional storage while the snowmelt runoff is still occurring. To actively manage the storage in Eightmile Lake, IPID personnel hike to the lake to open the gate on the low-level outlet pipeline sometime in July or August when flows in Icicle Creek begin to drop. IPID personnel return to close the gate, remove the stop logs and plastic, and perform maintenance in late September or October, when the lake is drawn down and the irrigation season is over.

When the gate is open, water discharges through the low-level outlet to Eightmile Creek, which is a tributary to Icicle Creek. Based on recent experience and observations from IPID personnel, the lake typically refills by early summer following the irrigation season when the lake is drawn down. The useable storage capacity available for release and the equivalent volume that has to be refilled is limited by the condition of the dam at the outlet. When the lake is full, water flows over the stop logs in a notch in the dam and down the low-level outlet or spillway channel to Eightmile Creek. Water continues to flow through the lake uncontrolled, until the gate is opened for controlled release.

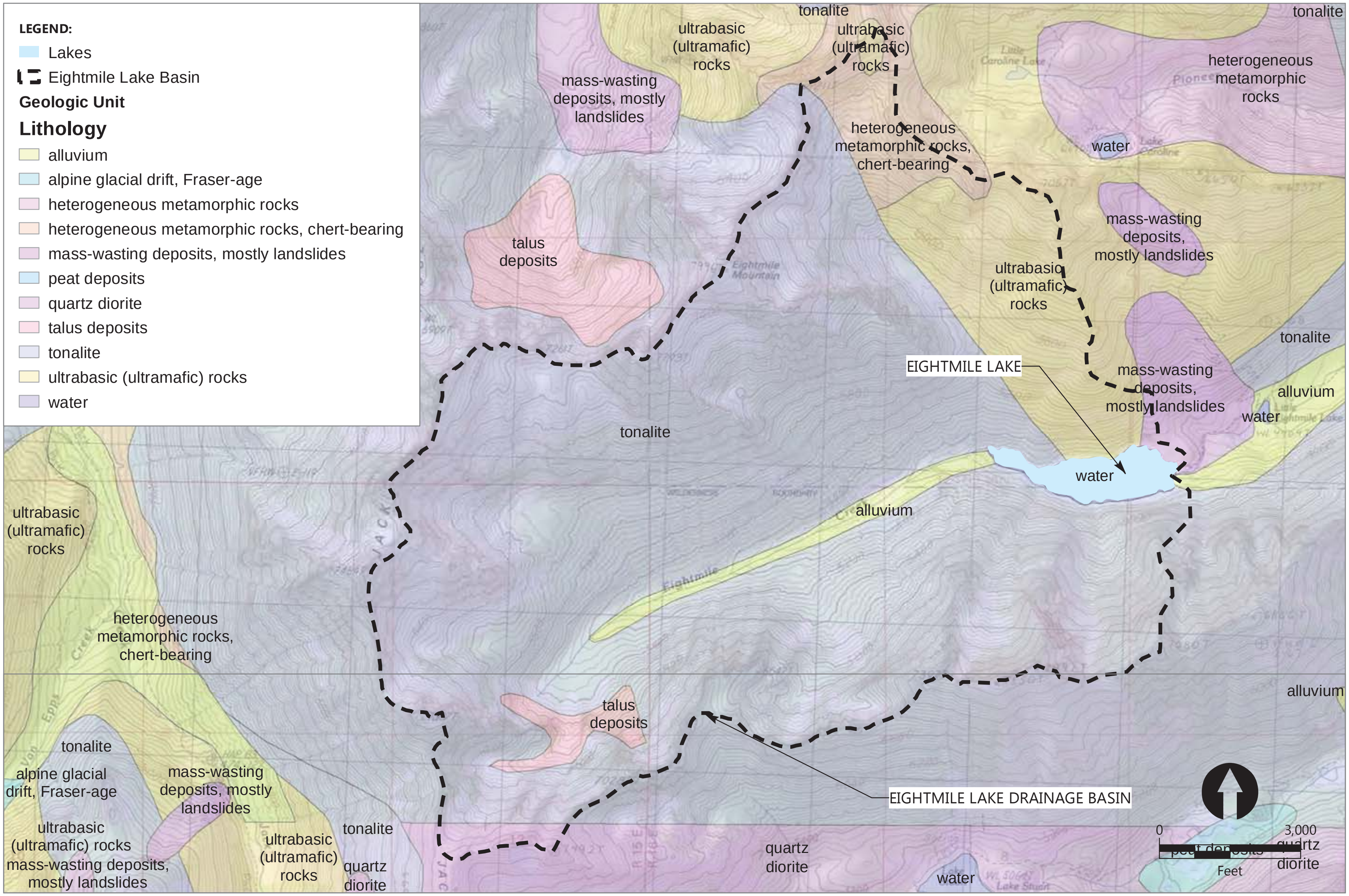

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Figure 2-2
Eightmile Lake Drainage Basin Geology Map
Eightmile Lake Storage Restoration Feasibility Study
Icicle and Peshastin Irrigation Districts

2.8 Challenges, Deficiencies, and Constraints

Several operational challenges and deficiencies exist due to the current configuration and condition of the facilities at Eightmile Lake. These include the following:

- **Gate Operation** – Current gate operation requires that IPID personnel attach a log as a come-along to a submerged metal loop welded to the gate stem to open and close the gate. IPID also indicated that rock settles above and against the gate. These two issues make the gate very difficult to open and close. Rock was removed from above and against the gate in the summer of 2015 when the lake was drawn down.
- **Dam Condition and Level Control** – The dam is no longer in condition to allow for effective control of the water level at the notch in the dam. The embankment portion of the dam has eroded adjacent to the rock masonry/concrete portion of the dam to an elevation that is lower than the dam crest and historical overflow elevation.
- **Lake Drawdown** – IPID's water rights allow for lake storage to be drawn down below the invert of the existing low-level outlet. Some drawdown below the low-level outlet occurs through seepage. However, drawing the lake down to access additional storage below the low-level outlet currently requires pumping.
- **Low-Level Outlet Pipe Condition** – The condition of the low-level outlet pipe was visually assessed by IPID in 2015. As noted previously, some sections of the pipe are damaged or collapsing. The largest collapse has recently reduced the capacity of the pipeline is a major concern for IPID. If water cannot be released at the historical rate of release, there could be water shortages in Icicle Creek during the late summer in coming drought years.

3 Eightmile Lake Hydrology

Critical information needed for the design of improvements at Eightmile Lake include hydrologic inputs to the lake, peak storm conditions, and estimates of the design capacity of the dam, spillway facilities, and low-level outlet facilities to safely pass or release flows while minimizing the risk to downstream properties and infrastructure. This section summarizes the hydrologic analysis done to determine the design storm and peak flow rates used for design of improvements to the dam, spillway, and low-level outlet pipeline.

3.1 Dam Safety Review

The proposed improvements to Eightmile Lake will require review and approval by Ecology's DSO. Consultation was initiated with DSO as part of this Feasibility Study to better understand their requirements for permitting construction of improvements to the dam and outlet facilities. DSO reviewed the draft Feasibility Study and provided general comments regarding the analysis and geotechnical evaluation of the proposed facilities that will be applied to the detailed design of the improvements. No changes were made to this report to reflect DSO comments regarding the detailed design of the proposed project. This study reflects the concept and feasibility-level analysis completed through the end of 2017 and does not include additional analysis requested by DSO in response to the Jack Creek Fire or recent emergency declaration by IPID. Consultation with DSO is ongoing and will continue through the design and construction of the proposed improvements. Based on consultation with DSO to date. DSO will likely require that the following items be submitted for review and approval prior to issuing a dam construction permit for the improvements:

- **Cover Letter** – The cover letter would summarize the project and introduce the deliverables.
- **Dam Construction Permit Application** – A completed dam construction permit application would be downloaded from the DSO web site and submitted with the supporting documents.
- **Engineering Reports**
  - **Geotechnical Engineering Report** – DSO will require that a geotechnical engineer perform a complete subsurface geotechnical field investigation and prepare a report with recommendations for the dam foundation, embankment composition and construction, a description of the local groundwater regime, and identification of earthquake and other potential hazards. Because the site is remote and cannot easily be accessed with equipment to do an effective subsurface geotechnical investigation, completion of geotechnical field investigations will be very challenging. Test pits and geophysical methods will likely be required, at a minimum, to support the design. The design will also require geotechnical supervision, input, and review during construction to address site conditions.
  - **Hydrology and Hydraulics Report** – DSO will require a detailed report with a description of the site, a summary of site hydrology, an estimate of all sources of inflow

to Eightmile Lake, and hydrologic analysis to estimate the Inflow Design Flood (IDF). The report would also detail the design of the reservoir and provide estimates of the reservoir capacity, low-level outlet capacity, spillway capacity, and other design calculations. Sections 3 and 4 of this report include most of the information that would go into the Hydrology and Hydraulics Report for DSO.

- **Detailed Design Drawings** – Feasibility level design drawings are included in Appendix A. The design drawings would be developed to the level of detail needed for construction.
- **Technical Specifications** – A set of detailed technical specifications would be developed with the detailed design drawings.
- **Construction Inspection Plan** – DSO would require a short report listing specific construction activities, quality assurance testing, construction management, change order process, record keeping, and reporting during construction.
- **Operations and Maintenance Plan** – This document would provide general information on project operation, routine inspection and maintenance, and instrumentation and monitoring. Forms would be included for reporting, inspections, incident reporting, and monitoring.
- **Emergency Action Plan** – This document would identify downstream risk from a dam breach and delineate the area that could be inundated based on modeling of a dam breach. This document would also identify the Owner’s response actions and responsible personnel.

The requirements and level of detail needed for each of these items will vary based on the scope and extent of improvements to the facilities at Eightmile Lake. For example, a full replacement of the existing dam, spillway, and low-level outlet facilities will require more detailed documentation than if only minor modifications were made to the existing facilities. However, DSO has indicated that they would need to perform some level of review and provide approval for any modifications to these facilities. This report has been reviewed with DSO and consultation is ongoing to define requirements for the detailed design of the proposed facilities.

3.2 Watershed Description

As noted earlier, Eightmile Lake is located in the Icicle Creek Sub-basin on the east slopes of the Cascade Mountains approximately 10 miles west of the City of Leavenworth, Washington. The lake currently has a full water surface area of approximately 76.6 acres. Eightmile Lake captures water from 3,822-acre drainage basin (approximately 6 square miles), as shown in Figure 2-1, and discharges water to Eightmile Creek, which is a tributary to Icicle Creek. The Eightmile Lake drainage basin is predominantly covered with rocky outcrops and exposed bedrock, with steep slopes and rugged terrain. Sub-alpine evergreen forest covers approximately 30% of the drainage basin.

3.3 Watershed Yield

Watershed yield is the annual volume of natural runoff that can be expected from a watershed and is typically estimated based on streamflow measured at a given location. There are not streamflow gaging stations or measurement devices in the Eightmile Lake drainage basin. In the absence of streamflow data, hydrologic analysis can be completed to estimate watershed yield. Watershed yield and lake recharge potential were originally evaluated as part of the *Appraisal Study, Alpine Lakes Optimization and Automation* (Aspect/Anchor QEA 2015). These calculations were updated and refined for the Eightmile Lake drainage basin as part of this study. The following describes the methodology used:

- The drainage basin for Eightmile Lake was delineated using geographic information system (GIS) software and DEM data from the USGS, as shown in Figure 2-1.
- Daily precipitation and snow-water equivalent data were downloaded from seven Snow Telemetry (SNOTEL) stations near Eightmile Lake. The monthly runoff, in inches, was estimated at each SNOTEL station based on daily precipitation and snow-water equivalent data.
- The average monthly precipitation in the Eightmile Lake drainage basin was estimated in GIS from the 1981 through 2016 average precipitation dataset from the Oregon State University PRISM Climate Group.
- The locations, elevations, and precipitation data from Water Years 1985 to 2016 of the SNOTEL sites was compared with the location, elevation, and estimated precipitation for the Eightmile Lake drainage basin. Based on the comparison, the Stevens Pass SNOTEL site was identified as the most appropriate for determining runoff for Eightmile Lake.
- A precipitation ratio was developed for Eightmile Lake that represents the ratio of the average annual precipitation in the lake's drainage basin, as estimated from the PRISM precipitation data, to the average annual precipitation at Stevens Pass from the SNOTEL data.
- Monthly runoff, in inches, was estimated for the Eightmile Lake drainage basin by multiplying the estimated runoff at the Stevens Pass SNOTEL site by the precipitation ratio developed for the lake for Water Years 1985 through 2016.
- The total monthly runoff volume, in acre-feet, was estimated for Eightmile Lake by multiplying the estimated runoff, in inches, by the area of the lake's drainage basin for Water Years 1985 through 2016.
- Evaporation was estimated for Eightmile Lake by using estimated evaporation from nearby stations. The two stations closest to Eightmile Lake are Wenatchee and Bumping Lake. It was determined that the Bumping Lake evaporation station would be the most appropriate for determining evaporation for Eightmile Lake because the elevations are similar. Monthly evaporation rates were determined by multiplying the monthly pan evaporation rate for Bumping Lake by 75% to convert pan evaporation to lake evaporation. The lake evaporation

was then multiplied by the full lake area to get an estimated monthly evaporation volume for Eightmile Lake for water years 1985 through 2016.

- Watershed yield was estimated for Eightmile Lake by subtracting the monthly evaporation volume from the monthly runoff volume.

Statistics of available annual watershed yield, or net annual inflow, were developed for Eightmile Lake, as shown in Table 3-1. The annual volume of useable storage allowed by IPID's water right (2,500 acre-feet) is a relatively small percentage of the watershed yield, even under drought conditions. Even if the maximum volume was released under drought conditions, the recharge potential for the lake is expected to be very high. The high recharge potential and relative ease of access make this lake an extremely valuable storage facility for maintaining flows in Icicle Creek and water supply available to IPID, especially during drought years.

Table 3-1
Eightmile Lake Drainage Area and Estimated Watershed Yield

Characteristic	Estimated Value
Drainage Area	3,822 acres
Maximum Annual Watershed Yield	31,001 acre-feet
10% Exceedance Annual Watershed Yield	24,829 acre-feet
Mean Annual Watershed Yield	19,686 acre-feet
50% Exceedance Annual Watershed Yield	19,128 acre-feet
90% Exceedance Annual Watershed Yield	15,152 acre-feet
Minimum Annual Watershed Yield	11,419 acre-feet

Notes:
1. Watershed yield estimated based on precipitation and evaporation data from 1985 through 2016.

3.4 Downstream Hazard Analysis

Ecology's *Dam Safety Guidelines Technical Note 1: Dam Break Inundation Analysis and Downstream Hazard Classification* (MGS Engineering Consultants, Inc. 2007) provides methodology for assessing downstream hazards based on a potential dam failure and resulting inundation. A preliminary hazard analysis was performed using Ecology's "Selection of Design/Performance Goals for Critical Project Elements" worksheet (Appendix C). The results of the hazard analysis yielded a "High" (Class 1A-1C) downstream hazard classification that indicates risk of loss of life, major economic loss, and lasting environmental damage from a potential dam break.

Ecology's *Dam Safety Guidelines Technical Note 2: Selection of Design/Performance Goals for Critical Design Elements* (Technical Note 2; Ecology 1992) provides guidelines for selecting design/performance goals for dam facilities using an eight-step format, where the design/performance goals become more stringent with each step. A “High” (Class 1A-1C) downstream hazard classification typically requires use of Step 7 or Step 8 design/performance goals. Section 2 of Technical Note 2 indicates that, “Design Step 8 is applicable where the consequences of dam failure could be catastrophic with hundreds of lives at risk.” The design/performance goal at Step 8 has an Annual Exceedance Probability (AEP) of 10^{-6}, or one chance in one million, of being exceeded in any given year, and generally corresponds to the theoretical maximum design event.

Ecology’s *Dam Safety Guidelines Part IV: Dam Design and Construction* (Ecology 1993) allows for an alternative method of selecting the magnitude of the IDF referred to as incremental damage analysis (IDA). IDA involves completing a detailed flood inundation analyses to demonstrate that failure of the dam during a candidate design storm event would not significantly increase the level of downstream flooding over that caused by the ongoing, natural flood without a dam failure. If the analysis can demonstrate that the incremental difference is minimal, a lower design step with a smaller design storm event can be used.

A preliminary estimate of the peak flow that would result from failure of the dam was estimated using the formula provided in Technical Note 2. The peak dam failure flow was estimated to be at least 22,000 cubic feet per second (cfs). A detailed flood inundation analysis is beyond the scope of this Feasibility Study. For the sake of developing conservative design recommendations that will meet DSO requirements, the Step 8 design storm with an AEP of 10^{-6} was used for the design calculations and recommendations developed in this Feasibility Study. However, completion of IDA is recommended as part of future design work because it is possible that the analysis could result in a reduction in the design storm event and resulting peak flows used, which would reduce the required size and capacity of the spillway and height of the dam.

3.5 Design Storm Calculation

Ecology’s *Dam Safety Guidelines Technical Note 3: Design Storm Construction* (Technical Note 3; MGS Engineering Consultants, Inc. 2009) provides steps for developing a design storm for use in calculating the IDF hydrograph. Chapter 1.2.2 of Technical Note 3 indicates that the short-duration thunderstorm is commonly the controlling design event in Eastern Washington when the drainage area is less than 50 square miles (MGS Engineering Consultants, Inc. 2009). Short duration storms are high intensity events that typically generate very high peak flood flows. Technical Note 3 also indicates that, in Eastern Washington, the long-duration storm is usually the controlling design event for larger watersheds or when the reservoir storage capacity is large enough to attenuate runoff from the contributing watershed. For this analysis, three design storm types were evaluated: short-duration, intermediate-duration, and long-duration. The following sections detail steps that were followed to complete this evaluation using the Step 8 design storm.

3.5.1 Identify Climatic Region

The site was determined to be within Climate Region 14 using the map provided in Figure 4 of Dam Safety Guidelines Technical Note 3. The climate region was verified using the precipitation data lookup worksheets from the DSO website (DSO 2016). Copies of the precipitation data lookup worksheets are included in Appendix D.

3.5.2 Estimate Mean Annual Precipitation

The mean annual, area-weighted precipitation for the Eightmile Lake drainage basin (centroid at 47.518924° N, 120.892544° W) was estimated to be 65.1 inches. The mean annual precipitation was determined using data mapped by MGS Engineering, Inc., and the Spatial Climate Analysis Service at Oregon State University using the PRISM climate model. The mean annual precipitation was verified using the precipitation data lookup worksheets from the DSO website.

3.5.3 Estimate L-Moment Statistics

The 2-, 6-, and 24-hour duration L-moment statistics for the project site were estimated based on the location and climatic region using the precipitation lookup worksheet from the DSO website. Statistics are summarized in Table 3-1.

3.5.4 Calculate Mean At-Site Precipitation

The 2-, 6-, and 24-hour “at-site” mean precipitation values were calculated using the precipitation lookup worksheets from the DSO website. At-site precipitation values are listed in Table 3-2.

3.5.5 Calculate Base Precipitation Values

The short-, intermediate-, and long-duration theoretical maximum precipitation storm values were calculated using the L-moment statistics, at-site mean precipitation, and equations from Dam Safety Guidelines Technical Note 3, as provided in the precipitation data lookup worksheets from the DSO website. Precipitation values for each storm duration were also calculated for the various return intervals shown in Table 3-2.

Table 3-2
Results of Precipitation Frequency Analysis

Analysis Result	Short-Duration (2-hour) Storm	Intermediate-Duration (6-hour) Storm	Long-Duration (24-hour) Storm
L-Cv	0.1414	0.1527	0.1764
L-Skew	0.2074	0.1724	0.1666
At-site Mean Precipitation (inches)	0.726	1.513	3.367
10-year Precipitation (inches)	0.97	2.06	4.79
25-year Precipitation (inches)	1.13	2.39	5.60
100-year Precipitation (inches)	1.39	2.90	6.82
500-year (Step 1) Precipitation (inches)	1.73	3.51	8.23
Step 2 Precipitation (inches)	1.89	3.79	8.84
Step 3 Precipitation (inches)	2.19	4.28	9.87
Step 4 Precipitation (inches)	2.52	4.78	10.90
Step 5 Precipitation (inches)	2.89	5.32	11.95
Step 6 Precipitation (inches)	3.30	5.88	13.01
Step 7 Precipitation (inches)	3.75	6.47	14.07
Step 8 Precipitation (inches)	4.26	7.09	15.15

Notes:

2. For worksheets and additional detail, See Appendix D.

L-Cv: Site-specific coefficient used in Dam Safety Office (DSO) spreadsheet to calculate At-site Mean Precipitation.
L-Skew: Site-specific skew value used in DSO spreadsheet to calculate At-site Mean Precipitation.

3.5.6 Scaling Precipitation Estimates

The precipitation estimates were scaled for design using a design factor recommended by Technical Note 3, as shown in Equation 1:

Equation 1

$$P_{sd} = DF \times P_{gds}$$

where:

P_{sd} = Scaling precipitation for 2-, 6- or 24-hour index period, in inches
DF = Design Factor; DF = 1.15 for new dams
P_{gds} = Estimated 2-, 6-, or 24-hour precipitation for selected frequency, in inches

3.5.7 Calculate Total Storm Precipitation

The total storm precipitation was calculated by multiplying the scaling precipitation by a total storm multiplier based on the climatic region for the project and the hyetograph for that region and storm type, as shown in Equation 2:

Equation 2

$$Total\ Storm\ Precip = P_{sd} \times Multiplier$$

where:

Total Storm Precip	=	Total precipitation for the design storm, in inches
P_{sd}	=	Scaling precipitation for 2-, 6- or 24-hour index period, in inches
$Multiplier$	=	Multiplier from mass curve for 4-, 18-, or 72-hour storm

Table 3-3 provides a summary of the design factor, scaling precipitation, multiplier, and total storm precipitation estimated by this method using the precipitation lookup worksheets from the DSO website.

Table 3-3
Total Precipitation for Design Storms

	100-year Storms			500-year Storms			Step 8 (10^6-year) Storms		
	2-hour	6-hour	24-hour	2-hour	6-hour	24-hour	2-hour	6-hour	24-hour
P_{gds} (inches)	1.39	2.90	6.82	1.73	3.51	8.23	4.26	7.09	15.15
DF	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
P_{sd} (inches)	1.60	3.33	7.84	1.99	4.04	9.46	4.90	8.15	17.42
Multiplier	1.091	1.879	1.685	1.091	1.879	1.685	1.091	1.879	1.685
Total Precipitation for Design Storm (inches)	1.74	6.26	13.21	2.17	7.59	15.95	5.34	15.31	29.36

Notes:
DF: design factor
P_{gds}: Estimated 2-, 6-, or 24-hour precipitation for selected frequency
P_{sd}: Scaling precipitation for 2-, 6- or 24-hour index period

3.5.8 Calculate Peak Rainfall Intensity

The peak rainfall intensity for the design storms was calculated as shown in Equation 3:

Equation 3

$$Peak\ rainfall\ intensity = (Total\ Storm\ Precip) \times (Peak\ Intensity\ Factor)$$

where:

Peak Rainfall Intensity	=	Peak rainfall intensity for the design storm, in inches/hour
Total Storm Precip	=	Total precipitation for the design storm, in inches
Peak Intensity Factor	=	Intensity factor based on climate region and storm type

The peak storm intensities are summarized in Table 3-4.

Table 3-4
Peak Storm Intensities for Design Storms

	100-year Storms			500-year Storms			Step 8 (10^6-year) Storms		
	2-hour	**6-hour**	**24-hour**	**2-hour**	**6-hour**	**24-hour**	**2-hour**	**6-hour**	**24-hour**
Total Precipitation for Design Storm (inches)	1.74	6.26	13.21	2.17	7.59	15.95	5.34	15.31	29.36
Peak Intensity Factor	2.99	0.270	0.123	2.99	0.270	0.123	2.99	0.270	0.123
Peak Storm Intensity (inches/hour)	4.79	1.69	1.63	5.98	2.05	1.97	14.71	4.14	3.62

3.5.9 Calculate Snowmelt Contribution

Floods may be produced during major rainfall events by a combination of rainfall and snowmelt. Rain on snow events typically only occur during the late winter or early spring, when only intermediate- and long-duration storms are most likely to occur. The contribution of snowmelt during the intermediate- and long-duration storms was calculated using a snowmelt spreadsheet provided by DSO (Appendix E). The snowmelt contribution was added to the total precipitation value for the design storms as shown in Table 3-5.

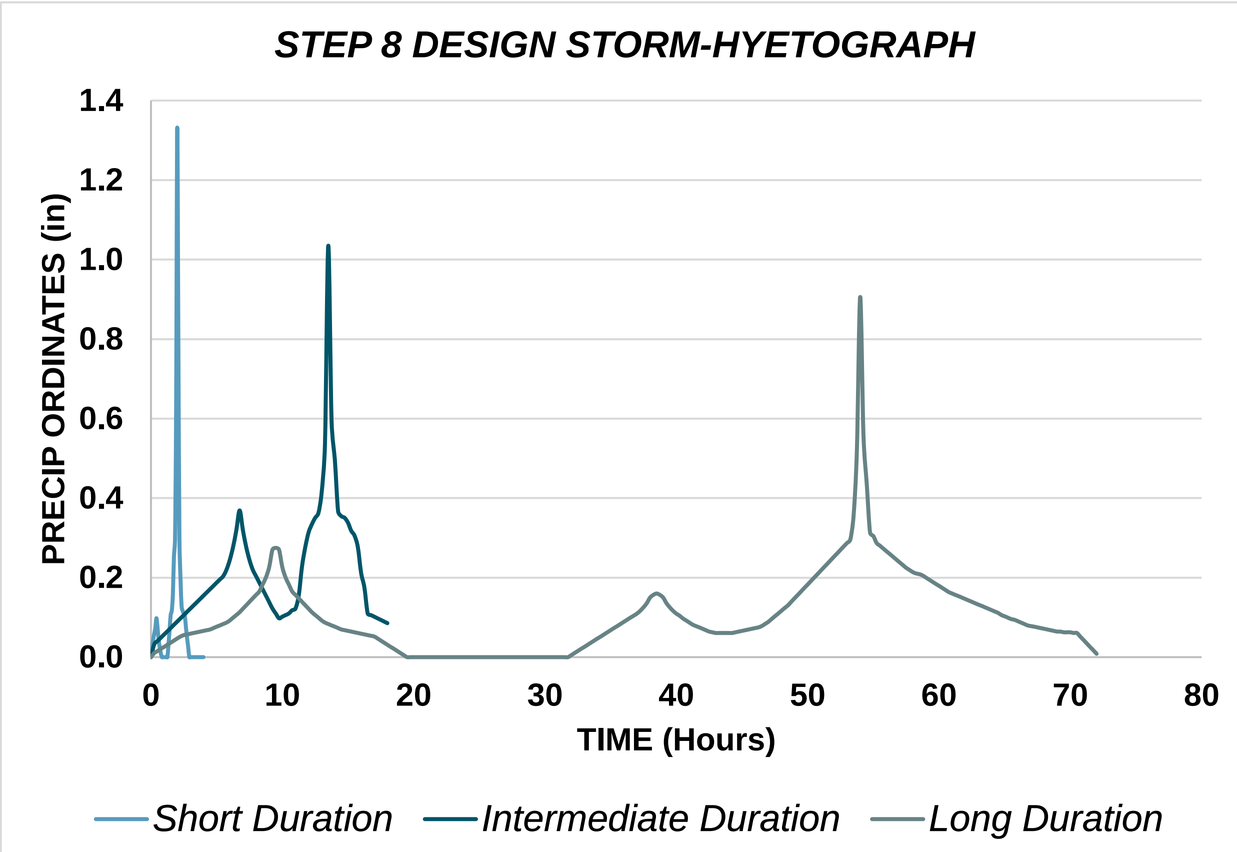
Table 3-5
Snowmelt Contribution for Design Storms

Frequency/Design Step		100-year	500-year	Step 8
Intermediate	Snowmelt (inches)	1.32	1.42	1.97
	Total Precipitation (inches)	6.26	7.59	15.3
	Precipitation + Snowmelt (inches)	7.58	9.01	17.3
Long	Snowmelt (inches)	4.45	4.65	5.52
	Total Precipitation (inches)	13.2	16.0	29.4
	Precipitation + Snowmelt (inches)	17.7	20.6	34.9

3.5.10 Calculate Design Storm Hyetograph

The design storm hyetographs were calculated based on a dimensionless unit-hyetograph. Technical Note 3 presents unit hyetographs for each storm duration and climatic region. The hyetographs are normalized so that the incremental ordinates add up to 1.0. The ordinates are then simply multiplied by the total design storm depth to obtain design storm precipitation values. Hyetographs showing the precipitation distribution estimated for the short-, intermediate-, and long-duration Step 8 design storms are plotted in Figure 3-1.

Figure 3-1
Design Storm (Step 8) Hyetographs



Notes:
in: inch

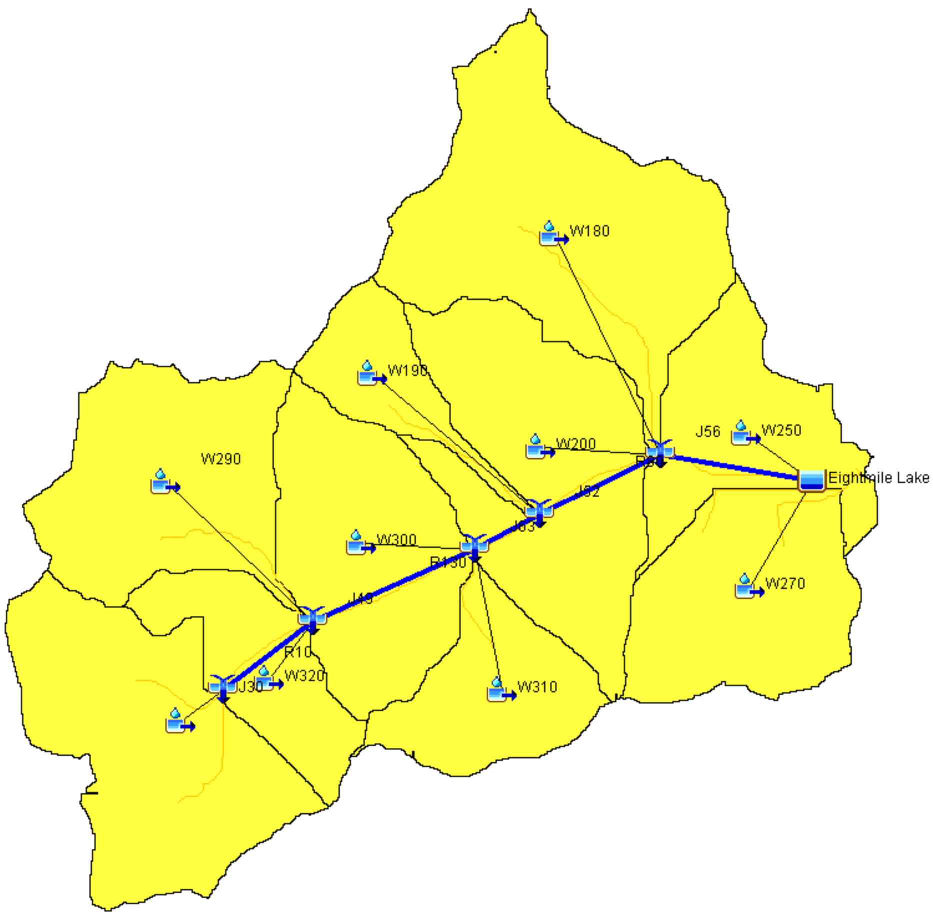
3.6 Design Storm Hydrologic Analysis

3.6.1 Methodology

The United States Army Corps of Engineers (Corps) Hydrologic Modeling System (HEC-HMS) software was used to estimate runoff volumes and flow rates from the drainage basin tributary to Eightmile Lake for the short-, intermediate-, and long-duration design storms characterized in Section 3.5. HEC-HMS software simulates the hydrologic processes of dendritic drainage systems and estimates hydrologic parameters, including infiltration, runoff routing, and runoff hydrographs.

The Eightmile Lake drainage basin was further divided into ten smaller sub-basins for the analysis. These were delineated using GIS software and DEM data from the USGS. The sub-basins used for the HEC-HMS analysis are shown in Figure 3-2.

Figure 3-2
HEC-HMS Sub-basin Delineation



Notes:
HEC-HMS: Hydrologic Modeling System

3.6.2 Soil Characteristics and Land Cover

The NRCS Web Soil Survey (Web Soil Survey 2017) for the area was reviewed to identify the soil characteristics for each sub-basin. Soils within the drainage area as a whole are characterized as follows:

- Rock outcrop – Rubble land-Glaciers snowfields complex, 30% to 99% slopes, no Hydrologic Soil Group. This soil covers approximately 51% of the drainage and is described as having lithic bedrock at 0 inch depth.
- Andic, Cryumbrepts-Haplocryods – Rock outcrop complex, 30% to 75% slopes, Hydrologic Soil Group C. This soil type covers approximately 29% of the drainage and is categorized as

having low available water storage and is underlain by bedrock 20 to 40 inches below ground surface (BGS).

- Soda – Very boulder sandy loam, 30% to 60% slopes, Hydrologic Soil Group B. This soil group covers approximately 16% of the drainage and is described as well drained, having low available water storage (about 4.3 inches), with a vegetative classification of subalpine fir/Cascade azalea.
- Culvop – Very gravelly loam, 30% to 60% slopes, Hydrologic Soil Group D. This soil covers approximately 3% of the drainage and is described as having very low water storage and is underlain by bedrock 10 to 20 inches BGS.

A hydrologic group of C was selected for the hydrologic analysis because a majority of the 6.1 square miles of drainage area tributary to Eightmile Lake are classified as Rock outcrop complex soil types. Hydrologic Type C group soils have low infiltration rates when thoroughly wetted and consist of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures. While the majority of the soils in the drainage have a high rate of water transmission, the underlying bedrock is relatively close to the surface.

3.6.3 Land Cover and Curve Number

The drainage area tributary to Eightmile Lake is undeveloped. Vegetation on the lower slopes tributary to the lake consist of shrubs and subalpine fir forests. The NRCS developed a method of combing the effects of soil type, topography, and land cover on the precipitation-runoff relationship into a single parameter called the runoff curve number. The HEC-HMS software uses the NRCS runoff curve number as one of the key parameters to calculate runoff. To determine the appropriate runoff curve numbers for each sub-basin, a hydrologic soil group was identified based on the soil characteristics of the site. Runoff curve numbers were estimated from Table 2-2c in the NRCS TR-55 Urban Hydrology for Small Watersheds (USDA NRCS 1986) for each sub-basin. Based on review of soil and land cover within the drainage area tributary to the lake, it was determined that site primarily contains a cover type of rocky outcrop and brush with less than 50% ground cover (poor conditions) over soils that are primarily in Hydrologic Soil Group C. Each sub-basin was assigned a composite runoff curve number that was used in the HEC-HMS model. The resulting composite runoff curve number for the entire basin was estimated at 80.

3.6.4 Estimated Inflow from Design Storm

The HEC-HMS model results for peak inflow and runoff volume for the short- (2-hour), intermediate- (6-hour), and long-duration (24-hour) design storms are included in Appendix F. Table 3-6 summarizes the key results.

Table 3-6
Estimated Inflow from Design Storm

	Design Storm (Step 8) Peak Inflow and Runoff Volume		
	Short	**Intermediate [1]**	**Long [1]**
Peak Inflow (cfs)	2,865	5,450	5,315
Runoff Volume (acre-feet)	890	4,460	9,535

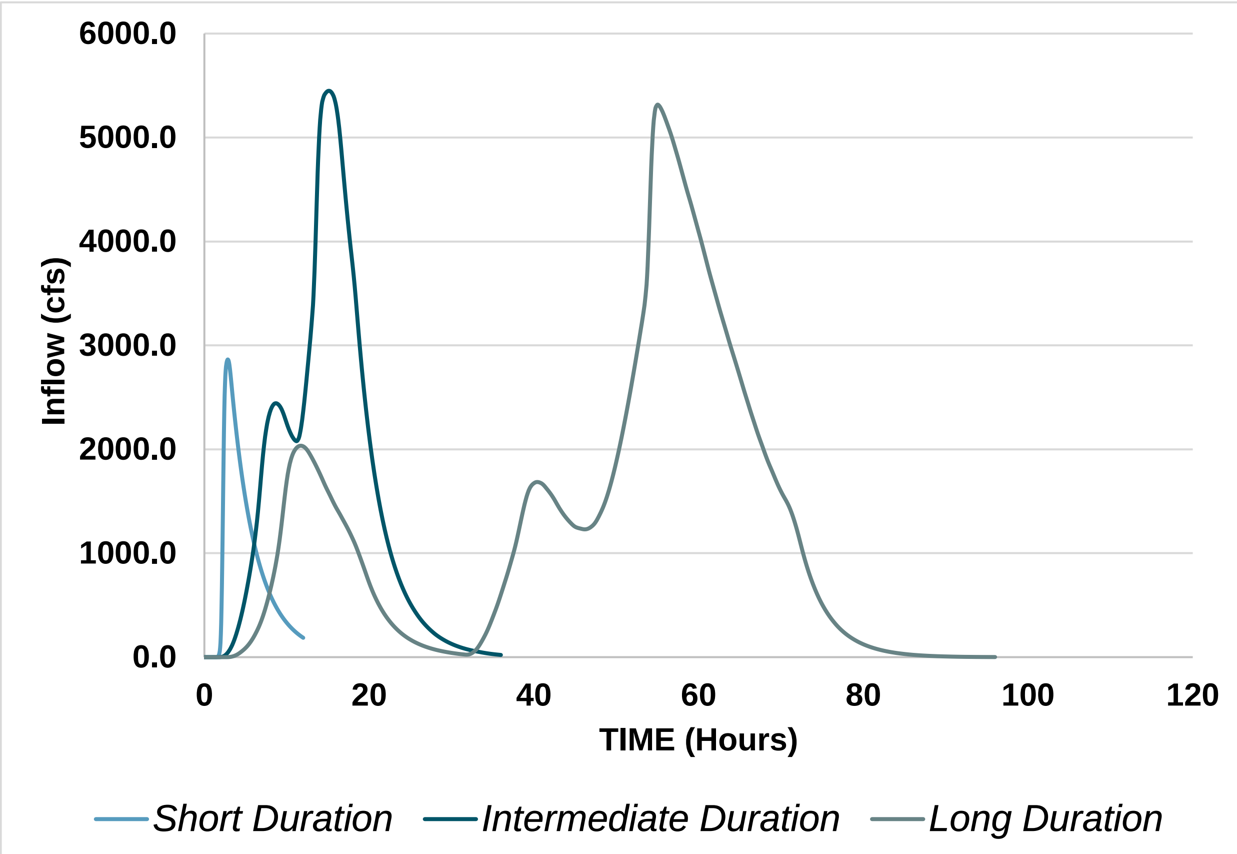
Notes:
1. The intermediate and long duration storm values include estimated snowmelt contributions
cfs: cubic feet per second

Design storm hydrographs were generated based on the HEC-HMS model results discussed above. The short-, intermediate-, and long-duration hydrographs for the Step 8 design storm resulting from the HEC-HMS analysis are shown in Figure 3-3.

3.6.5 Comparison to USGS Methodology

Ecology DSO recommended that the results from HEC-HMS be reviewed and that a check be completed using the USGS StreamStats program. DSO suggested that the variables used to estimate the time of concentration and excess runoff method in HEC-HMS (land cover and curve number) sometimes underestimate runoff from the short-duration storm. DSO suggested that the 100-year runoff estimated by USGS StreamStats be used to calibrate HEC-HMS by comparing the StreamStats results with the HEC-HMS results. The USGS StreamStats program estimates peak flow rates at basin outlet based on precipitation data and regression equations that relate flows at the basin outlet to measured flow rates at nearby USGS gaging stations. StreamStats was used to estimate the 2-year and 100-year flow rates at the outlet of Eightmile Lake. Peak runoff at the outlet of Eightmile Lake was estimated at 195 cfs for the 2-year precipitation event and 468 cfs for the 100-year precipitation event using USGS StreamStats. Peak runoff values for the 100-year short-, intermediate-, and long-duration precipitation events calculated using HEC-HMS were 338 cfs, 1,615 cfs, and 1,961 cfs respectively. In this case, HEC-HMS underestimated the runoff from 100-year short-duration storm, due to the relatively high curve number used. The curve number is used to estimate the amount of precipitation that does not run off due to infiltration or capture by vegetation. Because less precipitation is infiltrated or captured by vegetation during a short-duration storm, using the same curve number that is used for longer duration storms can result in a low estimate of runoff from the short-duration storm. Due to the shallow bedrock in this area, a relatively high curve number was used, which resulted in a conservative estimate of the 100-year short-duration storm in HEC-HMS.

Figure 3-3
Design Storm (Step 8) Inflow Hydrographs



Note:
cfs: cubic feet per second

4 Eightmile Lake Storage Restoration Design

The proposed reservoir improvements and grading are shown in the feasibility-level design drawings submitted with this report (Appendix A). This section summarizes the design of the proposed improvements.

4.1 Design Criteria

IPID proposes to replace the existing dam, low-level outlet pipe, and controls to meet the following design criteria:

- **Normal High Water Surface Elevation (WSEL):** The design will restore dam facilities so that the spillway and normal high WSEL are 4,671.00 feet, equal to the historical high WSEL.
- **Useable Storage Capacity:** The design will restore the useable storage capacity in Eightmile Lake to the annual release volume allowed by IPID's water right (2,500 acre-feet).
- **Low-level Outlet Capacity:** The design will allow for controlled release of the useable storage capacity over a 60-day period with a maximum flow capacity in the low-level outlet system of at least 30 cubic feet per second cfs.
- **Controls:** The design will provide improved control of releases with a new gate or valves. The design will also provide for automation and remote control of releases by installing an electronic actuator that can be connected to telemetry for remote control from IPID's office.
- **Regulatory Requirements:** The design will comply with minimum requirements and standards of Ecology's DSO, as required to get DSO approval of a dam construction permit. The following key criteria have been identified:
  - Spillway facilities will be sized to pass the inflow design flood while maintaining a minimum freeboard of 0.75 feet.
  - Low-level outlet facilities will be designed to provide for controlled release of water while preventing seepage or uncontrolled release of water under the dam.

4.2 Site Preparation

Drawing D-01 in Appendix A illustrates the proposed work that would need to be done to prepare the site for construction. Construction of the improvements would need to occur late in the summer after the lake has been drawn down to the invert elevation of the existing low-level outlet pipeline. The following would need to be done to prepare the site for construction:

- The lake would likely need to be drawn down further to allow improvements to be constructed "in the dry" through pumping, and dewatering facilities would need to be available to allow for dewatering of seepage water in excavations during construction.
- An area would need to be selected for staging of equipment and materials.
- Temporary erosion controls and other environmental protection measures would need to be installed prior to any disturbance and maintained throughout construction.

- Logs and debris collected at the edge of the lake along the proposed work area would need to be removed.
- The proposed construction area would need to be cleared of debris and vegetation. One of the goals of construction would be to minimize impact to native plants and vegetation, so the clearing area should be limited to just what is needed to construct the improvements.
- The existing control gate, debris rack, and related improvements would be removed.
- The rock masonry/concrete dam structure would be removed.
- The low-level outlet pipeline would be exposed by removing rock over the pipeline and excavating down to the pipe.
- The low-level outlet pipeline would be removed.

Additional detail and specific requirements for site preparation, demolition of existing facilities, and removal and disposal of materials will be included in the detailed drawings and project specifications prepared for construction.

4.3 Dam and Embankment Restoration

The project would replace the existing rock masonry/concrete dam structure and earthen embankment with new structures designed to meet the criteria specified in Section 4.2. The proposed dam and embankment restoration design is shown in the plan, profile, and section view in Drawings C-01 through C-06 in Appendix A. Key features are detailed in the following sections:

4.3.1 Central Dam and Flow/Level Control

The existing rock/concrete masonry structure will primarily be replaced with a new dam structure that will consist of a reinforced concrete core protected on both sides by an earth and rock embankment. The top of the reinforced concrete dam wall will be set at elevation 4,676.5 feet to provide freeboard over the spillway sections, as discussed in Section 4.5. Earth embankment, consisting of native material with a topping of native rocks and boulders will be placed on the upstream and downstream sides of the wall to protect the wall from debris and ice. An 8-foot wide notch in the center of the wall will allow IPID to control the lake level below the spillway elevation with stop logs similar to the form and function of the current dam. Under typical operations, IPID will remove the stop logs in the fall and the lake will fill to the crest elevation of the notch (4,666.0 feet) during the winter and spring. When the snow melts enough to allow access to the lake in the late spring or early summer, IPID will go up and place stop logs in the notch to the elevation of the spillway to allow the lake to capture late spring and early summer runoff and fill to the primary spillway elevation (4,671.0 feet). The lake would be full or near full to the spillway elevation when controlled releases begin late in the summer.

4.3.2 Primary Spillway Section

The design and sizing of spillways is detailed in Section 4.5. The primary spillway would include a 99-foot-long spillway section with a crest elevation of 4,671.0 feet, which matches the spillway elevation of the existing dam structure. The spillway section would consist of a reinforced concrete cutoff wall extending north from the reinforced concrete portion of the central dam structure. The spillway wall would be protected on the upstream and downstream sides by an earth and rock embankment. On the downstream side of the wall, the spillway would be lined with gabion baskets filled with native rock and slush concrete.

4.3.3 Secondary Spillway Section

The topography of the site indicates that there is a low spot south of the existing dam that is approximately 3 feet lower than the proposed and historical primary spillway elevation (4,671.0 feet). A secondary spillway section would be constructed in this low spot to provide additional spillway capacity, as described further in Section 4.5. The secondary spillway would include a 75-foot-long spillway section with a crest elevation of 4,673.2 feet. This spillway section would also consist of a reinforced concrete cutoff wall, protected on the upstream and downstream sides by an earth and rock embankment. Because the spillway crest would generally only extend a few feet above the existing ground surface, the extent of fill required would be limited. On the downstream side of the wall, the spillway would be lined with gabion baskets filled with native rock and slush concrete.

4.4 Spillway Analysis and Design

The primary spillway (crest elevation = 4,671.0 feet) will act as the main spillway for discharging peak flows to Eightmile Creek. The secondary spillway (crest elevation = 4,673.2 feet) was designed to provide additional capacity for flows exceeding the 100-year return interval storm inflow event. The following sections describe the approach used to size the spillway facilities.

4.4.1 Reservoir Storage and Spillway Dimensions

The HEC-HMS program was used to calculate the impact of flow routing through the improved Eightmile Lake. The crest elevations, lengths, and top elevations of the spillway and dam walls were adjusted through an iterative process to determine the spillway dimensions and elevations required to pass the Step 8 design storm peak flows from Eightmile Lake while maintaining a minimum of 0.75 feet of free board in the lake.

During the winter and spring, when the intermediate- and long-duration storm events are most likely to occur, the lake level would normally be at or below the crest elevation of the flow control notch because no stop logs would be placed in the notch until the late spring or early summer. During the early summer, with the stop logs placed in the notch, the lake level would fill to the primary spillway elevation. To reflect this, the analysis of the intermediate- and long-duration storms assumed a starting lake level of 4,666.0 feet and the short-duration analysis assumed a starting lake level of 4,671.0 feet. The analysis also assumed that valves on the low-level outlet would be closed so that the only outflows from the lake would be through the flow control notch or the spillways. Table 4-1 summarizes the proposed flow control notch and spillway dimensions and characteristics identified as part of this analysis. The flow control notch and primary and secondary spillways will be designed to discharge flows to the existing Eightmile Creek channel east of the dam.

Table 4-1
Spillway Dimensions and Characteristics

Design Variable	Flow Control Notch	Primary Spillway	Secondary Spillway
Crest Length (feet)	8	99	75
Crest Elevation (feet)	4,666.0	4,671.0	4,673.2
Side Slopes (H:1V)	0	0	3
Approximate Channel Length (feet)	18	18	18
Approximate Channel Drop (feet)	2	4	1
Bed Material	Concrete Filled Gabions	Concrete Filled Gabions	Concrete Filled Gabions

Notes:
H:1V: horizontal to 1 vertical

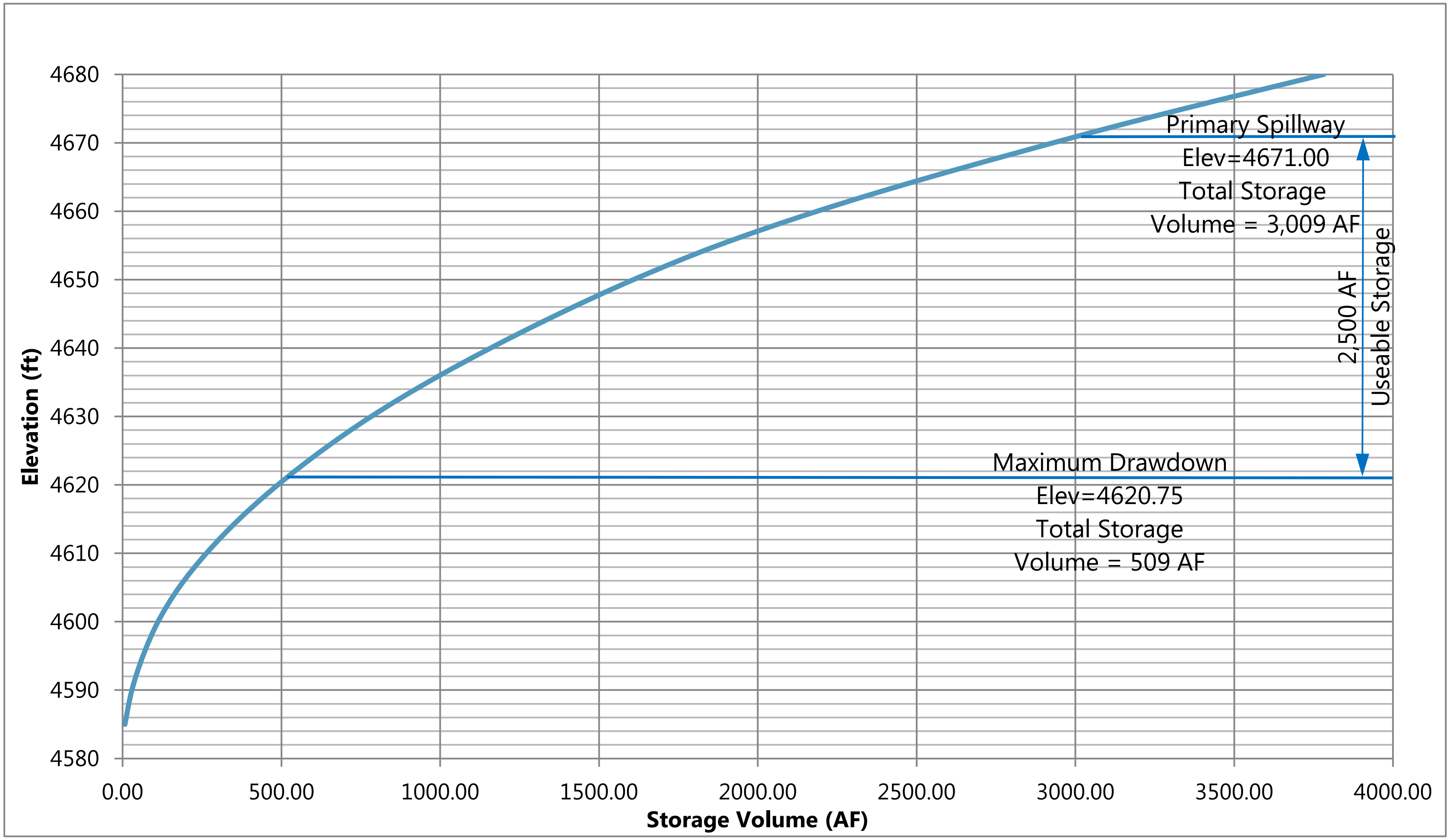
4.4.2 Spillway Discharge Calculations

A spreadsheet was downloaded from the DSO Web Site to verify spillway channel capacity. The spreadsheet (Appendix G) uses Manning's Equation to calculate the Froude number at set water level intervals based on the emergency spillway channel dimensions, material roughness, and channel slope. The calculations confirm that, at all stages, flow in the spillway channels will be super-critical, which means that flow at the crest of the spillways will be critical.

4.4.3 Inflow Routing Calculation

Because the flow is critical over the crest of the emergency spillway, the HEC-HMS program uses the standard broad-crested weir equation for critical flow to route flows from the lake through the spillways based on the given spillway characteristics shown in Table 4-1 and other the hydrologic inputs summarized in Section 3. The routing routine in HEC-HMS also relies on a user input stage-area-storage relationship for the lake. As part of the analysis, the lake contours from Gravity Consulting, LLC, and the proposed design were reviewed to verify the stage-area-storage relationship for Eightmile Lake with proposed improvements. The stage-storage curve for the proposed reservoir is included as Figure 4-1 with key storage and spillway elevation noted. The relationship between the water surface elevation, water surface area, and storage volume above the primary spillway crest elevation is summarized in Table 4-2.

Figure 4-1
Proposed Eightmile Lake Stage-Storage Curve



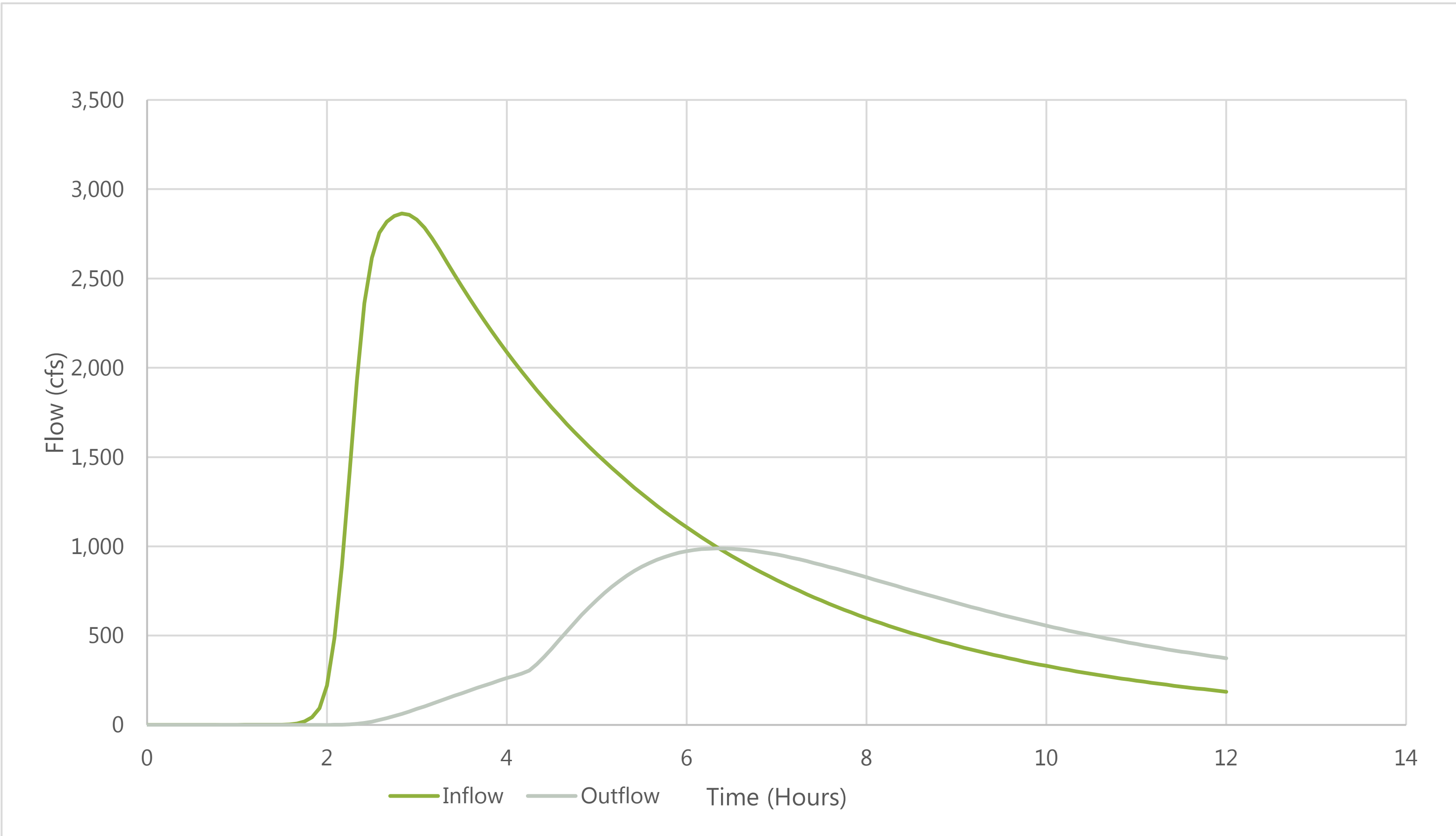
Notes: AF: acre-foot

Table 4-2
Elevation – Area – Storage Relationship Above Primary Spillway

Elevation (feet)	Depth Over Primary Spillway (feet)	Water Surface Area (acres)	Total Storage Above Primary Spillway (acre-feet)
4,671.0	0.0	81.4	0.0
4,671.5	0.5	81.9	41.7
4,672.0	1.0	82.4	83.4
4,672.5	1.5	82.9	125.1
4,673.0	2.0	83.4	166.8
4,673.5	2.5	83.9	208.5
4,674.0	3.0	84.4	250.2
4,674.5	3.5	84.9	292.0
4,675.0	4.0	85.4	333.7
4,675.5	4.5	85.9	377.6
4,676.0	5.0	86.4	421.5

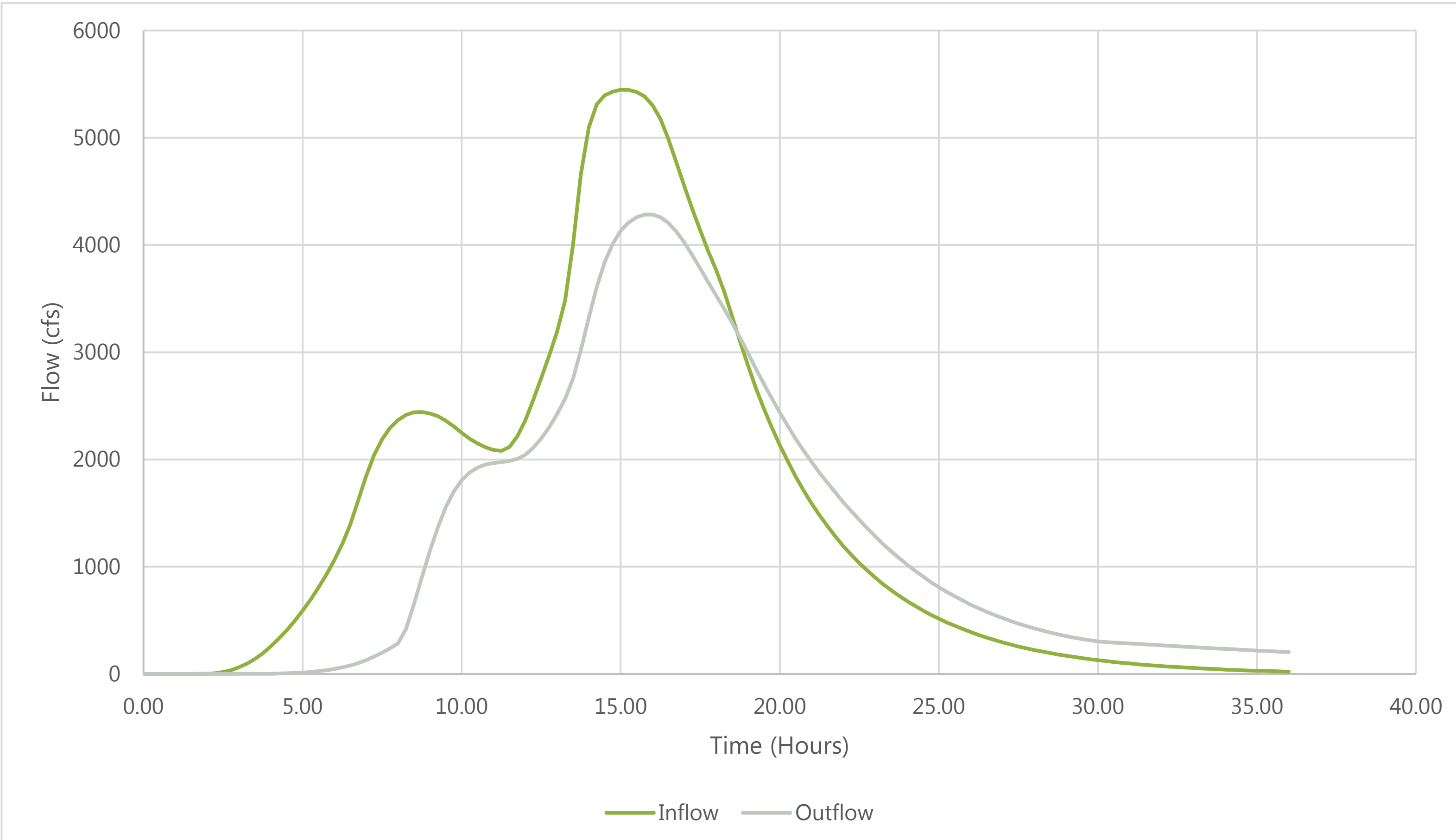
The HEC-HMS model estimates the relationship between inflows and outflows for each time step during the design storm. Inflow and outflow hydrographs were computed based on the Step 8 design storm for the short-, intermediate, and long-duration storms. The HEC-HMS routing results are summarized in Table 4-3, and the inflow-outflow relationships can be seen in Figures 4-2, 4-3, and 4-4. The results show that the peak inflow will be somewhat attenuated by the storage volume in the reservoir above the crest of the emergency spillway. Consequently, estimated peak outflows are less than peak inflows. However, the attenuation is limited, especially for the intermediate- and long-duration storms because the volume of the lake is small relative to the size of the watershed, the lake would start at full (to the primary spillway elevation), and the volume of runoff from the design storm would be much greater.

Figure 4-2
Short-Duration Storm, Inflow-Outflow Relationship



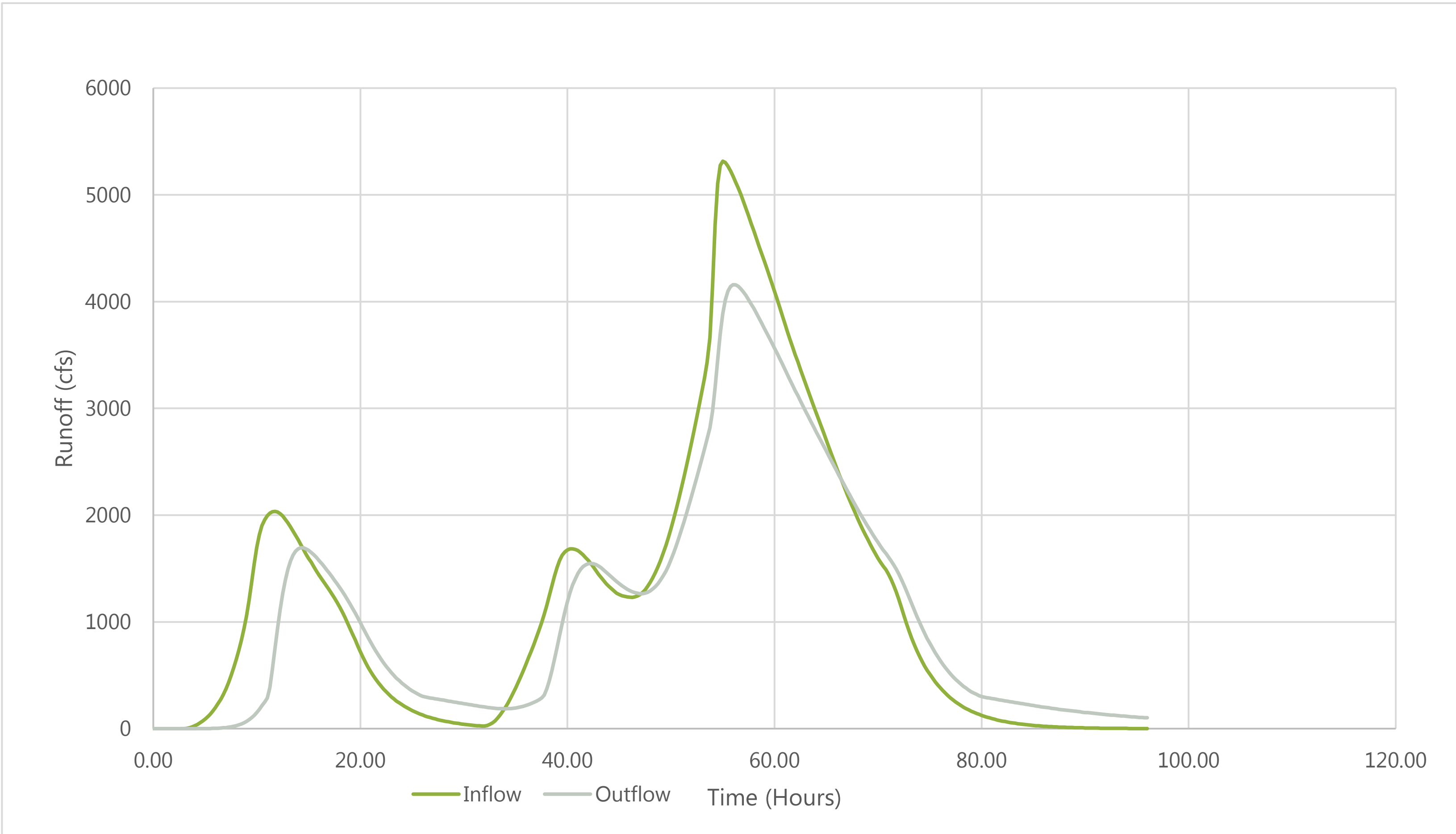
Note:
cfs: cubic feet per second

Figure 4-3
Intermediate-Duration Storm, Inflow-Outflow Relationship



Note:
cfs: cubic feet per second

Figure 4-4
Long-Duration Storm, Inflow-Outflow Relationship



NoteL
cfs: cubic feet per second

4.4.4 *Inflow Design Flood Selection*

With the dam and spillway configured as summarized above and shown in Drawings C-01 through C-06 in Appendix A, the intermediate-duration storm produces the highest water surface elevation and peak discharge rate over the spillways and is therefore the IDF, as shown in Table 4-3. The IDF results in a maximum WSEL of 4,675.7 feet, or 4.7 feet above the primary spillway crest elevation (4,671.0 feet) and 2.5 feet above the emergency spillway elevation (4,673.2 feet). With the top of the structure walls and embankment at 4,676.5 feet, the freeboard at the maximum WSEL is approximately 0.8 feet, which is slightly more than the required 0.75-foot minimum freeboard based on an analysis for intermediate dam freeboard.

Table 4-3
Spillway Outflow Summary for Potential Inflow Design Storms

	Short	Intermediate	Long
Peak Inflow (cfs)	2,864	5,447	5,315
Peak Outflow (cfs)	997	4,308	4,183.5
Peak Depth Above Primary Spillway (feet)	1.4	4.7	4.6
Peak Water Surface Elevation (feet)	4,672.4	4,675.7	4,675.6
Peak Storage Above Emergency Spillway (acre-feet)	3,031	3,314	3,305

Notes:
Results for intermediate and long storms include estimated snowmelt contribution
cfs: cubic feet per second

4.5 Low-level Outlet Pipe, Valves, and Release Controls

The proposed design also includes replacement of the low-level outlet pipeline and slide gate with a new pipeline that will be controlled by valves. The design of the low-level outlet pipeline, valves, and related controls is shown on Drawings C-07 through C-09 in Appendix A. The low-level outlet system would include the following primary components:

- **Low-level Outlet Pipeline:** The pipeline would consist primarily of 30-inch (nominal diameter) butt-fused, solid-wall high-density polyethylene (HDPE) pipe, which has an average inside diameter of approximately 27 inches. The pipe would neck down to 24-inch at valve enclosures to reduce the size and cost of the proposed valves. The pipe invert would be 4,618.25 feet at the inlet, 4,645.50 feet at the dam, and 4,614.00 feet at the outlet to Eightmile Creek. When the lake is full, the pipeline would operate full under gravity to release water from the lake, despite the high point in the pipe at the dam. When the lake is drawn down below the high point in the pipe at the dam, the pipe would operate as a siphon, relying on atmospheric pressure to keep water flowing through the pipe. This would allow IPID to draw down the lake to an elevation of 4,620.75 feet without pumping to access the full 2,500 acre-feet of storage permitted by IPID's water right.

- **Inlet Debris Rack:** A cylindrical debris rack, consisting of welded-steel or aluminum bar, would be attached to the pipe inlet to keep debris from entering the pipeline.
- **Pipe Anchoring:** Approximately 380 feet of pipeline would be installed along the lake bottom. The pipe would likely be installed by floating the pipe on the lake and then filling the pipe with water so that it drops and rests along the lake bottom. The pipe would require anchoring to prevent the pipe from floating when water is evacuated from the pipe.
- **Encasement:** The proposed pipe would be buried from the lake to the outlet in Eightmile Creek. The pipe would be encased in reinforced concrete under the dam and embankment.
- **Isolation Valve Enclosure:** A 24-inch gate valve would be provided in an enclosure on the downstream side of the dam to allow IPID to isolate the pipeline below the dam. The isolation valve would be designed to be either fully open or closed. The valve would be left open during normal operations and would be closed only when needed to maintain the pipeline downstream of the valve. The valve enclosure would also include an air release valve on the upstream side of the isolation valve that would allow for the release of air from the pipeline as it fills with water over the winter and spring. A vacuum pump would be provided with a connection to the pipeline for use in priming the pipeline, in the event that the siphon breaks when the lake level is drawn down and releases are occurring. The enclosure would also include a sump pump to evacuate water. Power for the vacuum pump and sump pump would come from batteries charged by a nearby solar panel. The enclosure would consist of a 60-inch-diameter pipe riser with a weathertight, locking lid and an access ladder.
- **Control Valve Enclosure:** A 24-inch plug valve would be provided to control flow through the pipeline near the downstream end of the pipeline. The valve would be closed during the winter, spring, and early summer. As the lake fills, the pipeline would fill behind the valve. In the late summer the valve would be adjusted to release flows to Eightmile Creek. The plug valve would be equipped with an electronic actuator and connected to telemetry to allow for automated releases to be controlled by IPID via radio from their office in Cashmere. Automation of releases from the Alpine Lakes is detailed in the *Feasibility Study, Alpine Lakes Optimization and Automation* report (Aspect 2017), which is being prepared concurrent with this report. The actuator would be powered by batteries charged by a nearby solar panel. The enclosure for the valve, actuator, batteries, and controls would consist of a 60-inch-diameter buried pipe riser with a weathertight, locking lid above the ground surface and an internal access ladder.

As outlined in the Dam Safety Guidelines Part IV: Dam Design and Construction, there are five primary concerns for the hydraulic design of low-level outlet pipelines:

- The inlet invert elevation of the low-level outlet must be selected so as to sufficiently evacuate reservoir storage while remaining free of sedimentation.
- Sufficient discharge capacity should be provided for the project demands and future needs.
- Sufficient discharge capacity should be provided to allow for drawdown of the reservoir in a reasonable period of time for emergencies, maintenance, inspections, and repair of reservoir elements that would normally be submerged.
- The design should provide features to reduce slug flow potential.
- The design should provide redundant and repairable valves and shut-off capabilities to allow for conduit inspection and repairs, and prevent unintended release of storage waters if a system component were to fail.

4.5.1 Hydraulic Analysis

Table 4-4 summarizes the key design parameters for the low-level outlet pipeline. Hydraulic analysis of the low-level outlet indicates that the pipeline would generally have capacity to release water at rates in excess of 30 cfs. When the lake is full, the control valve would need to be partially closed to limit releases. For example, if the lake were full to the spillway elevation (4671.00 feet), the control valve would need to be closed to 40° to restrict the discharge to Eightmile Creek to less than 36 cfs. As the lake draws down, flow through the pipeline would decrease until the valve would need to be fully open to release 30 cfs. If the lake were drawn down to an elevation approaching the pipe inlet, the capacity would drop further. For example, if the lake were fully drawn down to the top of the pipe at the inlet (4,620.75 feet), with the valves fully open and the siphon fully primed, the pipeline would be able to discharge nearly 18 cfs to Eightmile Creek.

Table 4-4
Low-level Outlet Pipeline Analysis

Parameter	Design Value
Low-level Invert Elevation at Outlet to Channel	4,614.00 feet
Outlet Water Surface Elevation at Channel	4,614.00 feet
Low-level Invert Elevation at Dam	4,645.50 feet
Low-level Inlet Invert Elevation at Lake	4,618.25 feet
Nominal Pipe Diameter	30 inches
Nominal Pipe Diameter at Valves	24 inches
Pipe Material	Solid-wall HDPE, butt-fused
Pipe Length	844 feet
Q_{min} with Lake Surface at 4,620.75 (Fully Drawn Down, Siphon Flow)	17 to 18 cfs
Q with Lake Surface at 4,623.25 (Drawn Down, Siphon Flow)	~30 cfs
Q with Lake Surface at 4,671.00 (Lake Full, Valve Closed at 40°)	35-36 cfs
Q with Lake Surface at 4,671.00 (Lake Full, Valve Fully Open)	>100 cfs

Notes:
cfs: cubic feet per second
HDPE: high-density polyethylene
Q: flow rate
Q_{min}: minimum flow rate

4.6 Reservoir Operations

Table 4-5 summarizes the anticipated operation of the controls at the proposed dam and on the low-level outlet. The lake would fill during the late fall, winter, and spring to the crest elevation at the bottom of the flow control notch. When the snow melts and the lake is accessible in the late spring or early summer, IPID would place stop logs in the notch to the elevation of the primary spillway and the lake level would continue to rise to the spillway level through the early summer. When additional flows are needed in Icicle Creek, the control valve would be opened. The control valve would be adjusted remotely by IPID to optimize releases to meet instream flow and irrigation water supply needs. The operation of the low-level outlet would transition from gravity flow to siphon as the lake level drops below the high-point on the pipeline (elevation 4,645.5 feet). At the end of the irrigation season the control valve would be closed, the stop logs would be removed, and the system would be winterized. If the lake has been fully drawn down and the siphon breaks, the low-level outlet would fill as the lake refills over the winter. The air release valve located at the high-point of the pipeline near the dam would release air trapped in the pipe as it fills with water.

Table 4-5
Anticipated Reservoir Operations

Month	Storage Level	Stop Logs in Flow Control Notch[1]	Low-level Outlet Pipe Operation[2]	Isolation Valve Status[3]	Control Valve Status[4]
January	Refill	Removed	Closed/Filling	Open	Closed
February	Refill		Closed/Filling	Open	Closed[4]
March	Refill/Spill		Closed/Filling	Open	Closed[4]
April	Refill/Spill		Closed/Filling	Open	Closed
May	Refill/Spill		Closed/Filling	Open	Closed
June	Refill	Placed to 4,671.0	Closed	Open	Closed
July	Full (4,671 Max)		Release Begins	Open	Partially Opened
August	Draw Down		Gravity Release	Open	Partially Opened
September	Draw Down		Gravity/Siphon Release	Open	Fully Opened
October	Low (4,621 Min)	Remove	Closed	Open	Closed
November	Refill		Closed/Filling	Open	Closed
December	Refill		Closed/Filling	Open	Closed

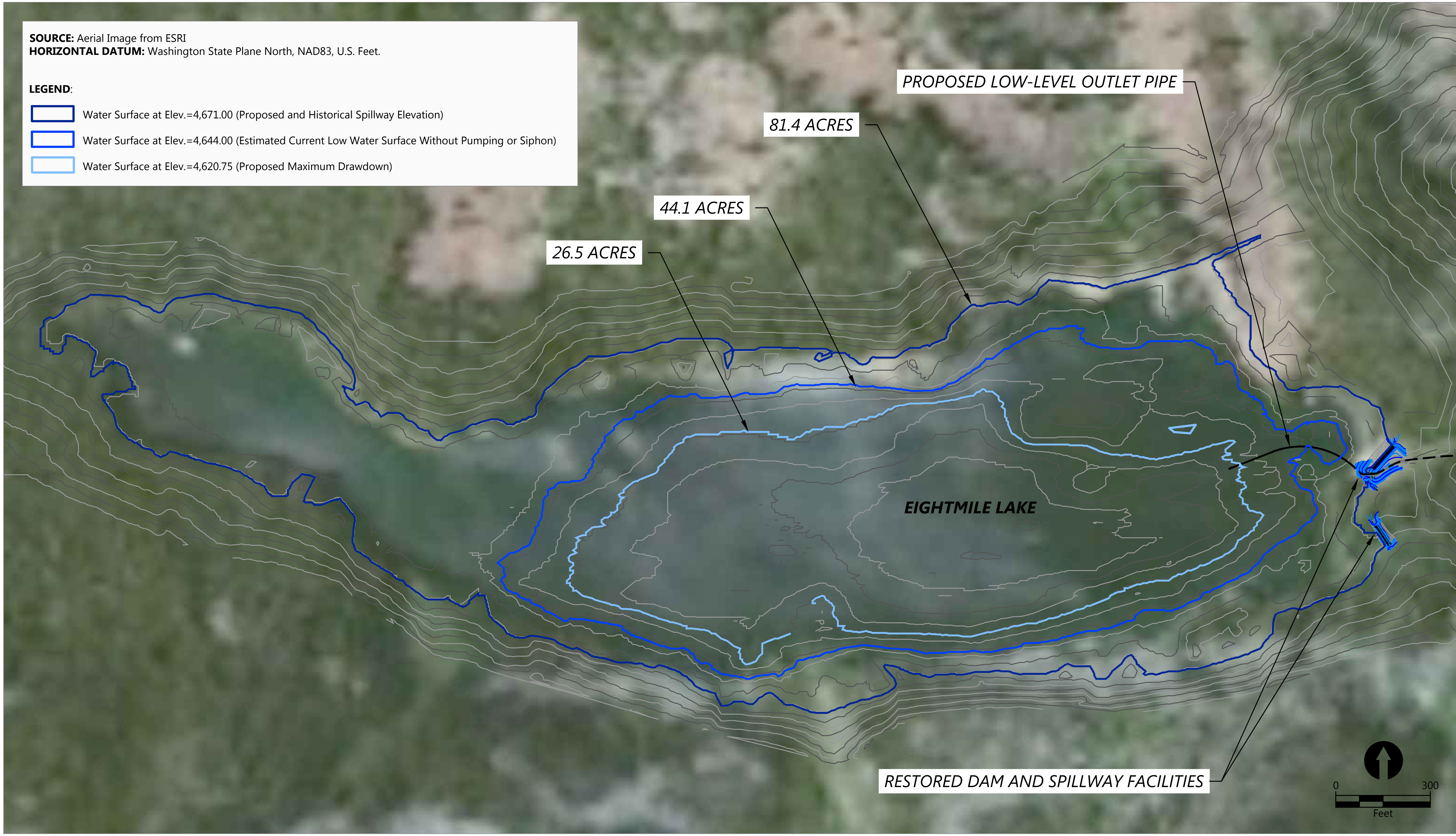
Notes:

1. Stop logs would be placed in the flow control notch in late spring, early summer to the spillway elevation when snow has melted and the lake is accessible. Stop logs would be removed at the end of the release period in early October.
2. Releases through the low-level outlet would occur during the late summer, with initial release operating fully under gravity flow conditions and late in the summer under siphon flow conditions.
3. The isolation valve would remain open unless the downstream end of the pipe needs to be isolated for maintenance.
4. The control valve would be used to control releases from the low-level outlet. It would generally remain closed until the late summer and then adjusted to release flows to match needs in Icicle Creek during the late summer. If desired the valve could be operated to allow for some release to meet Leavenworth National Fish Hatchery water supply needs during the winter low flow period.

4.7 Restored Useable Storage Capacity

The proposed improvements would restore the useable storage capacity in Eightmile Lake to 2,500 acre-feet, which is the annual volume permitted for release by IPID's water right. If the total usable storage is released over a 60-day release period, the average flow release would be approximately 21 cfs. Automation of the control valve will allow for remote control and adjustment of releases to more closely match the need for additional water downstream in Icicle Creek. The actual period of release will vary from year to year and the magnitude of the releases will be modified throughout the release period to meet water supply needs.

Figure 4-5 illustrates the new high and low water surfaces that would result from implementation of the proposed project, as reflected in the feasibility level design drawings. When the lake is full to the primary spillway elevation (4,671.00 feet), the water surface area of the lake will be approximately 81.4 acres. When the lake is drawn down to the top of the low-level outlet pipe at the inlet (4,620.75 feet), the water surface area of the lake will be approximately 26.5 acres. When the lake is drawn down to the invert of the existing low-level outlet pipe, the water surface area is approximately 47.9 acres. However, as noted earlier, the lake continues to draw down due to seepage. Forsgren Associates, Inc., and Gravity Consulting, LLC, estimated the low draw-down elevation to be approximately 4,644 feet, which corresponds to a water surface area of approximately 44.1 acres.



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Filepath: K:\Projects\0204-Aspect Consulting, L.L.C\Icicle Creek Comp Water Mgt\Eightmile Lake\0204-RP-001 FS FIG 4-5.dwg FIG 4-5

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Figure 4-5
Eightmile Lake Water Surface Area Comparison
Eightmile Lake Feasibility Study
Icicle and Peshastin Irrigation Districts

5 Construction Approach

5.1 Constraints and Limitations

The primary challenge to implementation of the proposed Eightmile Lake Storage Restoration project will be determining how to construct the project at a remote location within the Alpine Lakes Wilderness Area that is not accessible by roads. The project will require careful planning to secure appropriate permits and ensure that the project can be constructed safely to meet the requirements of the design. The primary constraints and limitations that will need to be addressed are construction access; mobilization of the work crew, provisions, equipment, and materials; delivery and control of materials to meet specification requirements; and constructing the project within what could be a very tight window between when the lake is drawn down and when the snow falls.

5.2 Access and Mobilization

As noted earlier and shown in Figure 1-1, Eightmile Lake is located 10 miles west of the City of Leavenworth, Washington. The lake is situated within Sections 32 and 33, T24N, R16E, and is entirely within the Alpine Lakes Wilderness Area. There are no roads that access the lake directly. The lake can be accessed on foot via the Eightmile Lake Trail (USFS Trail No. 1552). The trailhead is accessible from Leavenworth by vehicle following Icicle Road, USFS Road 7600, and USFS Road 7601. The distance from the trailhead to the lake is approximately 4 miles.

For routine maintenance and access, IPID accesses Eightmile Lake on foot. To complete maintenance at multiple lakes and for activities that require more equipment than can be easily carried on foot, IPID accesses the lakes via helicopter. Typically, that access is provided with a small helicopter with a payload of 1,000 to 2,000 pounds, which limits the number of people and amount of gear that can be transported in one trip. IPID has used helicopters recently to access nearby Colchuck Lake to perform more intense maintenance activities that have required the transport of a small work crew, hand tools, camping gear, food and provisions for the work, sacks of concrete, other materials, mixing equipment, and a generator. Transporting the work crew, other equipment, and materials has typically required multiple trips in a small helicopter.

5.3 Access Options

The proposed Eightmile Lake Storage project would require access by a work crew and transport of gear, food and provisions, hand tools, larger mechanical equipment (including at least one excavator, a small tracked loader, a means of mechanically sorting on-site materials, and possibly concrete mixing equipment), concrete, pipe, valves, generators, dewatering pumps, trench protection equipment, debris rack, and other construction materials. To the extent possible, rock and earthen material would be sourced from on site. Transporting larger mechanical equipment and some of the other construction materials that will be required to the site will likely require access via one of the following methods.

5.3.1.1 Helicopter

Transport of larger equipment and materials would require a much larger helicopter than what is used by IPID for typical maintenance. Columbia helicopters provides helicopter transport services for heavy lift, firefighting, and military applications. Columbia helicopters was contacted to understand the costs and limitations associated with use of helicopters to haul equipment and materials to the site (Dave Horax 2017). They provided the following information on options for helicopter transport:

- **Columbia Vertol 107-II:** The Vertol 107-II is a tandem rotor aircraft with a maximum gross weight of 22,000 pounds. The maximum payload at the elevation of the proposed project would be approximately 7,000 to 8,000 pounds. Mobilization of the helicopter and pilot would carry a $20,000 fee. The rental fee would be $7,500 per hour.
- **Columbia Chinook CH-47D:** The Chinook CH-47D is a tandem rotor aircraft with a maximum gross weight of 50,000 pounds. The maximum payload at the elevation of the proposed project would be approximately 20,000 to 22,000 pounds. Mobilization of the helicopter and pilot would carry a $45,000 fee. The rental fee would be $15,000 per hour.
- **Columbia 234-UT:** The 234-UT is also a tandem rotor aircraft with a maximum gross weight of 51,000 pounds. The maximum payload and costs for mobilization and rental would be similar to the cost for the Chinook CH-47D.

Other helicopter options exist that can carry similar payloads, but there are relatively few options that have a payload capacity similar to the Chinook CH-47D. With a payload capacity of 20,000 to 22,000 pounds, the Chinook CH-47D would have capacity to carry most of the materials and equipment. However, the challenge will be transporting an excavator that is large enough to efficiently move the material needed to remove and replace the existing dam and low-level outlet pipeline. For example, the largest Cat excavator that weighs less than 22,000 pounds would be a Cat 308E2 excavator, with an operating weight of 18,519 pounds. The 308E2 is a 65-horsepower machine and is classified as the largest of Cat's mini excavators. Other equipment that may need to be flown in by helicopter could include a small tracked multi-terrain loader.

One of the other key challenges will be transporting concrete; either the concrete would have to be batched on site with on-site water, or the concrete would have to be batched off-site, hauled to a pick-up location near the site, and transported via helicopter to the site. Columbia helicopters indicated that the Chinook CH-47D does not have a big bucket or hopper for transporting concrete. However, the Vertol 107-II helicopter has a bucket that can hall 1-1/2 yards of concrete.

5.3.1.2 Combined Helicopter/Overland Transport

Another option might include transport of smaller gear, equipment, and lighter materials with a small to medium-sized helicopter and walking a larger excavator to the site. A larger excavator would be able to complete the work much more efficiently, and transport overland would be much less expensive. However, this approach would likely have more of an impact on the environment along the trail to Eightmile Lake. Walking the excavator would consist of shifting the weight from the bucket to the tracks to maneuver the excavator over rocks, logs, and earth in a way that would minimize the impact on vegetation and other natural resources. IPID has proposed to investigate this option with the USFS to identify an overland route that would have least impact. IPID has indicated that there is a historical roadbed that was used in the past for access to Eightmile Lake that extends from Eightmile Lake Road up the slope almost to the boundary of the Alpine Lakes Wilderness. The existing Eightmile Lake Trail (USFS Trail No. 1552) ascends a steep slope from the trailhead and then uses this historic road bed as it extends west to the Alpine Lakes Wilderness Area. The historical road bed could be used as a route to transport the excavator part of the distance to Eightmile Lake. Where the trail narrows and enters the Alpine Lakes Wilderness Area, the excavator could be carefully maneuvered over rocks and logs near the base of the slope, parallel to but off the trail, where there is less vegetation that would be disrupted.

A couple of different types of excavators were investigated as options for this approach:

- **Standard Tracked Excavator:** The work required to restore storage at Eightmile Lake would be most effectively done with a medium- to large-sized tracked excavator, such as a Cat 330. This type of excavator moves on a heavy base with tracks and uses the tracks to distribute weight and travel over surfaces that are highly variable. IPID has a medium-sized excavator, as do most local contractors that would do this type of work.
- **Spider Excavator:** Another option may be to use a spider excavator. A spider excavator has legs with rubber-tired wheels, rather than a base with tracks. The legs and rubber-tired wheels allow for greater maneuverability. Some spider excavators come equipped with telescopic hydraulic stabilizing jacks that can extend from the front legs to stabilize the equipment for work on steep terrain. Spider excavators are often used on ski slopes and in remote mountain terrain, similar to the terrain around Eightmile Lake. Use of a spider excavator would likely have less impact on the environment, but would not likely provide the same horsepower, lifting, and digging capacity as a standard tracked excavator. Spider excavators are also less common, and so use of this type of excavator would likely limit the number of contractors that would be able to do the work. A contractor was contacted in California that does spider excavation all over the Western United States. The cost for the excavator and an operator would be $200 to $250 per hour, depending on the size of machine, plus a $200 per day per diem rate and a mobilization/demobilization fee of $5,000.

5.3.2 *Comparison*

Table 5-1 provides a summary and comparison of the potential approaches to accessing the site and delivering equipment and materials to the site.

Table 5-1
Potential Construction Access and Mobilization Approach Comparison

Access and Mobilization Approach	Large Helicopter, Small Excavator	Overland Access, Tracked Excavator	Overland Access, Spider Excavator
Mobilize Crew, Provisions	Small Helicopter or Trail	Small Helicopter or Trail	Small Helicopter or Trail
Mobilize Equipment	Small Helicopter	Small Helicopter	Small Helicopter
Mobilize Excavator	Large Helicopter	Walk Overland	Walk Overland
Mobilize Excavator	Large Helicopter	Small-Medium Helicopter	Small-Medium Helicopter
Type of Excavator	Small Excavator	Medium-Large Excavator	Spider Excavator
Excavator Example	Cat 308E2	Cat 330F	Menzi Muck M545
Excavator Weight	20,000 Pounds Max	60,000 Pounds+	25,000 to 30,000 Pounds
Excavator Horsepower	65 hp	235 hp	180 hp
Excavator Max Dig Depth	13 to 14 feet	23 to 24 feet	15 to 30 feet[1]
Impact to Environment	Least impact to area between trailhead and Eightmile Lake	Most impact to area between trailhead and Eightmile Lake	Some impact to area between trailhead and Eightmile Lake
Cost	Highest due to Helicopter Mobilization, Rental	Lowest	Slightly Higher than Standard Excavator
Equipment Limitations	Helicopter Payload; Excavator Size, Power, and Lifting Capacity	Excavator Maneuverability	Excavator Size, Power, and Lifting Capacity
Contractor and Equipment	Requires Specialized Helicopter, Pilot; Could Transport Other Equipment, Like a Small Tracked Loader	Standard Contractor, Standard Equipment	Specialty Contractor, Specialty Excavator
Work, Efficiency	Least Efficient due to Small Excavator	Most Efficient (Except that mobilization would take more time)	Medium Efficiency (Mobilization would also take time)

Notes:
1. Excavation depth depends on chassis configuration and position relative to ground slope.
hp: horsepower

5.4 Materials Delivery and Staging

The proposed project will require a variety of materials, including earth, rock, concrete, reinforcement, pipe, valves, valve enclosures, a debris rack, stop logs, an actuator, a vacuum pump, risers, solar panels, batteries, controllers, and other miscellaneous equipment. The following challenges will arise related to material delivery and quality control during construction:

- **Earthwork** – To the extent possible, native material should be used to construct the embankment and backfill excavations. Typically, specifications for materials placed for a dam structure or backfill adjacent to a structure have requirements for the size distribution of materials, compaction, moisture content, and other characteristics. The quality of these materials is managed by reviewing the materials prior to placement and performing compaction tests to ensure that materials are properly placed. Ensuring that on-site materials meet specific requirements will be a challenge for this project because the site is so remote. Sorting materials properly will be difficult because there will be a limit to the type of mechanical sorting equipment that can be brought to the site. Compaction testing equipment will have to be flown in and a certified testing agency will need to access the site regularly.
- **Concrete** – The project will require placement of approximately 168 cubic yards of concrete. As noted previously, concrete will either need to be flown in or batched on site. The benefits and challenges of flying in the concrete would include the following:
    - The concrete would be batched in a plant to meet the specifications.
    - The time between batching and placing the concrete could push acceptable limits. Depending on where concrete is batched, it would likely take more than an hour to transport concrete to a pick-up point, transfer the concrete to the hopper on the helicopter, and fly the concrete to the site.
    - Managing the moisture content throughout the transport would be a challenge.
    - Helicopters have limited capacity, so many trips would need to be made to transport concrete. The limited delivery rate would make the work less efficient.
    - There would be potential for pollution in flying concrete in a helicopter, so pollution controls would need to be implemented.

  The benefits and challenges of batching the concrete on site would include the following:
    - The concrete would not need to be transported long distances.
    - The dry concrete materials, including cement and aggregate, would have to be flown in, which would add complexity and time to the mobilization effort.
    - Quality control of the material would be very challenging. It would be almost impossible so that the concrete placed consistently meets the material specifications.
    - It would be difficult to manage the quality of the water used in the concrete mix.
    - On-site water would need to be used for the concrete mix, which may not be of consistent or appropriate quality for the concrete mix.
    - Batching on site would have potential for pollution and would require controls.
    - Space would need to be identified on site for mixing concrete and staging materials.
- **Other Equipment** – Pre-fabricated or manufactured materials and equipment would need to be transported to the site via helicopter and staged in a safe place prior to installation. HDPE

pipe would need to be transported in segments small enough for helicopter transport and then joined on site with a butt fusion machine. Valves, valve enclosures, a debris rack, stop logs, an actuator, a vacuum pump, risers, solar panels, batteries, controllers, and other miscellaneous equipment would all need to be transported in loads that were within the limitations of the helicopter. This may require some on-site assembly.

5.5 Construction Sequence and Scheduling

Sequencing of construction will be critical because the schedule for completing the work will be limited by the following:

- **Lake Drawdown** – The work at the lake will need to be completed after the lake has been drawn down well below the existing low-level outlet so that work can be completed "in the dry". Typically, the lake is not drawn down until late summer, when IPID releases water to maintain irrigation water supply. However, during the year the improvements are constructed, IPID may need to manage its other reservoirs to allow for early drawdown of Eightmile Lake. The draw down will still be constrained by the natural hydrologic cycle. If there is above average snow pack and a cool spring weather, the lake may still be capturing a lot of natural runoff well into late June or early July.
- **Weather** – Due to the location and elevation of Eightmile Lake, snow often begins to fall in October, although significant snow accumulation typically does not occur until November. Freezing weather may occur much earlier in the fall. In addition, October rainfall can result in runoff that would impact the lake level and the Contractor's ability to keep the site dry for construction. The Contractor will have to sequence and manage construction so that the project can be constructed in dry conditions and is substantially complete before significant snow accumulation or extended freezing weather occurs.

Ultimately, it is recommended that the construction specifications and contract documents be prepared so the selected Contractor as much flexibility as possible in determining the appropriate means and methods, schedule, and sequence for construction. Some of those means and methods, such as how materials and equipment are mobilized, where materials are staged, and what kind of controls will need to be in place to protect the environment, will likely be limited by permit approvals. However, to the extent possible, it will be beneficial to IPID and project funders to provide as much flexibility as possible to prospective bidders to figure out how to get the work done within the limitations dictated by the permit requirements and natural constraints at the site.

6 Cost Analysis

6.1 Summary of Probable Implementation Costs

Table 6-1 summarizes the opinion of probable project implementation costs for the project. A more detailed breakdown of the opinion of probable costs is included in Appendix H. The opinion of probable costs includes the following assumptions and allowances:

- An allowance of 10% of the construction subtotal (without helicopter costs) for general mobilization/demobilization.
- A separate allowance for helicopter mobilization and rental fees, as described below.
- A 20% contingency for the low estimate and a 40% contingency for the high estimate.
- A 20% allowance for engineering, permitting, and construction administration.
- A sales tax at 8.2%.

Table 6-1
Opinion of Probable Project Implementation Costs

Item	Cost
Site Preparation	$ 42,000
Demolition of Existing Facilities	$ 126,000
Install Low-Level Outlet and Valves	$ 449,000
Rebuild Dam and Embankment	$ 591,000
Automate Valves to Optimize Releases[1]	$ 45,000
Construction Subtotal[2]	**$ 1,253,000**
General Mobilization/Demobilization (10%)	$ 125,300
Helicopter Mobilization/Demobilization/Rental	$ 390,000
Construction Total[2]	**$ 1,768,000**
Contingency – LOW (20%)	$ 353,600
Contingency – HIGH (40%)	$ 707,200
Engineering, Permitting, and Administration	$ 353,600
Sales Tax	$ 144,976
Project Total - LOW[2,3]	**$ 2,620,000**
Project Total - HIGH[2,3]	**$ 2,974,000**

Notes:

1. Cost associated with installing monitoring equipment and telemetry connection to Icicle and Peshastin Irrigation Districts are included in the opinion of probable project costs for the Alpine Lakes Optimization and Automation project, as reported in the *Feasibility Study: Alpine Lakes Optimization and Automation* (Aspect 2017) and are not included here.
2. Subtotals and totals are rounded to the nearest $1,000.
3. Costs are represented in May 2017 dollars. Actual costs may vary based on labor rates, equipment costs, and materials costs at the time of construction.

6.2 Helicopter Mobilization and Rental

The opinion of probable project costs assumes that helicopters would be used to mobilize materials and equipment to the site, as discussed in Section 5. As noted earlier, Columbia Helicopters was contacted to get updated preliminary budget information on the cost of hauling equipment and materials to the site via helicopter. Table 6-2 summarizes the likely helicopter mobilization and rental costs that would be associated with this approach.

Table 6-2
Likely Helicopter Mobilization and Rental Costs

Type of Helicopter	Payload	Mobilization Fee	Rental Fee
Small[1]	1,000 to 2,000 pounds	--	$15,000 per day
Columbia Vertol 107-II[1, 2]	7,000 to 8,000 pounds	$20,000	$7,500 per hour
Columbia Chinook CH-47D[1, 2]	20,000 to 22,000 pounds	$45,000	$15,000 per hour

Notes:
1. Actual prices may vary based on availability of helicopters at the time of construction.
2. Provided by Columbia Helicopters.

The costs assume the following:

- A helicopter with a large payload, similar to the Chinook CH-47D, would be used to haul a small excavator, a tracked multi-terrain loader, and any other relatively heavy equipment and materials to the site to facilitate the work. Costs assume helicopter mobilization and 6 hours of use at the beginning and mobilization and 4 hours of use at the end of the project.
- A small helicopter with a payload of 1,000 to 2,000 pounds, contracted from a local helicopter company, would be used to transport provisions, smaller equipment, and personnel. This would require up to 10 total days of use during the project.
- Concrete materials would be mixed on site for the dam replacement project at Eightmile Lake. The alternative would be to haul ready-to-pour concrete via helicopter to the site, which would likely be accomplished with a smaller helicopter and more helicopter trips.

6.3 Long-term Operating Costs

The following are the costs to operate and maintain the new facilities:

- Regular maintenance and repair of valves, monitoring equipment, and communications equipment
- Repair and servicing of the power supply system (rechargeable direct current (DC) solar/battery power system)
- Inspection and repair of the new low-level outlet pipeline and related equipment

- One 2-day trip to the lake in the late spring to clear debris, place stop logs to capture the late spring early summer runoff, and perform preliminary start-up activities
- One 2-day trip to the lake in the fall to winterize the facilities
- Other short trips, as needed, to address operational issues, inspect the facilities, perform routine maintenance and cleaning, and prime the siphon in the event that the siphon pressure and flow break

Operation and maintenance of the proposed facilities would likely require more effort than the current facilities. However, remote operation of the facilities could reduce the number of trips required to access the lake because trips would not need to be made to adjust the gate to control releases. A conservative allowance of 0.5% of the total project cost was considered as a guideline for annual operations and maintenance costs (in 2017 dollars). Based on this guideline, operations, and maintenance costs would be on the order of $15,000 per year. This level of operations and maintenance would cover a 2-day trip to place stop logs and perform preliminary start-up activities in the late spring, a 2-day trip to winterize the facilities in the fall, two additional 1-day visits to the lake per year by IPID personnel to perform routine maintenance and resolve operational issues, and an allowance for cleaning, inspection, and repair of equipment at Eightmile Lake. The long-term operating costs would likely increase with inflation.

7 Water Rights

This section provides a summary of IPID's water rights and provides recommendations and guidance for additional work needed to prepare a change application to accommodate any changes in use of the water needed to be consistent with the goals and intent of the Icicle Strategy.

7.1 History

In 1926 Icicle Irrigation District (IID) filed an application with the state Office of Supervisor of Hydraulics (an Ecology predecessor agency) requesting to divert water from Eightmile Lake for seasonal irrigation. A petition was also filed with the Department of Public Lands (a Department of Natural Resources predecessor) to procure the shore and overflow rights to the lake[1]. The Office of Supervisor of Hydraulics issued a permit (Permit 828) in January 1927 to develop the lake source. Following payment of fees to cover damages to state lands from overflow of the lake, the Department of Public Lands then issued an Order dated October 26, 1927, which reads in part: "the right to overflow and perpetually inundate said lands [Eightmile Lake] may be duly exercised in accordance with the terms of this order[2], the lands included being more particularly described as follows: The bed and shores of Eight Mile Lake."

In 1927, water rights to Icicle Creek and its tributaries were adjudicated in Chelan County Superior Court. The 1929 Final Court Decree affirmed IID's water right permit for Eightmile Lake in the amount of 25 cfs, 2,500 acre-feet. The decree noted that the water right represented by the permit was "inchoate but may be perfected by compliance with provisions under which the permits were issued; that these rights for storage of water under said permits do not affect the water rights of any other claimant herein reported."

The storage right was subsequently certificated (Certificate 1228) by the Office of Supervisor of Hydraulics for 25 cfs for the purpose of irrigation of 7,000 acres; no annual quantity was specified on the certificate. The 2,500 acre-feet of annual storage volume specified in the Court Decree establishes the maximum authorized storage volume.

In the *Draft Icicle Irrigation District Instream Flow Improvement Options Analysis Study*, Forsgren Associates, Inc., and Gravity Consulting, LLC, estimated that the current high water mark corresponds to a usable storage volume of approximately 1,375 acre-feet, whereas the top of dam overflow elevation represents a usable volume of 1,666 acre-feet. Based on preferential operation of the lake early in the season, IPID can obtain approximately 300 acre-feet of additional capacity below the

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[1] Additional applications and petitions were concurrently filed for use of water from Klonaqua Lake and Colchuck Lake.

[2] No specific terms were spelled out in the Order. The Order references Section 102, Chapter 255 of the Session Laws of 1927. This chapter and section authorized the Commissioner of Public Lands to grant the right to "back and hold water" and overflow and inundate state shore lands for the purpose of constructing and operating works for the impoundment of water for irrigation and other uses.

gravity outlet by relying on natural seepage in the late summer/early fall. The total lake volume is 2,700 to 3,000 acre-feet at these corresponding water surface levels, which is in excess of the 2,500 acre-feet permitted to be stored and beneficially used under IID's water right. In dry years, it is possible for IID to augment its usable storage volume by drawing down the lake further than the normal outlet elevation through additional mechanical or gravity means. The water right record is unclear whether IID's water rights are single-fill storage rights, or whether they can rely on additional natural flows to augment storage, which would further enhance the beneficial use history of the water right. If additional water right authority were needed to augment storage to meet Guiding Principles under an Icicle Integrated Plan, it is possible that additional spring filling water rights could be granted by Ecology because water is routinely available in excess of adopted instream flows during this time period.

In 1990 IPID and the USFS agreed to a land exchange where the USFS received title to IPID's interest in lands adjacent to Eightmile Lake. Lands at Eightmile Lake conveyed to USFS are described as Section 5, Lots 1 and 2 of Township 23 N, Range 16 EWM and Section 33, Lot 1 of Township 24 N, Range 16 EWM. These descriptions correspond to an approximately 40-acre-square parcel at the lake outlet and dam structure and an approximately 80-acre rectangular parcel along the south shore of the lake (see Figure 2-3). Under the land exchange agreement recorded with the Chelan County recorder's office IPID retained several rights to the land, including the following:

> 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.

The recorded deed further recognized that IPID reserved their rights under water right Certificate 1228 and the Order granted by the Commissioner of Public Lands.

7.2 Water Right Change Strategy and Process

The proposed project would convert this historical irrigation use to a combination of instream flow and municipal uses, while retaining irrigation use authority with uses matched to water availability in different types of water years according to the IWG Guiding Principles. A key element to the water right change strategy is obtaining a new secondary use permit to authorize the reoperated water uses. Under this proposal, the total restored quantity (2,500 acre-feet), will be placed into the trust water rights program for instream flows and mitigation through the issuance of a new secondary use permit. This trust water right will be managed through a trust water right agreement that will stipulate in drought years that up to 1,600 acre-feet will be available to IPID for irrigation. In non-drought years, this water will remain instream for environmental benefit. Annually, up to 900 acre-feet of consumptive use will be available for new mitigated permits to the City of Leavenworth and Chelan County to support domestic use.

Additional secondary use permits can be issued per the guidelines laid out in Revised Code of Washington (RCW) 90.03.370. New secondary use permits are subject to the four-part test:

1. Availability: If storage is restored to the original high water mark, water will be available for this use.
2. Impairment: This new secondary use permit is non-diversionary and non-consumptive in nature. Increased stream flow will not likely impair senior water users.
3. Public Interest: Ecology has found on numerous occasions that increased stream flows are in the public interest. Other public interest factors would need to be considered including recreation, aesthetics, wilderness values, and others. These are being considered more fully in the PEIS.
4. Beneficial Use: The legislature has determined that instream flows and mitigation are a beneficial use in Chapter 90.38 RCW and 90.42 RCW. So too are irrigation, domestic, and municipal uses under RCW 90.54.020.

Applying for a secondary use permit will require the parent water right, Certificate 1228, to undergo a tentative determination of extent and validity. This will require consideration of beneficial use, relinquishment, and abandonment, which has not occurred since the adjudicated water right was issued. If there are periods of 5 years or more where underutilization has occurred, the statutory exemptions provided in RCW 90.14.140 would need to be examined for applicability. Because this is primarily a storage right, Ecology will consider whether 2,500 acre-feet per year was impounded and stored. The amount of water released will also inform that analysis.

8 Environmental and Permitting Strategy

A preliminary environmental and permitting evaluation was completed as part of the *Appraisal Study, Eightmile Lake Storage Restoration* (Anchor QEA 2015). That evaluation identified natural resources that could be impacted by the proposed project, summarized potential impacts and regulatory requirements, and provided a list of anticipated permits that would be required to complete the project. As noted in Section 1, the Anchor QEA/Aspect team is currently working toward completion of the *Icicle Strategy Programmatic Environmental Impact Statement.* The PEIS evaluates five alternatives and a no-action alternative. The alternatives each include a suite of projects that are collectively intended to meet the IWG Guiding Principles. The Eightmile Lake Storage Restoration Project is included as a component of three of the five action alternatives evaluated by the PEIS. Another alternative includes an Eightmile Lake Storage Enhancement Project, which is a different project than what is evaluated by this Feasibility Study. The Eightmile Lake Storage Enhancement Project would include facilities that would increase the accessible storage in Eightmile Lake to 3,500 acre-feet by raising the spillway elevation of the dam and increasing drawdown.

As part of the work done for the PEIS, detailed field investigations were completed during a series of July 2016 site visits to verify the natural and cultural resources that could be impacted by the project. The PEIS includes detailed information about these resources and identifies potential impacts to these resources that would result from construction of the improvements to Eightmile Lake. Two supporting reports, the *Icicle Creek Water Resource Management Strategy Draft Cultural Resources Discipline Report* (Anchor QEA 2017a) and the *Icicle Creek Water Resource Management Strategy Draft Natural Resources Discipline Report* (Anchor QEA 2017b) were prepared to summarize field observations and provide additional data to support the conclusions of the PEIS.

This section summarizes the findings of the work that was done to support the PEIS related specifically to the Eightmile Lake Storage Restoration Project, provides an updated table listing the likely permitting and regulatory requirements, and recommends a strategy for securing the necessary permit approvals to construct the project.

8.1 Affected Environment and Anticipated Impacts

The following provides a summary of the resources that would likely be affected by the Eightmile Lake Storage Restoration project, as proposed in this Feasibility Study, and the potential impacts to those resources that could result from the work. Additional detail is provided in the *Icicle Strategy Programmatic Environmental Impact Statement*.

8.1.1 Geology

The geology at the proposed project site was summarized in Section 2.6 and shown in Figure 2-2. Geology is characterized by shallow rocky soils over bedrock or exposed bedrock. A relative large mass wasting deposit near the outlet of Eightmile Lake includes loose rock and large boulders. On-site rock will be needed for dam and embankment construction. Overall, impacts on geology will be local to the project site and are not anticipated to be significant.

8.1.2 Water Resources and Water Use

The hydrology of the Eightmile Lake drainage basin is described in detail in Section 3. The proposed project will capture and store a portion of the natural winter, spring, and early summer runoff for release during the late summer to improve late summer flow conditions in Lower Icicle Creek. There is potential for some minor short-term water quality impacts, such as increased turbidity, from ground disturbance and placement of new dam materials during construction. Temporary erosion and sediment controls, spill prevention control, and other water quality controls would be installed to protect the water in Eightmile Lake during construction, in accordance with permit requirements and existing water quality standards. The potential impacts would also be minimized by drawing down the lake to construct improvements in the dry. The long-term impacts to downstream hydrology would generally be beneficial as the changes are designed to optimize releases to benefit natural resources in the Icicle Creek Sub-basin.

8.1.3 Aquatic Habitat and Species

Eightmile Lake is within a group of mountain lakes managed in Washington as "high lakes," which have historically lacked suitable spawning habitat or productive conditions for rearing juvenile fish. These lakes likely did not support fish populations until they were introduced for sport fishing by humans. Until 2005, Eightmile Lake had been stocked with cutthroat trout (*Oncorhynchus clarki lewisi*), rainbow trout (*O. mykiss*), and lake trout (*Salvelinus namaycush*). Fish abundance and stocking are tracked by Washington Department of Fish and Wildlife (WDFW) with the help of volunteer organizations. Invertebrates are a major source of food for fish and trout feed primarily on zooplankton and benthic invertebrates.

Eightmile Lake discharges to Eightmile Creek, which is a tributary to Icicle Creek. The Icicle Creek Corridor provides approximately 29 miles of spawning and rearing habitat for salmon and trout species, including Endangered Species Act (ESA)-listed Upper Columbia spring-run Chinook salmon (*O. tshawytscha*), Upper Columbia summer steelhead (*O. mykiss irideus*), and bull trout (*Salvelinus confluentus*). Passage for migratory fish species is blocked at several locations downstream of Eightmile Lake. Passage for migratory species is generally limited above the Icicle Creek Boulder Field at River Mile 5.6. Another project proposed as part of the Icicle Creek Strategy would modify the Boulder Field to improve passage and access to spawning and rearing habitat for anadromous fish species. Resident fish populations of bull trout, cutthroat trout, rainbow trout, and other species of minnows, sculpins, and suckers occupy Icicle Creek above the Boulder Field. Although bull trout and other fish species have been observed in the lower reaches of Eightmile Creek, passage is unlikely in the upper reaches of Eightmile Creek because the stream has a very steep gradient from Little Eightmile Lake to the lower reach of Eightmile Creek near its confluence with Icicle Creek.

The reoperation of the lake would generally result in increased habitat for resident fish in Eightmile Lake in the early summer and decreased habitat in the late summer. However, because existing fish populations in the lake are likely to be low, impacts would not be significant.

Impacts on fish and other aquatic species likely to be present below Eightmile Lake within Eightmile and Icicle Creek are expected to generally be beneficial because the project would optimize releases from Eightmile Lake to improve passage and habitat conditions in Icicle Creek. Implementation of activities as part of the Tribal and Non-Tribal Fisheries project would further help to ensure there are no significant impacts on tribal fishing.

8.1.4 Vegetation

The Alpine Lakes area is dominated by forested habitat with species such as silver fir (*Abies amabilis*), subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and mountain hemlock (*Tsuga mertensiana*) in the upper elevation areas. Avalanche chutes are brushy with deciduous species such as Sitka alder (*Alnus sinuata*), vine maple (*Acer circinatum*), and Rocky Mountain maple (*Acer glabrum*). Lower elevations include Douglas fir (*Pseudotsuga menziesii*), western white pine (*Pinus monticola*), ponderosa pine (*Pinus ponderosa*), shore pine (*Pinus contorta*), western hemlock (*Tsuga heterophylla*), and western red cedar (*Thuja plicata*) (USFS 2016; Franklin and Dyrness 1973). All of these species were observed during a reconnaissance site visit to Eightmile Lake in July 2016. Dominant shrub and understory species observed during the July 2016 site visit include Scouler willow (*Salix scouleriana*), Cascade azalea (*Rhododendron albiflorum*), twinberry (*Lonicera involucrata*), white spirea (*Spiraea betulifolia*), red huckleberry (*Vaccinium parvifolium*), kinnikinnick (*Arctosaphylos uva-ursi*), and western thimbleberry (*Rubus parviflorus*).

Existing mapping does not identify wetland habitats within the vicinity of Eightmile Lake. During the July 2016 site visit, wetland conditions were not observed at the outlet location, but several potential palustrine emergent, palustrine scrub-shrub, and palustrine forest wetland features were observed along the lake shoreline.

Short-term impacts to existing vegetation may include removal and disturbance of trees and bushes to accommodate the improvements to the dam and low-level outlet pipeline. In addition, short-term impacts could include clearing, removal, or disturbance of vegetation needed for overland access to the site with an excavator, if that option is pursued. Implementation of best management practices, such as clearing limits and protection of existing vegetation, would be implemented to protect vegetation. Long-term impacts would include inundation of area that was historically inundated, but has not recently been inundated by Eightmile Lake. This could impact existing vegetation along the shoreline of the lake in areas that were historically inundated but have not recently been inundated. However, the area around the lake that would be impacted would be relatively small. As noted previously, the project would also result in an increase in downstream flows within Eightmile and Icicle Creeks. Downstream impacts are anticipated to be beneficial for riparian vegetation along this corridor. Overall, the project is not anticipated to result in significant long-term adverse impacts on vegetation or wetlands.

8.1.5 Wildlife

Wetlands and riparian areas associated with the Alpine Lakes and receiving streams provide habitat for a variety of amphibians, such as Pacific tree frog (*Pseudacris regilla*), western toad (*Anaxyrus boreas*), tailed frog (*Ascaphus truei*), Cascades frog (*Rana cascadae*), Columbia spotted frog (*Rana luteiventris*), and long-toed salamander (*Ambystoma macrodactylum*). Reptiles, such as the western garter snake (*Thamnophis elegans*), are likely to occur in the upland habitats surrounding the lake. Upland habitats with rocks and wood debris support species such as northern alligator lizard (*Elgaria coerulea*) and western fence lizard (*Sceloporus occidentalis*). Common garter snakes (*Thamnophis sirtalis*) and northern alligator lizards were observed during the July 2016 site visit.

Mammal species associated with forested habitats at the Alpine Lakes area include mountain beaver (*Aplodontia rufa*), bobcat (*Lynx rufus*), hoary marmot (*Marmota caligata*), fisher (*Martes pennanti*), Douglas squirrel (*Tamiasciurus douglasii*), voles (*Microtus spp*.), pika (*Ochotona princeps*), and striped skunk (*Mephitis mephitis*). Larger mammals, such as elk (*Cervus elaphus*), black-tailed deer (*Odocoileus hemionus*), black bear (*Ursus americanus*), cougar (*Felis concolor*), and coyote (*Canis latrans*), are also found in the forested habitat. Mountain goats (*Oreamnos americanus*) are found in the high-altitude areas. Deer tracks and scat were frequently observed during the July 2016 site visit.

Forested habitats around Eightmile Lake provide foraging and nesting habitat for a wide variety of bird species, including songbird species, migratory bird species, and others. Predatory birds, such as bald eagle (*Haliaeetus leucocephalus*), red-tailed hawk *(Buteo jamaicensis),* and osprey *(Pandion haliaetus),* commonly hunt in these habitat types and occur in forested areas near bodies of water. The lake environment can be expected to provide habitat for belted kingfisher *(Ceryle alcyon*) and wintering and migratory waterfowl, including gadwall *(Anas strepera),* American widgeon *(Mareca americana),* mallard *(Anas platyrhynchos),* common loon (*Gavia immer*), and western grebe (*Aechmophorus occidentalis*).

Construction activity could temporarily disrupt the use of riparian and forested habitat by native wildlife species to breed, forage, rest, and overwinter. The greatest potential for short-term impacts on wildlife would occur as the result of increased noise during construction. Short-term increases would include some helicopter trips, movement and processing of on-site earth and rocks, and possibly blasting. The majority of construction noise would be relatively minor. In general, most wildlife species are expected to disperse in response to periodic increases in noise and activity to adjacent habitat areas to avoid impacts. However, particularly vulnerable species may include those that may be breeding during this time. Construction scheduling and other practices would be implemented, as required by applicable permits, to minimize impacts during construction.

As noted above, long-term impacts would include inundation of area that was historically inundated, but has not recently been inundated by Eightmile Lake. This could impact wildlife along the shoreline of the lake as the result of periodic decreases in wildlife habitat when this area is flooded. However, the area impacted would be relatively small and is expected to occur for few months each spring. Overall, the project is not anticipated to result in significant long-term impacts on wildlife.

8.1.6 Cultural Resources

As part of the July 2016 reconnaissance site visits performed to assess conditions at the Alpine Lakes for the PEIS, an archaeological survey was completed at Eightmile Lake. This survey included a pedestrian survey and recordation of irrigation structures.

The survey revealed no cultural resources along the existing Eightmile Trail. However, at Eightmile Lake, the dam and low-level outlet facilities were recorded as a historical water release system. Along with the outlet facilities a Square Lake, Colchuck Lake, and Klonaqua Lake, the Eightmile Lake facilities were recommended as eligible for listing on the National Register of Historic Places (NRHP), based on the following criteria:

- Criterion A for the facilities association with historically significant and controversial water management in Chelan County
- Criterion B for the unique style influenced by the extremely difficult terrain and constraints of mid-century construction methods
- Criterion D for the potential to yield data about early twentieth century engineering and construction

No cultural resources were observed along the margins of the lake or within the existing width of the trail to the project site. No sacred sites (Native American ceremonial areas or natural landmarks) or sites recorded as Traditional Cultural Properties were identified at or near Eightmile Lake.

The improvements will modify the dam and low-level outlet facilities by removing the existing facilities and replacing them with new facilities. These activities would require compliance with various local, state, and federal regulations, which address in part the protection of cultural resources. If deemed necessary, compliance with these regulations could result in the development of mitigation measures to reduce cultural resources impacts in coordination with the Washington State Department of Archeology and Historic Preservation (DAHP).

8.2 Anticipated Permitting Requirements

For the purpose of this Feasibility Study, likely permitting requirements and the anticipated permitting process for the improvements to Eightmile Lake were identified. Table 8-1 lists the anticipated permits and approvals that will need to be secured for the project.

Table 8-1
Anticipated Eightmile Lake Storage Restoration Project Permitting Requirements

Permit	Agency	Apply with the JARPA (Y/N)	Permits Needed	Notes
Section 404 Permit[1]	Corps	Y	✓	Triggered by excavation in or placement of fill material into waters of the United States
NEPA Review[1]	Corps	N	✓	NEPA review would be triggered by the Corps CWA review.
USFS Special Use Permit	USFS	N		Authorizes uses on National Forest Service land that provide a benefit to the general public and protect public and natural resources values. Not required for work inside IPID easement, but could be required if work extends outside IPID easement.
ESA Section 7 Concurrence[2]	NMFS and USFWS	N	✓	This review is triggered by the Section 404 permit. The Corps would coordinate with NMFS and USFWS as needed to ensure potential impacts on fish and wildlife species are adequately addressed. It is anticipated that potential adverse impacts on downstream ESA-listed fish would be minimized through implementation of a long-term management plan for flow releases.
Magnuson-Stevens Fishery Conservation and Management Act Concurrence[2]		N	✓	
Fish and Wildlife Coordination Act Concurrence[2]		N	✓	
NHPA Section 106 concurrence, Archaeological Resources Protection Act Permit[2]	Corps and DAHP	N	✓	This review is triggered by the Section 404 permit. If significant adverse impacts are identified, consultation between the Corps, DAHP, IPID, and potentially affected tribes would be required to ensure the impacts are adequately addressed.
Section 401 Water Quality Certification[3]	Ecology	Y	✓	Triggered by excavation in or discharge dredge or fill material into water or isolated wetlands.
Dam Construction Permit[4]	Ecology	N	✓	Required for dams and supplemental structures impounding or controlling more than 10 acre-feet of water.
Water Right Change Permit[5]	Ecology	N	✓	Required for dams and supplemental structures impounding or controlling more than 10 acre-feet of water.
Ecology Sand and Gravel Permit[6]	Ecology	N	✓	Needed for projects that quarry on-site sand and gravel for use in construction to reduce construction costs.
Burn Permit[7]	WDNR	N	✓	May be required if project calls for burning of on-site cleared debris and logs, per WDNR requirements.

Permit	Agency	Apply with the JARPA (Y/N)	Permits Needed	Notes
Hydraulic Project Approval[8]	WDFW	Y	✓	Triggered by work below the ordinary high water mark in waters of the state.
Aquatic Use Authorization	WDNR	Y	✓	Triggered by work affecting bed/flow of state waters. This may not be required and should be confirmed.
NPDES Construction Stormwater General Permit[9]	Ecology	N	✓	Triggered by clearing, grading, and/or excavation resulting in the disturbance of 1 or more acres and discharges stormwater to surface waters of the state.
Shoreline Substantial Development Permit[10]	Chelan County	N	✓	Per the Chelan County Shoreline Management Plan, possible exemption for modification of existing agriculture facilities.
SEPA Determination	Chelan County	N	✓	SEPA determination to be made for Icicle Strategy PEIS, which includes the Eightmile Lake Storage Restoration project. Subsequent project-level review may be required but is expected to be streamlined.
Critical Areas Ordinance Compliance[11]	Chelan County	N	✓	Per the Chelan County Shoreline Management Plan, possible exemption for construction of irrigation structures.
Fill and Grade, Building Permits[11]	Chelan County	N	✓	Required by Chelan County.

Notes:

1. Corps NWP / NEPA Categorical Exclusion are the likely level of regulatory compliance for this project. Compliance with General Conditions 20 would require completion of a preconstruction notification, acknowledging potentially eligible resources pursuant to the National Historic Preservation Act; however, given the nature of the activities, it is anticipated that minimal review would be required. The preconstruction notification is fulfilled by filling out the Washington JARPA. Eightmile Lake is not a navigable waterway per Corps guidance and therefore does not require a Section 10 permit.
2. The Corps permit evaluation will address consistency with these regulations.
3. Streamlined review (e.g., approval letter) issued when CWA NWP conditions are adhered to.
4. Ecology Dam Safety Office review requiring submittal of engineering plans, specifications, and reports.
5. Required for adding instream flows as secondary uses.
6. Needed if on-site gravel would be quarried for construction to save costs.
7. A permit to burn cleared logs would only be required if it exceeded the specifications (i.e., fire content, size, and timing limitation) set forth by WDNR.
8. Compliance handled through the JARPA review process and expected to be minimal.
9. General permit anticipated, requiring compliance with general conditions.
10. A Shoreline Substantial Development Permit may not be required. This needs to be confirmed with Chelan County. Past operations and maintenance activities have most often resulted in Chelan County issuing approval versus a formal Shoreline Substantial Development Permit.
11. Permits may not be required. Need to confirm with Chelan County. It is possible that Ecology review if required as indicated in Note 4 would suffice to support Chelan County's approval.

Corps: U.S. Army Corps of Engineers
CWA: Clean Water Act
DAHP: Washington State Department of Archaeology and Historic Preservation
Ecology: Washington State Department of Ecology
ESA: Endangered Species Act
IPID: Icicle and Peshastin Irrigation District
JARPA: Joint Aquatic Resource Application
NEPA: National Environmental Policy Act
NHPA: National Historic Preservation Act
NMFS: National Marine Fisheries Service
NPDES: National Pollutant Discharge Elimination System
PEIS: Programmatic Environmental Impact Statement
SEPA: State Environmental Policy Act
USFS: U.S. Forest Services
USFWS: U.S. Fish and Wildlife Service
WDFW: Washington Department of Fish and Wildlife
WDNR: Washington Department of Natural Resources

8.3 Recommended Permitting Approach

In Anchor QEA's experience, project objectives, constraints, and challenges are communicated early on in the project to save time and effort required to respond to comments and questions from regulatory reviews later in the design process. Initial outreach and coordination has occurred as the result of developing the PEIS and many of the regulatory agencies listed in Table 8-1 are generally aware of the overall Icicle Creek Strategy. However, as the details of the Eightmile Lake Storage Restoration Project become further developed, it is recommended that a pre-planning meeting with a focused group of agencies occur to discuss the project to more clearly understand regulatory constraints and confirm the assumptions identified in Table 8-1 and discussed further in this section.

Anchor QEA recommends that this initial meeting occur with the Corps[3] and include Ecology, WDFW, and Washington Department of Natural Resources (WDNR). The timing of this meeting should occur 12 months prior to beginning construction to allow sufficient time for the appropriate permits/approvals to be secured. This timeline assumes that compliance with the Clean Water Act (CWA) and the National Environmental Policy Act (NEPA) could be addressed through a nationwide permit and Categorical Exclusion. The remainder of this section discusses the permitting triggers and thresholds relevant in the consideration of developing an efficient and coordinated project-level permitting strategy.

Because the project would include work within waters of the United States and of the state of Washington, environmental review related to the following permits/approvals is expected to be required:

- CWA Section 404 permit by the Corps
- CWA Section 401 certification by Ecology
- Hydraulic Project Approval review by WDFW
- Aquatic Use Authorization by WDNR (may not be required)

Review to support these permits/approvals would be initiated by submittal of the Washington Joint Aquatic Resource Permit Application (JARPA). This would provide the initial information the regulatory agencies listed above would need to be able to review the project.

Submittal of the JARPA to the Corps would also trigger their environmental review under NEPA, ESA, the Magnusson-Stevens Fisheries Act (MSA), the Fish and Wildlife Coordination Act (FWCA), and the National Historic Preservation Act. To provide sufficient information to the Corps to be able to consult with the appropriate agencies (e.g., U.S. Fish and Wildlife Service [USFWS], National Marine Fisheries Service [NMFS], and DAHP), IPID would develop and submit a preconstruction notification (PCN), which would be fulfilled through completion of the JARPA. Once the Corps has received initial

[3] It is Anchor QEA's understanding that the proposed work would occur within the existing IPID easement and while upfront coordination with USFS should be completed, USFS would not take the lead on ensuring compliance with the required federal permits/approvals.

project information, it is recommended that additional coordination meetings occur with USFWS, NMFS, and DAHP, focusing on the issues identified below.

Because the field survey completed in July 2016 identified the Eightmile Lake dam and low-level outlet facilities for listing on the NRHP, this information must be disclosed in the PCN and it is likely formal consultation with Washington State DAHP will be required. Consultation and review of all projects that comprise the alternatives outlined in the *Icicle Strategy Programmatic Environmental Impact Statement* will be initiated with DAHP as part of the PEIS review process. Specific consultation related to the Eightmile Lake Storage Restoration project should begin soon thereafter. Consultation with DAHP will focus on identifying appropriate mitigation for the impact to historic structures that will be removed and replaced as part of the project. It is possible that a Memorandum of Agreement may be executed between the Corps, DAHP, IPID, and any other participating agencies or tribes. To the extent that conceptual mitigation can be developed in coordination with DAHP through the process of completing the PEIS, this could help to shorten the project-level permitting timeline identified above.

Submittal of the JARPA to the Corps would also trigger the need for the Corps to ensure the proposed project compliance with the ESA, MSA, and FWCA. This would likely require coordination with NMFS and USFWS. As noted previously, the potential impacts on fish and wildlife under the jurisdiction of these agencies are generally limited to those that could occur during construction or are otherwise expected to be largely beneficial over the long term. It is not expected that compliance would require the development of a biological assessment or formal consultation between these agencies; however, this should be confirmed at the onset. Similarly, to the extent that potentially significant impacts and conceptual mitigation are identified through the process of completing the PEIS, this could help to shorten the project-level permitting timeline identified above.

Ecology's DSO has regulatory jurisdiction over all reservoirs that impound 10 acre-feet or more of water. Replacement of the dam at Eightmile Lake will require a dam construction permit from DSO. Consultation was initiated with DSO as part of this Feasibility Study. The requirements for securing a dam safety permit were outlined in Section 3.1. DSO should be given the opportunity to review this report and consultation should continue throughout the design process to ensure that DSO requirements are met.

Compliance with the remaining permits and approvals outlined in Table 8-1 would be mostly under the jurisdiction of Chelan County. It is possible that certain permits/approvals (e.g., project-level SEPA, Shoreline Substantial Development Permit, Critical Areas Ordinance, Cleanup and Abatement Order review) may be satisfied through demonstrated compliance with other state and federal approvals discussed above. Others would still be obtained during final project design but are anticipated to be relatively straightforward (e.g., NPDES construction permit, fill and grading permits).

9 Summary and Recommendations

9.1 Summary of Proposed Improvements

IPID has relied on Eightmile Lake and the other Alpine Lakes they manage for nearly 80 years. IPID constructed control facilities on the outlet of Eightmile Lake in the 1930s to capture and store spring and early summer runoff for release in the late summer when additional flow is needed in lower Icicle Creek to maintain irrigation diversions and instream flows for fish. Eightmile Lake captures runoff from a 3,822-acre drainage basin. Due to the large size of the drainage basin relative to the storage volume in the lake, Eightmile Lake has a high potential for refill, even during dry years. Because the storage is so reliable and the lake is more accessible than the other Alpine Lakes that IPID manages, the lake is a critical piece of IPID's water supply infrastructure.

The infrastructure at Eightmile Lake is aging and will require improvement to continue to operate in a way that meets IPID's needs. The most urgent issue identified by IPID is that the low-level outlet pipe has collapsed in multiple locations, which has recently reduced the capacity of the pipeline and limits the rate at which IPID can release water to Icicle Creek. If the pipe is not replaced or repaired before the next big drought cycle, IPID will likely not be in a position to meet the irrigation water supply needs of the IPID water users. The gate that controls flow to the low-level outlet pipe also needs to be replaced. It was damaged by ice or debris and is now very difficult to open and close. In addition, the dam structure that allows IPID to store water has deteriorated. Erosion of the earthen embankment portion of the dam structure has reduced the active storage capacity available for release without pumping or siphoning to less than 1,400 acre-feet. Some storage is released via seepage. Due to these limitations, improvements are needed to restore the useable storage capacity of Eightmile Lake to 2,500 acre-feet, which is the volume allowed for storage and release by IPID's water right for the lake. Improvements are also needed to ensure efficient control and release of water stored in the lake to meet downstream water supply and instream flow needs.

This Feasibility Study identified and evaluated the following improvements for restoring the storage at Eightmile Lake and improving the control and release of water from the lake:

- Replacement of the dam with a reinforced concrete and earthen embankment structure that would have a primary spillway elevation of 4,671 feet, which would match the historical high WSEL in the lake and restore the useable storage capacity to 2,500 acre-feet.
- Construction of an embankment and secondary spillway structure in a low spot south of the existing dam to provide additional spillway capacity to meet Ecology DSO requirements.
- Replacement of the existing low-level outlet facilities with a new pipeline that would allow for greater flexibility in drawing down the lake. Flow through the new low-level outlet would be controlled by an automated valve. Telemetry would allow for remote access from IPID's office

to operate the valve and optimize releases. The low-level outlet would operate by gravity when the lake is full and transition to siphon operation as the lake is drawn down.

The primary challenge to implementing this improvement project will be determining how to construct the project at a remote location within the Alpine Lakes Wilderness. IPID has an easement agreement with the USFS that was established when the property was transferred to the USFS for management as part of the Alpine Lakes Wilderness Area. The easement agreement allows IPID to continue to have access to the site, including with mechanized equipment, to maintain the facilities and to make full use of IPID's water right. However, the site is not accessible by roads. The Alpine Lakes are often accessed by IPID by helicopter for maintenance, but even the largest helicopters have payload limitations that will make mobilization of large equipment to the site a challenge. Options that were identified are transport of a smaller excavator by large helicopter, overland transport of a larger tracked excavator, or overland transport of a spider excavator. The approach will likely be dictated by funding, the equipment available, and permit approval constraints.

Another challenge to implementing this project that is closely related to the challenge of mobilizing equipment will be the narrow window available for construction. The lake will need to be drawn down to construct the project, which typically does not happen until late in the summer. IPID might be able to facilitate early drawdown of the lake for construction, but will be constrained by weather and runoff conditions in the early summer. Construction will need to be complete before significant snowfall and consistent freezing temperatures occur. Due to the elevation of the site, snowfall and consistent freezing temperatures are likely to occur in October or early November.

The estimated implementation cost of a project that would rely on helicopters to transport and mobilize equipment to the site is approximately $2.62 to $2.97 million. Based on the estimated increase in useable storage that would occur (1,125 acre feet), the cost would be $2,329 to $2,644 per acre-foot of additional storage created.

9.2 Recommended Next Steps

Because the need to implement these improvements is critical to maintaining IPID's water supply during drought conditions, it is recommended that IPID pursue funding for detailed design of the proposed improvements and move consultation forward with the USFS to identify the best method of accessing the site for construction. Securing the appropriate permits for construction of these improvements will be critical to implementation of the project. Consequently, it is recommended that consultation specific to the Eightmile Lake Storage Restoration project proceed with the key regulatory agencies as soon as the *Icicle Strategy Programmatic Environmental Impact Statement* has been reviewed and finalized (likely late in the summer of 2017). In addition to the USFS, agencies that will require early consultation may include the DAHP, the Corps, Ecology (including DSO), WDFW, USFWS, and NMFS.

Detailed design and construction of the project will require additional field data, which would likely need to be collected in the summer or early fall, when weather conditions permit access to the site:

- **Supplemental Topographic Survey**: Additional topographic survey will be needed of the area in and around the dam and along Eightmile Creek to the downstream end of the propose low-level outlet. Some data was collected last fall, but there are still gaps in the topographic data that will need to be addressed to accurately determine where material is available, where it will be placed, and what the final design grades should be.
- **Geotechnical Review**: Work to date has only included general field observations of geology and a desk review of geologic mapping and conditions. Ecology DSO will require a geotechnical engineering report that provides recommendations for dam construction based on a detailed field investigation of geologic conditions at the site. Access to the site with equipment like a drill or backhoe, which are typically used to investigate subsurface soil conditions, will be very challenging. To satisfy DSO requirements for geotechnical review, the following is recommended:
  - Complete the field investigation and prepare a geotechnical design report prior to detailed design. The investigation would include, at a minimum, test pits (if a backhoe or excavator can be mobilized to the site) and a geophysical investigation. An exhaustive desk review of available mapping and geology reports will also be completed. If needed, additional work will be done to mobilize a remote drill for additional subsurface investigation. IPID will work with DSO to verify requirements, review data collecting, and discuss findings and recommendations for design.
  - Provide detailed field direction by a geotechnical engineer during construction. Because the ability to gather subsurface geotechnical information will be limited and subsurface conditions are likely to be variable at the site, it is recommended that supervision and field direction be provided regarding processing and placement of earth and rock materials during construction.

Based on the information reviewed and analysis of the proposed improvements, no fatal flaws have been identified that would prevent implementation of the project. However, Anchor QEA acknowledges that the project will be very challenging due to the remote location of the proposed project, regulatory constraints, and access limitations. Early consultation regarding these challenges will be key to the success of the project.

10 References

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Appendix A

Feasibility-Level Drawings

FEASIBILITY-LEVEL DESIGN

EIGHTMILE LAKE RESTORATION PROJECT

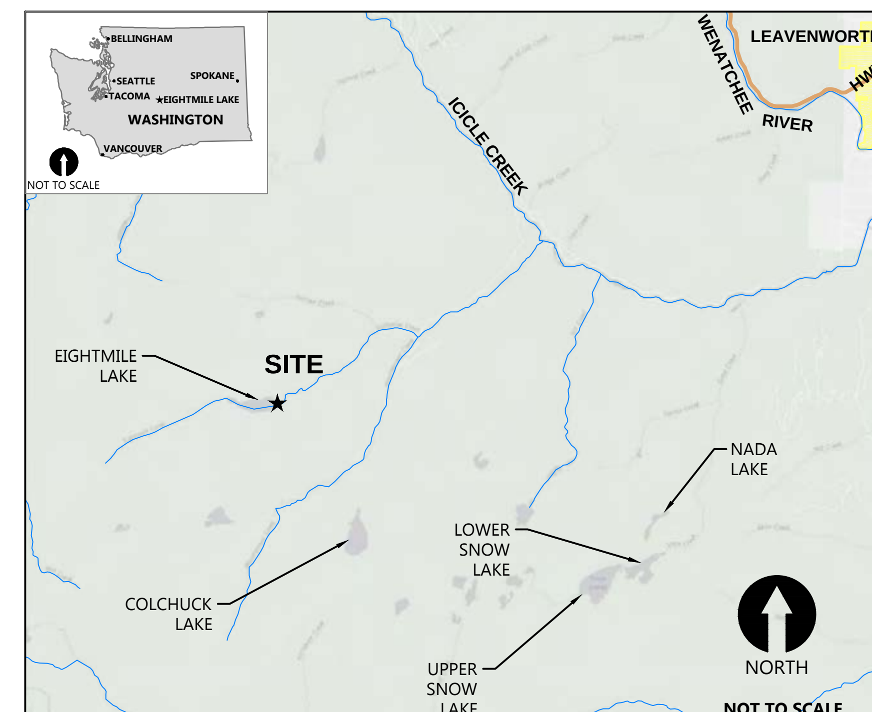
NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88
3. PROJECT LOCATION: SECTION 33, TOWNSHIP 24 NORTH, RANGE 16 EAST

SHEET LIST		
SHEET NUMBER	SHEET	SHEET TITLE
1	G-01	COVER SHEET
2	G-02	GENERAL NOTES, LEGEND, AND ABBREVIATIONS
3	G-03	OVERALL SITE PLAN
4	G-04	EXISTING CONDITIONS PLAN
5	T-01	CONSTRUCTION ACCESS PLAN
6	D-01	DEMOLITION PLAN
7	C-01	RESTORATION PLAN
8	C-02	EMBANKMENT PLAN
9	C-03	EMBANKMENT PROFILES
10	C-04	EMBANKMENT SECTIONS (1)
11	C-05	EMBANKMENT SECTIONS (2)
12	C-06	EMBANKMENT SECTIONS (3)
13	C-07	LOW-LEVEL OUTLET PLAN
14	C-08	LOW-LEVEL OUTLET PROFILE
15	C-09	DETAILS

NOTES:

1. STRUCTURAL DESIGN DRAWINGS AND ADDITIONAL DETAIL DRAWINGS WILL BE ADDED DURING FUTURE PHASES OF DESIGN.



AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

K:\Projects\0204-Aspect Consulting, LLC\Icicle Creek Comp Water Mgt\Eightmile Lake\Construction Plans\0204-PL-001 COVER.dwg G-01

Apr 10, 2017 7:38am drice

ANCHOR QEA

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: D. RICE
DRAWN BY: M. PRATSCHNER
CHECKED BY: R. MONTGOMERY
APPROVED BY: D. RICE
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

COVER SHEET

G-01

SHEET NO. 1 OF 15

LEGEND:

- EXISTING MAJOR CONTOUR (5' INTERVAL)
- EXISTING MINOR CONTOUR (1' INTERVAL)
- PROPOSED MAJOR CONTOUR (5' INTERVAL)
- PROPOSED MINOR CONTOUR (1' INTERVAL)

PROJECT INFORMATION:

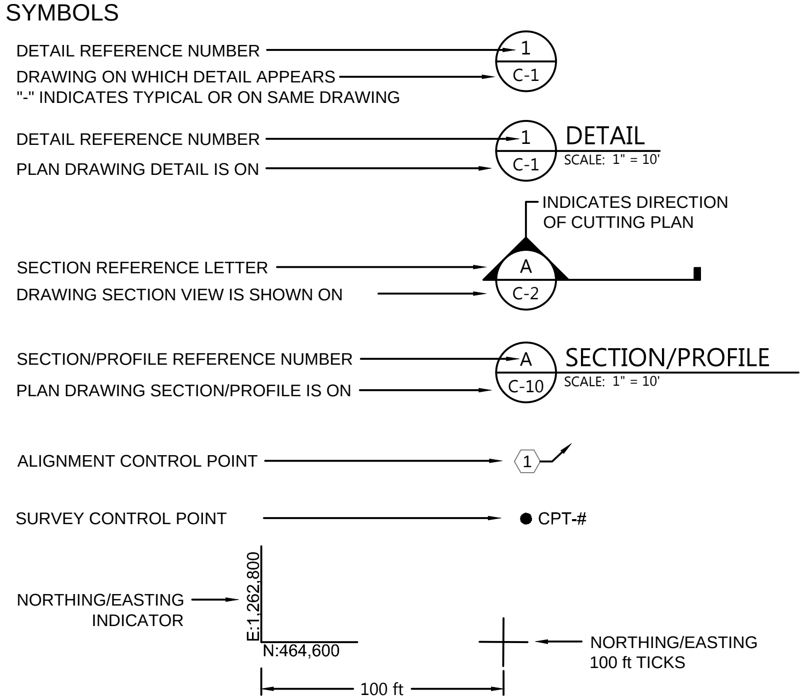
OWNER: TONY JANTZER, MANAGER
ICICLE AND PESHASTIN IRRIGATION DISTRICT
P.O. BOX 371
5594 WESCOTT DRIVE
CASHMERE, WA 98815-0371
(509) 782-2561

ENGINEER: DAVID RICE, P.E.
ANCHOR QEA, LLC
750 OLIVE WAY, SUITE 1900
SEATTLE, WA 98101
(206) 219-5902

SURVEY NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET
2. VERTICAL DATUM: NAVD88
3. SOURCES OF DATA:
   a. AERIAL PHOTOGRAPHY: ESRI BASEMAPS DATED 2016.
   b. BATHYMETRY: GRAVITY CONSULTANTS HYDROGRAPHIC SURVEY, OCTOBER 2013
   c. TOPGRAPHY: GRAVITY CONSULTANTS TOPOGRAPHIC SURVEY OF THE SHORELINE, OCTOBER 2013, SUPPLEMENTED BY USGS GRID ELEVATION DATA AWAY FROM THE SHORELINE. TOPOGRAPHY WAS VERIFIED AND SUPPLEMENTED BY LIMITED DATA COLLECTED BY ANCHOR QEA ALONG THE DAM AND EMBANKMENT CREST, AT THE SHORELINE NEAR THE DAM, AND AT ALONG THE PIPELINE ALIGNMENT, OCTOBER 2016.

SYMBOLS



GENERAL CONSTRUCTION NOTES:

1. CONTRACT DOCUMENTS REFER TO THESE DRAWINGS AND THE PROJECT SPECIFICATIONS. ALL COMPONENTS OF THE CONTRACT DOCUMENTS SHALL FULLY APPLY TO THE WORK WHETHER SPECIFICALLY REFERENCED ON THE DRAWINGS OR NOT. ANY ITEMS NOT SPECIFICALLY REFERENCED IN THE NOTES ON THE DRAWINGS SHALL BE AS DESCRIBED IN THE SPECIFICATIONS.
2. THE CONTRACTOR SHALL HAVE A COPY OF THE APPROVED CONTRACT DOCUMENTS ON THE JOBSITE AT ALL TIMES.
3. THE CONTRACTOR SHALL FURNISH ALL MATERIALS, EQUIPMENT, AND LABOR NECESSARY TO COMPLETE ALL WORK AS INDICATED ON THE CONTRACT DOCUMENTS.
4. A PRE-CONSTRUCTION MEETING BETWEEN THE CONTRACTOR, IPID, AND THE CONTRACTING OFFICER'S REPRESENTATIVE (COR) SHALL BE REQUIRED PRIOR TO ANY ON-SITE WORK. SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
5. THE CONTRACTOR SHALL VISIT THE JOB SITE PRIOR TO CONSTRUCTION AND SHALL BE RESPONSIBLE FOR VERIFYING FIELD CONDITIONS AND DIMENSIONS, DEVELOPNG A PLAN TO MOBILIZE EQUIPMENT AND MATERIALS NEEDED TO THE SITE TO COMPLETE THE WORK, AND CONFIRMING THAT THE WORK CAN BE ACCOMPLISHED AS SHOWN ON THESE CONTRACT DOCUMENTS. ANY DISCREPANCIES BETWEEN THE EXISTING FIELD CONDITIONS AND THE DRAWINGS OR ANY INCONSISTENCIES OR AMBIGUITIES BETWEEN THE DRAWINGS AND OTHER CONTRACT DOCUMENTS SHALL BE REPORTED IN WRITING TO THE COR PRIOR TO PROCEEDING WITH THE WORK. WORK DONE BY THE CONTRACTOR INVOLVING SUCH DISCREPANCIES WITHOUT A WRITTEN REPORT AND RESPONSE FROM THE COR SHALL BE DONE AT THE CONTRACTOR'S SOLE RISK AND EXPENSE.
6. THE CONTRACTOR SHALL RECEIVE, IN WRITING, AUTHORIZATION TO PROCEED BEFORE STARTING WORK ON ANY ITEM NOT CLEARLY DEFINED OR IDENTIFIED BY THE CONTRACT DOCUMENTS.
7. THE CONTRACTOR SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION, INCLUDING THE SAFETY OF ALL PERSONS AND PROPERTY. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND IS NOT LIMITED TO NORMAL WORKING HOURS.
8. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ALL CONSTRUCTION MEANS, METHODS, TECHNIQUES, SEQUENCES, AND PROCEDURES AND FOR COORDINATING ALL PORTIONS OF THE WORK UNDER THIS CONTRACT.
9. THE CONTRACTOR SHALL INSTALL ALL EQUIPMENT AND MATERIALS IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS UNLESS SPECIFICALLY INDICATED OTHERWISE IN THE CONTRACT DOCUMENTS, FIELD DIRECTED BY THE CONTRACTING OFFICER, OR WHERE LOCAL CODES OR REGULATIONS TAKE PRECEDENCE. ALL WORK SHALL BE IN STRICT ACCORDANCE WITH APPLICABLE PERMIT REQUIREMENTS, CODES, REGULATIONS, AND ORDINANCES.
10. THE DETAILS PROVIDED ON THE CONTRACT DOCUMENTS ARE INTENDED TO SHOW THE FINAL RESULT OF THE DESIGN. MINOR MODIFICATIONS MAY BE REQUIRED TO SUIT JOB SITE DIMENSIONS OR CONDITIONS. SUCH MODIFICATIONS SHALL BE INCLUDED AS PART OF THE WORK.
11. THE CONTRACTOR SHALL MAKE ALL NECESSARY PROVISIONS TO PROTECT EXISTING STRUCTURES, IMPROVEMENTS, FENCES, GATES, ROADWAYS, DRAINAGE WAYS, CULVERTS, AND VEGETATION UNTIL SUCH ITEMS ARE TO BE DISTURBED OR REMOVED AS INDICATED ON THE CONTRACT DOCUMENTS. IF SUCH ITEMS ARE DAMAGED OR NEED TO BE REMOVED OR MODIFIED TO FACILITATE CONSTRUCTION, THE CONTRACTOR SHALL FIRST NOTIFY THE COR AND THEN REPLACE OR REPAIR THE ITEMS TO EQUAL OR BETTER CONDITION AT THE CONTRACTOR'S EXPENSE AND TO THE SATISFACTION OF THE COR.
12. THE CONTRACTOR SHALL KEEP THE JOB SITE AREA CLEAN AND FREE FROM HAZARDS. THE CONTRACTOR SHALL DISPOSE OF ALL DIRT, DEBRIS, AND RUBBISH FOR THE DURATION OF THE WORK. UPON COMPLETION, THE CONTRACTOR SHALL REMOVE ALL MATERIAL AND EQUIPMENT NOT SPECIFIED TO REMAIN ON THE PROPERTY. SEE THE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
13. REPRESENTATIONS OF TRUE NORTH SHALL NOT BE USED TO IDENTIFY OR ESTABLISH THE BEARING OF TRUE NORTH AT THE JOB SITE.
14. WHERE A CONSTRUCTION DETAIL IS NOT SHOWN OR NOTED, THE DETAIL SHALL BE THE SAME AS FOR OTHER SIMILAR WORK.

GENERAL CONSTRUCTION NOTES: (CONTINUED)

15. THE NOTES, DETAILS AND SPECIFICATIONS ON THE CONTRACT DOCUMENTS SHALL TAKE PRECEDENCE OVER THESE GENERAL NOTES.
16. DIMENSION CALL-OUTS SHALL TAKE PRECEDENCE OVER SCALES SHOWN ON THE CONTRACT DOCUMENTS.
17. STATIONING, DISTANCES, AND LENGTHS SHOWN ON THE DRAWINGS ARE BASED ON HORIZONTAL MEASUREMENTS.
18. THE CONTRACTOR SHALL BE REQUIRED TO CONTROL ON-SITE STORM WATER RUNOFF BY USING TEMPORARY OR PERMANENT DRAINAGE EROSION/SILTATION CONTROL PROCEDURES, AS INDICATED ON THE CONTRACT DOCUMENTS.
19. THE CONTRACTOR SHALL MAINTAIN HAND DRAWN REDLINES, FIELD NOTES AND PHOTOGRAPHS ("FIELD DOCUMENTATION") OF ALL IMPROVEMENTS AS THE WORK PROGRESSES. THE CONTRACTOR SHALL ALSO TAKE PHOTOGRAPHS AND VIDEO TO DOCUMENT CONDITIONS PRIOR TO CONSTRUCTION. THE CONTRACTOR'S FIELD DOCUMENTATION SHALL BE MAINTAINED ON SITE AND SHALL BE AVAILABLE FOR REVIEW BY THE CONTRACTING OFFICER AT ALL TIMES. THE CONTRACTOR SHALL PROVIDE FIELD DOCUMENTATION TO THE COR FOR THE PREPARATION OF CERTIFIED RECORD DRAWINGS PRIOR TO PROJECT ACCEPTANCE.

GENERAL CIVIL CONSTRUCTION NOTES:

1. ALL SITE WORK SHALL BE AS INDICATED ON THE CONTRACT DOCUMENTS. DO NOT EXCAVATE AND DISTURB BEYOND THE CLEARING LIMITS SHOWN ON THE CONTRACT DOCUMENTS UNLESS OTHERWISE APPROVED BY THE COR.
2. DEBRIS AND GARBAGE SHALL BE REMOVED FROM THE JOB SITE AND DISPOSED OF LEGALLY, AS REQUIRED BY THE PROJECT SPECIFICATIONS.
3. THE AREAS OF THE JOB SITE DISTURBED BY THE WORK SHALL BE GRADED SMOOTH AND PROTECTED AND/OR REVEGETATED AS SPECIFIED HEREIN.
4. PIPE MATERIALS SHALL BE AS INDICATED ON THE CONTRACT DOCUMENTS.
5. ALL EQUIPMENT AND MATERIALS NOT INDICATED ON THE DRAWINGS TO COME FROM THE SITE SHALL BE NEW AND UNDAMAGED, UNLESS OTHERWISE APPROVED BY THE COR AND THE ENGINEER. THE SAME MANUFACTURER OF EACH ITEM SHALL BE USED THROUGHOUT THE WORK UNLESS OTHERWISE APPROVED BY THE COR AND THE ENGINEER.

ABBREVIATIONS:

ABB	TERM
AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
ABB	TERM
ABB	ABBREVIATION
APPROX	APPROXIMATE
ASSY	ASSEMBLY
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
BM	BENCH MARK
CFS	CUBIC FEET PER SECOND
CL	CENTERLINE
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
CONT	CONTINUED OR CONTINUOUS
CP	CONTROL POINT (AS IN SURVEY)
CPE	CORRUGATED POLYETHYLENE
CSBC	CRUSHED SURFACING BASE COURSE
CSTC	CRUSHED SURFACING TOP COURSE
°	DEGREES
DIA	DIAMETER
E	EAST, EASTING
EA	EACH
ELE	ELEVATION
EX	EXISTING
FG	FINISHED GRADE
FT	FOOT OR FEET
GALV	GALVANIZED
GPM	GALLONS PER MINUTE
HDPE	HIGH-DENSITY POLYETHYLENE
ID	INSIDE DIAMTER
IE	INVERT ELEVATION
IN	INCH OR INCHES
IPID	ICICLE AND PESHASTIN IRRIGATION DISTRICTS
MAX	MAXIMUM
MIN	MINIMUM
N	NORTH, NORTHING
OC	ON CENTER
OD	OUTSIDE DIAMTER
PE	PROFESSIONAL ENGINEER
QTY	QUANTITY
R	RADIUS
S	SLOPE
SF	SQUARE FOOT OR FEET
SPEC	SPECIFICATION
STA	STATION
SY	SQUARE YARD
TOW	TOP OF WALL
TYP	TYPICAL
W	WEST
WSDOT	WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
WSEL	WATER SURFACE ELEVATION
YR	YEAR

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

LEGEND:

—4570— MAJOR CONTOUR (10')

MINOR CONTOUR (2')

NORTH

0 200 400

SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88
3. FOR ADDITIONAL SURVEY NOTES, SEE DWG. G-02.
4. AERIAL PHOTOGRAPHY: ESRI BASE MAPS, 2015.

DRAFT

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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Apr 10, 2017 7:42am drice

ANCHOR QEA

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

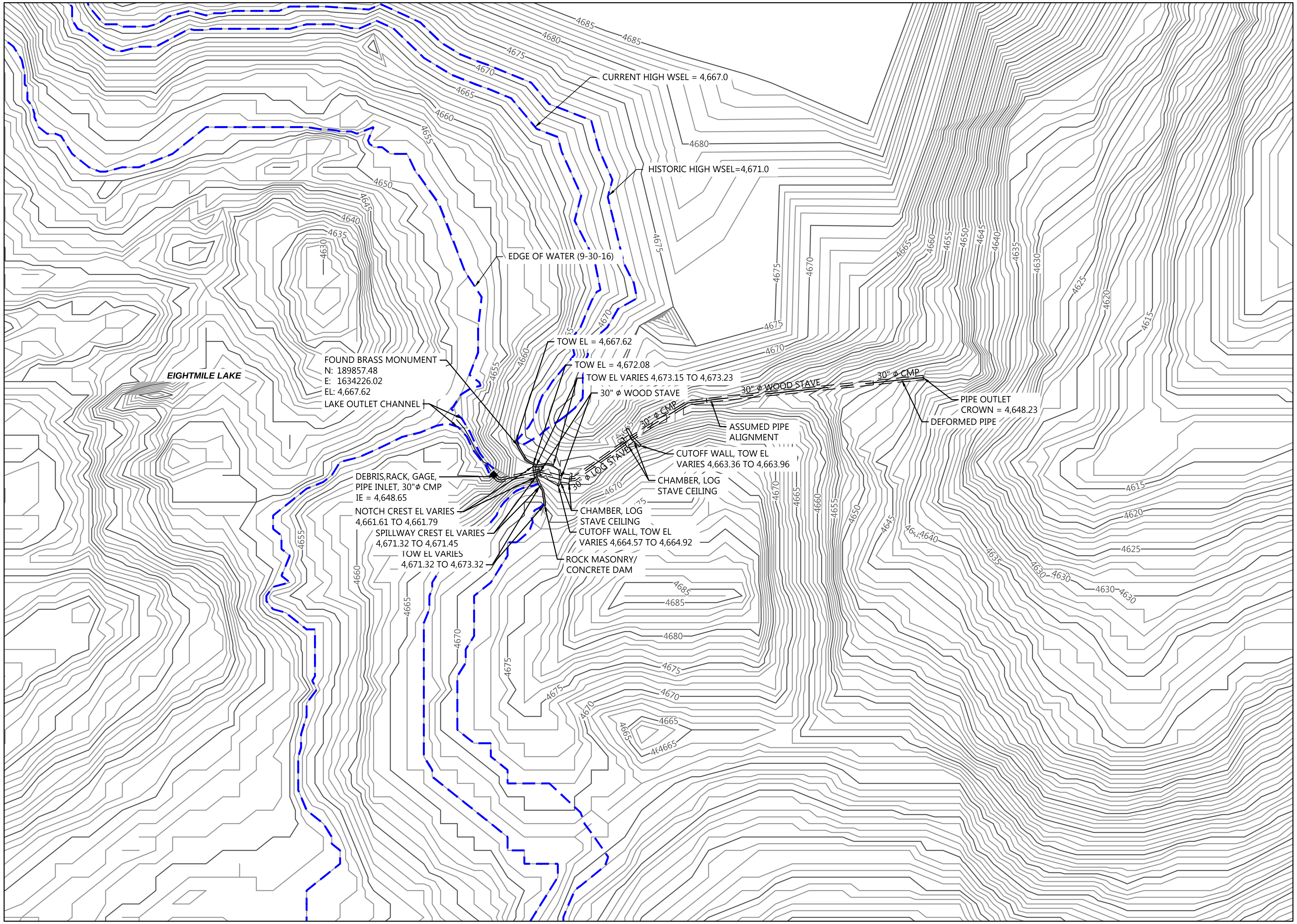
DESIGNED BY: D. RICE
DRAWN BY: M. PRATSCHNER
CHECKED BY: R. MONTGOMERY
APPROVED BY: D. RICE
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

OVERALL SITE PLAN

G-03

SHEET NO. 3 OF 15



LEGEND:

—4570— MAJOR CONTOUR (10')

MINOR CONTOUR (2')

EXISTING PIPE (BURIED)

EDGE OF WATER

NORTH

0 30 60

SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88
3. FOR ADDITIONAL SURVEY NOTES, SEE DWG. G-02.

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

ANCHOR QEA

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

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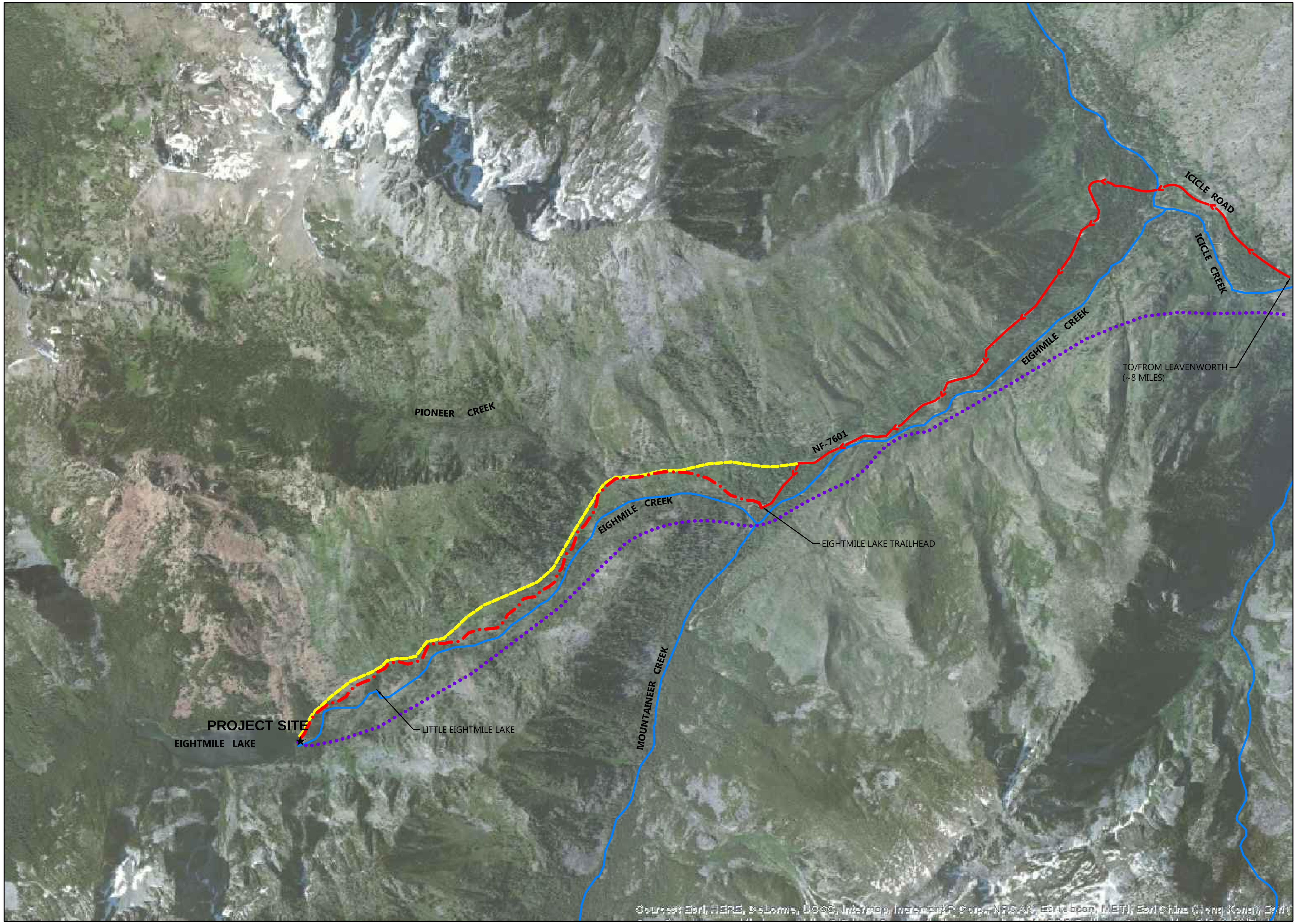
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

EXISTING CONDITIONS

G-04

SHEET NO. 4 OF 15



LEGEND:

- CREEK
- VEHICULAR ACCESS
- FOOT ACCESS
- EXCAVATOR ACCESS (IF PERMITTED)
- HELICOPTER ACCESS

NORTH

0 1,200 2,400

SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88
3. FOR ADDITIONAL SURVEY NOTES, SEE DWG. G-02.

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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Apr 10, 2017 7:48am drice

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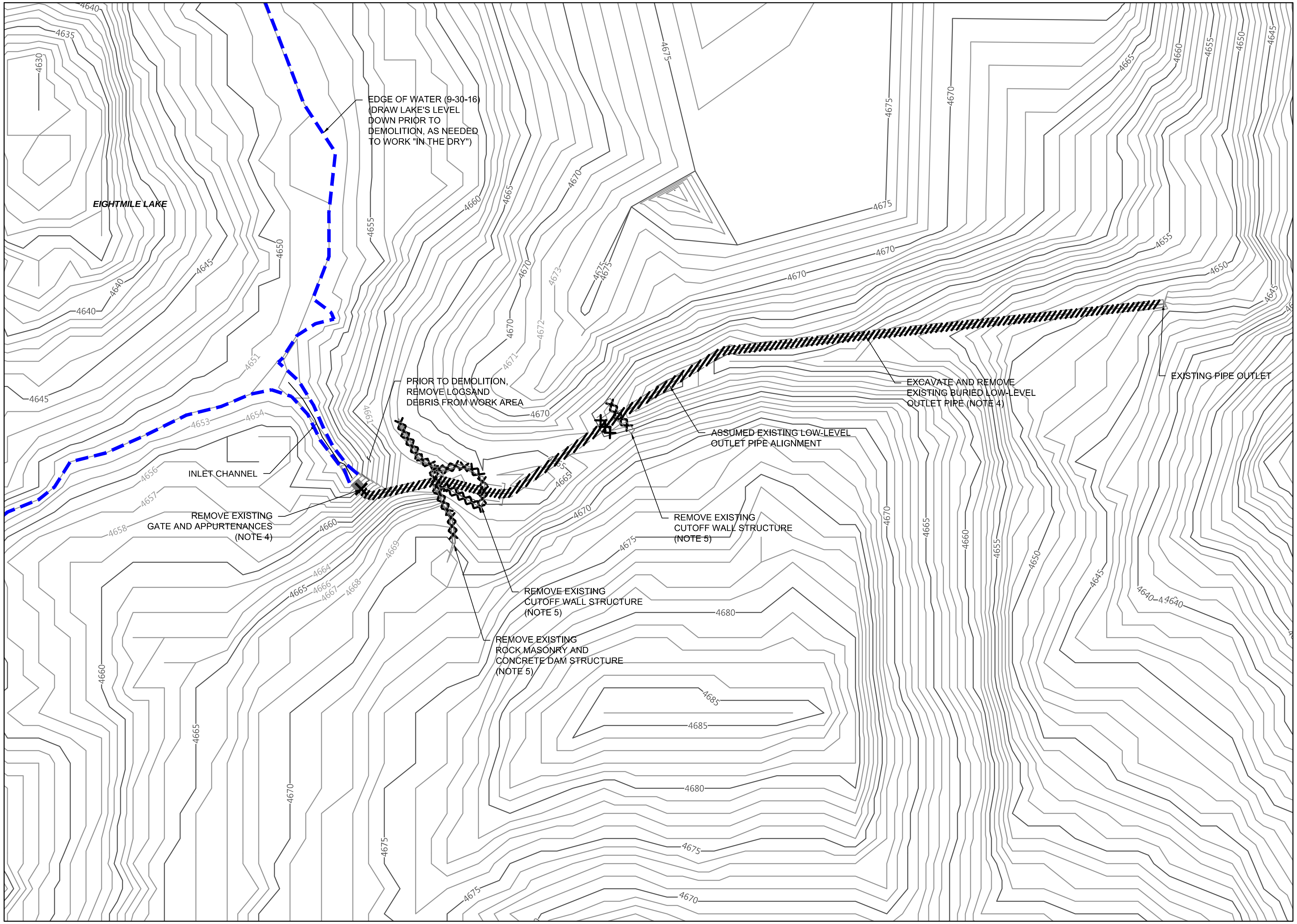
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

CONSTRUCTION ACCESS PLAN

T-01

SHEET NO. 5 OF 15



LEGEND:

—4570—	MAJOR CONTOUR (10')
———	MINOR CONTOUR (2')
///////////	REMOVE PIPE
XXXXX	REMOVE STRUCTURE
X	REMOVE EQUIPMENT

NORTH

0 16 32

SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88
3. FOR ADDITIONAL SURVEY NOTES, SEE DWG. G-02.
4. PIPE, GATE, AND OTHER EQUIPMENT SHALL BE FULLY REMOVED, HAULED FROM THE SITE BY HELICOPTER OR OTHER APPROVED METHOD, AND DISPOSED OF AS REQUIRED BY SPECIFICATIONS.
5. EXISTING ROCK MASONRY AND CONCRETE STRUCTURES SHALL BE BROKEN DOWN, STOCKPILED, AND REUSED, IF POSSIBLE, AS PART OF NEW DAM AND SPILLWAY CONSTRUCTION. IF NOT REUSED, CONCRETE AND REINFORCEMENT SHALL BE HAULED FROM THE SITE BY HELICOPTER AND DISPOSED OF, AS REQUIRED BY THE SPECIFICATIONS.

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

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Jun 02, 2017 5:57am drice

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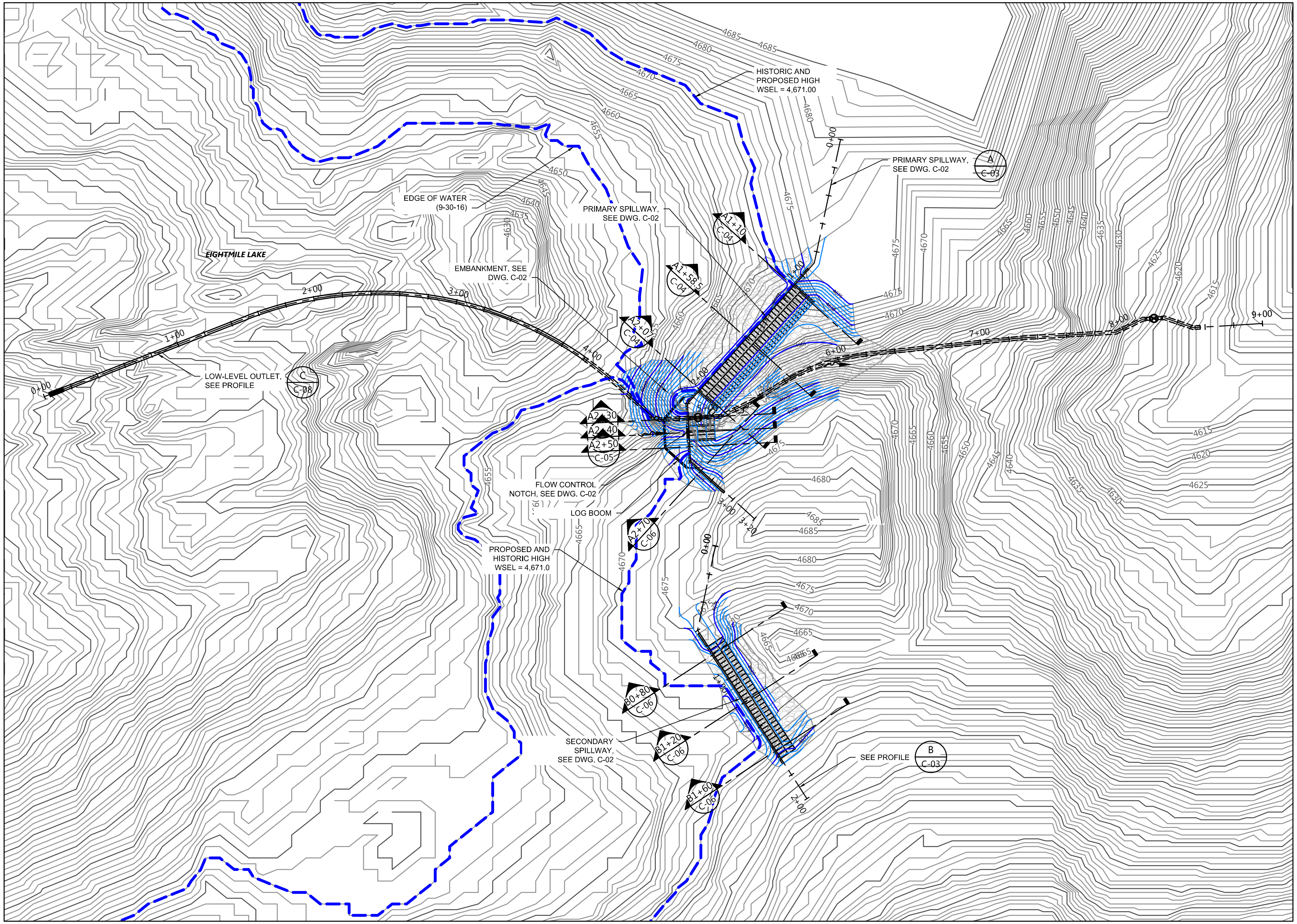
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

DEMOLITION PLAN

D-01

SHEET NO. 6 OF 15



LEGEND:

- 4570 EXISTING MAJOR CONTOUR (5')
- EXISTING MINOR CONTOUR (1')
- MAJOR CONTOUR (5' INTERVAL)
- MINOR CONTOUR (1' INTERVAL)
- SLOPE ARMORING
- SPILLWAY GABIONS W/CONCRETE
- REINFORCED CONCRETE WALL
- DIRECTION OF SURFACE SLOW

INDICATES DIRECTION OF CUTTING PLAN

SECTION "A" IS SHOWN ON DRAWING "C-02"

A / C-02

NORTH

0 30 60

SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88
3. FOR DETAILED EMBANKMENT PLAN, SEE DWG C-02.
4. FOR DETAILED LOW-LEVEL OUTLET PLAN, SEE DWG C-07.

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

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May 29, 2017 10:02am drice

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REVISIONS				
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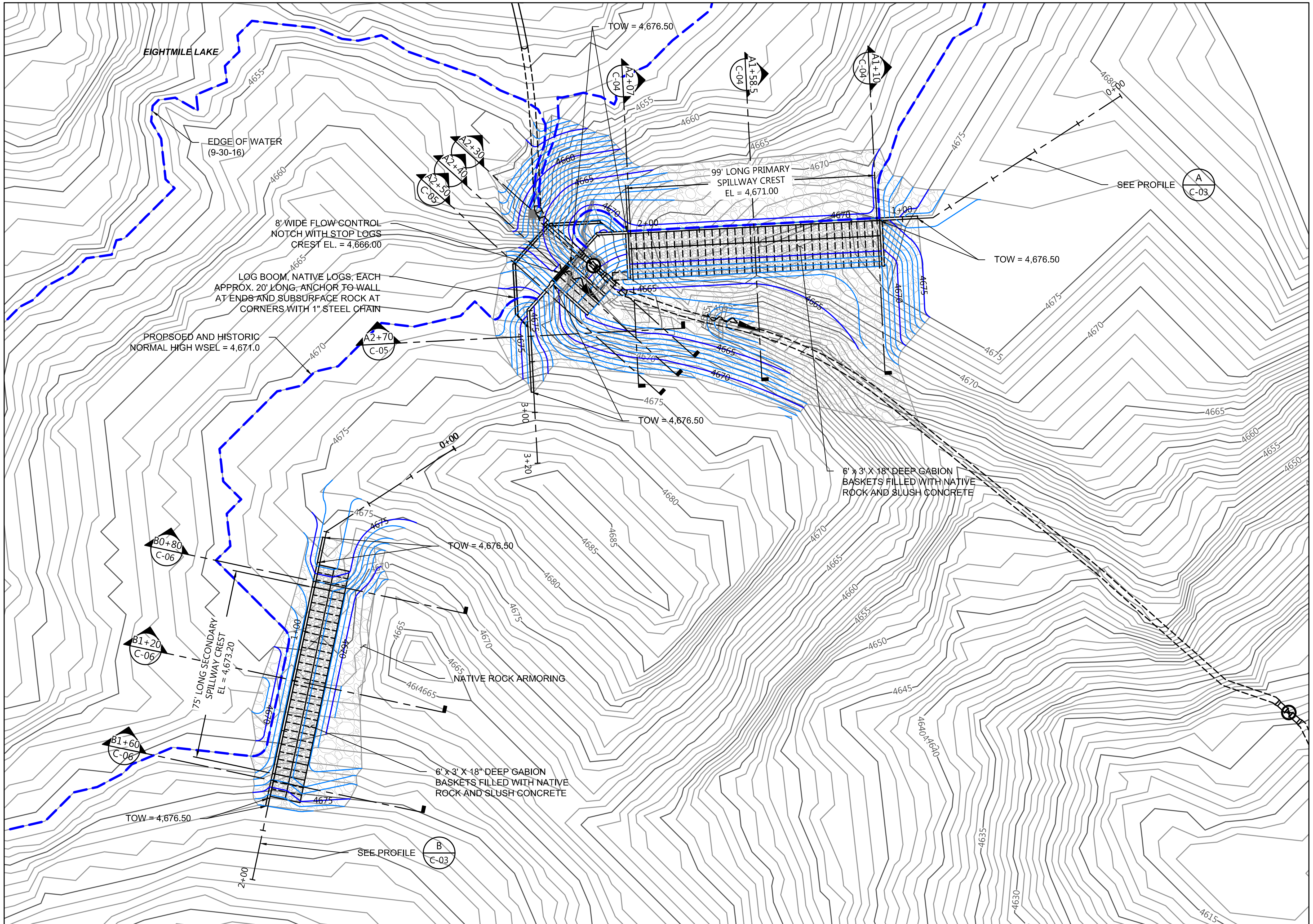
APPROVED BY: D. RICE
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

RESTORATION PLAN

C-01

SHEET NO. 7 OF 15



LEGEND:

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- EXISTING MINOR CONTOUR (1')
- MAJOR CONTOUR (5' INTERVAL)
- MINOR CONTOUR (1' INTERVAL)
- SLOPE ARMORING
- SPILLWAY GABIONS W/CONCRETE
- REINFORCED CONCRETE WALL
- DIRECTION OF SURFACE SLOW

SECTION "A" IS SHOWN ON DRAWING "C-02"

INDICATES DIRECTION OF CUTTING PLAN

A C-02

NORTH

0 20 40

SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

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May 29, 2017 9:44am drice

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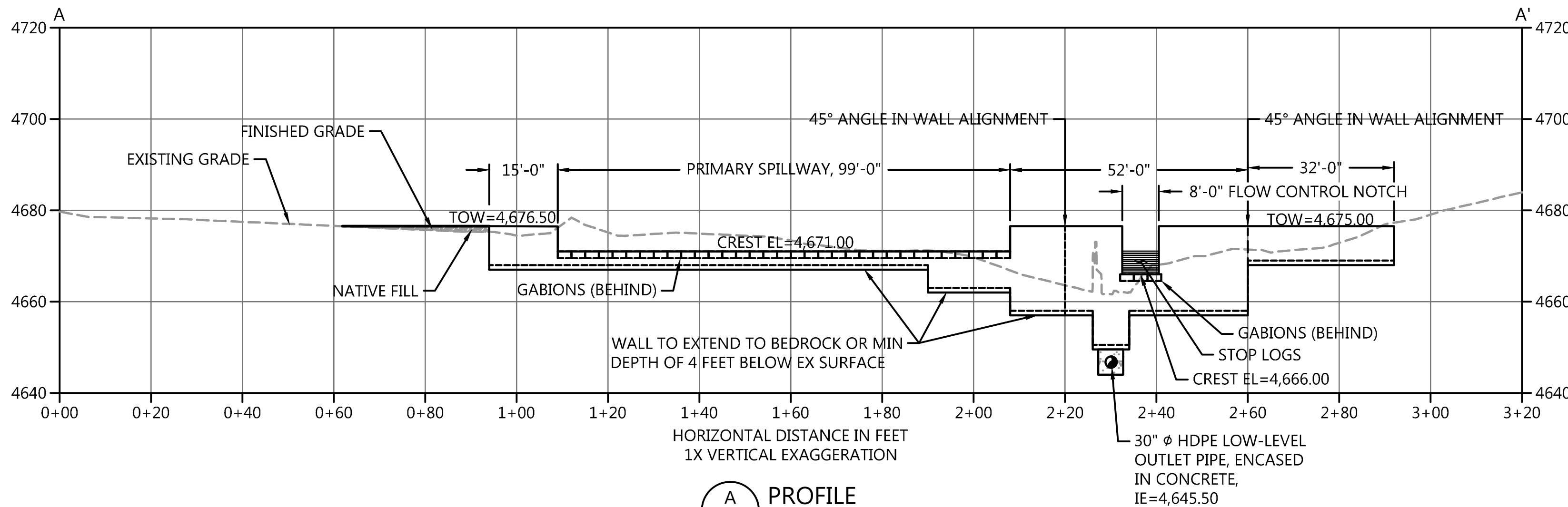
APPROVED BY: D. RICE
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

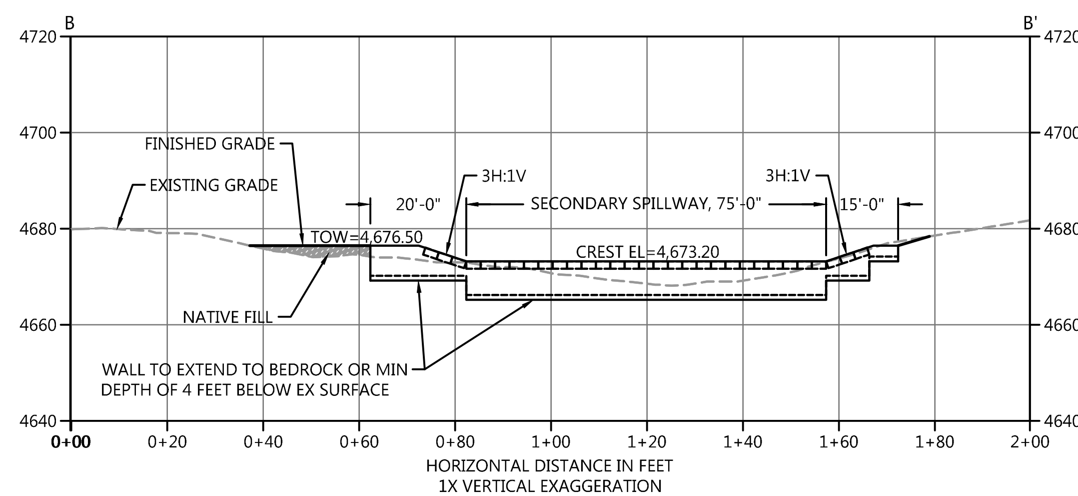
EMBANKMENT PLAN

C-02

SHEET NO. 8 OF 15



A PROFILE
C-02
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 20'



B PROFILE
C-02
HORIZ. SCALE: 1" = 20'
VERT. SCALE: 1" = 20'

NORTH

0 20 40

SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

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May 29, 2017 9:49am drice

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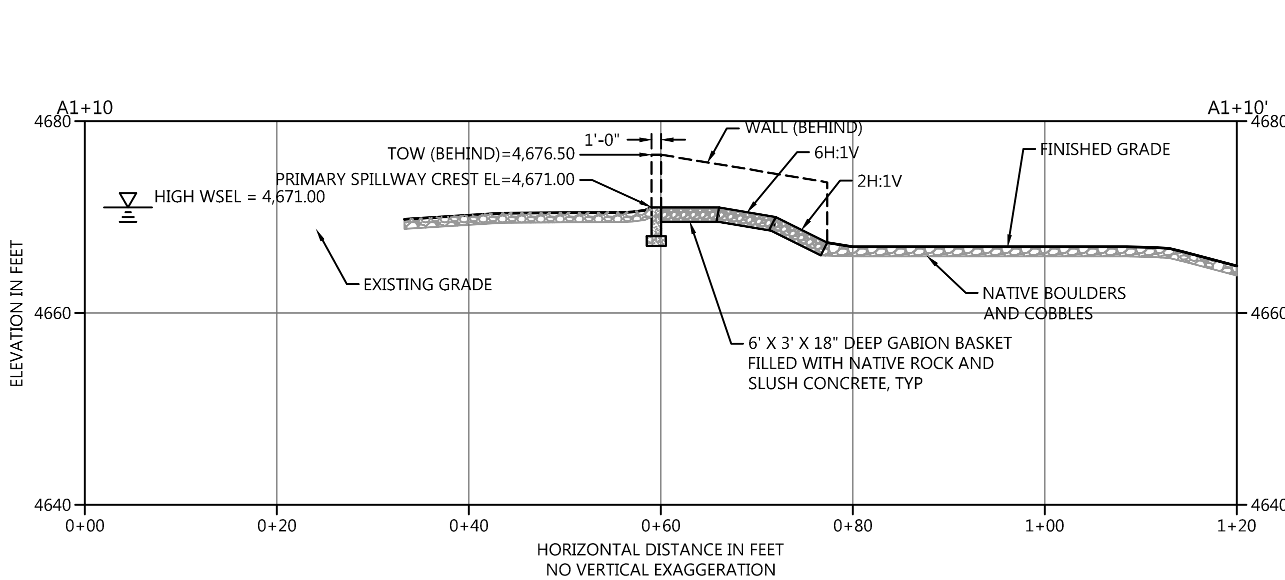
APPROVED BY: D. RICE
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

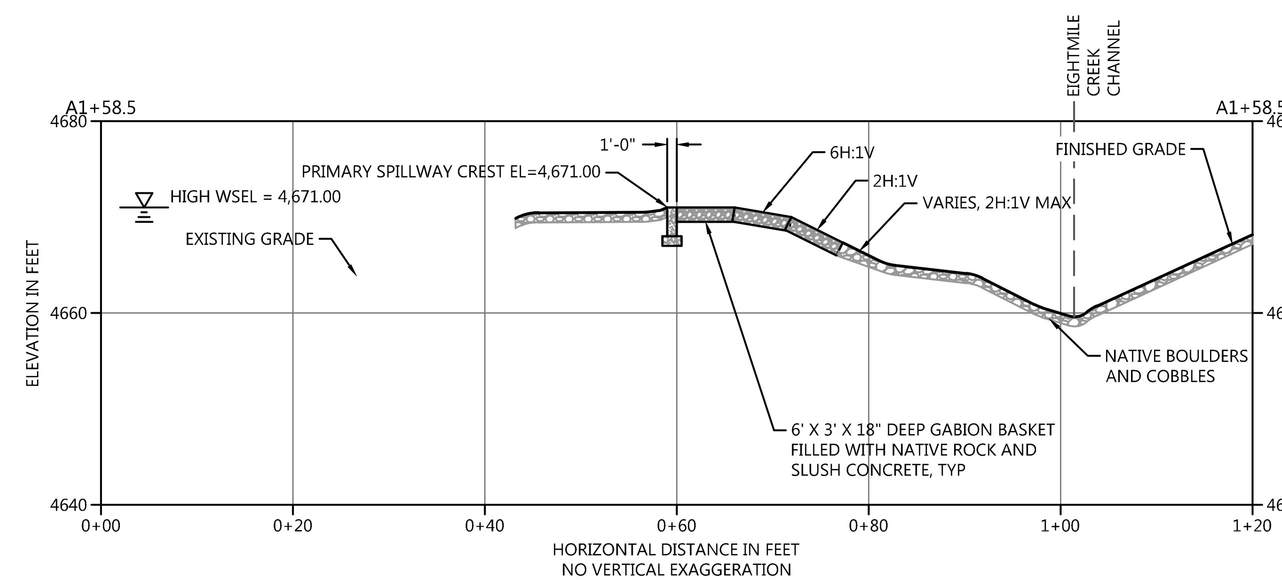
EMBANKMENT PROFILES

C-03

SHEET NO. 9 OF 15



A1+10 / C-2 SECTION
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



A1+58.5 / C-2 SECTION
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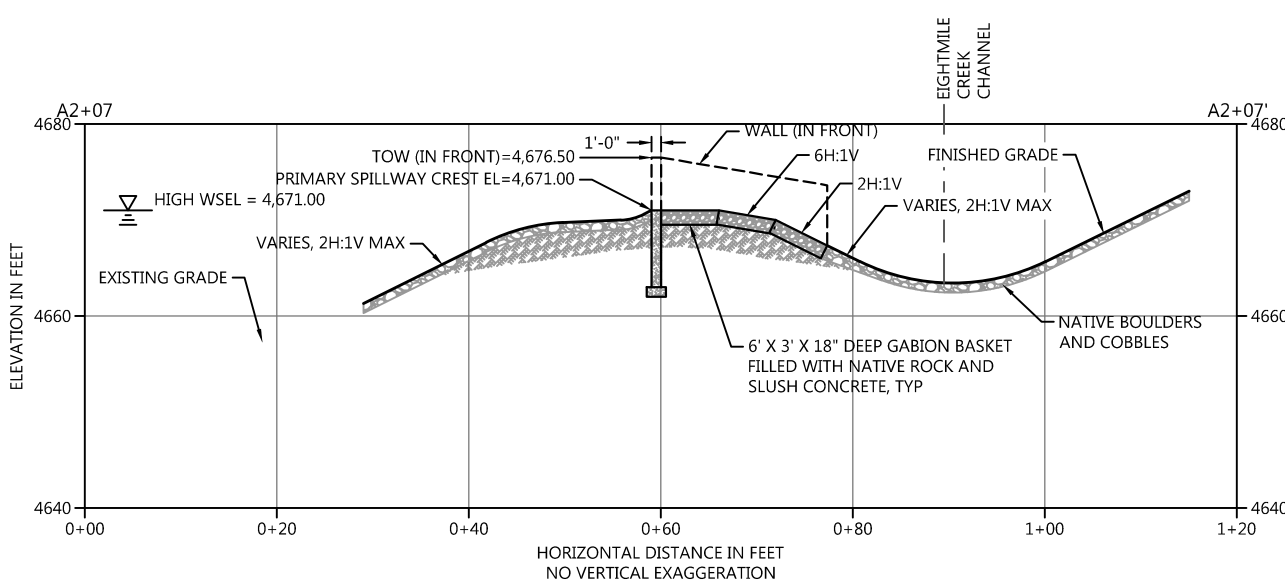
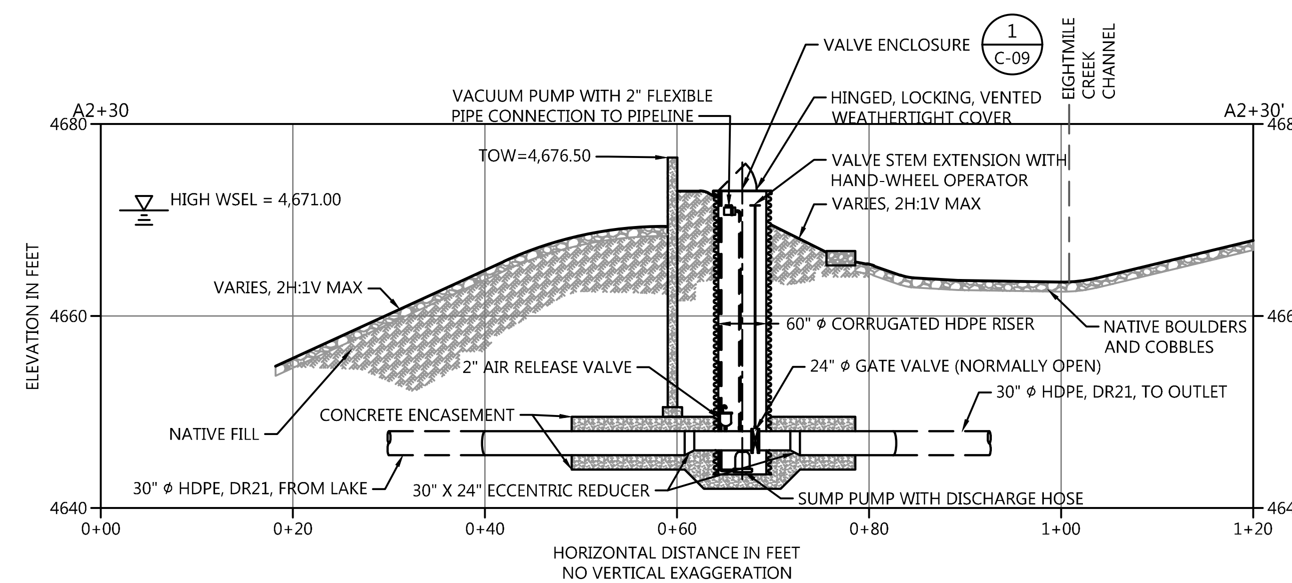
VERT. SCALE: 1" = 10'



A2+07 / C-2 SECTION
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



A2+30 / C-2 SECTION
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'

NORTH

0 10 20
SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

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May 29, 2017 10:23am drice

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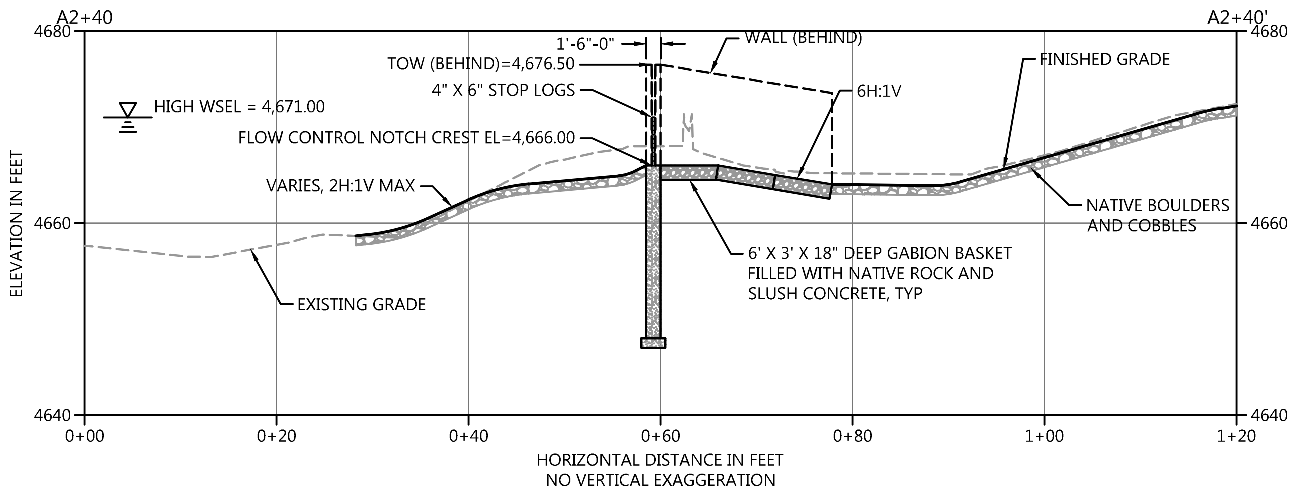
APPROVED BY: D. RICE
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

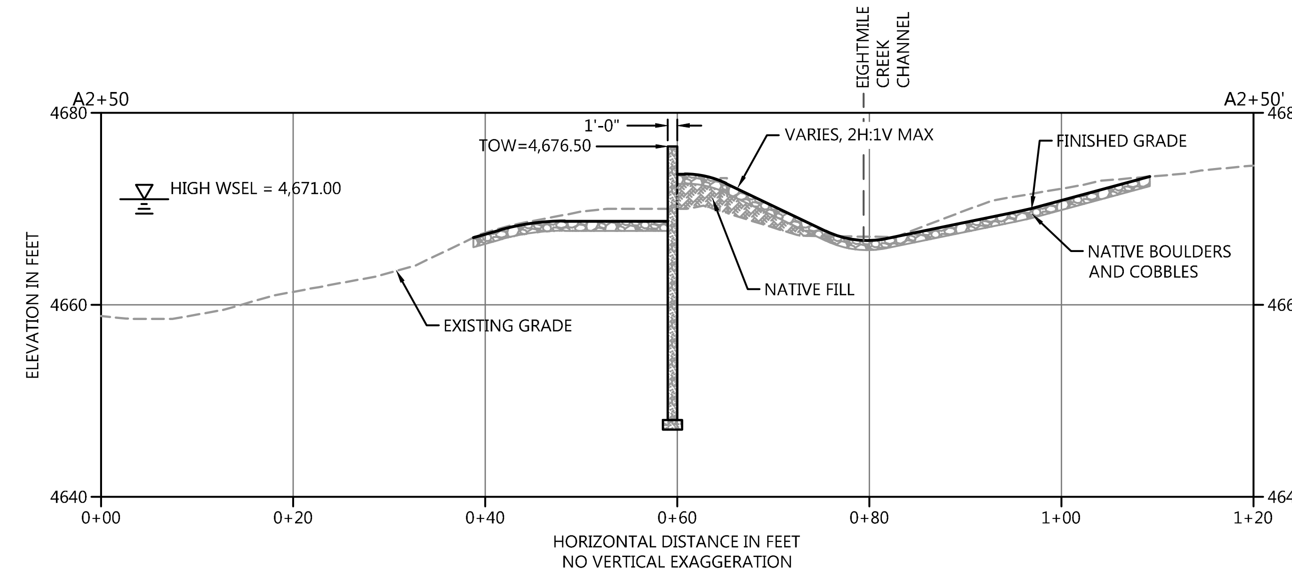
EMBANKMENT SECTIONS (1)

C-04

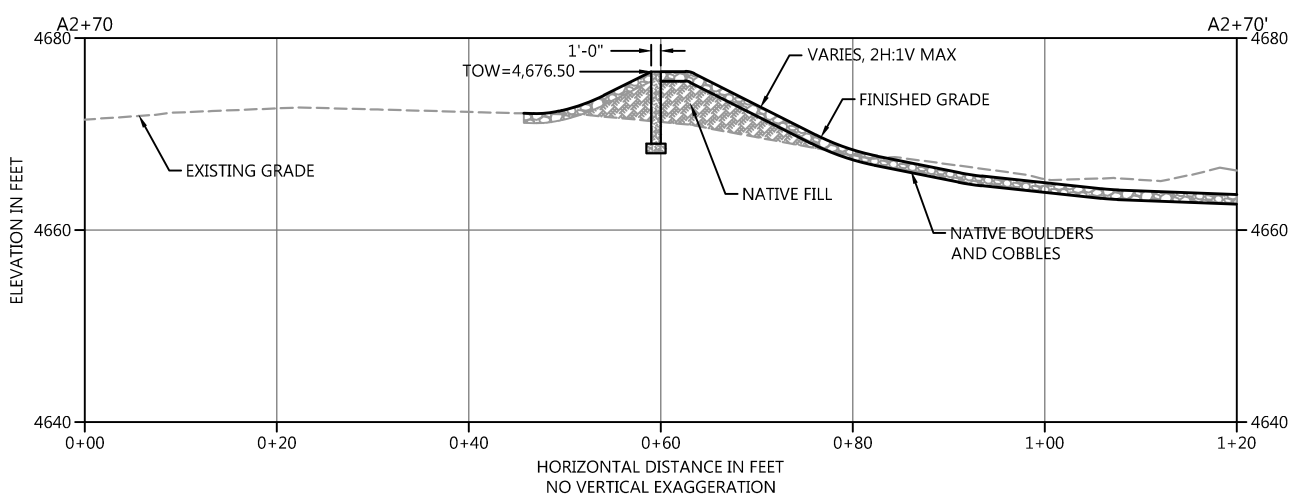
SHEET NO. 10 OF 15



A2+40 / C-2 SECTION
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



A2+50 / C-2 SECTION
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



A2+70 / C-2 SECTION
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'

NORTH

0 10 20
SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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CHECKED BY: R. MONTGOMERY
APPROVED BY: D. RICE
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

EMBANKMENT SECTIONS (2)

C-05

SHEET NO. 11 OF 15

K:\Projects\0204-Aspect Consulting, LLC\Icicle Creek Comp Water Mgt\Eightmile Lake\Construction Plans\0204-PL-008 EMBANKMENT SPILL XSEC.dwg C-05
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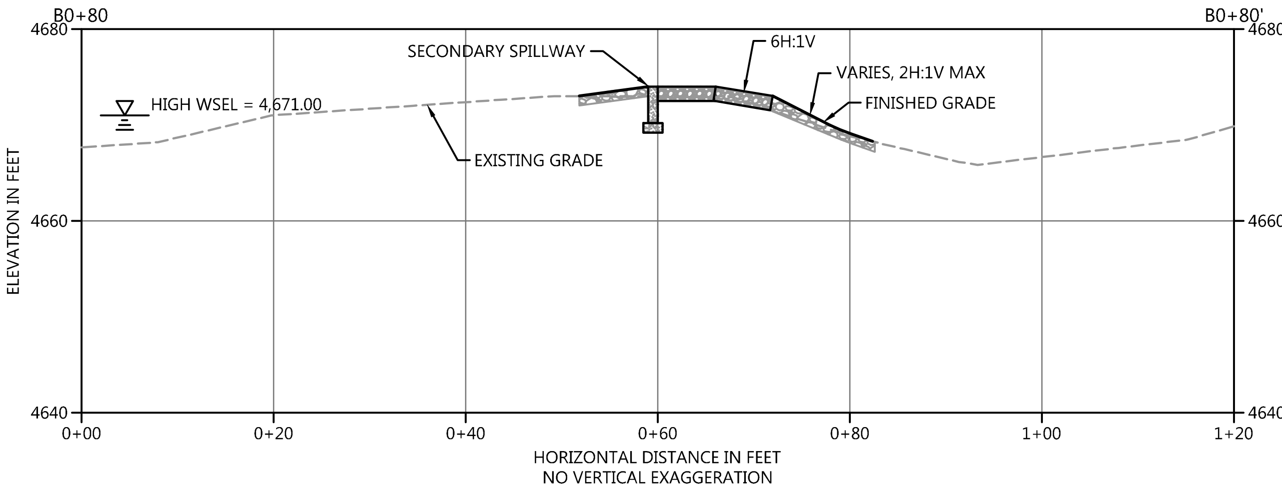

B0+80 / C-2 SECTION
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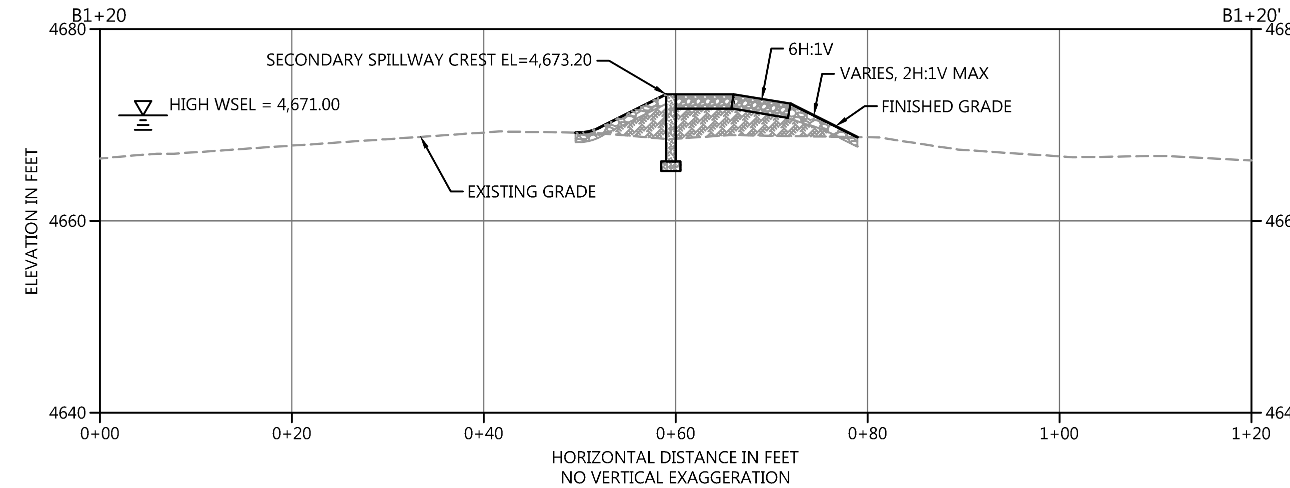
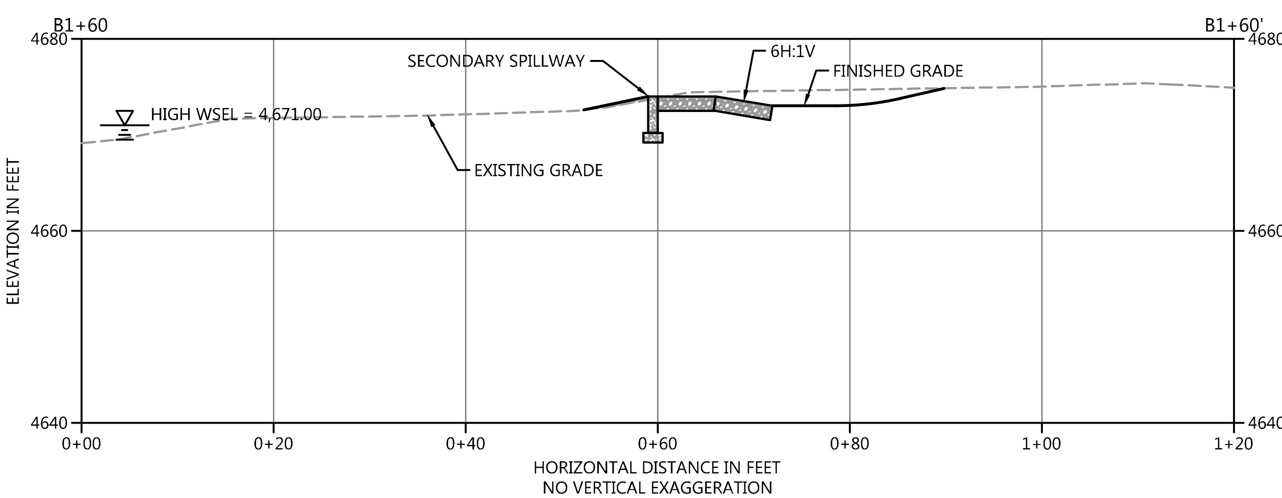
VERT. SCALE: 1" = 10'



B1+20 / C-2 SECTION
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



B1+60 / C-2 SECTION
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'

NORTH

0 10 20
SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

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DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

EMBANKMENT SECTIONS (3)

C-06

SHEET NO. 12 OF 15

K:\Projects\0204-Aspect Consulting, LLC\Icicle Creek Comp Water Mgt\Eightmile Lake\Construction Plans\0204-PL-008 EMBANKMENT SPILL XSEC.dwg C-06
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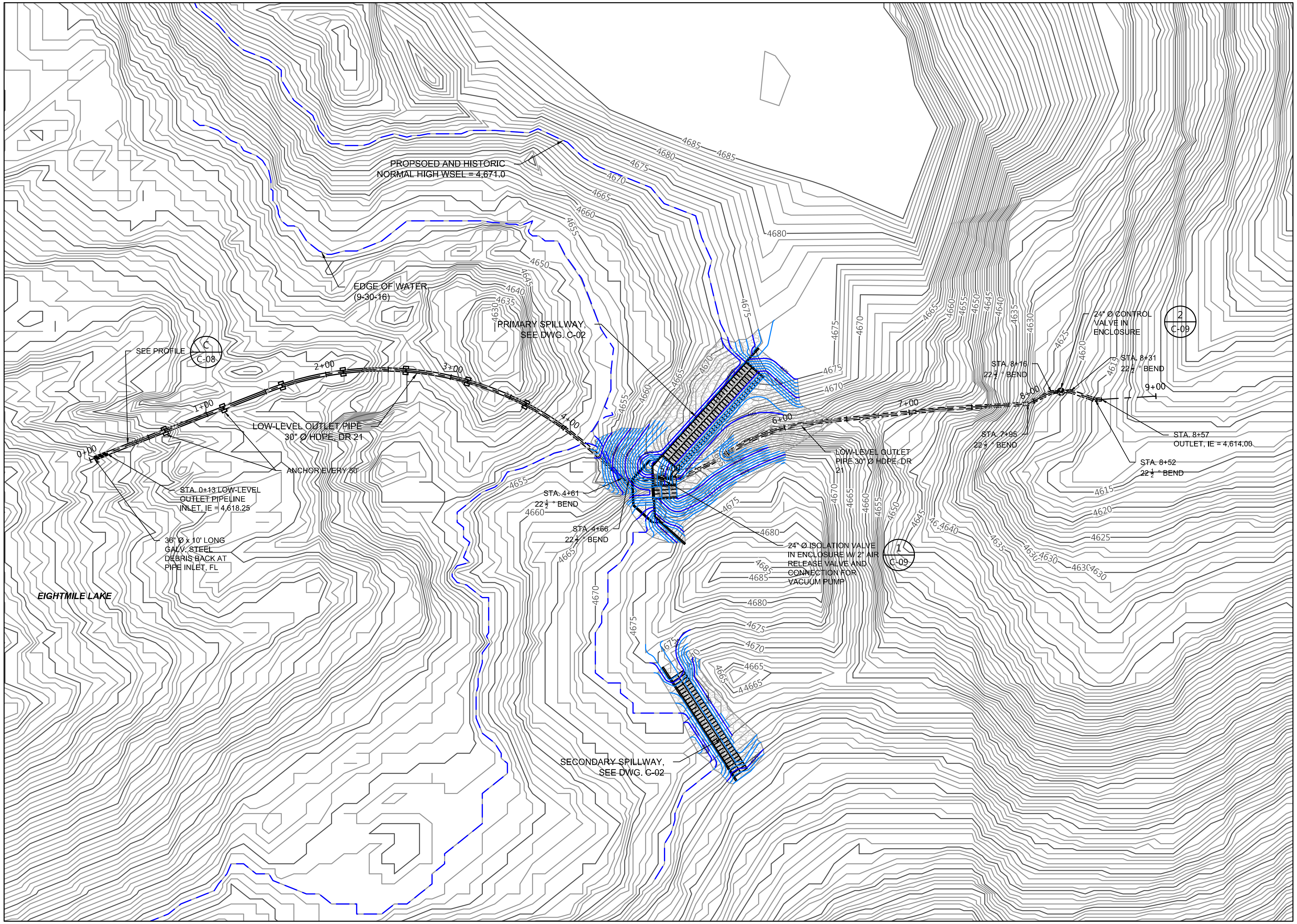

LEGEND:

- —4570— EXISTING MAJOR CONTOUR (5')
- EXISTING MINOR CONTOUR (1')
- MAJOR CONTOUR (5' INTERVAL)
- MINOR CONTOUR (1' INTERVAL)
- SUBMERGED PIPELINE
- BURIED PIPELINE
- SLOPE ARMORING
- SPILLWAY GABIONS W/CONCRETE
- REINFORCED CONCRETE WALL

NORTH

0 40 80

SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

K:\Projects\0204-Aspect Consulting, LLC\Icicle Creek Comp Water Mgt\Eightmile Lake\Construction Plans\0204-PL-009 OUTLET.dwg C-07

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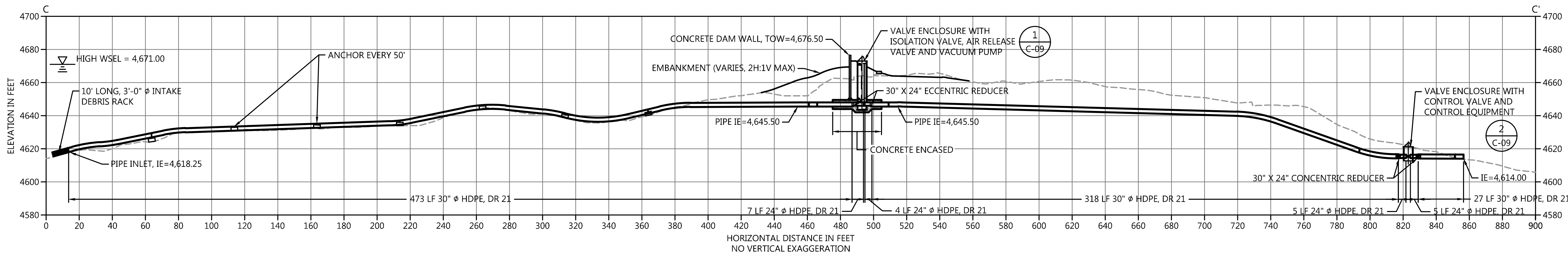
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

LOW-LEVEL OUTLET PLAN

C-07

SHEET NO. 13 OF 15



C / C-07 LOW-LEVEL OUTLET PROFILE
HORIZ. SCALE: 1" = 30'
VERT. SCALE: 1" = 30'

NORTH

0 30 60
SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD88

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

ANCHOR QEA

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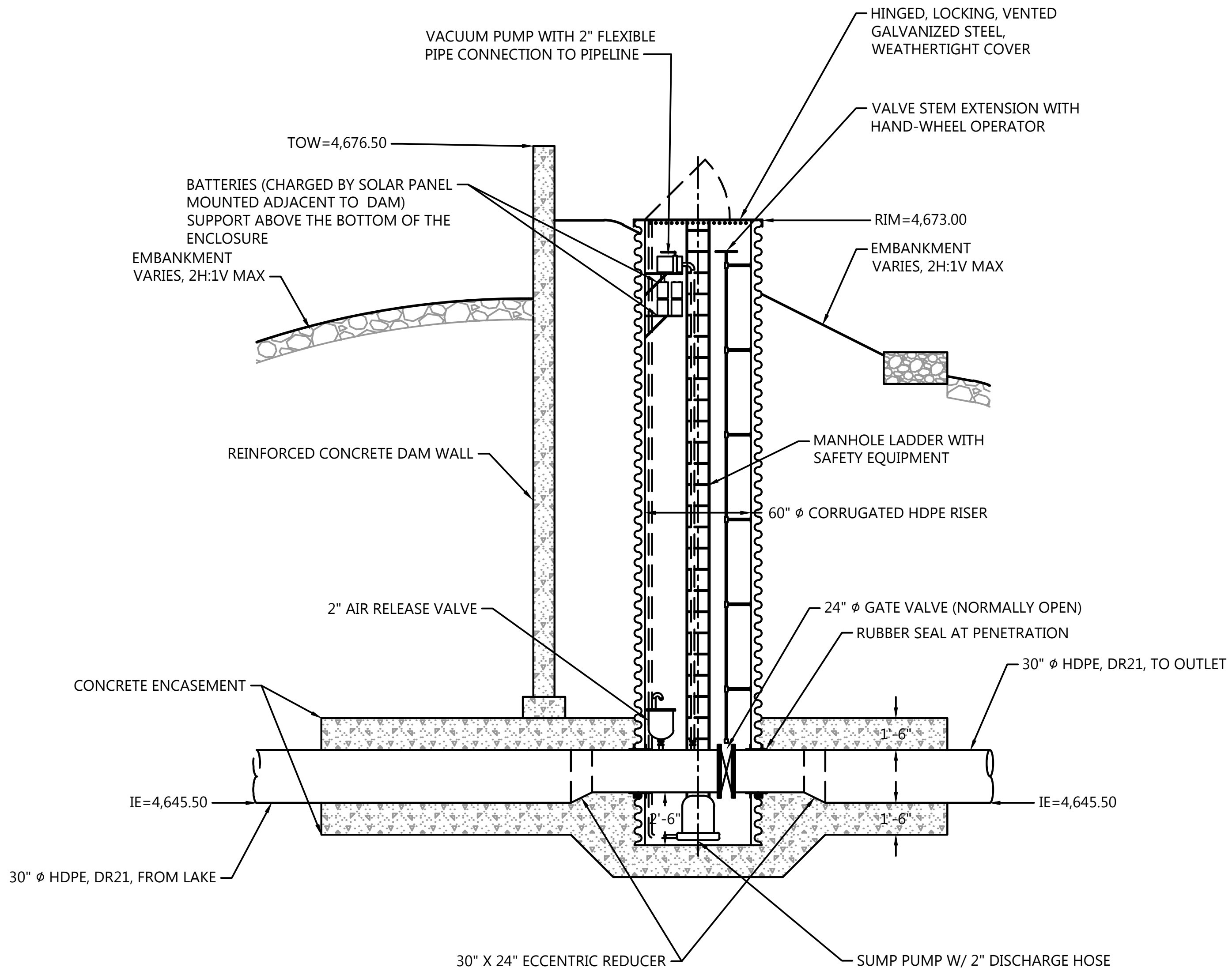
CHECKED BY: R. MONTGOMERY
APPROVED BY: D. RICE
SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

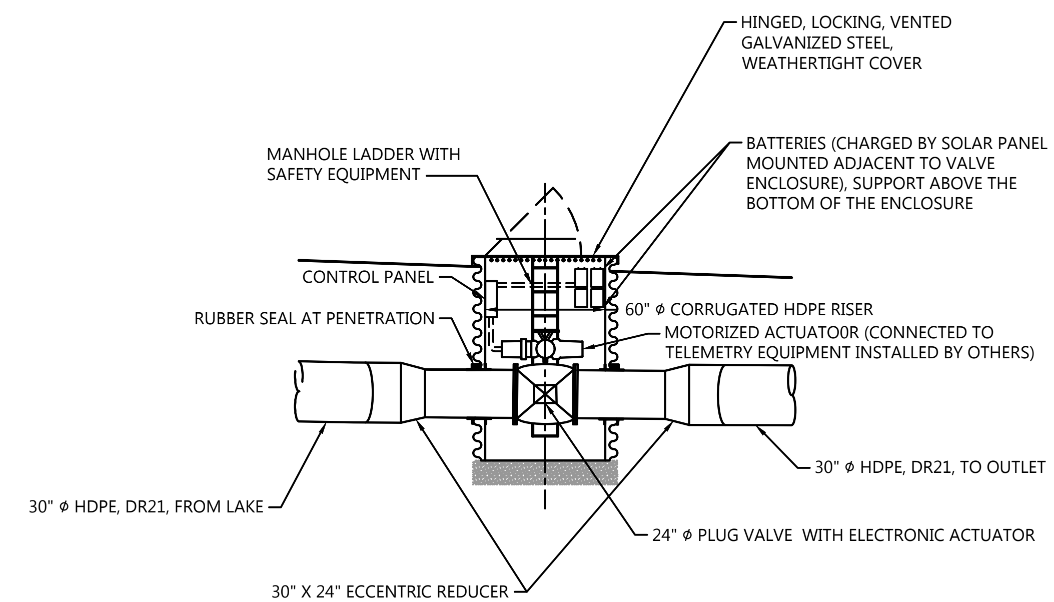
LOW-LEVEL OUTLET PROFILE

C-08

SHEET NO. 14 OF 15



1 / C-07 ISOLATION VALVE ENCLOSURE
SCALE: 1" = 4'



2 / C-07 CONTROL VALVE ENCLOSURE
SCALE: 1" = 4'

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT

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Jun 02, 2017 6:04am drice

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SCALE: AS NOTED
DATE: APRIL 2017

EIGHTMILE LAKE RESTORATION PROJECT

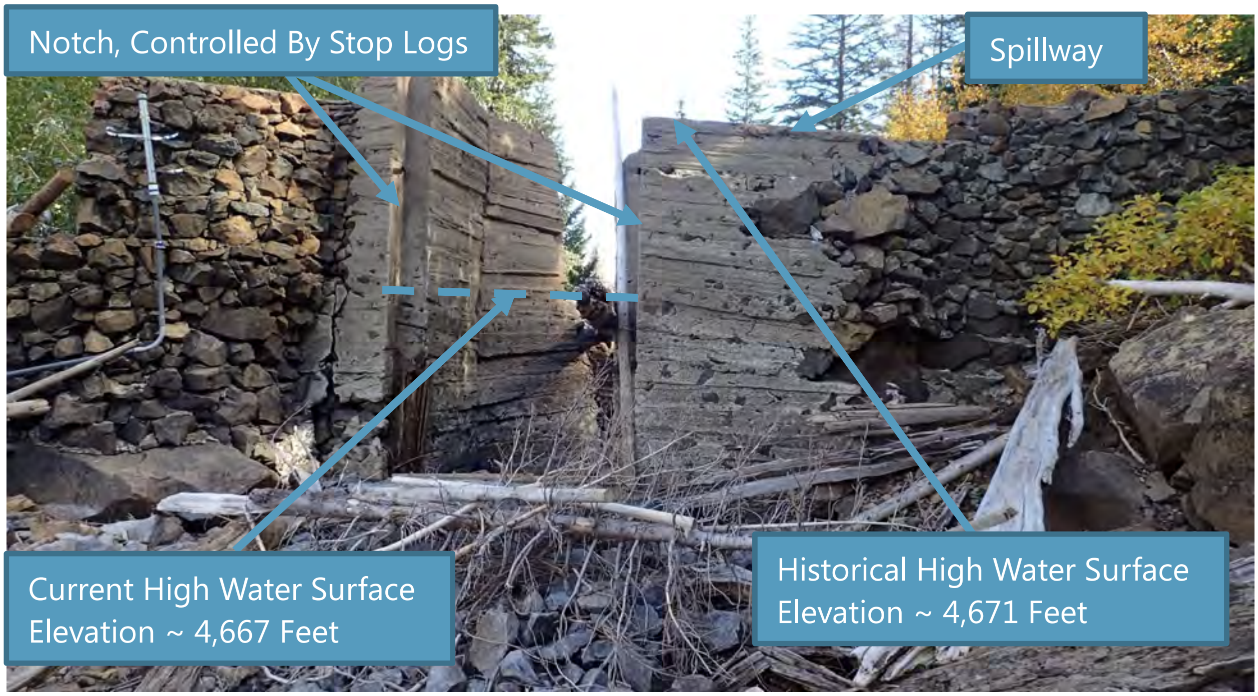
DETAILS

C-09

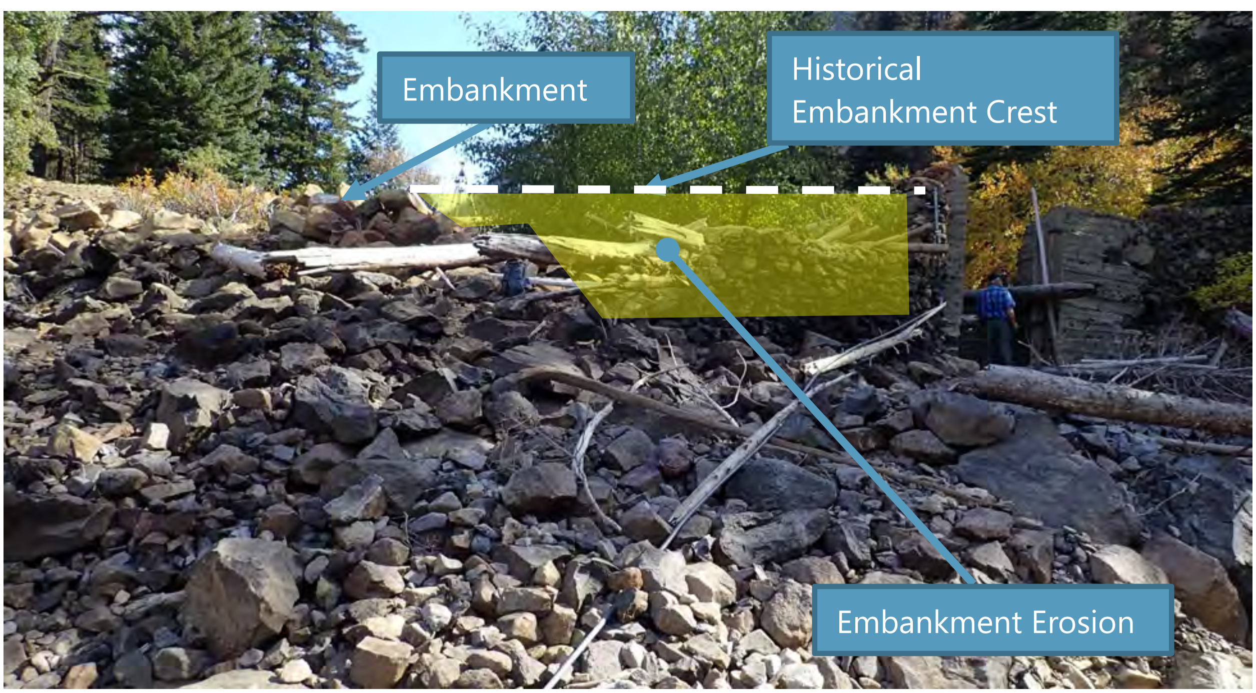
SHEET NO. 15 OF 15

Appendix B
Photographs

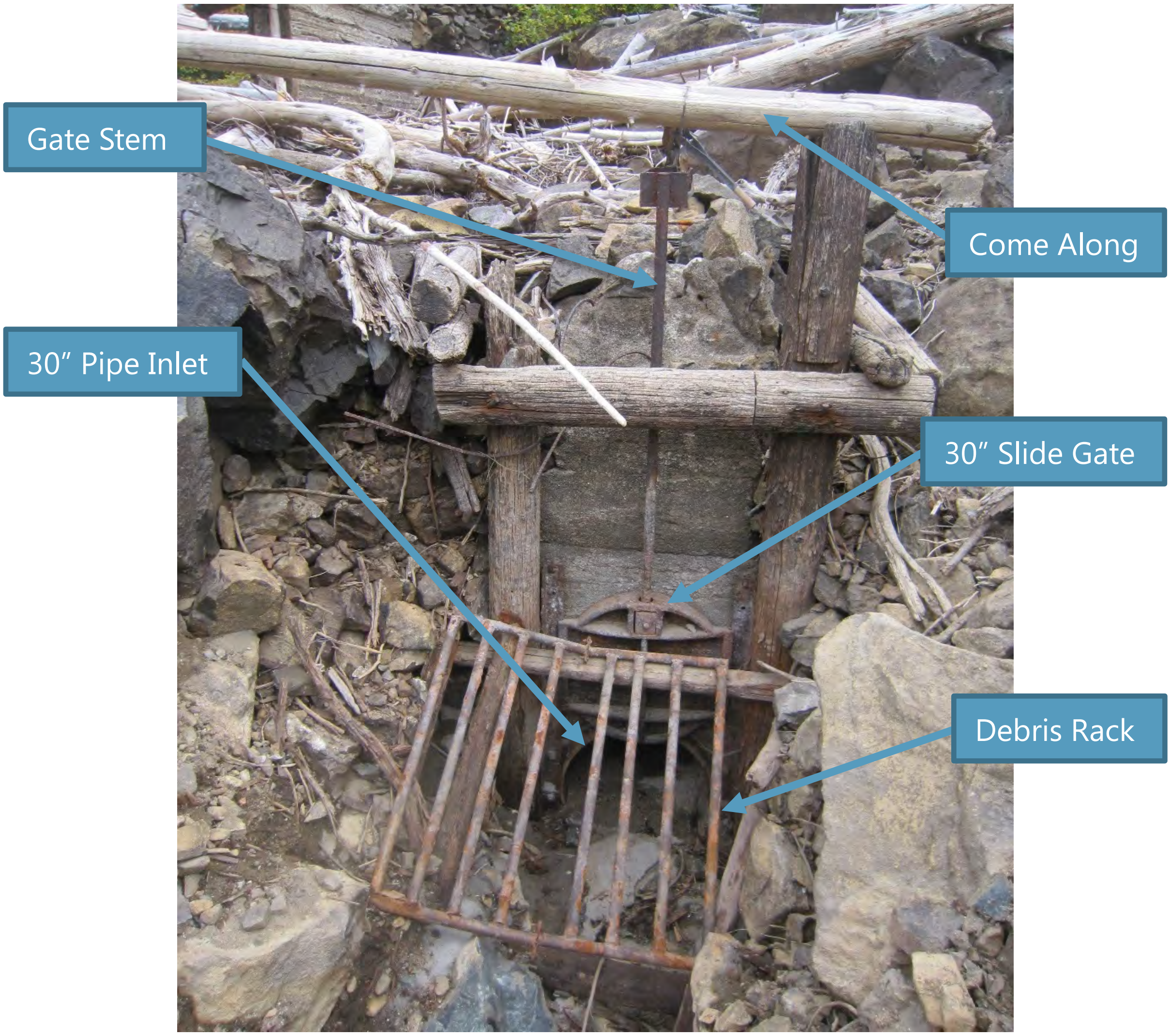
Photograph 1
Existing Dam and Spillway



Photograph 2
Existing Embankment

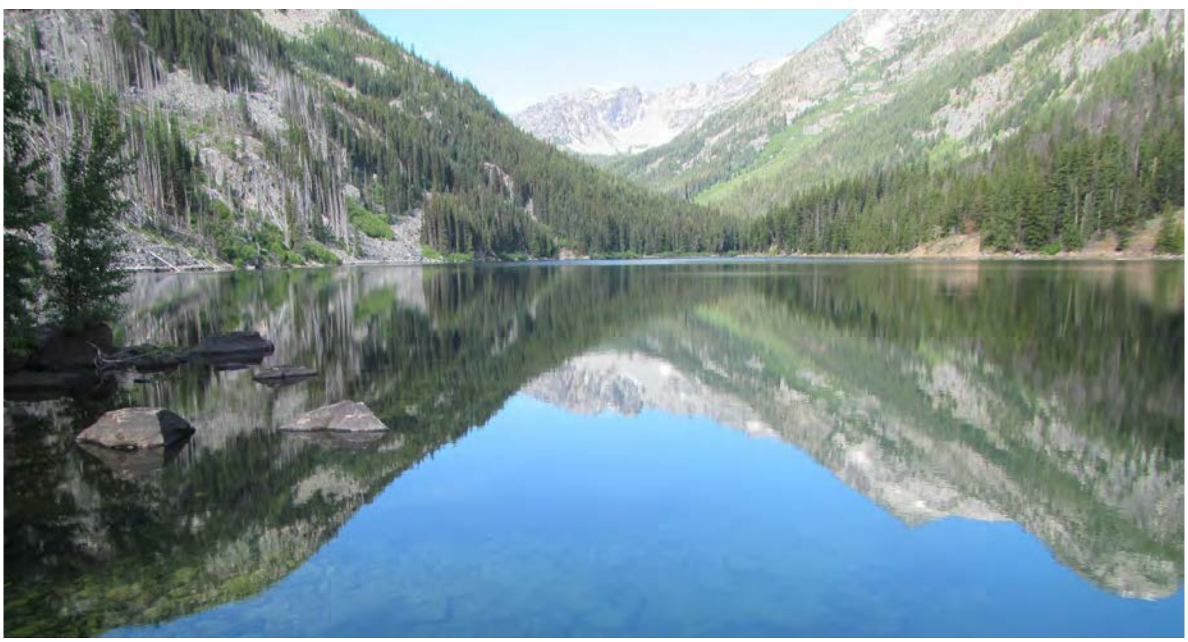


Photograph 3
Low-Level Outlet Gate



Photograph 4
Eightmile Lake – Drawn Down (September 15, 2015)

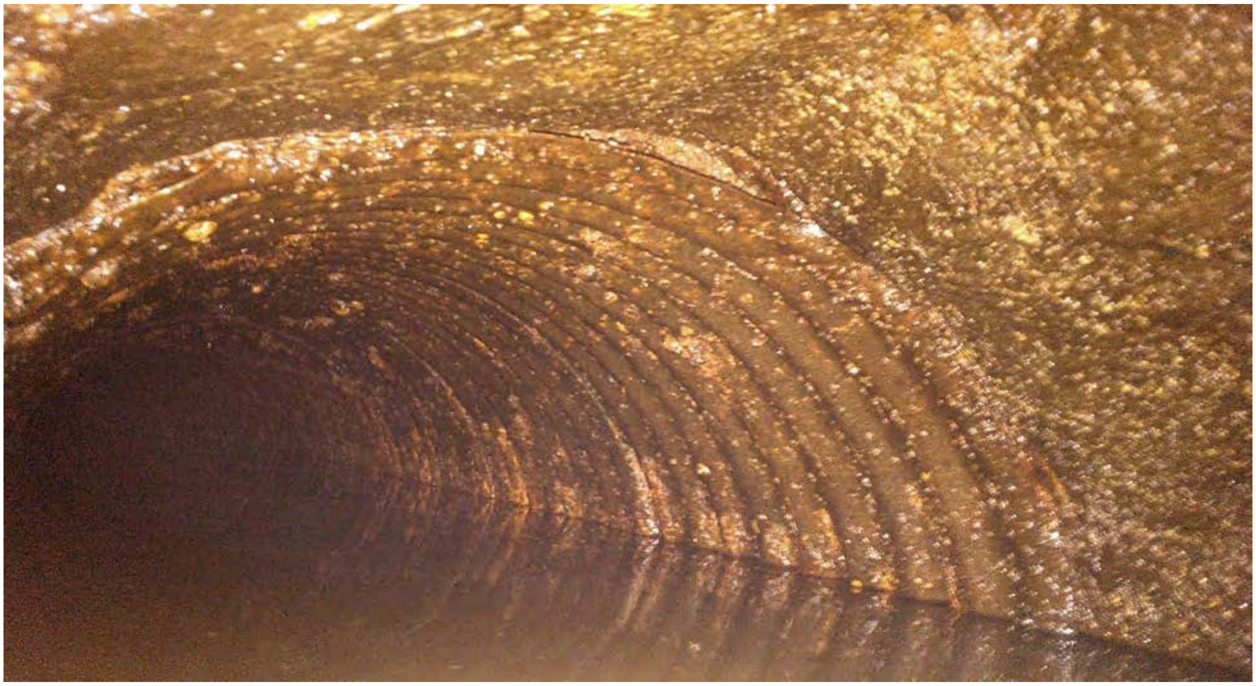
Photograph 5
Eightmile Lake – Full (July 25, 2016)



Photograph 6
Eightmile Lake – Drawn Down (September 15, 2015)

Photograph 7
Eightmile Lake – Near Full (August 29, 2012)

Photograph 8
Low-Level Outlet Pipe, Near Pipe Inlet



Photograph 9
Low-Level Outlet Pipe, Log-Stave Section

Photograph 10
Low-Level Outlet Pipe, Wood-Stave Section

Photograph 11
Low-Level Outlet Pipe, Near Pipe Outlet

Appendix C
Downstream Hazard Analysis Worksheet

WORKSHEET
DAM SAFETY GUIDELINES

SELECTION OF DESIGN/PERFORMANCE GOALS
FOR CRITICAL PROJECT ELEMENTS

PROJECT NAME: Eightmile Lake Storage Restoration Feasibility Study

DAM NAME: Eightmile Lake

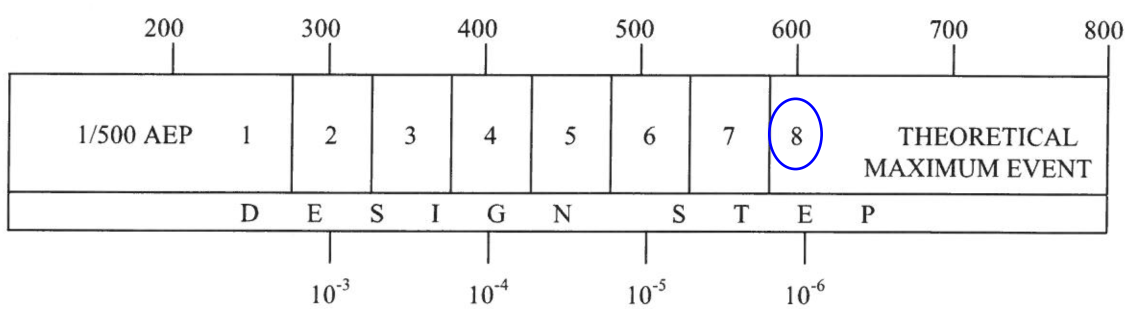
CONSEQUENCES EVALUATED FOR FAILURE OF Total failure at base of dam

AT RESERVOIR LEVEL OF EL=4673

SUMMARY SHEET

		CONSEQUENCE RATING POINTS
I.	CAPITAL VALUE OF PROJECT	110
II.	POPULATION AT RISK	295
III.	DOWNSTREAM PROPERTY AT RISK	77
	BASE POINTS	**150**
	CUMULATIVE CONSEQUENCE RATING POINTS	632

CUMULATIVE CONSEQUENCE RATING POINTS



DESIGN/PERFORMANCE GOAL - ANNUAL EXCEEDANCE PROBABILITY

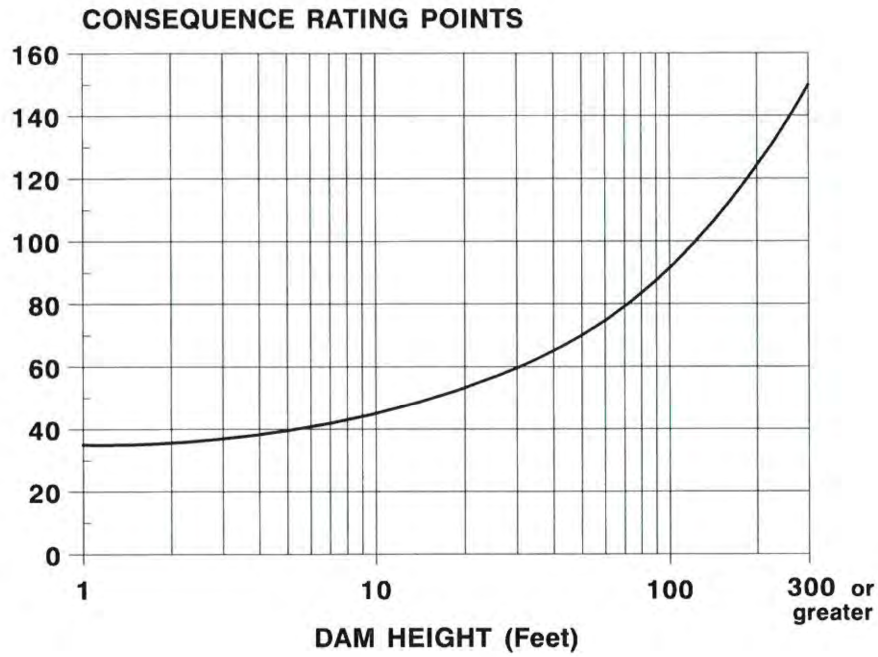
DESIGN STEP NUMBER 8

PROJECT ENGINEER David W. Rice **DATE** 02/2017

I. CAPITAL VALUE OF PROJECT

A. DAM HEIGHT INDEX

	Dam Height (feet)	Consequence Rating Points
Maximum Dam Height	26	60



I. CAPITAL VALUE OF PROJECT - Continued

B. VALUE OF RESERVOIR CONTENTS/PROJECT BENEFITS

Mandatory Consideration for Some Projects		Points Per Item	Consequence Rating Points
1.	Public Water Supply Storage	25 - 75	
Discretionary Considerations			
2.	Irrigation Water Supply Storage	10 - 75	40
3.	Industrial Water Supply Storage	10 - 75	
4.	Hydropower Generation Facilities	10 - 75	
5.	Mining or Manufacturing Process Water	10 - 75	
6.	Aesthetics, Recreation or Wildlife Habitat	10 - 25	10
7.	Other ______________________________		

Describe: ____

Assignment of consequence rating points to dams which provide a community with a limited resource, such as a public water supply, is mandatory.

Assignment of consequence rating points to dams which provide benefits primarily to the owner, is at the discretion of the owner and/or project engineer.

A wide range of consequence rating points are possible for the various project benefits. Selection of an appropriate value should be based on the size and importance of the project benefit under consideration relative to the broad range of projects of that type. In addition, a larger or smaller value may be selected depending on the owner's and/or project engineer's perceived need for conservatism in protecting project benefits.

SUBSECTION I - SUBTOTAL OF CONSEQUENCE RATING POINTS 110

II. POPULATION AT RISK

A. CATASTROPHIC POTENTIAL INDEX

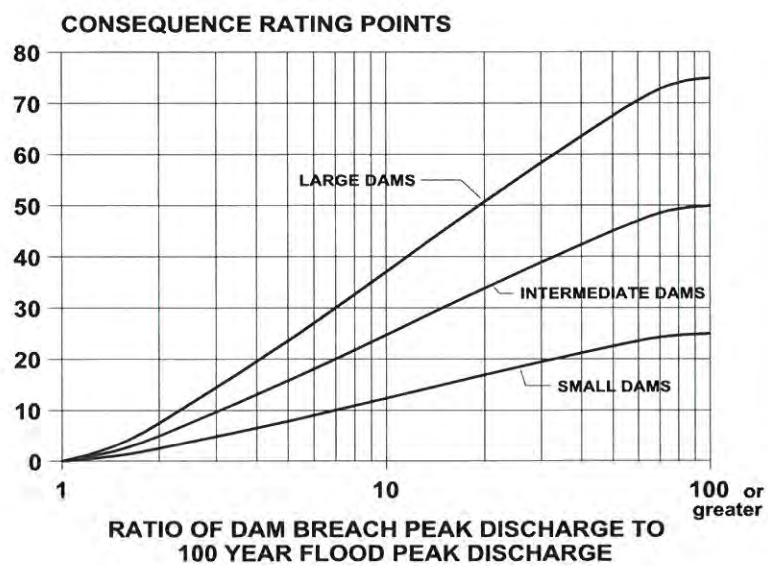
1. Estimated Dam Breach Peak Discharge at Dam Site due to Failure of Critical Project Element 24,000-45,000 cfs

2. Estimated 100 year Flood Peak Discharge 1620 cfs

Taken on a Natural Watercourse at First Location Downstream of the Dam Where There is a Potential for Loss of Life or

If There is No Downstream Development, It is Taken on the Natural Watercourse at a Point 1 Mile Downstream of Dam

	Index	Consequence Rating Points
3. Ratio of Dam Breach Peak Discharge to 100 Year Flood Peak Discharge	11-22	30

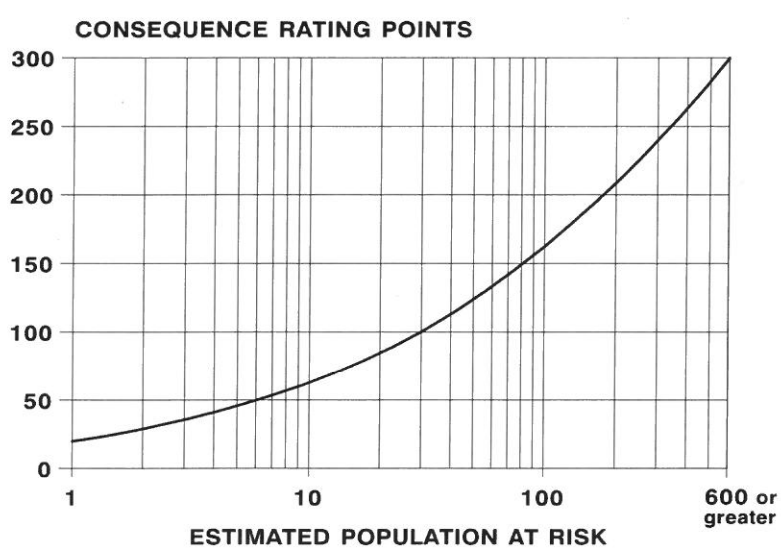


II. POPULATION AT RISK - Continued

B. POPULATION AT RISK INDEX

		No. of Persons	Consequence Rating Points
1.	Estimated Current Population at Risk (PAR)	150	
2.	Increase in Population Due to Development		
3.	TOTAL - Future Population at Risk	150	175

Describe: ____



II. POPULATION AT RISK - Continued

C. ADEQUACY OF WARNING

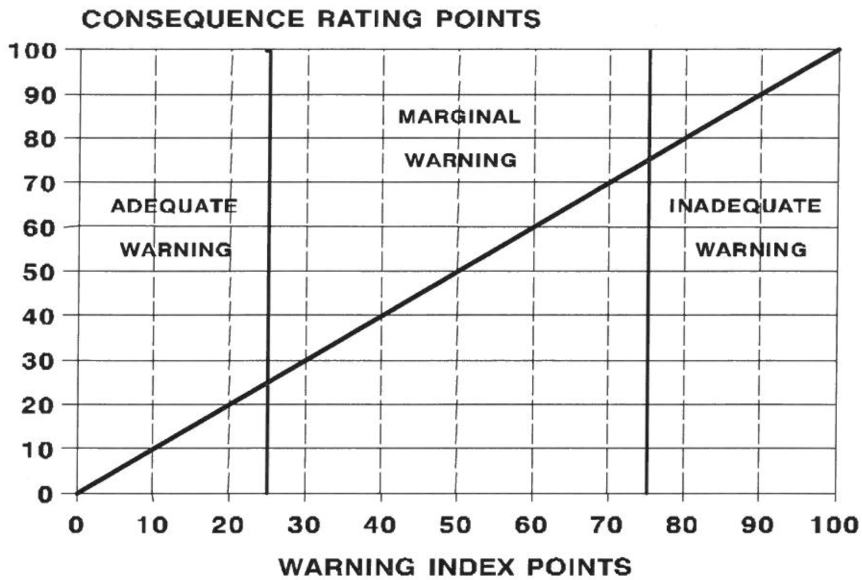
To be used when there is Population at Risk

FACTOR	ADEQUATE WARNING	MARGINAL WARNING	INADEQUATE WARNING
ADVANCED WARNING TIME	More than 30 minutes *0 Warning Index Points*	More Than 10 Minutes but Less Than 30 Minutes *25 Warning Index Points*	Less Than 10 Minutes *50 Warning Index Points*
LIKELIHOOD OF DANGEROUS SITUATION TO BE OBSERVED AND NOTIFICATION GIVEN TO GENERAL PUBLIC	Dam Owner Resides near Dam Site, or Designated Responsible Party Has Reasonably Short Access Time to Dam Site and has Duty of Initiating Warning *0 Warning Index Points*	Designated Responsible Party not Located near Dam Site, but Dam Site is Visible to General Public. There is Reasonably Good Vehicular Access near Dam Site and Intermittent Vehicular Traffic. *15 Warning Index Points*	No Designated Responsible Party near Dam Site. Dam in Remote Location. Poor Vehicular Access to Dam Site. *30 Warning Index Points*
DOWNSTREAM VALLEY SETTING AND EASE OF EVACUATION	Valleys with Good Access to High Ground and Good Roadway Systems for Escape Routes *0 Warning Index Points*	Valleys with Limited Access to High Ground and Limited Roadway Systems *10 Warning Index Points*	Narrow Confining Valley with Roadways near the Stream Bank or Along Valley Floor and Poor Access to High Ground *20 Warning Index Points*

	Item	Warning Index Points	Consequence Rating Points
1.	Advanced Warning Time	50	
2.	Likelihood of Dangerous Situations to be Observed and Notification Give to Public	30	
3.	Downstream Valley Setting and Ease of Evacuation	10	
	TOTAL WARNING INDEX POINTS	90	

WARNING RATED AS ____________________ 90

II. POPULATION AT RISK - Continued



Describe: ____

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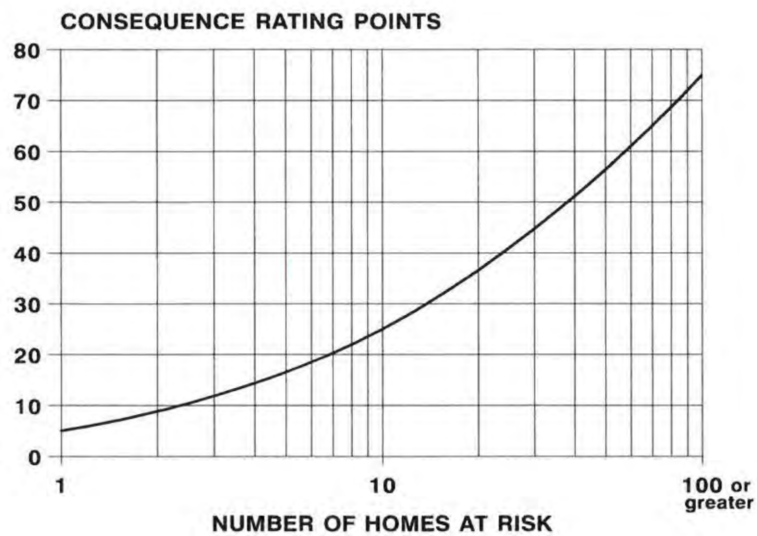
SUBSECTION II - SUBTOTAL OF CONSEQUENCE RATING POINTS ____295____

III. DOWNSTREAM PROPERTY AT RISK

A. RESIDENTIAL UNITS

	No. of Items	Consequence Rating Points
1. Equivalent Single Family Dwelling Units	50	55



B. LIFELINE FACILITIES

1. Transportation Links - Bridges and Stream Crossings

	Points Per Item	No. of Items	Consequence Rating Points
a. Freeways/interstate highways Railway main lines	25		
b. State highways	10		
c. Other public roads Railway spur lines	2 - 5	3	12

III. DOWNSTREAM PROPERTY AT RISK - Continued

	Points Per Item	No. of Items	Consequence Rating Points
2. Water Supply Systems			
a. Storage Reservoirs (Downstream)	10 - 75		
b. Treatment Facilities	10 - 25		
c. Delivery Systems	5 - 25		
3. Domestic Waste Treatment Systems			
a. Treatment Facilities	5 - 25		
4. Electric Power Facilities			
a. Electric power plant or Appurtenant works	5 - 75		
5. Emergency Response Facilities			
a. Hospitals, Police, Fire, Paramedical Units	10 - 75		

C. OTHER IMPORTANT FACILITIES

	Points Per Item	No. of Items	Consequence Rating Points
1. Public Buildings, Schools, Libraries	10 - 75		
2. Fish Hatcheries	5 - 25	1	10
3. Industrial, Commercial and Agricultural Developments	5 - 75		
4. Other Facilities or Considerations			

A wide range of consequence rating points are possible for the damages that could occur to property and lifeline facilities. Selection of an appropriate value should be based on the size and importance of the features under consideration relative to the broad range of features of that type. In addition, a larger or smaller value may be selected depending on the owner's and/or project engineer's perceived need for the protection against property damages.

III. DOWNSTREAM PROPERTY AT RISK - Continued

D. ENVIRONMENTAL DEGRADATION

	Points Per Item	No. of Items	Consequence Rating Points
1. Deleterious contents in proposed reservoir			
a. Release of reservoir contents will result in long term environmental degradation	10 - 75	_____	_________
b. Release of reservoir contents will result in temporary, minor environmental degradation	5 - 20	_____	_________
2. Damage to downstream facilities could result in release of deleterious materials stored on-site			
a. Release of deleterious materials will result in long term environmental degradation	10 - 75	_____	_________
b. Release of deleterious materials will result in temporary, minor environmental degradation	5 - 20	_____	_________

Description of damages to property, lifeline facilities, and environmental degradation: ________

SUBSECTION III - SUBTOTAL OF CONSEQUENCE RATING POINTS 77

GENERAL NOTES AND COMMENTS:

Appendix D
Precipitation Data Lookup Worksheets

Precipitation Magnitude-Frequency Gridded Data Set Lookup Calculator

MGS Engineering Consultants, Inc.
7326 Boston Harbor Road NE
Olympia, WA 98506
(360) 570-3450
www.mgsengr.com

This Work Book contains a Visual Basic for Applications macro that interpolates precipitation magnitude from gridded data set files. The user inputs the latitude and longitude of the location of interest, the precipitation duration (2-hours, 6-hours, or 24-hours), and the interpolation method. Clicking the ***Calculate*** button runs the macro and outputs the Climatic Region Number, L-Moment Statistics, and Precipitation Magnitude-Frequency Statistics below.

User Inputs		
Latitude (Decimal Degrees)	47.5199	
Longitude (Decimal Degrees)	120.87919	
Duration (hours)	6	(Enter 2, 6, or 24)
Grid Cell Interpolation Method	1	(Enter 0 for Center of Grid-Cell or 1 for Inverse Distance Weighting)

Project Name	Eightmile Lake

Calculate

Program Output	
Climatic Region Number	14
Mean Annual Precipitation (inches)	65.1
At-Site Mean (inches)	1.513
L-Cv	0.1527
L-Skew	0.1724
Hondo	-0.150

Precipitation Magnitude Frequency Output, 6-Hour Duration	
Precipitation Frequency	
10-Year	2.06
25-Year	2.39
100-Year	2.90
Step 1	3.51
Step 2	3.79
Step 3	4.28
Step 4	4.78
Step 5	5.32
Step 6	5.88
Step 7	6.47
Step 8	7.09
Program Status Message	*Successful*

Eightmile Lake (Icicle and Peshastin Irrigation Districts)

Worksheet for Computation of **Intermediate** Precipitation Magnitude-Frequency Curve
Reference: Technical Note 3, Oct 2009 revision
JTS, 12/09/2016

Project data: *Input* *Input*

Dam location:	T 24 N, R 16E, Section 33; 10 miles W of Levenworth, WA		
Watershed Lat/Long:	47.5199 deg. N	-120.8792 deg. W	(> 3 decimal places)
Watershed elevation:	6026 feet		(Lat/Long and elev for centroid of watershed)
Climatic Region:	14		(MGS Look-up Calculator)
Mean Annual Precip:	65.1 inches		(MGS Look-up Calculator)
Duration of interest:	6 hours		(Index for intermediate storm)
Design Step:	8		(Worksheet from Tech Note 2)
Drainage area:	6 sq.miles.		(Compare to small watershed < 10 sq.miles)

Input

Key equations :

Precipitation estimates are calculated from gridded data set files by the MGS Look-up Calculator (the "Calculator" tab in this workbook) using the four-parameter Kappa probablility distribution. The specific equations are described in more detail in the following references :

Schaefer MG, Barker BL, Taylor GH and Wallis JR, Regional Precipitation-Frequency Analysis and Spatial Mapping of Precipitation for 24-Hour and 2-Hour Durations in Western Washington, prepared for Washington State Department of Transportation, Report WA-RD 544.1, MGS Engineering Consultants, March 2002.

Schaefer MG, Barker BL, Taylor GH and Wallis JR, Regional Precipitation-Frequency Analysis and Spatial Mapping of Precipitation for 24-Hour and 2-Hour Durations in Eastern Washington, prepared for Washington State Department of Transportation, MGS Engineering Consultants, January 2006.

The calculations were extended to the Dam Safety storms by the update to Technical Note 3.
The gridded data sets are provided by Ecology along with this spreadsheet and look-up calculator.

Scaling precipitation, P_{sd} = DF * P_{gds} Use design factor = 1.15 *Input*

where: P_{gds} = estimated 6-hr precip for selected frequency, inches
DF = design factor; DF = 1.15 for new dams
P_{sd} = scaling precip for 6-hr index period, inches

Total storm precip = (scaling precip for 6-hr index) x (multiplier from mass curve for 18-hr storm)
multiplier for 18-hr storm = 1.8790 for Climatic Region 14
*(from **Multipliers** worksheet)* Hyetograph no. 11

This project :

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Precip estimate, P_{gds} (in.) :	2.06	2.39	2.90	3.51	3.79	4.28
Scaling precipitation, P_{sd} (in.) :	2.37	2.75	3.33	4.04	4.36	4.92
Total precip for design storm :	4.46	5.16	6.26	7.59	8.20	9.24

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Precip estimate, P_{gds} (in.) :	4.78	5.32	5.88	6.47	7.09	9.62
Scaling precipitation, P_{sd} (in.) :	5.50	6.12	6.76	7.44	8.15	9.62
Total precip for design storm :	10.33	11.49	12.70	13.97	15.31	18.08

Eightmile Lake (Icicle and Peshastin Irrigation Districts)

Worksheet for Computation of Intermediate Precipitation Magnitude-Frequency Curve
Reference: Technical Note 3, Oct 2009 revision

JTS, 12/09/2016

Comparison to PMP for general storm. Ref: HMR-57, Map 1 - NW, Table 10.10.

PMP for a 6-hour period is estimated as a percentage of the 24-hour PMP. The percentage factor varies by climatic region as follows :

	Western Washington				Eastern Washington	
	Coast	Olympics	Cascades	Puget Sound	Mountains	Central Basin
Regions :	5	151-142	15-154	31-32	14-147-13	77-07
Factor :	0.43	0.40	0.40	0.44	0.52	0.59

This project :

General storm, 24-hour PMP = 18.5 in. (*Input*) From HMR-57 Map 1

For region: 14

6-hr PMP= 0.52 (*Input*) x 24-hr = 9.62 in.

Frequency / design step :	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
Scaling precipitation, P_{sd} (in.) :	4.92	5.50	6.12	6.76	7.44	8.15
Percentage of 6-hr PMP (%) :	51.1	57.2	63.6	70.3	77.3	84.7

Note: Per Tech Note 3, page 10: For IDF = PMF, use PMP > Step 6.

Comparison to PMP for local storm (thunderstorm). Ref: HMR-57, Fig. 11.19 and 11.12, Table 11.4.

Local storm, 1-hour PMP = 6.6 in. (*Input*)

6-hour PMP = 115% x 1-hr = 7.6 in.

Frequency / design step :	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
Scaling precipitation, P_{sd} (in.) :	4.92	5.50	6.12	6.76	7.44	8.15
Percentage of 6-hr PMP (%) :	64.8	72.5	80.6	89.1	98.0	107.4

Note: Per Tech Note 3, page 10: For IDF = PMF, use PMP > Step 6.

Eightmile Lake (Icicle and Peshastin Irrigation Districts)

Worksheet for Computation of Intermediate Precipitation Magnitude-Frequency Curve
Reference: Technical Note 3, Oct 2009 revision

Peak rainfall intensity for design storm.

Peak rainfall intensity (in/hr) = (total storm precip) x (peak intensity factor)
peak intensity factor = 0.27032 for Climatic Region 14
*(from **Multipliers** worksheet)* Hyetograph no. 11

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Total precip for design storm :	4.46	5.16	6.26	7.59	8.20	9.24
Peak storm intensity (in/hr) :	1.21	1.40	1.69	2.05	2.22	2.50

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Total precip for design storm :	10.33	11.49	12.70	13.97	15.31	18.08
Peak storm intensity (in/hr) :	2.79	3.11	3.43	3.78	4.14	4.89

Total storm multipliers for intermediate storm hyetographs

MDW, 10/13/09

Regions	Hyetograph	Total storm multiplier	Peak intensity factor
5	8	1.6810	0.31408
151-142	9	1.8580	0.28416
15-154	9	1.8580	0.28416
31-32	10	1.6670	0.33352
14	11	1.8790	0.27032
147-77-07	12	1.5515	0.40476
13	13	1.6285	0.35612

This project :

Region	Hyetograph	Multiplier	Factor
14	11	1.8790	0.27032
	Input	*Input*	*Input*

Precipitation Magnitude-Frequency Gridded Data Set Lookup Calculator

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(360) 570-3450
www.mgsengr.com

This Work Book contains a Visual Basic for Applications macro that interpolates precipitation magnitude from gridded data set files. The user inputs the latitude and longitude of the location of interest, the precipitation duration (2-hours, 6-hours, or 24-hours), and the interpolation method. Clicking the ***Calculate*** button runs the macro and outputs the Climatic Region Number, L-Moment Statistics, and Precipitation Magnitude-Frequency Statistics below.

User Inputs		
Latitude (Decimal Degrees)	47.5199	
Longitude (Decimal Degrees)	120.87919	
Duration (hours)	24	(Enter 2, 6, or 24)
Grid Cell Interpolation Method	1	(Enter 0 for Center of Grid-Cell or 1 for Inverse Distance Weighting)

Project Name	Eightmile Lake

Calculate

Program Output	
Climatic Region Number	14
Mean Annual Precipitation (inches)	65.1
At-Site Mean (inches)	3.367
L-Cv	0.1764
L-Skew	0.1666
Hondo	-0.050

Precipitation Magnitude Frequency Output, 24-Hour Duration	
Precipitation Frequency	
10-Year	4.79
25-Year	5.60
100-Year	6.82
Step 1	8.23
Step 2	8.84
Step 3	9.87
Step 4	10.90
Step 5	11.95
Step 6	13.01
Step 7	14.07
Step 8	15.15
Program Status Message	*Successful*

Eightmile Lake (Icicle and Peshastin Irrigation Districts)

Worksheet for Computation of **Long Duration** Precipitation Magnitude-Frequency Curve
Reference: Technical Note 3, Oct 2009 revision
JTS, 12/09/2016

Project data :	*Input*		*Input*	
Dam location:	T 24 N, R 16E, Section 33; 10 miles W of Levenworth, WA			
Watershed Lat/Long:	47.5199	deg. N	-120.8792 deg. W	(> 3 decimal places)
Watershed elevation:	6026	feet	(Lat/Long and elev for centroid of watershed)	
Climatic Region:	14		(MGS Look-up Calculator)	
Mean Annual Precip:	65.1	inches	(MGS Look-up Calculator)	
Duration of interest:	24	hours	(Index for long duration storm)	
Design Step:	8		(Worksheet from Tech Note 2)	
Drainage area:	6	sq.miles.	(Compare to small watershed < 10 sq.miles)	
	Input			

Key equations :

Precipitation estimates are calculated from gridded data set files by the MGS Look-up Calculator (the "Calculator" tab in this workbook) using the four-parameter Kappa probablility distribution. The specific equations are described in more detail in the following references :

Schaefer MG, Barker BL, Taylor GH and Wallis JR, Regional Precipitation-Frequency Analysis and Spatial Mapping of Precipitation for 24-Hour and 2-Hour Durations in Western Washington, prepared for Washington State Department of Transportation, Report WA-RD 544.1, MGS Engineering Consultants, March 2002.

Schaefer MG, Barker BL, Taylor GH and Wallis JR, Regional Precipitation-Frequency Analysis and Spatial Mapping of Precipitation for 24-Hour and 2-Hour Durations in Eastern Washington, prepared for Washington State Department of Transportation, MGS Engineering Consultants, January 2006.

The calculations were extended to the Dam Safety storms by the update to Technical Note 3.
The gridded data sets are provided by Ecology along with this spreadsheet and look-up calculator.

Scaling precipitation, P_{sd} = DF * P_{gds} Use design factor = 1.15 *Input*

where: P_{gds} = estimated 24-hr precip for selected frequency, inches
DF = design factor; DF = 1.15 for new dams
P_{sd} = scaling precip for 24-hr index period, inches

Total storm precip = (scaling precip for 24-hr index) x (multiplier from mass curve for 72-hr storm)
multiplier for 72-hr storm = 1.6854 for Climatic Region 14
*(from **Multipliers** worksheet)* Hyetograph no. 17

This project :

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Precip estimate, P_{gds} (in.) :	4.79	5.60	6.82	8.23	8.84	9.87
Scaling precipitation, P_{sd} (in.) :	5.51	6.45	7.84	9.46	10.17	11.35
Total precip for design storm :	9.29	10.86	13.21	15.95	17.14	19.12

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Precip estimate, P_{gds} (in.) :	10.90	11.95	13.01	14.07	15.15	18.50
Scaling precipitation, P_{sd} (in.) :	12.54	13.74	14.96	16.18	17.42	18.50
Total precip for design storm :	21.13	23.16	25.21	27.27	29.36	31.18

Eightmile Lake (Icicle and Peshastin Irrigation Districts)

Worksheet for Computation of Long Duration Precipitation Magnitude-Frequency Curve
Reference: Technical Note 3, Oct 2009 revision

JTS, 12/09/2016

Comparison to PMP for general storm. Ref: HMR-57, Map 1 - NW.

Input

General storm, 24-hour PMP = 18.5 in.

Frequency / design step :	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
Scaling precipitation, P_{sd} (in.) :	11.35	12.54	13.74	14.96	16.18	17.42
Percentage of 24-hr PMP (%):	61.3	67.8	74.3	80.8	87.5	94.2

Note: Per Tech Note 3, page 8: For IDF = PMF, use PMP > Step 6.

Peak rainfall intensity for design storm.

Peak rainfall intensity (in/hr) = (total storm precip) x (peak intensity factor)

peak intensity factor = 0.12340 for Climatic Region 14

(from ***Multipliers*** *worksheet)* Hyetograph no. 17

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Total precip for design storm :	9.29	10.86	13.21	15.95	17.14	19.12
Peak storm intensity (in/hr) :	1.15	1.34	1.63	1.97	2.11	2.36

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Total precip for design storm :	21.13	23.16	25.21	27.27	29.36	31.18
Peak storm intensity (in/hr) :	2.61	2.86	3.11	3.37	3.62	3.85

Total storm multipliers for long duration storm hyetographs

MDW, 10/13/09

Regions	Hyetograph	Total storm multiplier	Peak intensity factor
5	14	1.4643	0.11756
151-142	15	1.6215	0.09124
15-154	15	1.6215	0.09124
31-32	16	1.4153	0.13280
14	17	1.6854	0.12340
147-77-07	18	1.2545	0.21360
13	19	1.4473	0.19620

This project :

Region	Hyetograph	Multiplier	Factor
14	17	1.6854	0.12340
	Input	*Input*	*Input*

Precipitation Magnitude-Frequency Gridded Data Set Lookup Calculator

MGS Engineering Consultants, Inc.
7326 Boston Harbor Road NE
Olympia, WA 98506
(360) 570-3450
www.mgsengr.com

This Work Book contains a Visual Basic for Applications macro that interpolates precipitation magnitude from gridded data set files. The user inputs the latitude and longitude of the location of interest, the precipitation duration (2-hours, 6-hours, or 24-hours), and the interpolation method. Clicking the ***Calculate*** button runs the macro and outputs the Climatic Region Number, L-Moment Statistics, and Precipitation Magnitude-Frequency Statistics below.

User Inputs		
Latitude (Decimal Degrees)	47.5199	
Longitude (Decimal Degrees)	120.87919	
Duration (hours)	2	(Enter 2, 6, or 24)
Grid Cell Interpolation Method	1	(Enter 0 for Center of Grid-Cell or 1 for Inverse Distance Weighting)

Project Name	Eightmile Lake

Calculate

Program Output	
Climatic Region Number	14
Mean Annual Precipitation (inches)	65.1
At-Site Mean (inches)	0.726
L-Cv	0.1414
L-Skew	0.2074
Hondo	-0.150

Precipitation Magnitude Frequency Output, 2-Hour Duration	
Precipitation Frequency	
10-Year	0.97
25-Year	1.13
100-Year	1.39
Step 1	1.73
Step 2	1.89
Step 3	2.19
Step 4	2.52
Step 5	2.89
Step 6	3.30
Step 7	3.75
Step 8	4.26
Program Status Message	*Successful*

Eightmile Lake (Icicle and Peshastin Irrigation Districts)

Worksheet for Computation of **Short Duration** Precipitation Magnitude-Frequency Curve
Reference: Technical Note 3, Oct 2009 revision
JTS, 12/09/2016

Project data:

	Input		*Input*	
Dam location:	T 24 N, R 16E, Section 33; 10 miles W of Levenworth, WA			
Watershed Lat/Long:	47.5199	deg. N	-120.8792 deg. W	(> 3 decimal places)
Watershed elevation:	6026	feet		(Lat/Long and elev for centroid of watershed)
Climatic Region:	14			(MGS Look-up Calculator)
Mean Annual Precip:	65.1	inches		(MGS Look-up Calculator)
Duration of interest:	2	hours		(Index for short duration storm)
Design Step:	8			(Worksheet from Tech Note 2)
Drainage area:	6	sq.miles.		(Compare to small watershed < 1 sq.mile.)
	Input			

Key equations :

Precipitation estimates are calculated from gridded data set files by the MGS Look-up Calculator (the "Calculator" tab in this workbook) using the four-parameter Kappa probablility distribution. The specific equations are described in more detail in the following references :

Schaefer MG, Barker BL, Taylor GH and Wallis JR, Regional Precipitation-Frequency Analysis and Spatial Mapping of Precipitation for 24-Hour and 2-Hour Durations in Western Washington, prepared for Washington State Department of Transportation, Report WA-RD 544.1, MGS Engineering Consultants, March 2002.

Schaefer MG, Barker BL, Taylor GH and Wallis JR, Regional Precipitation-Frequency Analysis and Spatial Mapping of Precipitation for 24-Hour and 2-Hour Durations in Eastern Washington, prepared for Washington State Department of Transportation, MGS Engineering Consultants, January 2006.

The calculations were extended to the Dam Safety storms by the update to Technical Note 3.
The gridded data sets are provided by Ecology along with this spreadsheet and look-up calculator.

Scaling precipitation, P_{sd} = DF * P_{gds} Use design factor = 1.15 *Input*

where: P_{gds} = estimated 2-hr precip for selected frequency, inches
DF = design factor; DF = 1.15 for new dams
P_{sd} = scaling precip for 2-hr index period, inches

Total storm precip = (scaling precip for 2-hr index) x (multiplier from mass curve for 4-hr storm)
multiplier for 4-hr storm = 1.0910 for Climatic Region 14
*(from **Multipliers** worksheet)* Hyetograph no. 6

This project :

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Precip estimate, P_{gds} (in.) :	0.97	1.13	1.39	1.73	1.89	2.19
Scaling precipitation, P_{sd} (in.) :	1.11	1.30	1.59	1.99	2.18	2.52
Total precip for design storm :	1.22	1.41	1.74	2.17	2.38	2.75

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Precip estimate, P_{gds} (in.) :	2.52	2.89	3.30	3.75	4.26	7.26
Scaling precipitation, P_{sd} (in.) :	2.90	3.32	3.79	4.32	4.90	7.26
Total precip for design storm :	3.16	3.63	4.14	4.71	5.34	7.92

Eightmile Lake (Icicle and Peshastin Irrigation Districts)

Worksheet for Computation of Short Duration Precipitation Magnitude-Frequency Curve
Reference: Technical Note 3, Oct 2009 revision
JTS, 12/09/2016

Comparison to PMP for local storm (thunderstorm). Ref: HMR-57, Fig. 11.19 and 11.12, Table 11.4.

		Input	
Local storm, 1-hour PMP	=	6.6	in.
2-hour PMP = 110% x 1-hr	=	7.3	in.

Frequency / design step :	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
Scaling precipitation, P_{sd} (in.) :	2.52	2.90	3.32	3.79	4.32	4.90
Percentage of 2-hr PMP (%) :	34.7	39.9	45.8	52.3	59.4	67.5

Note: Per Tech Note 3, page 10: For IDF = PMF, use PMP > Step 6.

Basin average precipitation for large watershed.

Drainage area = 6 sq.miles. (Compare to small watershed < 1 sq.mile.)

Basin avg. precip = 92 % of total storm point precip.
*(from **Multipliers** worksheet)*

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Total storm point precip :	1.22	1.41	1.74	2.17	2.38	2.75
Basin avg total storm precip :	1.12	1.30	1.60	2.00	2.19	2.53

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Total storm point precip :	3.16	3.63	4.14	4.71	5.34	7.92
Basin avg total storm precip :	2.91	3.34	3.81	4.33	4.92	7.29

Peak rainfall intensity for design storm.

Peak rainfall intensity (in/hr) = (total storm precip) x (peak intensity factor)
peak intensity factor = 2.99172 for Climatic Region 14
*(from **Multipliers** worksheet)* Hyetograph no. 6

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Basin avg total storm precip :	1.12	1.30	1.60	2.00	2.19	2.53
Peak storm intensity (in/hr) :	3.34	3.89	4.79	5.98	6.54	7.57

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Basin avg total storm precip :	2.91	3.34	3.81	4.33	4.92	7.29
Peak storm intensity (in/hr) :	8.71	9.98	11.39	12.96	14.71	21.80

Total storm multipliers for short duration storm hyetographs
MDW, 10/13/09

Regions	Hyetograph	Total storm multiplier	Peak intensity factor
5	5	1.2050	2.23068
151-142	5	1.2050	2.23068
15-154	5	1.2050	2.23068
31-32	5	1.2050	2.23068
14-147-13	6	1.0910	2.99172
77-07	7	1.0350	3.50136

This project :

Region	Hyetograph	Multiplier	Factor
14	6	1.0910	2.99172
	Input	*Input*	*Input*

Areal adjustment factors for short duration storm hyetographs
MDW, 9/11/09

Refs :
Tech Note 3 (2009 update), Table 1 on page 9
Schaefer, Extreme Storms; Figure 16 on page 70

Basin average precipitation for large watershed.

Drainage area (sq.miles)	Percentage of point precip (%)
< 1	100
1 < 2	100
2 < 3	99
3 < 5	96
5 < 7	92
7 < 10	89
> 10	85

This project :

Drainage area = 6 sq.miles. (Compare to small watershed < 1 sq.mile.)

Basin avg. precip = 92 % of total storm point precip.
Input

Appendix E
Snowmelt Calculation Worksheet

Eightmile Lake (Icicle and Peshastin Irrigation Districts)

Calculate snowmelt during rain-on-snow events
JTS, 02/15/17

Snowmelt calculations for sub-basins within Eightmile Lake watershed

References :

Corps of Engineers. **Runoff from Snowmelt**. EM 1110-2-1406. USACE. 1998.
WSDOT. **Hydraulics Manual**. M 23-03. WSDOT. 2010. Section 2-4.1 on pages 2-5 to 2-6.

Key equations:

Snowmelt = [(LW rad + Conv + rain melt) (T_{air} - 32)]
+ [SW rad + ground melt]

where : Conv = 0.0084 k V_{air} ; k = f (% forest cover)
use V_{air} = 18 mph
checking : 80 % forest cover
Conv = 0.045 *OK*

Rainmelt = 0.007 P_r

% forest	k	SW rad
0	1.0	0.07
10	1.0	0.07
20	0.9	0.07
30	0.8	0.07
40	0.7	0.07
50	0.6	0.07
60	0.5	0.07
70	0.4	0.07
80	0.3	0.05
90	0.3	0.03
100	0.3	0.03

coefficients :

	24-hr values :		18-hr values :	72-hr values :
LW rad	0.029	in. / day F	0.022	0.087
Conv	0.0084	in. / day mph F	0.0063	0.0252
rain melt	0.007	in. / in. F	0.007	0.007
SW rad	0.07	in. / day	0.053	0.21
grnd melt	0.02	in. / day	0.015	0.06

Calculation procedure :

1) Identify elevation zones in increments of 1000 feet where snow may occur. Determine area and % of sub-basin for each elevation zone.
2) Estimate snowpack depth and water content for each elevation zone (represents upper limit for snowmelt runoff).
3) Estimate air temperature for highest elevation. Estimate air temperature lapse rate : 5.5 deg F per 1000 feet elevation change. Calculate average air temperature for each elevation zone.
4) Estimate R_{18} and R_{72} from design precipitation worksheets. Estimate typical wind velocity W from climatological data. If not available, estimate W = 18 mph.
5) Calculate M_{18} and M_{72} for each elevation zone. Calculate weighted average (weighted by % area) snowmelt depths M_{18} and M_{72} for the entire sub-basin.
6) Add snowmelt to rainfall to get total storm precipitation available for runoff.

Average January temperature = 26 deg F at Leavenworth, WA
Average March/April temperature 44 deg F at Leavenworth, WA

Snowmelt calculations for sub-basins within Eightmile Lake watershed

Snowmelt calculations for Eightmile Lake

Sub-basin drainage area =	6	acres / sq.miles			
Highest elevation =	7980	feet	Temperature =	32.0	deg F
Average wind velocity =	17	miles/hour			
Reservoir elevation =	4670	feet	Temperature =	50.2	deg F
Zone 1 base elev. =	6500	feet	Average temp. =	36.1	deg F
Zone 2 base elev. =	5500	feet	Average temp. =	42.9	deg F
Zone 3 base elev. =	4500	feet	Average temp. =	48.4	deg F

Frequency/design step:		100 yr	Step 1	Step 5	Step 7	Step 8
Rainfall :						
Intermediate :	R_{18} =	6.26	7.59	11.49	13.97	15.31
Long duration:	R_{72} =	13.21	15.95	23.16	27.27	29.36

Elevation Zone **1** :

Elevations =	6500 feet	to	7980 feet			
Zone drainage area =	1.93	acres / sq.miles		forest cover =	10	% forest
% of sub-basin =	32.2	%		conv k =	1.0	
Air temperature =	36.1	deg F.		SW rad =	0.07	in. / day
Snowpack depth =	10.0	feet	=	120 inches		
Water content =	20	%	=	24.0 inches		

Frequency/design step :		100 yr	Step 1	Step 5	Step 7	Step 8
Snowmelt (inches):						
Intermediate :	M_{18} =	0.77	0.81	0.92	0.99	1.03
	% of snow water content =	3.2	3.4	3.8	4.1	4.3
	revised M_{18} =	0.77	0.81	0.92	0.99	1.03
	weighted M_{18} =	0.248	0.260	0.296	0.318	0.331
Long duration:	M_{72} =	2.74	2.82	3.03	3.14	3.20
	% of snow water content =	11.4	11.8	12.6	13.1	13.4
	revised M_{72} =	2.74	2.82	3.03	3.14	3.20
	weighted M_{72} =	0.883	0.908	0.974	1.012	1.031

Eightmile Lake (Icicle and Peshastin Irrigation Districts)

Snowmelt calculations for Eightmile Lake

Elevation Zone **2** :

Elevations =	5500 feet	to	6500 feet			
Zone drainage area =	2.48	acres / sq.miles		forest cover =	50	% forest
% of sub-basin =	41.3	%		conv k =	0.6	
Air temperature =	42.9	deg F.		SW rad =	0.07	in. / day
Snowpack depth =	5.0	feet	=	60 inches		
Water content =	20	%	=	12.0 inches		

Frequency/design step :		100 yr	Step 1	Step 5	Step 7	Step 8
Snowmelt (inches):						
Intermediate :	M_{18} =	1.48	1.58	1.88	2.07	2.17
% of snow water content =		12.3	13.2	15.7	17.2	18.1
revised M_{18} =		1.48	1.58	1.88	2.07	2.17
weighted M_{18} =		0.612	0.654	0.777	0.855	0.897
Long duration:	M_{72} =	5.02	5.23	5.78	6.10	6.25
% of snow water content =		41.9	43.6	48.2	50.8	52.1
revised M_{72} =		5.02	5.23	5.78	6.10	6.25
weighted M_{72} =		2.076	2.163	2.390	2.519	2.585

Elevation Zone **3** :

Elevations =	4500 feet	to	5500 feet			
Zone drainage area =	1.59	acres / sq.miles		forest cover =	75	% forest
% of sub-basin =	26.5	%		conv k =	0.4	
Air temperature =	48.4	deg F.		SW rad =	0.06	in. / day
Snowpack depth =	3.0	feet	=	36 inches		
Water content =	20	%	=	7.2 inches		

Frequency/design step :		100 yr	Step 1	Step 5	Step 7	Step 8
Snowmelt (inches):						
Intermediate :	M_{18} =	1.75	1.90	2.35	2.63	2.79
% of snow water content =		24.3	26.4	32.6	36.6	38.7
revised M_{18} =		1.75	1.90	2.35	2.63	2.79
weighted M_{18} =		0.464	0.504	0.623	0.698	0.739

Frequency/design step :		100 yr	Step 1	Step 5	Step 7	Step 8
Snowmelt (inches):						
Long duration:	M_{72} =	5.64	5.95	6.78	7.25	7.49
% of snow water content =		78.3	82.7	94.2	100.7	104.1
revised M_{72} =		5.64	5.95	6.78	7.20	7.20
weighted M_{72} =		1.494	1.578	1.797	1.908	1.908

Snowmelt calculations for Eightmile Lake

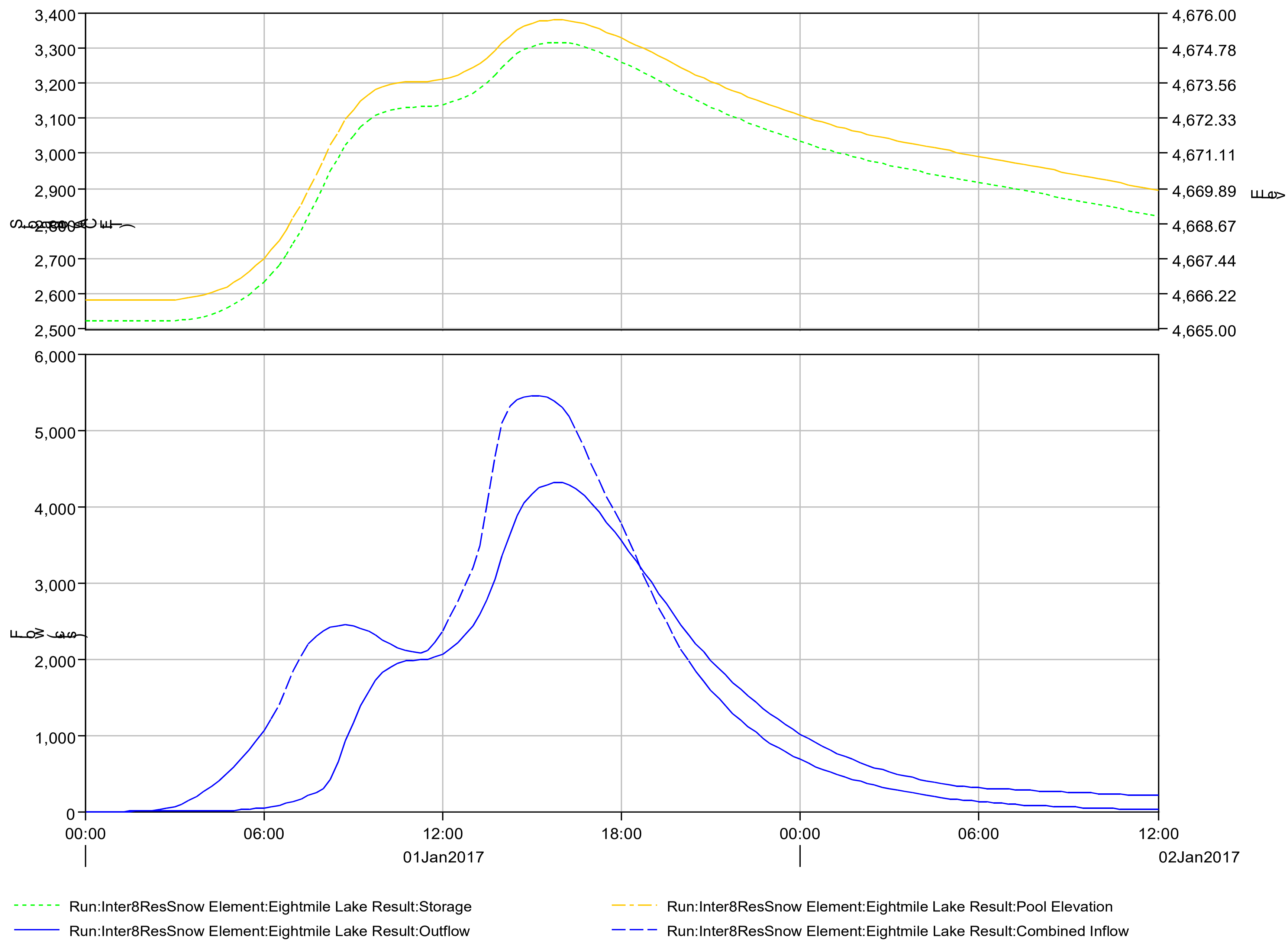
Snowmelt and design storm precipitation (in inches) for overall sub-basin :

Frequency/design step :		100 yr	Step 1	Step 5	Step 7	Step 8
Intermediate :	M_{18} =	1.32	1.42	1.70	1.87	1.97
	R_{18} =	6.26	7.59	11.49	13.97	15.31
	P_{18} =	7.58	9.01	13.19	15.84	17.28
Long duration:	M_{72} =	4.45	4.65	5.16	5.44	5.52
	R_{72} =	13.21	15.95	23.16	27.27	29.36
	P_{72} =	17.66	20.60	28.32	32.71	34.88

[end for this sub-basin]

Appendix F
HEC-HMS Model Results

Reservoir "Eightmile Lake" Results for Run "Inter8ResSnow"



Project: EightmileLake Simulation Run: Inter8ResSnow
Reservoir: Eightmile Lake

Start of Run:	01Jan2017, 00:00	Basin Model:	EightmileLkResv
End of Run:	02Jan2017, 12:00	Meteorologic Model:	Inter8Snowmelt
Compute Time:	13Apr2017, 07:33:15	Control Specifications:	Intermediate

Volume Units: AC-FT

Computed Results

Peak Inflow:	5447.3 (CFS)	Date/Time of Peak Inflow:	01Jan2017, 15:00
Peak Discharge:	4308.4 (CFS)	Date/Time of Peak Discharge	01Jan2017, 15:45
Inflow Volume:	4462.2 (AC-FT)	Peak Storage:	3314.1 (AC-FT)
Discharge Volume	3728.7 (AC-FT)	Peak Elevation:	4675.7 (FT)

Project: EightmileLake Simulation Run: Inter8ResSnow
Reservoir: Eightmile Lake

Start of Run: 01Jan2017, 00:00 Basin Model: EightmileLkResv
End of Run: 02Jan2017, 12:00 Meteorologic Model: Inter8Snowmelt
Compute Time: 13Apr2017, 07:33:15 Control Specifications: Intermediate

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	00:00	0.0	2522.6	4666.0	0.0
01Jan2017	00:15	0.0	2522.6	4666.0	0.0
01Jan2017	00:30	0.0	2522.6	4666.0	0.0
01Jan2017	00:45	0.0	2522.6	4666.0	0.0
01Jan2017	01:00	0.0	2522.6	4666.0	0.0
01Jan2017	01:15	0.0	2522.6	4666.0	0.0
01Jan2017	01:30	0.0	2522.6	4666.0	0.0
01Jan2017	01:45	0.2	2522.6	4666.0	0.0
01Jan2017	02:00	1.5	2522.6	4666.0	0.0
01Jan2017	02:15	6.3	2522.7	4666.0	0.0
01Jan2017	02:30	17.2	2522.9	4666.0	0.0
01Jan2017	02:45	35.4	2523.5	4666.0	0.0
01Jan2017	03:00	61.4	2524.5	4666.0	0.1
01Jan2017	03:15	95.6	2526.1	4666.0	0.3
01Jan2017	03:30	139.0	2528.5	4666.1	0.6
01Jan2017	03:45	192.8	2531.9	4666.1	1.2
01Jan2017	04:00	255.7	2536.5	4666.2	2.1
01Jan2017	04:15	326.5	2542.4	4666.3	3.6
01Jan2017	04:30	405.7	2549.9	4666.4	5.9
01Jan2017	04:45	493.5	2559.1	4666.5	9.0
01Jan2017	05:00	589.8	2570.0	4666.6	13.3
01Jan2017	05:15	693.9	2582.9	4666.8	19.1
01Jan2017	05:30	805.2	2598.0	4667.0	26.6
01Jan2017	05:45	925.4	2615.2	4667.2	36.1
01Jan2017	06:00	1060.1	2634.8	4667.5	48.0
01Jan2017	06:15	1214.5	2657.2	4667.7	62.8

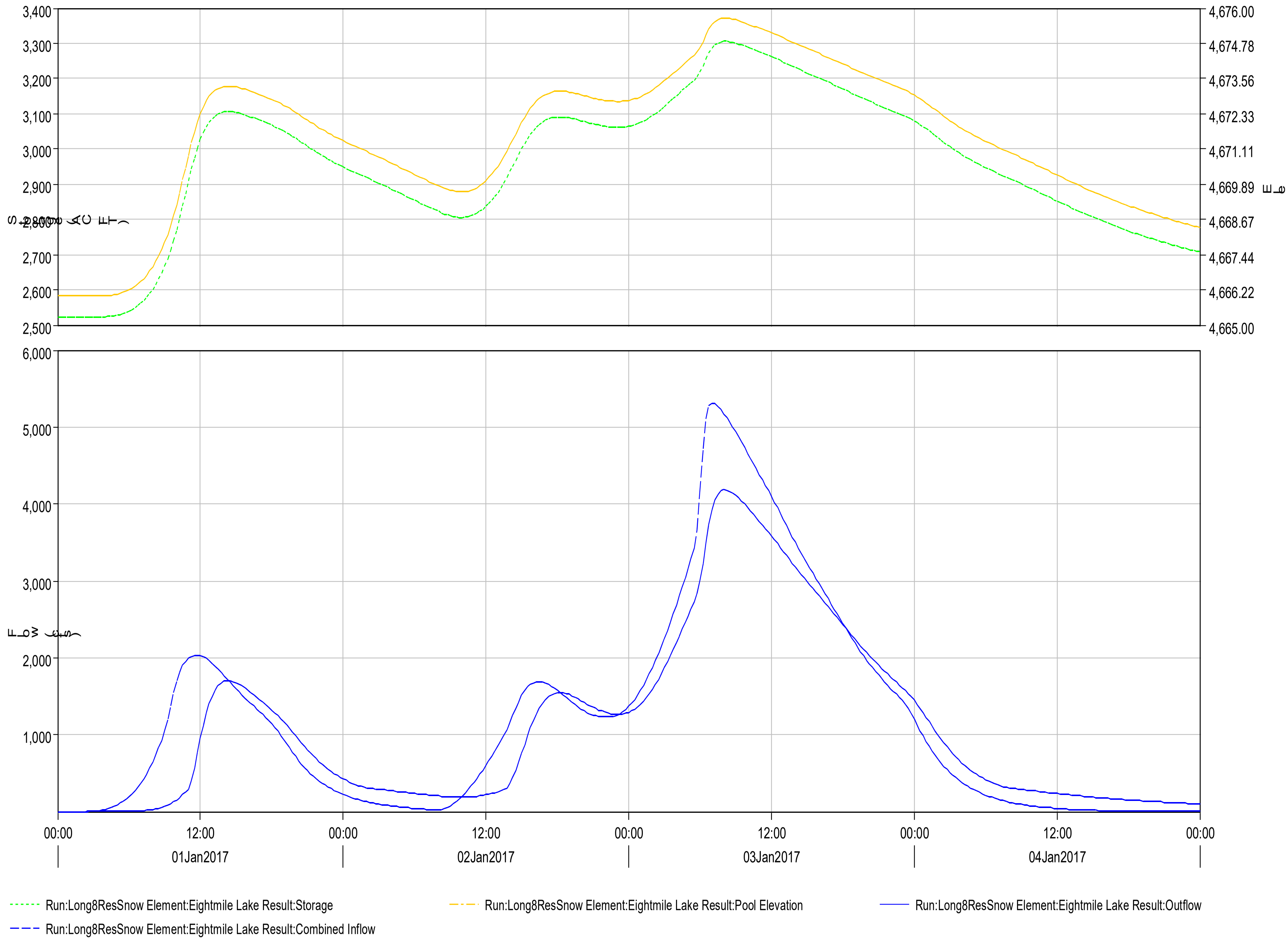
Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	06:30	1395.6	2682.7	4668.1	81.2
01Jan2017	06:45	1614.2	2711.8	4668.4	103.9
01Jan2017	07:00	1845.2	2745.2	4668.9	131.9
01Jan2017	07:15	2041.4	2782.2	4669.3	165.4
01Jan2017	07:30	2189.0	2822.1	4669.8	204.0
01Jan2017	07:45	2294.8	2863.8	4670.3	246.7
01Jan2017	08:00	2367.5	2906.4	4670.9	292.7
01Jan2017	08:15	2414.1	2948.6	4671.4	423.7
01Jan2017	08:30	2438.5	2987.6	4671.9	659.3
01Jan2017	08:45	2442.3	3021.8	4672.3	917.5
01Jan2017	09:00	2429.9	3050.6	4672.6	1165.1
01Jan2017	09:15	2403.8	3074.1	4672.9	1385.5
01Jan2017	09:30	2362.6	3092.8	4673.1	1570.5
01Jan2017	09:45	2308.3	3107.0	4673.3	1717.0
01Jan2017	10:00	2249.0	3117.1	4673.4	1824.2
01Jan2017	10:15	2194.4	3123.8	4673.5	1896.8
01Jan2017	10:30	2148.7	3128.0	4673.6	1942.5
01Jan2017	10:45	2112.1	3130.4	4673.6	1968.9
01Jan2017	11:00	2086.9	3131.7	4673.6	1982.7
01Jan2017	11:15	2079.8	3132.3	4673.6	1989.8
01Jan2017	11:30	2116.9	3133.1	4673.6	1998.2
01Jan2017	11:45	2216.3	3134.9	4673.6	2018.0
01Jan2017	12:00	2366.2	3138.4	4673.7	2058.0
01Jan2017	12:15	2549.9	3144.1	4673.7	2121.6
01Jan2017	12:30	2754.2	3151.7	4673.8	2208.4
01Jan2017	12:45	2966.1	3161.0	4674.0	2315.8
01Jan2017	13:00	3192.8	3171.6	4674.1	2440.6
01Jan2017	13:15	3480.2	3183.8	4674.2	2585.9
01Jan2017	13:30	4009.4	3199.5	4674.4	2778.7
01Jan2017	13:45	4656.5	3220.6	4674.7	3044.1
01Jan2017	14:00	5096.0	3244.5	4674.9	3353.1

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	14:15	5314.1	3266.1	4675.2	3642.4
01Jan2017	14:30	5396.3	3283.2	4675.4	3875.5
01Jan2017	14:45	5430.1	3295.4	4675.5	4044.2
01Jan2017	15:00	5447.3	3303.6	4675.6	4160.6
01Jan2017	15:15	5446.8	3309.1	4675.7	4238.1
01Jan2017	15:30	5426.4	3312.5	4675.7	4285.6
01Jan2017	15:45	5383.7	3314.1	4675.7	4308.4
01Jan2017	16:00	5302.1	3314.0	4675.7	4308.0
01Jan2017	16:15	5172.0	3312.2	4675.7	4282.2
01Jan2017	16:30	4990.4	3308.4	4675.7	4228.2
01Jan2017	16:45	4771.8	3302.6	4675.6	4145.9
01Jan2017	17:00	4548.4	3295.1	4675.5	4040.6
01Jan2017	17:15	4334.0	3286.5	4675.4	3921.2
01Jan2017	17:30	4133.9	3277.4	4675.3	3795.7
01Jan2017	17:45	3945.9	3268.1	4675.2	3669.1
01Jan2017	18:00	3767.4	3258.8	4675.1	3544.2
01Jan2017	18:15	3569.1	3249.5	4675.0	3419.2
01Jan2017	18:30	3336.3	3239.5	4674.9	3287.6
01Jan2017	18:45	3099.3	3228.7	4674.7	3147.5
01Jan2017	19:00	2875.4	3217.4	4674.6	3002.4
01Jan2017	19:15	2667.7	3205.8	4674.5	2857.2
01Jan2017	19:30	2475.4	3194.4	4674.3	2714.9
01Jan2017	19:45	2297.8	3183.1	4674.2	2577.6
01Jan2017	20:00	2133.6	3172.1	4674.1	2446.0
01Jan2017	20:15	1981.7	3161.5	4674.0	2320.9
01Jan2017	20:30	1841.1	3151.2	4673.8	2201.9
01Jan2017	20:45	1711.0	3141.2	4673.7	2089.2
01Jan2017	21:00	1590.7	3131.6	4673.6	1982.3
01Jan2017	21:15	1479.2	3122.4	4673.5	1880.9
01Jan2017	21:30	1376.1	3113.4	4673.4	1784.3
01Jan2017	21:45	1280.6	3104.6	4673.3	1692.4

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	22:00	1192.1	3096.1	4673.2	1603.9
01Jan2017	22:15	1110.1	3087.6	4673.1	1518.2
01Jan2017	22:30	1034.1	3079.2	4673.0	1435.3
01Jan2017	22:45	963.5	3071.0	4672.9	1355.8
01Jan2017	23:00	898.0	3063.0	4672.8	1279.9
01Jan2017	23:15	837.3	3055.3	4672.7	1207.8
01Jan2017	23:30	780.8	3047.7	4672.6	1139.6
01Jan2017	23:45	728.2	3040.4	4672.5	1075.1
02Jan2017	00:00	679.3	3033.4	4672.4	1014.3
02Jan2017	00:15	633.8	3026.6	4672.3	957.1
02Jan2017	00:30	591.4	3020.0	4672.3	903.3
02Jan2017	00:45	551.9	3013.7	4672.2	852.6
02Jan2017	01:00	515.1	3007.6	4672.1	805.1
02Jan2017	01:15	480.9	3001.7	4672.0	760.6
02Jan2017	01:30	448.8	2996.0	4672.0	718.8
02Jan2017	01:45	418.7	2990.5	4671.9	679.6
02Jan2017	02:00	390.4	2985.2	4671.8	642.8
02Jan2017	02:15	364.1	2980.1	4671.8	608.4
02Jan2017	02:30	339.6	2975.1	4671.7	576.1
02Jan2017	02:45	316.9	2970.3	4671.7	545.8
02Jan2017	03:00	295.7	2965.7	4671.6	517.6
02Jan2017	03:15	275.7	2961.2	4671.5	491.2
02Jan2017	03:30	257.0	2956.8	4671.5	466.6
02Jan2017	03:45	239.5	2952.5	4671.4	443.5
02Jan2017	04:00	222.9	2948.3	4671.4	422.1
02Jan2017	04:15	207.9	2944.3	4671.3	402.3
02Jan2017	04:30	194.0	2940.3	4671.3	383.9
02Jan2017	04:45	181.1	2936.4	4671.2	367.1
02Jan2017	05:00	169.1	2932.6	4671.2	351.7
02Jan2017	05:15	157.8	2928.9	4671.2	337.7
02Jan2017	05:30	147.2	2925.2	4671.1	325.3

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
02Jan2017	05:45	137.4	2921.5	4671.1	314.7
02Jan2017	06:00	128.2	2917.8	4671.0	306.2
02Jan2017	06:15	119.6	2914.1	4671.0	301.4
02Jan2017	06:30	111.6	2910.3	4670.9	297.1
02Jan2017	06:45	104.2	2906.4	4670.9	292.8
02Jan2017	07:00	97.2	2902.5	4670.8	288.5
02Jan2017	07:15	90.6	2898.5	4670.8	284.1
02Jan2017	07:30	84.6	2894.5	4670.7	279.7
02Jan2017	07:45	78.9	2890.5	4670.7	275.3
02Jan2017	08:00	73.7	2886.4	4670.6	270.9
02Jan2017	08:15	68.8	2882.3	4670.6	266.5
02Jan2017	08:30	64.2	2878.3	4670.5	262.1
02Jan2017	08:45	59.9	2874.2	4670.5	257.7
02Jan2017	09:00	55.8	2870.1	4670.4	253.3
02Jan2017	09:15	52.0	2866.0	4670.4	249.0
02Jan2017	09:30	48.3	2861.9	4670.3	244.7
02Jan2017	09:45	44.5	2857.9	4670.3	240.5
02Jan2017	10:00	41.2	2853.8	4670.2	236.3
02Jan2017	10:15	37.9	2849.8	4670.2	232.1
02Jan2017	10:30	34.9	2845.8	4670.1	228.0
02Jan2017	10:45	32.2	2841.8	4670.1	223.9
02Jan2017	11:00	29.7	2837.9	4670.0	219.9
02Jan2017	11:15	27.4	2834.0	4670.0	215.9
02Jan2017	11:30	25.2	2830.1	4669.9	212.0
02Jan2017	11:45	23.2	2826.3	4669.9	208.1
02Jan2017	12:00	21.2	2822.5	4669.8	204.3

Reservoir "Eightmile Lake" Results for Run "Long8ResSnow"



Project: EightmileLake Simulation Run: Long8ResSnow
Reservoir: Eightmile Lake

Start of Run:	01Jan2017, 00:00	Basin Model:	EightmileLkResv
End of Run:	05Jan2017, 00:00	Meteorologic Model:	Long 8 Snowmelt
Compute Time:	13Apr2017, 07:33:39	Control Specifications:	LongStep8Res

Volume Units: AC-FT

Computed Results

Peak Inflow:	5315.3 (CFS)	Date/Time of Peak Inflow:	03Jan2017, 07:00
Peak Discharge:	4183.5 (CFS)	Date/Time of Peak Discharge	03Jan2017, 08:00
Inflow Volume:	9534.6 (AC-FT)	Peak Storage:	3305.3 (AC-FT)
Discharge Volume	8641.0 (AC-FT)	Peak Elevation:	4675.6 (FT)

Project: EightmileLake Simulation Run: Long8ResSnow
Reservoir: Eightmile Lake

Start of Run: 01Jan2017, 00:00 Basin Model: EightmileLkResv
End of Run: 05Jan2017, 00:00 Meteorologic Model: Long 8 Snowmelt
Compute Time: 13Apr2017, 07:33:39 Control Specifications: LongStep8Res

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	00:00	0.0	2522.6	4666.0	0.0
01Jan2017	00:15	0.0	2522.6	4666.0	0.0
01Jan2017	00:30	0.0	2522.6	4666.0	0.0
01Jan2017	00:45	0.0	2522.6	4666.0	0.0
01Jan2017	01:00	0.0	2522.6	4666.0	0.0
01Jan2017	01:15	0.0	2522.6	4666.0	0.0
01Jan2017	01:30	0.0	2522.6	4666.0	0.0
01Jan2017	01:45	0.0	2522.6	4666.0	0.0
01Jan2017	02:00	0.0	2522.6	4666.0	0.0
01Jan2017	02:15	0.0	2522.6	4666.0	0.0
01Jan2017	02:30	0.0	2522.6	4666.0	0.0
01Jan2017	02:45	0.2	2522.6	4666.0	0.0
01Jan2017	03:00	1.1	2522.6	4666.0	0.0
01Jan2017	03:15	3.7	2522.6	4666.0	0.0
01Jan2017	03:30	8.7	2522.8	4666.0	0.0
01Jan2017	03:45	16.1	2523.0	4666.0	0.0
01Jan2017	04:00	26.0	2523.5	4666.0	0.0
01Jan2017	04:15	38.6	2524.1	4666.0	0.1
01Jan2017	04:30	53.4	2525.1	4666.0	0.2
01Jan2017	04:45	69.8	2526.3	4666.0	0.3
01Jan2017	05:00	88.3	2528.0	4666.1	0.5
01Jan2017	05:15	109.7	2530.0	4666.1	0.8
01Jan2017	05:30	134.5	2532.5	4666.1	1.3
01Jan2017	05:45	163.1	2535.5	4666.2	1.9
01Jan2017	06:00	195.6	2539.2	4666.2	2.8
01Jan2017	06:15	232.0	2543.5	4666.3	3.9

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	06:30	272.2	2548.6	4666.3	5.5
01Jan2017	06:45	317.8	2554.6	4666.4	7.4
01Jan2017	07:00	369.8	2561.5	4666.5	9.9
01Jan2017	07:15	428.7	2569.5	4666.6	13.1
01Jan2017	07:30	494.5	2578.8	4666.7	17.2
01Jan2017	07:45	567.0	2589.3	4666.9	22.2
01Jan2017	08:00	646.1	2601.3	4667.0	28.4
01Jan2017	08:15	731.7	2614.9	4667.2	35.9
01Jan2017	08:30	825.7	2630.2	4667.4	45.1
01Jan2017	08:45	931.7	2647.3	4667.6	56.1
01Jan2017	09:00	1053.5	2666.5	4667.9	69.4
01Jan2017	09:15	1200.2	2688.2	4668.1	85.3
01Jan2017	09:30	1368.6	2712.7	4668.5	104.7
01Jan2017	09:45	1541.7	2740.4	4668.8	127.8
01Jan2017	10:00	1696.5	2770.9	4669.2	155.0
01Jan2017	10:15	1815.1	2803.7	4669.6	185.9
01Jan2017	10:30	1899.4	2837.9	4670.0	219.8
01Jan2017	10:45	1956.9	2872.8	4670.5	256.2
01Jan2017	11:00	1994.4	2907.9	4670.9	294.5
01Jan2017	11:15	2018.2	2942.5	4671.3	393.9
01Jan2017	11:30	2031.1	2974.4	4671.7	571.2
01Jan2017	11:45	2034.2	3002.6	4672.1	767.0
01Jan2017	12:00	2028.3	3026.7	4672.3	958.0
01Jan2017	12:15	2013.7	3046.8	4672.6	1131.7
01Jan2017	12:30	1991.0	3063.3	4672.8	1282.0
01Jan2017	12:45	1960.7	3076.3	4672.9	1406.7
01Jan2017	13:00	1926.2	3086.4	4673.1	1505.9
01Jan2017	13:15	1889.3	3093.9	4673.2	1581.7
01Jan2017	13:30	1850.7	3099.3	4673.2	1636.8
01Jan2017	13:45	1810.3	3102.8	4673.3	1673.9
01Jan2017	14:00	1768.5	3104.9	4673.3	1695.3

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	14:15	1725.1	3105.7	4673.3	1704.1
01Jan2017	14:30	1680.2	3105.6	4673.3	1702.4
01Jan2017	14:45	1636.9	3104.7	4673.3	1692.6
01Jan2017	15:00	1596.6	3103.1	4673.3	1677.0
01Jan2017	15:15	1556.8	3101.2	4673.2	1657.0
01Jan2017	15:30	1515.5	3098.9	4673.2	1633.5
01Jan2017	15:45	1475.5	3096.4	4673.2	1607.0
01Jan2017	16:00	1438.2	3093.6	4673.1	1578.4
01Jan2017	16:15	1403.7	3090.6	4673.1	1548.5
01Jan2017	16:30	1369.2	3087.6	4673.1	1518.1
01Jan2017	16:45	1332.9	3084.5	4673.0	1486.9
01Jan2017	17:00	1297.2	3081.2	4673.0	1455.0
01Jan2017	17:15	1260.8	3077.9	4673.0	1422.6
01Jan2017	17:30	1222.7	3074.5	4672.9	1389.5
01Jan2017	17:45	1182.3	3071.0	4672.9	1355.6
01Jan2017	18:00	1139.9	3067.4	4672.8	1320.7
01Jan2017	18:15	1095.6	3063.5	4672.8	1284.7
01Jan2017	18:30	1046.7	3059.5	4672.7	1247.1
01Jan2017	18:45	994.5	3055.2	4672.7	1207.7
01Jan2017	19:00	940.6	3050.7	4672.6	1166.4
01Jan2017	19:15	885.5	3045.9	4672.6	1123.4
01Jan2017	19:30	829.5	3040.9	4672.5	1079.0
01Jan2017	19:45	772.5	3035.6	4672.5	1033.3
01Jan2017	20:00	717.5	3030.1	4672.4	986.7
01Jan2017	20:15	666.1	3024.5	4672.3	940.0
01Jan2017	20:30	618.4	3018.9	4672.2	893.7
01Jan2017	20:45	574.4	3013.2	4672.2	848.5
01Jan2017	21:00	533.6	3007.5	4672.1	804.7
01Jan2017	21:15	495.8	3002.0	4672.0	762.6
01Jan2017	21:30	460.8	2996.5	4672.0	722.4
01Jan2017	21:45	428.3	2991.2	4671.9	684.1

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	22:00	398.2	2986.0	4671.8	647.7
01Jan2017	22:15	370.3	2980.9	4671.8	613.4
01Jan2017	22:30	344.5	2975.9	4671.7	581.0
01Jan2017	22:45	320.5	2971.1	4671.7	550.5
01Jan2017	23:00	298.3	2966.4	4671.6	521.9
01Jan2017	23:15	277.6	2961.9	4671.6	495.1
01Jan2017	23:30	258.4	2957.4	4671.5	470.1
01Jan2017	23:45	240.6	2953.1	4671.4	446.7
02Jan2017	00:00	224.0	2948.9	4671.4	425.0
02Jan2017	00:15	208.7	2944.8	4671.3	404.8
02Jan2017	00:30	194.4	2940.8	4671.3	386.2
02Jan2017	00:45	181.2	2936.9	4671.2	369.0
02Jan2017	01:00	169.0	2933.0	4671.2	353.3
02Jan2017	01:15	157.6	2929.2	4671.2	339.1
02Jan2017	01:30	146.9	2925.5	4671.1	326.5
02Jan2017	01:45	137.1	2921.8	4671.1	315.5
02Jan2017	02:00	127.8	2918.1	4671.0	306.8
02Jan2017	02:15	119.2	2914.4	4671.0	301.7
02Jan2017	02:30	111.2	2910.6	4670.9	297.4
02Jan2017	02:45	103.7	2906.7	4670.9	293.1
02Jan2017	03:00	96.7	2902.8	4670.8	288.7
02Jan2017	03:15	90.2	2898.8	4670.8	284.4
02Jan2017	03:30	84.1	2894.7	4670.7	279.9
02Jan2017	03:45	78.4	2890.7	4670.7	275.5
02Jan2017	04:00	73.1	2886.6	4670.6	271.1
02Jan2017	04:15	68.1	2882.5	4670.6	266.6
02Jan2017	04:30	63.5	2878.4	4670.5	262.2
02Jan2017	04:45	59.2	2874.3	4670.5	257.8
02Jan2017	05:00	55.1	2870.2	4670.4	253.5
02Jan2017	05:15	51.3	2866.1	4670.4	249.1
02Jan2017	05:30	47.7	2862.0	4670.3	244.8

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
02Jan2017	05:45	44.3	2858.0	4670.3	240.6
02Jan2017	06:00	41.1	2853.9	4670.2	236.3
02Jan2017	06:15	38.2	2849.9	4670.2	232.2
02Jan2017	06:30	35.4	2845.9	4670.1	228.0
02Jan2017	06:45	32.8	2841.9	4670.1	224.0
02Jan2017	07:00	30.4	2838.0	4670.0	220.0
02Jan2017	07:15	28.2	2834.1	4670.0	216.0
02Jan2017	07:30	26.2	2830.2	4669.9	212.1
02Jan2017	07:45	24.2	2826.4	4669.9	208.3
02Jan2017	08:00	24.9	2822.7	4669.8	204.5
02Jan2017	08:15	29.8	2819.0	4669.8	200.9
02Jan2017	08:30	39.6	2815.6	4669.8	197.5
02Jan2017	08:45	54.1	2812.6	4669.7	194.5
02Jan2017	09:00	72.8	2809.9	4669.7	191.9
02Jan2017	09:15	98.2	2807.7	4669.7	189.8
02Jan2017	09:30	128.7	2806.1	4669.6	188.2
02Jan2017	09:45	162.7	2805.3	4669.6	187.4
02Jan2017	10:00	199.5	2805.1	4669.6	187.3
02Jan2017	10:15	238.8	2805.8	4669.6	187.9
02Jan2017	10:30	283.1	2807.3	4669.6	189.4
02Jan2017	10:45	331.1	2809.7	4669.7	191.7
02Jan2017	11:00	381.3	2813.1	4669.7	195.0
02Jan2017	11:15	433.0	2817.4	4669.8	199.3
02Jan2017	11:30	486.2	2822.7	4669.8	204.6
02Jan2017	11:45	543.4	2829.1	4669.9	210.9
02Jan2017	12:00	603.5	2836.5	4670.0	218.4
02Jan2017	12:15	664.9	2845.0	4670.1	227.1
02Jan2017	12:30	727.1	2854.6	4670.2	237.0
02Jan2017	12:45	789.9	2865.2	4670.4	248.2
02Jan2017	13:00	856.3	2877.0	4670.5	260.7
02Jan2017	13:15	925.0	2889.9	4670.7	274.6

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
02Jan2017	13:30	994.4	2903.8	4670.8	289.9
02Jan2017	13:45	1069.9	2919.0	4671.0	308.6
02Jan2017	14:00	1154.8	2935.1	4671.2	361.5
02Jan2017	14:15	1246.3	2951.6	4671.4	439.0
02Jan2017	14:30	1339.5	2968.3	4671.6	533.3
02Jan2017	14:45	1428.8	2984.8	4671.8	639.6
02Jan2017	15:00	1509.2	3000.7	4672.0	753.3
02Jan2017	15:15	1576.1	3015.8	4672.2	869.5
02Jan2017	15:30	1625.0	3029.7	4672.4	983.3
02Jan2017	15:45	1655.0	3042.2	4672.5	1090.4
02Jan2017	16:00	1673.0	3053.0	4672.7	1187.4
02Jan2017	16:15	1683.4	3062.3	4672.8	1272.9
02Jan2017	16:30	1684.8	3070.0	4672.9	1346.1
02Jan2017	16:45	1679.2	3076.3	4672.9	1407.0
02Jan2017	17:00	1668.4	3081.3	4673.0	1456.1
02Jan2017	17:15	1650.3	3085.1	4673.0	1493.8
02Jan2017	17:30	1626.5	3087.9	4673.1	1520.8
02Jan2017	17:45	1602.0	3089.6	4673.1	1538.4
02Jan2017	18:00	1575.9	3090.6	4673.1	1547.9
02Jan2017	18:15	1547.2	3090.8	4673.1	1550.5
02Jan2017	18:30	1515.5	3090.4	4673.1	1546.9
02Jan2017	18:45	1481.0	3089.5	4673.1	1537.7
02Jan2017	19:00	1446.9	3088.2	4673.1	1523.8
02Jan2017	19:15	1415.0	3086.4	4673.1	1506.4
02Jan2017	19:30	1385.5	3084.4	4673.0	1486.6
02Jan2017	19:45	1358.4	3082.3	4673.0	1465.4
02Jan2017	20:00	1333.5	3080.0	4673.0	1443.3
02Jan2017	20:15	1310.6	3077.8	4673.0	1421.0
02Jan2017	20:30	1289.5	3075.5	4672.9	1398.9
02Jan2017	20:45	1270.0	3073.3	4672.9	1377.2
02Jan2017	21:00	1255.1	3071.1	4672.9	1356.4

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
02Jan2017	21:15	1246.1	3069.1	4672.9	1337.4
02Jan2017	21:30	1240.3	3067.3	4672.8	1320.5
02Jan2017	21:45	1235.4	3065.8	4672.8	1305.8
02Jan2017	22:00	1231.0	3064.4	4672.8	1292.9
02Jan2017	22:15	1230.0	3063.2	4672.8	1281.9
02Jan2017	22:30	1233.9	3062.3	4672.8	1273.1
02Jan2017	22:45	1242.8	3061.6	4672.8	1267.0
02Jan2017	23:00	1256.5	3061.3	4672.8	1263.9
02Jan2017	23:15	1274.5	3061.3	4672.8	1264.2
02Jan2017	23:30	1299.7	3061.8	4672.8	1268.2
02Jan2017	23:45	1333.2	3062.7	4672.8	1276.7
03Jan2017	00:00	1371.9	3064.1	4672.8	1290.1
03Jan2017	00:15	1413.7	3066.0	4672.8	1308.3
03Jan2017	00:30	1460.8	3068.5	4672.8	1331.3
03Jan2017	00:45	1514.7	3071.4	4672.9	1359.5
03Jan2017	01:00	1575.4	3074.9	4672.9	1393.1
03Jan2017	01:15	1642.3	3079.0	4673.0	1432.6
03Jan2017	01:30	1715.1	3083.6	4673.0	1478.1
03Jan2017	01:45	1793.3	3088.7	4673.1	1529.7
03Jan2017	02:00	1876.6	3094.4	4673.2	1587.4
03Jan2017	02:15	1964.5	3100.7	4673.2	1651.2
03Jan2017	02:30	2056.7	3107.3	4673.3	1719.9
03Jan2017	02:45	2153.0	3114.1	4673.4	1792.6
03Jan2017	03:00	2253.0	3121.2	4673.5	1868.7
03Jan2017	03:15	2356.5	3128.5	4673.6	1947.4
03Jan2017	03:30	2463.2	3135.8	4673.7	2028.5
03Jan2017	03:45	2573.1	3143.2	4673.7	2111.7
03Jan2017	04:00	2685.9	3150.7	4673.8	2196.5
03Jan2017	04:15	2801.2	3158.2	4673.9	2282.9
03Jan2017	04:30	2919.0	3165.7	4674.0	2370.6
03Jan2017	04:45	3039.1	3173.2	4674.1	2459.3

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
03Jan2017	05:00	3161.3	3180.7	4674.2	2549.2
03Jan2017	05:15	3285.4	3188.2	4674.3	2640.0
03Jan2017	05:30	3430.6	3195.9	4674.4	2733.5
03Jan2017	05:45	3664.3	3204.5	4674.5	2840.9
03Jan2017	06:00	4137.3	3216.7	4674.6	2994.0
03Jan2017	06:15	4716.5	3234.2	4674.8	3218.6
03Jan2017	06:30	5105.3	3254.2	4675.0	3482.4
03Jan2017	06:45	5276.7	3272.5	4675.3	3729.4
03Jan2017	07:00	5315.3	3286.4	4675.4	3919.6
03Jan2017	07:15	5302.1	3295.6	4675.5	4048.3
03Jan2017	07:30	5268.7	3301.2	4675.6	4126.6
03Jan2017	07:45	5224.8	3304.2	4675.6	4168.1
03Jan2017	08:00	5173.5	3305.3	4675.6	4183.5
03Jan2017	08:15	5119.2	3305.1	4675.6	4180.7
03Jan2017	08:30	5063.7	3304.0	4675.6	4165.8
03Jan2017	08:45	5004.2	3302.4	4675.6	4142.4
03Jan2017	09:00	4939.2	3300.2	4675.6	4112.6
03Jan2017	09:15	4872.0	3297.7	4675.6	4077.6
03Jan2017	09:30	4804.4	3295.0	4675.5	4039.1
03Jan2017	09:45	4733.6	3292.0	4675.5	3997.9
03Jan2017	10:00	4661.2	3288.9	4675.5	3954.2
03Jan2017	10:15	4588.8	3285.6	4675.4	3908.9
03Jan2017	10:30	4516.6	3282.3	4675.4	3862.5
03Jan2017	10:45	4448.0	3278.9	4675.3	3815.8
03Jan2017	11:00	4381.1	3275.5	4675.3	3769.5
03Jan2017	11:15	4311.1	3272.1	4675.3	3723.4
03Jan2017	11:30	4239.4	3268.7	4675.2	3676.6
03Jan2017	11:45	4167.4	3265.2	4675.2	3629.2
03Jan2017	12:00	4095.4	3261.6	4675.1	3581.5
03Jan2017	12:15	4023.6	3258.0	4675.1	3533.4
03Jan2017	12:30	3948.5	3254.4	4675.1	3484.8

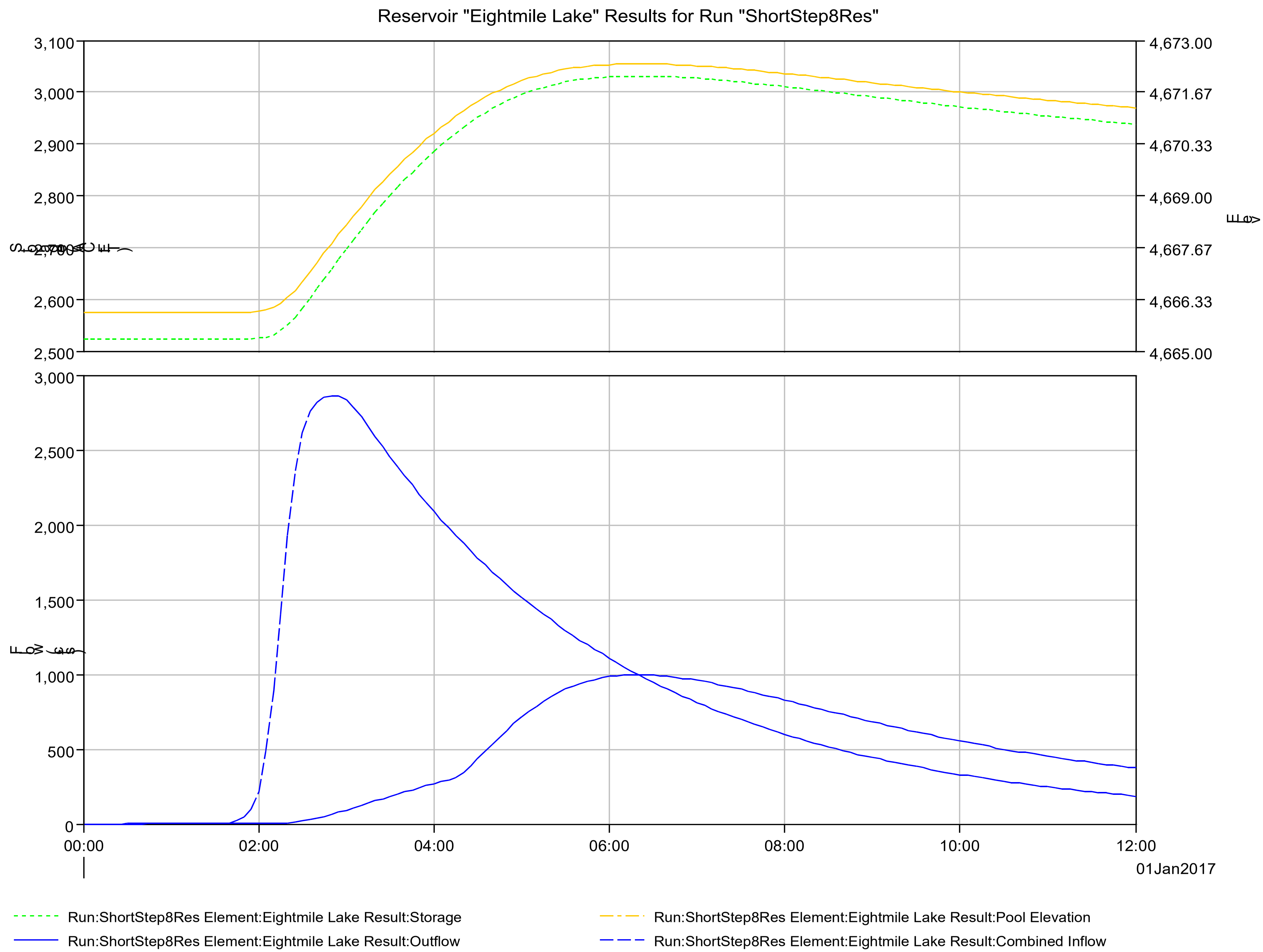
Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
03Jan2017	12:45	3871.9	3250.7	4675.0	3435.2
03Jan2017	13:00	3795.2	3246.9	4675.0	3384.7
03Jan2017	13:15	3718.9	3243.0	4674.9	3333.7
03Jan2017	13:30	3646.1	3239.1	4674.9	3282.7
03Jan2017	13:45	3575.1	3235.2	4674.8	3232.4
03Jan2017	14:00	3504.4	3231.4	4674.8	3182.6
03Jan2017	14:15	3433.7	3227.6	4674.7	3133.2
03Jan2017	14:30	3362.8	3223.7	4674.7	3084.0
03Jan2017	14:45	3294.9	3219.9	4674.6	3035.2
03Jan2017	15:00	3228.4	3216.2	4674.6	2987.1
03Jan2017	15:15	3161.8	3212.4	4674.6	2939.7
03Jan2017	15:30	3094.8	3208.6	4674.5	2892.5
03Jan2017	15:45	3027.2	3204.9	4674.5	2845.4
03Jan2017	16:00	2962.3	3201.1	4674.4	2798.5
03Jan2017	16:15	2898.6	3197.4	4674.4	2752.1
03Jan2017	16:30	2834.6	3193.6	4674.3	2706.2
03Jan2017	16:45	2769.8	3189.9	4674.3	2660.4
03Jan2017	17:00	2704.3	3186.1	4674.2	2614.5
03Jan2017	17:15	2638.1	3182.3	4674.2	2568.2
03Jan2017	17:30	2571.3	3178.4	4674.2	2521.6
03Jan2017	17:45	2507.0	3174.5	4674.1	2474.8
03Jan2017	18:00	2443.7	3170.6	4674.1	2428.4
03Jan2017	18:15	2379.7	3166.7	4674.0	2382.0
03Jan2017	18:30	2318.1	3162.7	4674.0	2335.9
03Jan2017	18:45	2257.5	3158.8	4673.9	2290.1
03Jan2017	19:00	2196.4	3154.9	4673.9	2244.6
03Jan2017	19:15	2137.6	3151.0	4673.8	2199.5
03Jan2017	19:30	2082.5	3147.1	4673.8	2155.2
03Jan2017	19:45	2028.2	3143.2	4673.7	2111.8
03Jan2017	20:00	1972.7	3139.4	4673.7	2068.8
03Jan2017	20:15	1918.9	3135.6	4673.6	2026.3

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
03Jan2017	20:30	1868.3	3131.8	4673.6	1984.4
03Jan2017	20:45	1821.6	3128.1	4673.6	1943.7
03Jan2017	21:00	1775.4	3124.5	4673.5	1904.1
03Jan2017	21:15	1727.6	3120.9	4673.5	1865.1
03Jan2017	21:30	1681.0	3117.3	4673.4	1826.4
03Jan2017	21:45	1637.1	3113.7	4673.4	1788.3
03Jan2017	22:00	1596.4	3110.2	4673.3	1751.0
03Jan2017	22:15	1558.6	3106.8	4673.3	1714.8
03Jan2017	22:30	1523.5	3103.4	4673.3	1679.7
03Jan2017	22:45	1487.7	3100.1	4673.2	1645.5
03Jan2017	23:00	1446.5	3096.8	4673.2	1611.1
03Jan2017	23:15	1397.8	3093.2	4673.1	1575.1
03Jan2017	23:30	1341.6	3089.4	4673.1	1536.3
03Jan2017	23:45	1278.5	3085.2	4673.0	1493.9
04Jan2017	00:00	1209.1	3080.5	4673.0	1447.5
04Jan2017	00:15	1134.0	3075.3	4672.9	1396.9
04Jan2017	00:30	1056.6	3069.6	4672.9	1342.3
04Jan2017	00:45	981.9	3063.5	4672.8	1284.7
04Jan2017	01:00	912.1	3057.2	4672.7	1225.5
04Jan2017	01:15	847.4	3050.6	4672.6	1165.9
04Jan2017	01:30	787.4	3044.1	4672.6	1107.0
04Jan2017	01:45	731.9	3037.5	4672.5	1049.4
04Jan2017	02:00	680.3	3031.0	4672.4	993.7
04Jan2017	02:15	632.2	3024.5	4672.3	940.1
04Jan2017	02:30	587.8	3018.3	4672.2	888.9
04Jan2017	02:45	546.5	3012.1	4672.2	840.1
04Jan2017	03:00	508.4	3006.1	4672.1	793.9
04Jan2017	03:15	473.1	3000.3	4672.0	750.2
04Jan2017	03:30	440.4	2994.7	4672.0	709.0
04Jan2017	03:45	410.0	2989.2	4671.9	670.2
04Jan2017	04:00	381.8	2983.9	4671.8	633.8

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
04Jan2017	04:15	355.6	2978.8	4671.8	599.7
04Jan2017	04:30	331.1	2973.8	4671.7	567.7
04Jan2017	04:45	308.0	2969.0	4671.6	537.7
04Jan2017	05:00	286.9	2964.3	4671.6	509.6
04Jan2017	05:15	267.2	2959.8	4671.5	483.5
04Jan2017	05:30	249.1	2955.4	4671.5	459.1
04Jan2017	05:45	232.2	2951.1	4671.4	436.4
04Jan2017	06:00	216.5	2947.0	4671.4	415.3
04Jan2017	06:15	201.9	2942.9	4671.3	395.9
04Jan2017	06:30	188.3	2938.9	4671.3	377.9
04Jan2017	06:45	175.7	2935.1	4671.2	361.5
04Jan2017	07:00	163.9	2931.3	4671.2	346.5
04Jan2017	07:15	152.9	2927.5	4671.1	333.0
04Jan2017	07:30	142.6	2923.8	4671.1	321.2
04Jan2017	07:45	133.1	2920.1	4671.0	311.2
04Jan2017	08:00	124.1	2916.4	4671.0	304.0
04Jan2017	08:15	115.8	2912.7	4671.0	299.7
04Jan2017	08:30	108.1	2908.8	4670.9	295.5
04Jan2017	08:45	100.8	2904.9	4670.9	291.1
04Jan2017	09:00	94.1	2901.0	4670.8	286.8
04Jan2017	09:15	87.8	2897.0	4670.8	282.4
04Jan2017	09:30	81.9	2892.9	4670.7	278.0
04Jan2017	09:45	76.4	2888.9	4670.7	273.5
04Jan2017	10:00	71.2	2884.8	4670.6	269.1
04Jan2017	10:15	66.4	2880.7	4670.6	264.7
04Jan2017	10:30	61.9	2876.6	4670.5	260.3
04Jan2017	10:45	57.7	2872.5	4670.5	255.9
04Jan2017	11:00	53.8	2868.4	4670.4	251.6
04Jan2017	11:15	50.1	2864.3	4670.4	247.3
04Jan2017	11:30	46.7	2860.3	4670.3	243.0
04Jan2017	11:45	43.5	2856.2	4670.3	238.8

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
04Jan2017	12:00	40.5	2852.2	4670.2	234.6
04Jan2017	12:15	37.7	2848.2	4670.2	230.4
04Jan2017	12:30	35.1	2844.2	4670.1	226.3
04Jan2017	12:45	32.7	2840.3	4670.1	222.3
04Jan2017	13:00	30.4	2836.4	4670.0	218.3
04Jan2017	13:15	28.3	2832.5	4670.0	214.4
04Jan2017	13:30	26.1	2828.7	4669.9	210.6
04Jan2017	13:45	24.3	2824.9	4669.9	206.8
04Jan2017	14:00	22.5	2821.2	4669.8	203.0
04Jan2017	14:15	20.9	2817.5	4669.8	199.3
04Jan2017	14:30	19.5	2813.8	4669.7	195.7
04Jan2017	14:45	18.1	2810.2	4669.7	192.2
04Jan2017	15:00	16.8	2806.6	4669.6	188.7
04Jan2017	15:15	15.6	2803.1	4669.6	185.3
04Jan2017	15:30	14.5	2799.6	4669.5	181.9
04Jan2017	15:45	13.4	2796.2	4669.5	178.6
04Jan2017	16:00	12.4	2792.8	4669.5	175.4
04Jan2017	16:15	11.5	2789.4	4669.4	172.2
04Jan2017	16:30	10.7	2786.1	4669.4	169.1
04Jan2017	16:45	9.9	2782.9	4669.3	166.1
04Jan2017	17:00	9.1	2779.7	4669.3	163.1
04Jan2017	17:15	8.5	2776.5	4669.3	160.1
04Jan2017	17:30	7.8	2773.4	4669.2	157.3
04Jan2017	17:45	7.2	2770.4	4669.2	154.5
04Jan2017	18:00	6.7	2767.3	4669.1	151.7
04Jan2017	18:15	6.2	2764.4	4669.1	149.0
04Jan2017	18:30	5.7	2761.4	4669.1	146.4
04Jan2017	18:45	5.2	2758.5	4669.0	143.8
04Jan2017	19:00	4.8	2755.7	4669.0	141.2
04Jan2017	19:15	4.4	2752.9	4669.0	138.8
04Jan2017	19:30	4.0	2750.2	4668.9	136.3

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
04Jan2017	19:45	3.7	2747.4	4668.9	133.9
04Jan2017	20:00	3.4	2744.8	4668.9	131.6
04Jan2017	20:15	3.1	2742.1	4668.8	129.3
04Jan2017	20:30	2.9	2739.6	4668.8	127.1
04Jan2017	20:45	2.7	2737.0	4668.8	124.9
04Jan2017	21:00	2.5	2734.5	4668.7	122.8
04Jan2017	21:15	2.3	2732.0	4668.7	120.7
04Jan2017	21:30	2.1	2729.6	4668.7	118.6
04Jan2017	21:45	1.9	2727.2	4668.6	116.6
04Jan2017	22:00	1.8	2724.9	4668.6	114.6
04Jan2017	22:15	1.6	2722.6	4668.6	112.7
04Jan2017	22:30	1.5	2720.3	4668.6	110.8
04Jan2017	22:45	1.4	2718.0	4668.5	109.0
04Jan2017	23:00	1.3	2715.8	4668.5	107.2
04Jan2017	23:15	1.2	2713.7	4668.5	105.4
04Jan2017	23:30	1.2	2711.5	4668.4	103.7
04Jan2017	23:45	1.1	2709.4	4668.4	102.0
05Jan2017	00:00	1.0	2707.4	4668.4	100.3


Reservoir "Eightmile Lake" Results for Run "ShortStep8Res"
3,100
3,000
2,900
2,800
2,700
2,600
2,500
4,673.00
4,671.67
4,670.33
4,669.00
4,667.67
4,666.33
4,665.00
3,000
2,500
2,000
1,500
1,000
500
0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
01Jan2017
Run:ShortStep8Res Element:Eightmile Lake Result:Storage
Run:ShortStep8Res Element:Eightmile Lake Result:Outflow
Run:ShortStep8Res Element:Eightmile Lake Result:Pool Elevation
Run:ShortStep8Res Element:Eightmile Lake Result:Combined Inflow

Project: EightmileLake Simulation Run: ShortStep8Res
Reservoir: Eightmile Lake

Start of Run:	01Jan2017, 00:00	Basin Model:	EightmileLkResv
End of Run:	01Jan2017, 12:00	Meteorologic Model:	ShortStep8Res
Compute Time:	13Apr2017, 07:34:02	Control Specifications:	ShortStep8Res

Volume Units: AC-FT

Computed Results

Peak Inflow:	2864.1 (CFS)	Date/Time of Peak Inflow:	01Jan2017, 02:50
Peak Discharge:	997.0 (CFS)	Date/Time of Peak Discharge	01Jan2017, 06:20
Inflow Volume:	887.3 (AC-FT)	Peak Storage:	3031.4 (AC-FT)
Discharge Volume:	471.9 (AC-FT)	Peak Elevation:	4672.4 (FT)

Project: EightmileLake Simulation Run: ShortStep8Res
Reservoir: Eightmile Lake

Start of Run: 01Jan2017, 00:00 Basin Model: EightmileLkResv
End of Run: 01Jan2017, 12:00 Meteorologic Model: ShortStep8Res
Compute Time: 13Apr2017, 07:34:02 Control Specifications: ShortStep8Res

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	00:00	0.0	2522.6	4666.0	0.0
01Jan2017	00:05	0.0	2522.6	4666.0	0.0
01Jan2017	00:10	0.0	2522.6	4666.0	0.0
01Jan2017	00:15	0.0	2522.6	4666.0	0.0
01Jan2017	00:20	0.0	2522.6	4666.0	0.0
01Jan2017	00:25	0.0	2522.6	4666.0	0.0
01Jan2017	00:30	0.0	2522.6	4666.0	0.0
01Jan2017	00:35	0.0	2522.6	4666.0	0.0
01Jan2017	00:40	0.0	2522.6	4666.0	0.0
01Jan2017	00:45	0.0	2522.6	4666.0	0.0
01Jan2017	00:50	0.1	2522.6	4666.0	0.0
01Jan2017	00:55	0.2	2522.6	4666.0	0.0
01Jan2017	01:00	0.3	2522.6	4666.0	0.0
01Jan2017	01:05	0.4	2522.6	4666.0	0.0
01Jan2017	01:10	0.4	2522.6	4666.0	0.0
01Jan2017	01:15	0.4	2522.6	4666.0	0.0
01Jan2017	01:20	0.5	2522.6	4666.0	0.0
01Jan2017	01:25	0.6	2522.6	4666.0	0.0
01Jan2017	01:30	1.2	2522.6	4666.0	0.0
01Jan2017	01:35	3.1	2522.6	4666.0	0.0
01Jan2017	01:40	8.0	2522.6	4666.0	0.0
01Jan2017	01:45	18.9	2522.7	4666.0	0.0
01Jan2017	01:50	42.5	2522.9	4666.0	0.0
01Jan2017	01:55	93.5	2523.4	4666.0	0.0
01Jan2017	02:00	220.0	2524.5	4666.0	0.1
01Jan2017	02:05	486.7	2526.9	4666.1	0.4

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	02:10	890.5	2531.7	4666.1	1.1
01Jan2017	02:15	1400.0	2539.5	4666.2	2.9
01Jan2017	02:20	1928.2	2551.0	4666.4	6.2
01Jan2017	02:25	2362.8	2565.7	4666.6	11.6
01Jan2017	02:30	2615.9	2582.7	4666.8	19.0
01Jan2017	02:35	2755.5	2601.1	4667.0	28.2
01Jan2017	02:40	2817.7	2620.0	4667.3	38.9
01Jan2017	02:45	2850.4	2639.2	4667.5	50.8
01Jan2017	02:50	2864.1	2658.5	4667.8	63.8
01Jan2017	02:55	2856.8	2677.7	4668.0	77.5
01Jan2017	03:00	2830.6	2696.7	4668.3	91.9
01Jan2017	03:05	2785.1	2715.4	4668.5	106.8
01Jan2017	03:10	2726.1	2733.6	4668.7	122.0
01Jan2017	03:15	2660.0	2751.2	4668.9	137.3
01Jan2017	03:20	2590.5	2768.3	4669.2	152.6
01Jan2017	03:25	2521.4	2784.8	4669.4	167.9
01Jan2017	03:30	2454.0	2800.7	4669.6	183.0
01Jan2017	03:35	2388.5	2816.1	4669.8	198.0
01Jan2017	03:40	2324.7	2830.9	4669.9	212.8
01Jan2017	03:45	2262.9	2845.2	4670.1	227.3
01Jan2017	03:50	2202.7	2859.0	4670.3	241.6
01Jan2017	03:55	2144.1	2872.2	4670.5	255.6
01Jan2017	04:00	2087.4	2885.0	4670.6	269.3
01Jan2017	04:05	2032.0	2897.3	4670.8	282.7
01Jan2017	04:10	1978.4	2909.1	4670.9	295.7
01Jan2017	04:15	1926.2	2920.4	4671.0	311.9
01Jan2017	04:20	1875.4	2931.3	4671.2	346.5
01Jan2017	04:25	1826.1	2941.5	4671.3	389.3
01Jan2017	04:30	1778.0	2951.0	4671.4	436.0
01Jan2017	04:35	1731.4	2960.0	4671.5	484.4
01Jan2017	04:40	1686.1	2968.2	4671.6	532.9

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	04:45	1641.9	2975.9	4671.7	580.6
01Jan2017	04:50	1599.1	2982.9	4671.8	626.7
01Jan2017	04:55	1557.3	2989.3	4671.9	670.6
01Jan2017	05:00	1516.7	2995.1	4672.0	712.0
01Jan2017	05:05	1477.3	3000.4	4672.0	750.6
01Jan2017	05:10	1438.8	3005.1	4672.1	786.2
01Jan2017	05:15	1401.3	3009.4	4672.1	818.7
01Jan2017	05:20	1364.8	3013.1	4672.2	848.3
01Jan2017	05:25	1329.2	3016.5	4672.2	874.8
01Jan2017	05:30	1294.8	3019.4	4672.3	898.3
01Jan2017	05:35	1261.2	3022.0	4672.3	919.0
01Jan2017	05:40	1228.5	3024.1	4672.3	936.8
01Jan2017	05:45	1196.8	3026.0	4672.3	952.1
01Jan2017	05:50	1165.8	3027.5	4672.4	964.9
01Jan2017	05:55	1135.8	3028.8	4672.4	975.3
01Jan2017	06:00	1106.5	3029.7	4672.4	983.5
01Jan2017	06:05	1078.0	3030.5	4672.4	989.6
01Jan2017	06:10	1050.3	3031.0	4672.4	993.8
01Jan2017	06:15	1023.3	3031.3	4672.4	996.2
01Jan2017	06:20	997.1	3031.4	4672.4	997.0
01Jan2017	06:25	971.6	3031.3	4672.4	996.3
01Jan2017	06:30	946.8	3031.0	4672.4	994.2
01Jan2017	06:35	922.6	3030.6	4672.4	990.8
01Jan2017	06:40	899.1	3030.1	4672.4	986.3
01Jan2017	06:45	876.2	3029.4	4672.4	980.8
01Jan2017	06:50	854.0	3028.7	4672.4	974.3
01Jan2017	06:55	832.3	3027.8	4672.4	966.9
01Jan2017	07:00	811.3	3026.8	4672.3	958.8
01Jan2017	07:05	790.7	3025.8	4672.3	950.1
01Jan2017	07:10	770.8	3024.6	4672.3	940.7
01Jan2017	07:15	751.4	3023.4	4672.3	930.8

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	07:20	732.4	3022.1	4672.3	920.5
01Jan2017	07:25	714.1	3020.8	4672.3	909.7
01Jan2017	07:30	696.1	3019.5	4672.3	898.6
01Jan2017	07:35	678.7	3018.0	4672.2	887.2
01Jan2017	07:40	661.7	3016.6	4672.2	875.6
01Jan2017	07:45	645.2	3015.1	4672.2	863.7
01Jan2017	07:50	629.1	3013.6	4672.2	851.7
01Jan2017	07:55	613.4	3012.0	4672.2	839.5
01Jan2017	08:00	598.2	3010.5	4672.1	827.3
01Jan2017	08:05	583.3	3008.9	4672.1	815.0
01Jan2017	08:10	568.8	3007.3	4672.1	802.7
01Jan2017	08:15	554.8	3005.7	4672.1	790.3
01Jan2017	08:20	541.1	3004.0	4672.1	778.0
01Jan2017	08:25	527.7	3002.4	4672.0	765.7
01Jan2017	08:30	514.7	3000.8	4672.0	753.5
01Jan2017	08:35	502.0	2999.1	4672.0	741.3
01Jan2017	08:40	489.7	2997.5	4672.0	729.2
01Jan2017	08:45	477.7	2995.8	4672.0	717.2
01Jan2017	08:50	466.0	2994.2	4671.9	705.3
01Jan2017	08:55	454.6	2992.5	4671.9	693.5
01Jan2017	09:00	443.5	2990.9	4671.9	681.9
01Jan2017	09:05	432.6	2989.2	4671.9	670.4
01Jan2017	09:10	422.1	2987.6	4671.9	659.0
01Jan2017	09:15	411.8	2986.0	4671.8	647.8
01Jan2017	09:20	401.8	2984.3	4671.8	636.7
01Jan2017	09:25	392.1	2982.7	4671.8	625.8
01Jan2017	09:30	382.6	2981.1	4671.8	615.1
01Jan2017	09:35	373.3	2979.5	4671.8	604.5
01Jan2017	09:40	364.3	2977.9	4671.8	594.1
01Jan2017	09:45	355.5	2976.4	4671.7	583.9
01Jan2017	09:50	347.0	2974.8	4671.7	573.8

Date	Time	Inflow (CFS)	Storage (AC-FT)	Elevation (FT)	Outflow (CFS)
01Jan2017	09:55	338.6	2973.2	4671.7	563.9
01Jan2017	10:00	330.5	2971.7	4671.7	554.2
01Jan2017	10:05	322.6	2970.2	4671.7	544.7
01Jan2017	10:10	314.9	2968.6	4671.6	535.4
01Jan2017	10:15	307.3	2967.1	4671.6	526.2
01Jan2017	10:20	300.0	2965.6	4671.6	517.2
01Jan2017	10:25	292.8	2964.1	4671.6	508.4
01Jan2017	10:30	285.9	2962.7	4671.6	499.8
01Jan2017	10:35	279.1	2961.2	4671.5	491.3
01Jan2017	10:40	272.4	2959.7	4671.5	483.0
01Jan2017	10:45	266.0	2958.3	4671.5	474.9
01Jan2017	10:50	259.7	2956.9	4671.5	467.0
01Jan2017	10:55	253.5	2955.4	4671.5	459.2
01Jan2017	11:00	247.6	2954.0	4671.5	451.6
01Jan2017	11:05	241.7	2952.6	4671.4	444.2
01Jan2017	11:10	236.0	2951.2	4671.4	436.9
01Jan2017	11:15	230.5	2949.9	4671.4	429.8
01Jan2017	11:20	225.1	2948.5	4671.4	422.9
01Jan2017	11:25	219.8	2947.1	4671.4	416.1
01Jan2017	11:30	214.7	2945.8	4671.4	409.5
01Jan2017	11:35	209.6	2944.4	4671.3	403.1
01Jan2017	11:40	204.7	2943.1	4671.3	396.8
01Jan2017	11:45	200.0	2941.8	4671.3	390.7
01Jan2017	11:50	195.3	2940.5	4671.3	384.8
01Jan2017	11:55	190.8	2939.2	4671.3	379.0
01Jan2017	12:00	186.3	2937.9	4671.3	373.4

Appendix G
Spillway Channel Capacity Worksheet

Channel capacity, compare critical flow with uniform flow

Eightmile Lake-JTS, 11.28.2016

Note : Tinted boxes indicate user input required.

Key equations :

Channel geometry :

- Cross section area : $A = b\,y + Z_{avg}\,(y^2)$
- Top width : $T = b + (Z_R + Z_L)(y)$
- Wetted perimeter : $P_w = b + (Z_{Rdiag} + Z_{Ldiag})(y)$
- Hydraulic radius : $R_h = A / P_w$
- Hydr. mean depth : $y_m = A / T$
- Side slopes : $Z_{avg} = 1/2\ (Z_R + Z_L)$
  $Z_{diag} = (Z_i\text{^}2 + 1)\text{^}1/2$
- Channel bed slope : S_o = elev.diff. / L
- Hydr. friction slope : S_f = W.L.diff. / L

Channel freeboard (Ref: Part IV, pg. 4-16) :

- Required: $FB_{req} = 2.0 + (0.025 * V * y\text{^}1/3)$
- Available: $FB_{avail} = Y_{max} - y_i$
- Excess : $FB_{exs} = (Y_{max} - y_i) - FB_{req}$

Critical flow conditions :

- Velocity : $V\text{^}2 = g * y_m$
- Discharge $Q = V * A * (1 - \%\ obstr / 100)$

Uniform flow conditions :

- Velocity : $V = (1.486 / \mathbf{n})\ R_h\text{^}2/3\ \ S_f\text{^}1/2$
- Discharge $Q = V * A * (1 - \%\ obstr / 100)$

Froude Number : $Fr\text{^}2 = (V\text{^}2) / (g * y_m)$

$Fr_{unif} = V_{unif} / V_{crit}$

Roughness coefficient (**n** value) for riprap :

Abt equation, steep bed slope :

$\mathbf{n} = 0.0456\ [\ (D_{50}\ S_o)\text{^}0.159\ ]$

Anderson eqn, mild bed slope :

$\mathbf{n} = 0.0395\ [\ (D_{50})\text{^}1/6\ ]$

Channel reach location and description : **[Verify:]** Spillway down face of dam from crest to downstream toe.

Description of hydraulics : **[Verify:]** Super-critical flow down dam face, draw-down from critical flow at crest. Hydraulic profile S2 **[verify]**; see Henderson, Open Channel Flow, pg. 111.

Channel geometry : *Input*

bottom width, b	=	99	ft.
right side slope Z_R	=	0.0	
Z_{Rdiag}	=	1.00	
left side slope Z_L	=	0.0	
Z_{Ldiag}	=	1.00	
Z_{avg}	=	0.0	
% obstruction	=	0	%
channel efficiency	=	1.00	

Elevations and hydraulic gradients : *Input*

Channel length	=	18	ft.
Bed, upstream	=	4671.0	ft.
Bed, downstream	=	4665.0	ft.
S_o	=	0.333	ft/ft.
WL, upstream	=	4671.0	ft.
WL, downstream	=	4665.0	ft.
S_f	=	0.333	ft/ft.

Input

Bed material	=	Concrete		
Riprap D_{50}	=	1	in.	
riprap **n**	=	0.038		(steep)
riprap **n**	=	0.026		(mild)
Roughness **n**	=	0.030		*Input*

Ref: WSDOT / Brater & King / Haan *et al*

Input

Dam crest elev.	=	4671.0	ft.
Y_{max}	=	0.0	ft.

Channel capacity, compare critical flow with uniform flow
Eightmile Lake-JTS, 11.28.2016

Input
"y" incr. = 0.60 ft.

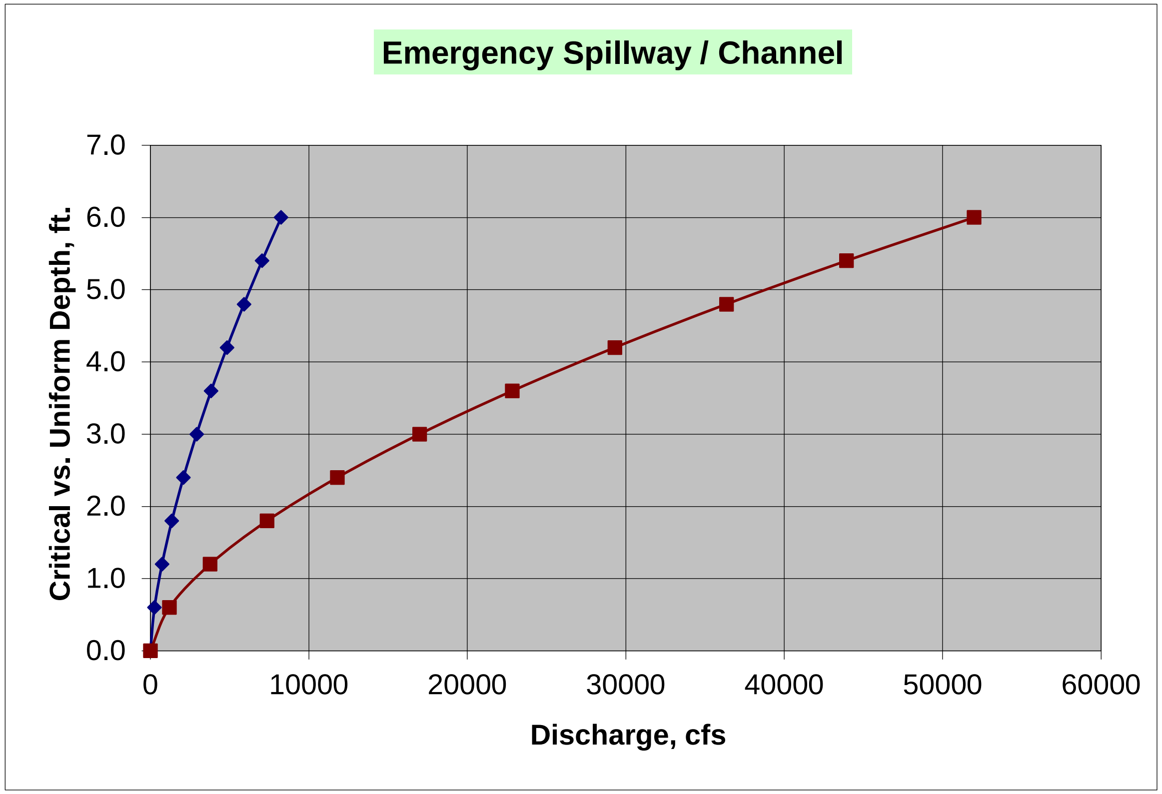
						Critical flow :		Uniform flow :	
y (ft.)	A (sq.ft.)	T (ft.)	P_w (ft.)	R_h (ft.)	y_m (ft.)	V_{crit} (ft/sec)	Q_{crit} (cfs)	V_{unif} (ft/sec)	Q_{unif} (cfs)
0	0	99	99	0	0	0	0	0	0
0.60	59.40	99.00	100.20	0.59	0.60	4.4	261.1	20.2	1198.8
1.20	118.80	99.00	101.40	1.17	1.20	6.2	738.5	31.8	3775.8
1.80	178.20	99.00	102.60	1.74	1.80	7.6	1356.7	41.3	7363.5
2.40	237.60	99.00	103.80	2.29	2.40	8.8	2088.7	49.7	11801.8
3.00	297.00	99.00	105.00	2.83	3.00	9.8	2919.1	57.2	16987.8
3.60	356.40	99.00	106.20	3.36	3.60	10.8	3837.2	64.1	22846.3
4.20	415.80	99.00	107.40	3.87	4.20	11.6	4835.5	70.5	29318.5
4.80	475.20	99.00	108.60	4.38	4.80	12.4	5907.8	76.5	36356.1
5.40	534.60	99.00	109.80	4.87	5.40	13.2	7049.4	82.2	43918.8
6.00	594.00	99.00	111.00	5.35	6.00	13.9	8256.4	87.5	51971.6

y (ft.)	V_{crit} (ft/sec)	FB_{req} (ft.)	FB_{exs} (ft.)	V_{unif} (ft/sec)	FB_{req} (ft.)	FB_{exs} (ft.)	Froude no.	regime
0	0	2	-2	0	2	-2		
0.60	4.4	2.1	-2.7	20.2	2.4	-3.0	4.59	Super
1.20	6.2	2.2	-3.4	31.8	2.8	-4.0	5.11	Super
1.80	7.6	2.2	-4.0	41.3	3.3	-5.1	5.43	Super
2.40	8.8	2.3	-4.7	49.7	3.7	-6.1	5.65	Super
3.00	9.8	2.4	-5.4	57.2	4.1	-7.1	5.82	Super
3.60	10.8	2.4	-6.0	64.1	4.5	-8.1	5.95	Super
4.20	11.6	2.5	-6.7	70.5	4.8	-9.0	6.06	Super
4.80	12.4	2.5	-7.3	76.5	5.2	-10.0	6.15	Super
5.40	13.2	2.6	-8.0	82.2	5.6	-11.0	6.23	Super
6.00	13.9	2.6	-8.6	87.5	6.0	-12.0	6.29	Super

Channel capacity, compare critical flow with uniform flow

Eightmile Lake-JTS, 11.28.2016

y (ft.)	Q_{crit} (cfs)	Q_{unif} (cfs)
0	0	0
0.6	261.1	1198.8
1.2	738.5	3775.8
1.8	1356.7	7363.5
2.4	2088.7	11801.8
3.0	2919.1	16987.8
3.6	3837.2	22846.3
4.2	4835.5	29318.5
4.8	5907.8	36356.1
5.4	7049.4	43918.8
6.0	8256.4	51971.6



This spreadsheet was developed by engineers in the Dam Safety Office of the Washington State Department of Ecology. It is made available to other engineers as part of our technical assistance efforts.

This spreadsheet is intended for use by Professional Engineers only, or by junior engineers under the supervision of a Professional Engineer. Engineers using this spreadsheet must make sure that these calculations are correctly applied to their project.

Dam owners and design engineers are reminded that they retain full responsibility for the safety of their structures. Also, the design engineer retains full responsibility for the completeness and adequacy of his or her design. Neither the State of Washington, the Department of Ecology, nor Ecology's reviewing engineer(s) are authorized to accept any of the design engineer's professional responsibility and/or potential liability in this regard.

Be sure to read the instruction paper (Instruct.doc) before using this and the accompanying spreadsheets.

If you have any questions regarding the use of this spreadsheet or about Dam Safety's review of your project, please feel free to contact us at :

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Appendix H
Opinion of Probable Project Costs

Opinion of Probable Costs
Eightmile Lake Storage Restoration

ITEM	UNIT	UNIT COST	QTY	COST (LOW)
Install Monitoring Equipment[1]				
Install Staff Gage / Lake Level Monitoring (Transducer Type)[1]	EA	$0	0	$0
Install Staff Gage / Discharge Monitoring and Develop Rating[1]	EA	$0	0	$0
Subtotal - Install Monitoring Equipment				**$0**
Site Preparation				
Clear Wood and Debris from Dam	LS	$6,000	1	$6,000
Clearing and Tree Removal	AC	$12,000	0.5	$6,000
Install and Maintain Temporary Erosion and Sediment Controls	LS	$15,000	1	$15,000
Install and Maintain Dewatering System	LS	$10,000	1	$10,000
Install and Maintain Other Pollution Controls	LS	$5,000	1	$5,000
Subtotal - Site Preparation				**$42,000**
Demolition of Existing Facilities				
Demolish and Remove Ex Concrete/Rock Masonry Dam and Cutoff Walls	LS	$8,000	1	$8,000
Demolish and Remove Ex Slide Gate and Appurtenances	LS	$500	1	$500
Excavate for Removal of Ex Low-Level Outlet Pipeline	CY	$50	2,250	$112,500
Demolish and Remove Ex Low-Level Outlet Pipeline	LS	$5,000	1	$5,000
Subtotal - Demolition of Existing Facilities				**$126,000**
Install Low-level Outlet and Valves				
Install Buried 30-inch HDPE Low-Level Outlet Pipeline	LF	$200	418	$83,600
Install Buried 24-inch HDPE Low-Level Outlet Pipeline	LF	$150	11	$1,650
Encase Pipe in Reinforced Concrete Under Dam	CY	$1,000	28	$28,000
Excavate Additional Material to Install Low-level Outlet Pipeline	CY	$50	1,325	$66,250
Place Processed On-site Bedding Around Low-level Outlet Pipeline	CY	$30	200	$6,000
Place Backfill Over Low-level Outlet Pipeline	CY	$20	3,300	$66,000
Install Submerged 30-inch HDPE Low-Level Outlet Pipeline	LF	$250	373	$93,250
Install Debris Rack at Pipe Inlet	EA	$5,000	1	$5,000
Install Air Release Valve	EA	$3,000	1	$3,000
Install Vacuum Pump and Connection	EA	$5,000	1	$5,000
Install 24-inch Gate Valve for Isolation with Stem Extension	EA	$45,000	1	$45,000
Install 24-inch Plug Valve on Low-level Outlet	EA	$30,000	1	$30,000
Install Isolation Valve Enclosure	LS	$10,000	1	$10,000
Sump Pump for Isolation Valve Enclosure	EA	$1,000	1	$1,000
Install Control Valve Enclosure	LS	$5,000	1	$5,000
Subtotal - Install Low-level Outlet and Valves				**$449,000**
Rebuild Dam and Embankment				
Loose Rock Removal for Dam Construction	CY	$50	720	$36,000
Hard Rock Removal for Dam Construction	CY	$110	1,680	$184,800
Place Reinforced Concrete for Dam	CY	$1,000	140	$140,000
Additional On-site Excavation for Embankment Material	CY	$50	480	$24,000
Place Embankment Material	CY	$40	2,750	$110,000
Place Gabions with Native Rock and Slush Concrete	CY	$350	180	$63,000
Place Native Rock for Armoring	CY	$40	820	$32,800
Subtotal - Rebuild Dam and Embankment				**$591,000**
Automate Valves to Optimize Releases				
Motorized Valve Actuator	EA	$20,000	1	$20,000
Power Supply (Solar Panels and Battery Pack), Controls, Communication	EA	$25,000	1	$25,000
Repeater Station[1]	EA	$0	0	$0
Subtotal - Automate Valves to Optimize Releases				**$45,000**

Opinion of Probable Costs
Eightmile Lake Storage Restoration

ITEM	UNIT	UNIT COST	QTY	COST (LOW)
Construction Subtotal - All Work[2]				**$1,253,000**
Mobilization Costs (Assumes Use of Helicopter)[2]				**$515,000**
General Mobilization/Demobilization	10.0%			$125,300
Helicopter Mobilization/Demobilization/Rental	LS	$390,000	1	$390,000
ConstructionTotal[2]				**$1,768,000**
Contingency - LOW	20.0%			$353,600
Contingency - HIGH	40.0%			$707,200
Engineering, Permitting and Administration	20.0%			$353,600
Sales Tax	8.2%			$144,976
Total Project Cost - LOW[2, 3]				**$2,620,000**
Total Project Cost - HIGH[2, 3]				**$2,974,000**

Notes:
1) Cost associated with installing monitoring equipment and telemetry connection to IPID are included in the opinion of probable project costs for the Alpine Lakes Optimization and Automation project, as reported in the *Feasibility Study: Alpine Lakes Optimization and Automation* (Aspect 2017) and are not included here.
2) Subtotals and totals are rounded to the nearest $1,000.
3) Costs are represented in May 2017 dollars. Actual costs may vary based on labor rates, equipment costs, and materials costs at the time of construction.

APPENDIX C

Alpine Lakes Optimization and Automation Feasibility Study

FEASIBILITY STUDY

Alpine Lakes Optimization and Automation

Prepared for:
Chelan County Natural Resources Department

Project No. 120045 • April 30, 2018 Final

earth + water

Aspect
CONSULTING

FEASIBILITY STUDY

Alpine Lakes Optimization and Automation

Prepared for:
Chelan County Natural Resources Department

This project was funded by the Washington State Department of Ecology, Office of Columbia River, Grant Number WROCR-VER1-ChCoNR-00002

Project No. 120045 • April 30, 2018 Final

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Executive Summary

Project Overview

This feasibility study was conducted by Aspect Consulting, LLC (Aspect) and Anchor QEA, LLC (Anchor) under contract with the Chelan County Natural Resources Department (CCNRD) in close coordination with the Icicle Work Group (IWG). The IWG has been co-convened by CCNRD and the Washington State Department of Ecology (Ecology) Office of Columbia River (OCR) to identify and evaluate projects that will improve management of water in the Icicle Creek Sub-basin and improve instream flow conditions in lower Icicle Creek.

This project was funded by the Washington State Department of Ecology, Office of Columbia River (Grant Number WROCR-VER1-ChCoNR-00002).

The nine Guiding Principles related to implementation of water resource projects within the Icicle Basin adopted by the IWG include: 1) broad benefits to streamflow, 2) promotion of sustainable hatchery system, 3) fulfillment of tribal treaties, 4) improvement to municipal and domestic supplies, 5) improvement to agricultural reliability, 6) protection of aquatic and terrestrial habitat, 7) legal compliance, 8) protection of non-treaty harvest, and 9) compliance with wilderness acts and management plans.

The intent of this feasibly study is to determine whether fatal flaws exist related to optimizing and automating water storage at the seven alpine lakes managed by the Icicle-Peshastin Irrigation District (IPID) and the U.S. Fish and Wildlife Service (USFWS). This included acquisition of field data (e.g., LiDAR mapping), performing pilot releases (e.g., manual optimized-release pursuant to the guiding principles), and progressing the engineering of automation improvements to a conceptual design level (10% engineering). Refined costs and permitting strategies were also explored.

Currently, release from the Alpine Lakes is manually controlled by IPID and USFWS staff hiking into the lakes to periodically manage release from existing manmade infrastructure. In drought years, water is released from all of the lakes to meet IPID and Leavenworth National Fish Hatchery (LNFH) demand. In non-drought years, partial release occurs which results in water remaining in the lakes (subject to additional drawdown periods for maintenance). Automation would allow for additional release from the lakes in non-drought years in a manner that maximizes efficiency in an optimized manner.

Two related studies are being completed concurrently with this study, including improvements and restoration of outlet controlling works at upper Snow Lake and Eightmile Lake, respectively.

Findings

Overall Findings

Based on results of the 2016 and 2017 Pilot Release Studies (Pilot Release Studies), in conjunction with refined storage estimates from LiDAR, and refined engineering developed herein, instream flow augmentation of on the order of 90 cubic feet per second (cfs)[1] and 6,670 acre-feet per year[2] may be released from the lakes in an automated fashion to improve instream flows in Icicle Creek. Water could be adaptively managed with automation but is generally expected to be available for approximately 90 days from mid-July through mid-October.

Typical improvements needed to facilitate automated release include outlet works modification (gate modification or replacement), installation of electronic motorized gate actuators, programable controls, power generation equipment (e.g., solar panels, batteries), communications equipment (e.g., radio modem, directional antennae), and enclosures consisting of modest (e.g., 6-foot square) cast-in-place reinforced concrete shed buildings with faux rock finished exteriors.

No fatal flaws related to optimization or automation were identified during the course of this study; however, continued property owner coordination and acquisition access to land for repeater sites is recommended prior to commencing design and construction. This includes coordination with a private property owner (Johnson's), who owns the proposed Wedge Mountain repeater site, and the U.S. Forest Service (USFS), who owns the existing Icicle Repeater site. If one or both repeater sites cannot be acquired, the project may still be viable. However, this may require stronger radio signals (e.g., 25 watt in lieu of 5 watt) or alternative means of communication, which were not evaluated herein.

Feasibility level costs for automation have been estimated at $876,000,[3] which include both direct hard costs (construction) and softs costs (design and permitting).

Due to the harsh environmental conditions (extreme heat / cold), equipment design life is expected to be shorter than comparable improvements; therefore, operations and maintenance costs will be higher than usual. For example, electrical equipment and batteries will have shorter design life than customary installation and require more frequent maintenance and replacement. Annual operations and maintenance costs are estimated at approximately $35,700.

[1] Release flows of up to 90 cfs were observed during 2016 pilot release; however, significantly higher release flows may be possible during lake-full conditions. Release flows were limited to 75 cfs during the 2017 pilot release to extend the duration of benefit later into the Icicle low-flow period.

[2] 6,670 acre-feet represents the combined storage volume of Square, Klonaqua, Eightmile and Colchuck. Additional storage volume of approximately 12,730 acre-feet is available in Upper and Lower Snow Lakes. These lakes are already operated each year to augment LNFH operations. Some additional augmentation or instream flow benefit is possible with a tradeoff in refill potential if the following year is a drought.

[3] These costs include the infrastructure necessary for permanent monitoring and control of release from all lakes; however, costs associated with gate replacement and automation at Eightmile and valve replacement at Upper Snow Lakes are excluded (accounted for in separate studies).

LiDAR Mapping Findings

LiDAR data collected at each lake was processed using topographic analysis software (AutoCAD Civil3D). Stage-storage relationship curves were developed from LiDAR for each lake. A summary of active storage volumes calculated based on LiDAR analysis is provided in Table ES-1.

Table ES-1. Alpine Lakes Storage Volume Estimates

Lake Name	Maximum Normal Stage (feet)	Minimum Normal Stage (feet)	Operational Range (feet)	Active Storage Volume (acre-feet)[1]
Square	4,985	4,954	31	2,130
Klonaqua[2]	5,094	5,066	28	1,690
Eightmile	4,667	4,644	23	1,370
Colchuck	5,563	5,546	17	1,480
Upper Snow	5,433	5,273	160	12,590
Lower Snow	5,429	5,427	2	140

Notes:

1) Active storage volume represents the bathymetric volume between maximum normal stage (e.g., spillway elevation) and minimum normal stage (e.g., invert of low level outlet works). Additional dead storage is available in all lakes below manmade controlling works. Further, active storage volumes do not account for additional release volumes which may occur due to natural seepage.

2) Volumes stated represent Lower Klonaqua Lake only. Prior study indicates that approximately 2,450 acre-feet of storage may be available in Upper Klonaqua lake (which would require 50 feet of drawdown).

2016 Pilot Release Findings

The objective of the 2016 pilot release was to simulate optimized release from the IPID-managed Alpine Lakes to meet guiding principles, to the extent feasible while balancing 2016 IPID maintenance objectives and tributary fish protection issues raised by the Instream Flow Subcommittee of the IWG. Key findings are as follows:

- Flow augmentation using over 6,400 acre-feet of water stored in Alpine Lakes reservoirs can significantly enhance stream flows in the Historic Channel of Icicle Creek.
- While flow augmentation is not a total solution for achieving the IWG's flow targets in the Historic Channel, it might account for about one-third of the solution, based on 2016 results.
- Augmentation flows up to 90 cfs extended Historic Channel flows above the 100 cfs target for 3 weeks of the 9-week low-flow period in 2016, during a period when flows would have otherwise dropped below the target.
- Augmentation flows equaled between 31 and 78 percent of late-season discharge in the Historic Channel.
- Quantities of water released for flow augmentation are not adequate to reverse or even keep up with the seasonal falling hydrograph. However, flow augmentation

can slow the rate of decline, prolonging the period of time when flows remain above the 100 cfs target.

2017 Pilot Release Findings

The objectives of the 2017 pilot release were to confirm the 2016 findings and to address data gaps. In contrast to the 2016 pilot release, the approach for the 2017 pilot release consisted of preserving water in storage longer in the season by limiting combined releases from the lakes to 75 cfs.

- Findings of the 2016 Pilot Study were generally confirmed. No fatal flaws were identified.
- Flow augmentation releases available from storage in the Alpine Lakes nearing 6,500 acre-feet were confirmed to significantly enhance stream flows in the Historic Channel of Icicle Creek.
- While flow augmentation is not a total solution for achieving the IWG's flow targets in the Historic Channel, it may account for over half the volume needed to meet the target.
- Quantities of water released for flow augmentation are not adequate to reverse or even keep up with the seasonally falling hydrograph. However, flow augmentation can slow the rate of decline, prolonging the period when flows remain above the target. Specifically, during the 2017 Pilot Study:
  - Augmentation flows of up to 75 cfs improved flows in the Historic Channel by about one half during critical low-flow periods.
  - Augmentation flows increased flows in the Historic Channel of Icicle Creek to above the 100 cfs target for about 10 days.
  - Augmentation flows equaled up to 95 percent of discharge in the Historic Channel during critical low-flow periods.
- Winter augmentation opportunities are limited by lack of sufficient inflows to replace summer and fall storage releases and, at Eightmile Lake, by seepage losses from storage.

Recommendations and Next Steps

Automating and optimizing water storage at the seven Alpine Lakes offers an efficient and cost-effective way to improve management of water in the Icicle Creek Sub-basin. It is recommended that IPID and the USFWS continue to work with the IWG to implement a project that includes the following:

- Install permanent monitoring equipment to improve monitoring of lake levels and release rates from the lakes managed by IPID and USFWS.
- Repair existing gates and control structures at Snow, Square, Lower Klonaqua, and Colchuck Lakes.

- Automate releases by installing motorized actuators on the valve on the penstock at Upper Snow Lake and the gates at Square Lake, Lower Klonaqua Lake, Eightmile Lake, and Colchuck Lake.
- Install repeater stations and telemetry equipment needed to provide for remote control of valves and gates.
- Replace the existing dam at Eightmile Lake and replace the existing low-level outlet and gate with a siphon and gate, as recommended in the *Eightmile Lake Storage Restoration Feasibility Study* (Anchor and Aspect, 2018), being prepared concurrent with this study.
- Replace the existing valve at Upper Snow Lake, as recommended in the *Snow Lakes Valve Replacement Value Engineering Draft Report* (Reclamation, 2015).

The next steps toward implementation would include:

- Improve accuracy of Icicle Creek discharge monitoring in the Historic Channel by obtaining real-time stream flow measurements at Structure 2 (located at the head of the Historic Channel).
- Determine benefits and impacts of release flows on bull trout habitat in French and Leland creeks that drain Square and Klonaqua lakes, respectively. Additionally, investigate whether release flows above the interim 10 cfs target would not be detrimental after September 15. These lakes hold nearly half the water physically available for flow augmentation, and releases above 10 cfs in late season would provide greater flexibility to manage flow augmentation to Icicle Creek.
- Improve the understanding of the fate of flow augmentation water including lag effects due to stream channel storage. Evaluate gaining/losing characteristics of tributaries draining reservoirs and mainstem Icicle Creek.
- Coordinate with USFWS to improve understanding of releases from Snow Lakes.
- Coordinate with USFWS, IPID, Cascade Orchards Irrigation Company, and the City of Leavenworth to quantify diversions occurring upstream of the Historic Channel. Perform property owner negotiation, including submitting preliminary special use permit, for USFS site.
- Completion of Programmatic Environmental Impact Study (PEIS).
- Perform additional communications testing if land associated with preferred communications radio repeaters is unsuccessful. If needed, evaluate modifications that could be made to mitigate for communications related changes if needed.
- Negotiate with landowners (Johnson’s and USFS) regarding use of their lands for permanent repeater site installations.
- Perform engineering design and cost estimating of improvements.
- Negotiate trust water agreement and obtain a new secondary use permit from Ecology for instream flow benefit.

- Continue monitoring of flow and water quality in Icicle Creek and key bull trout tributaries (e.g., French Creek, Leland Creek) as part of continuing pilot release.

Introduction

The Chelan County Natural Resources Department (CCNRD), Icicle and Peshastin Irrigation Districts (IPID), and the Icicle Work Group (IWG) requested that Aspect Consulting, LLC (Aspect) and Anchor QEA, LLC (Anchor) provide an evaluation of the automation of infrastructure related to seven naturally-occurring alpine lakes (Alpine Lakes) which have been enhanced to operate as reservoirs by the U.S. Fish and Wildlife Service (USFWS)/Bureau of Reclamation (Reclamation) and IPID. The Alpine Lakes are part of the Alpine Lakes Wilderness, which is managed by the U.S. Forest Service (USFS).

This report serves to provide a feasibility-level analysis to identify potential fatal flaws and to outline future steps required to proceed with design (Project). This report summarizes recent data collection efforts, preliminary equipment selection and sizing, describes permitting strategy and describes visual impacts resulting from the potential improvements. A Project Vicinity Map is provided as Figure 1.

Icicle Work Group

The IWG has been co-convened by CCNRD and Washington State Department of Ecology (Ecology) Office of Columbia River (OCR) to identify and evaluate projects that will improve management of water in the Icicle Creek Sub-basin and improve instream flow conditions in the lower Icicle Creek. Automation and optimization of the Alpine Lakes is one of several projects being considered by the IWG.

The IWG has adopted nine Guiding Principles intended to guide the identification of water management solutions that lead to implementation of high-priority water resource projects within the Icicle Creek drainage. The nine Guiding Principles include:

1. Streamflow that:
    a. Provides passage
    b. Provides healthy habitat
    c. Serves channel formation function
    d. Meets aesthetic and water quality objectives
    e. Is resilient to climate change
2. Sustainable hatchery that:
    a. Provides healthy fish in adequate numbers
    b. Is resource efficient
    c. Significantly reduces phosphorus loading
    d. Has appropriately screened diversion(s)

   e. Does not impede fish passage

3. Tribal Treaty and federally protected fishing/harvest rights are met at all times.
4. Provide additional water to meet municipal and domestic demand.
5. Improved agricultural reliability that:
   a. Is operational
   b. Is flexible
   c. Decreases risk of drought impacts
   d. Is economically sustainable
6. Improves ecosystem health including protection and enhancement of aquatic and terrestrial habitat.
7. Comply with state and federal law.
8. Protect Non-Treaty Harvest.
9. Comply with the Wilderness Act of 1964, the Alpine Lakes Wilderness Act of 1976, and the Alpine Lakes Wilderness Management Plan.

This Project is expected to meet all of the guiding principles by helping to sustain streamflows in certain reaches of Icicle Creek during key low-flow periods.

Scope of Work

The scope of work of this study includes feasibility level investigation of automation improvements at the six Alpine Lakes that are operated as reservoirs: Square, Klonaqua, Eightmile, and Colchuck lakes (IPID-managed) and Upper and Lower Snow lakes (USFWS/Reclamation-managed). A seventh lake (Nada) is related to the Alpine Lakes but was excluded from the scope of this Project because it does not contribute appreciable storage volumes and is managed differently than the other lakes.

The project scope of work was completed under the following tasks:

1. **Feasibility Level Design** – Summarize infrastructure improvements necessary for automated release (gates, actuators, measurements, telemetry, and embankment improvements).
2. **Evaluation of Infrastructure Improvements and Identification of Constraints**
3. **Create Conceptual Design Drawings** – Create conceptual design drawings, showing location and general layout of major materials and equipment in plan view.
4. **Project Cost Estimates –** Estimate probable costs for the improvements outlined in the conceptual design.
5. **Aesthetic Impacts –** Develop illustrated rendering of improvements.
6. **Permitting Strategy**

Background

The Alpine Lakes were enhanced to operate as reservoirs by Reclamation and IPID in the 1920s. The following provides background on water management of the lakes under both existing and future conditions.

Prior Studies

The *Water Storage Report, Wenatchee River Basin* (Anchor, 2011), provided a summary of potential water storage projects and conservation projects intended to increase water supply and instream flows in the Wenatchee River Basin. One of the projects that was identified and evaluated as part of that study was the potential for increasing water storage in Upper and Lower Snow Lakes and automating releases.

The evaluation of water storage at Snow Lakes presented in Anchor (2011) relied on information provided in the *Management Recommendations for Reservoir Releases from Upper Snow Lake: Leavenworth National Fish Hatchery* (Wurster, 2006). That report provided an assessment of inflows, storage, and releases from Upper Snow Lake. Recommendations were provided regarding the timing and duration of releases to optimize flow benefits with the reliability of refill in Upper Snow Lake.

The *Multi-purpose Storage Assessment in the Wenatchee River Watershed* (Montgomery Water Group, 2006), preceded the Anchor (2011) and provided a broad scale overview of storage opportunities in the Wenatchee River Basin. This study identified the various Alpine Lakes (Klonaqua, Square, Colchuck, Eightmile, Snow, and Nada) as potential opportunities for additional storage.

Anchor and Aspect prepared a report, *Eightmile Lake Storage Restoration Appraisal Study* (Eightmile Lake Appraisal Study; Anchor and Aspect, 2015). The evaluation provided in that report was based on initial work completed by Gravity Consulting (Gravity) and Forsgren Associates (Forsgren), summarized in the draft *Icicle Irrigation District Instream Flow Improvement Options Analysis Study* (Forsgren, 2014). The work completed by Forsgren and Gravity included bathymetric and topographic surveys of the lake, adjacent shoreline, and dam facilities and an evaluation of storage volumes based key control elevations.

Aspect and Anchor also prepared a report, *Appraisal Study Alpine Lakes Optimization and Automation* (Alpine Lakes Appraisal Study; Aspect and Anchor, 2015), concurrent with Anchor and Aspect (2015). The Alpine Lakes Appraisal Study evaluated the potential for optimizing releases by automating gates that could be operated remotely by IPID and USFWS. The report concluded that there would be high refill probability at most of the Alpine Lakes, developed conceptual cost estimates for automating lake releases, and identified the potential need for a future feasibility study (this study).

Concurrent Studies

Pilot Release

Optimized manual releases from the Alpine Lakes were performed during the summers of 2016 and 2017 to characterize the effects of releases on Icicle Creek at various control locations (Pilot Release Studies). Results of the Pilot Release Studies are appended to this report (Appendix A).

LiDAR Topographic Mapping

Following the 2016 Pilot Release Study, Light Detection and Ranging (LiDAR) was collected in October 2016 by Quantum Spatial of Corvallis, Oregon. The scope of LiDAR collected included approximately 1,500 acres encompassing Square, Lower Klonaqua, Colchuck, Upper and Lower Snow, and Nada lakes at drawn-down conditions. The LiDAR collection report is provided as Appendix B.

Eightmile Lake Storage Improvements Feasibility Study

Improvements to Eightmile Lake are being evaluated by Anchor and Aspect concurrent with this study. An existing dam consists of a concrete/rock-masonry structure and an earthen embankment. The earthen embankment has eroded at the left edge of the concrete/rock-masonry structure. Due to erosion of the embankment, the dam can now only store water to an elevation of approximately 4,667 feet and IPID can only access approximately 1,375 acre-feet of storage. Further, the current facilities are old and in need of significant repairs. The release gate is damaged and is very difficult to open and close. The low-level outlet pipeline is collapsing in multiple locations and the capacity has been limited as a result.

Improvements planned for Eightmile Lake include replacement of the existing dam with a new dam, spillway, and low-level outlet facilities that meet the following objectives:

- Allow for IPID to store water to the historical spillway elevation of 4,671 feet and access the full capacity allowed by IPID's water right (2,500 acre-feet of storage);
- Improve operation of the facilities; and
- Replace the existing facilities with facilities that that meets current requirements of the Washington State Department of Ecology Dam Safety Office (DSO).

Water Management Strategy Overview for Alpine Lakes

There are various water management strategies (both existing and proposed) associated with operation of the Alpine Lakes. Release strategies involve both release period (time of year) and release quantities.

Release Period

Under existing conditions, IPID manages the lakes in a manner that meets their operational needs and reduces drought-related risk. This generally involves releasing water from at least one lake per year and alternating between lakes amongst years. During drought years, IPID may release water from two or more lakes, as needed to maintain diversions from Icicle Creek during the late part the irrigation season or when needed for maintenance.[4] A detailed characterization of current operation is provided in Aspect and Anchor (2015).

To meet the IWG Guiding Principles, two enhanced release strategies have been identified to make additional use of combined lake storage and associated release in the future. With both strategies, water management includes drawdown of all lakes each year to the extent that they may be reliably refilled. The Seasonal Release strategy would provide for release from Alpine lakes during the driest period only with release commencing in July and ending in late September or early October.[5] The Year-round Release strategy would include multiple release and refill periods throughout the year. The various release period scenarios are illustrated in Table 1 below.

Table 1. Release Period Scenarios

<table>
<tr><th>Lake</th><th>Existing</th><th>Optimized
Seasonal Release</th><th>Optimized
Year-round Release</th></tr>
<tr><td>Square</td><td rowspan="4">one release per lake every 4 years, on average</td><td rowspan="6">one release per lake per year</td><td rowspan="4">one to two releases per lake per year</td></tr>
<tr><td>Klonaqua</td></tr>
<tr><td>Eightmile</td></tr>
<tr><td>Colchuck</td></tr>
<tr><td>Upper Snow</td><td rowspan="2">one release per year</td><td rowspan="2">one release per year</td></tr>
<tr><td>Lower Snow</td></tr>
</table>

Release Flows

Square, Klonaqua, Colchuck and Eightmile (IPID-Managed Lakes)

Each lake has various limitations on release flow quantity at various stages. The controlled range of flow releases from the four IPID-managed lakes is approximately 5 to 25 cfs for most lakes, with as high as 50 cfs possible.

Based upon the Pilot Release Studies, release quantities observed at various lakes and stages are shown in Table 2.

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[4] IPID typically performs maintenance on lakes once they are drawn down. Periodic needs for special maintenance may dictate the need for special operation of lakes out of sequence.

[5] Individual lakes would have different exact release periods within this general window.

Table 2. Observed Release Quantities

Lake	Peak Observed Lake Full (cfs)[1]	Drawdown Conditions		
		Observed Flow (cfs)[2]	Stage (ft H_2O)	Estimated Gate Position
Square	35[3]	10	-27.5	Partially Open
Klonaqua	37	1	-23.5	Fully Open
Eightmile[4]	22	2.5[5]	-19.0	Fully Open
Colchuck	28	2	-11.0	Fully Open

Notes:

Higher release flows may be possible during lake-full conditions. Release flows were limited to for stream gauging / safety purposes during pilot releases.

[2] Observed flows at lake discharge during drawdown conditions with gate near maximum degree of open during pilot releases.

[3] Flows as high as 35 cfs were estimated by extrapolating values beyond rating of section (25-cfs limit on measured flows).

[4] IPID has observed that the release capacity from Eightmile Lake was recently reduced over the historical capacity due to partial or full collapse of the low-level outlet pipe at multiple locations.

[5] The release flow of 2.5 cfs is entirely attributed to seepage (i.e., not flowing through the gate, but rather seeping through the ground under the dam.)

During the Pilot Release Studies, observed conditions indicate that relatively modest initial gate settings (e.g., 6-inch gate adjustment) were necessary to achieve flows approaching 25 cfs (or higher). As lake levels dropped, larger gate adjustments were necessary to maintain flows at those levels. As expected, lake levels ultimately dropped sufficiently that peak flows could no longer be maintained with gates fully open. Results of the Pilot Release Studies, including flow release quantities by month, are provided in Figures 6 and 7 of Appendix A.

The primary conclusion from the 2016 Pilot Release Study was that a wide range of controlled flow release is achievable (e.g., 0 cfs to 25 cfs or higher from each lake) within the first 3 to 4 weeks of releases. After that period, the upper limit of releasable flow decreases as the lake level drops.

The results of the 2016 Pilot Release Study were confirmed during the 2017 Pilot Release Study. A key conclusion of the 2017 Pilot Release was that while quantities of water released for flow augmentation are not adequate to reverse or even keep up with the seasonally falling hydrograph, flow augmentation slowed the rate of decline and prolonged the period when flows remained above the target. Augmentation flow during the 2017 release slowed the rate of the seasonally falling hydrograph by an average of about 1 cfs per day, delaying the date when Icicle flows would otherwise diminish to below the 100 cfs target by approximately 10 days.

Upper and Lower Snow (USFWS/Reclamation-Managed Lakes)

USFWS, in association with Reclamation, manages releases from Snow Lakes to enhance water supply to the Leavenworth National Fish Hatchery (LNFH). LNFH is operated by the USFWS under an agreement with Reclamation as mitigation for impacts from the operation of Grand Coulee Dam. Currently, the USFWS releases water from Upper Snow Lake through a controlled low-level outlet tunnel and pipe to Nada Lake during the late summer. Water flows through Nada Lake and eventually merges with Snow Creek, a tributary to Icicle Creek.

Under full lake level conditions, water from Upper Snow Lake spills over or passes through a small dam structure (Upper Snow Lake Dam) to Lower Snow Lake, and from Lower Snow Lake over a small dam structure (Lower Snow Lake Dam) to Snow Creek. During the late summer, when controlled releases draw down Upper Snow Lake, the water from Lower Snow Lake can be higher than the water level in Upper Snow Lake. As a result, water can flow the opposite direction from Lower Snow Lake through the Upper Snow Lake Dam and into Upper Snow Lake.

Controlled releases from Upper Snow Lake to Nada Lake are limited to approximately 55 cfs by the size of the existing butterfly valve that is used to control those releases. The USFWS and Reclamation are currently exploring options for replacement of the existing valve and related appurtenances to restore flows to historic release conditions. This would allow for full access of water rights that authorize a release of up to 85 cfs by both the USFWS and IPID.

Existing Conditions

Existing conditions were characterized in the Alpine Lakes Appraisal Study (Aspect and Anchor, 2015). Since the completion of that study, new information has been collected (e.g., additional site visits, topographic mapping, etc.). A summary of pertinent information related to existing conditions at each of the Alpine Lakes considered for automation and optimization is provided below.

LiDAR Results, Stage-Storage Summary

LiDAR data collected at each lake was processed using topographic analysis software (AutoCAD Civil3D). Stage-storage relationship curves were developed from LiDAR for each lake and are provided as Figure 2. A summary of active storage volumes calculated based on LiDAR analysis is provided in Table 3 below.

Table 3. Alpine Lakes Storage Volume Estimates

Lake Name	Maximum Normal Stage (feet)	Minimum Normal Stage (feet)	Operational Range (feet)	Active Storage Volume[1] (acre-feet)
Square	4,985	4,954	31	2,130
Klonaqua[2]	5,094	5,066	28	1,690
Eightmile	4,667	4,644	23	1,370
Colchuck	5,563	5,546	17	1,480
Upper Snow	5,433	5,273	160	12,590
Lower Snow	5,429	5,427	2	140

Notes:

1) Active storage volume represents the bathymetric volume between maximum normal stage (e.g., spillway elevation) and minimum normal stage (e.g., invert of low level outlet works). Additional dead storage is available in all lakes below manmade controlling works. Further, active storage volumes do not account for additional release volumes which may occur due to natural seepage.

2) Volumes stated represent Lower Klonaqua Lake only. Prior study indicates that approximately 2,450 acre feet of storage may be available in Upper Klonaqua lake (which would require 50-feet of drawdown).

Existing Infrastructure Summary

Lake / Reservoir Infrastructure

Existing operational infrastructure at each lake is described in the Alpine Lakes Appraisal Study (Aspect and Anchor, 2015) which has been updated with new information. A summary of pertinent infrastructure is provided in Table 4.

Table 4. Alpine Lakes Infrastructure Summary

Lake Name	Dam / Embankment Type		Outlet Works / Control	
Square	Concrete/Rock-Masonry Dam and Spillway	Approx. 85 ft Length x 2 ft Width	5 ft Wide x 7 ft Tall Tunnel	30-inch Circular Gate mounted in Tunnel
Lower Klonaqua	Concrete/Rock-Masonry Dam and Spillway and Earthen / Rock Embankment	Approx. 100 ft Length x 8 ft Crest Width	30-inch Pipe	30-inch Circular Gate mounted in Vertical Gate Chamber
Eightmile Lake	Concrete/Rock-Masonry Dam and Spillway and Earthen / Rock Embankment	Approx. 95 ft Overall Length, width / composition varies	Buried Piped, Various Size / Material	30-inch Circular Gate mounted on Rock Masonry Tower (collapsed)
Colchuck	Concrete Dam and Spillway	Approx. 40 ft Length	Buried Piped	30-inch Rectangular Gate mounted on Rock Masonry Tower
Upper Snow	Rubble Masonry	Approx. 110 ft Length	Tunnel	Gate Valve, 24-inch Butterfly Valve[1]
Lower Snow	Embankment	Approx. 40ft Length	Flap Gate at Upper Snow Lake Dam, Spill at Lower Snow Lake Dam	

USFWS is exploring options which may increase butterfly valve to 36-inch diameter.

Repeater Sites

IPID operates several base stations and repeater sites under two FCC licenses (call signs WQKS355 and WQKR961). An existing radio repeater at Blag Mountain (approximately 7 miles east of Leavenworth, elevation 4,500 feet) is frequently used by IPID. This repeater is identified as Location 2 under FCC Call Sign WQKR961 and is listed with an estimated signal strength of 45 watts.[6] This repeater has line of sight to several key points including:

- IPID Peshatin Headworks
- Icicle Ridge Repeater
- Wedge Mountain Site

[6] IPID District staff has stated that they can typically receive signals from Blag mountain at Eightmile Lake and Colchuck due to the high power signal (45 watt) of the transceiver – despite line-of-sight not being available. At times, IPID is able to transmit signals from Colchuck to the Blag mountain repeater using small handheld radios (5 watt).

The IPID Peshastin Headworks is located several miles up US Route 97 / Peshastin Creek. According to IPID, this facility is relevant due to the main connection to the IPID supervisory control and data acquisition (SCADA) system. This facility could be used to transmit data to other locations within the District or to an internet connection if desired.

The Icicle Ridge Repeater (MGRS 10TFT6856772797) is owned and operated by the USFS and is located approximately 4 miles west of Leavenworth and approximately 7 miles northeast of Eightmile Lake, at an elevation of approximately 6,800 feet. This station is equipped with a 50-watt collinear antenna with a listed height of 6 meters (~20 feet). The site includes onsite power generation (400-watt solar), 500 watt-hours of batteries, and a storage shed. The site is inaccessible by vehicle; however, there is a helipad at the site.

According to Mr. Howard Banks of the USFS (Icicle Repeater facility manager), the equipment has limited capacity for expansion; however, there may be room at the site for additional towers, etc.[7] This site is a candidate location for a new repeater to send and receive signals from the four IPID-managed lakes. It may also be possible to send and receive signals from Snow Lakes and LNFH at this location, although this has not been evaluated.

Wedge Mountain is located approximately 5 miles southwest of Leavenworth and approximately 3 miles northeast of Snow Lakes, at elevation of 5,000 feet. Property at this site (Parcel ID 231703000050) is owned by Robert and Nancy Johnson of Leavenworth, and is a candidate location for a new repeater to Snow Lakes and LNFH. This site may also be conducive to sending and receiving communications from more distant lakes (e.g., Square, Klonaqua, Colchuck and Eightmile) if more powerful signals (e.g., 25 watt signals rather than 5 watt signals) are transmitted from those locations.

Radio repeater sites, including base stations, are identified on Figure 3. Background information related to existing repeater sites is provided in Appendix C.

Site Investigation

A site investigation was performed on October 7, 2016, by Aspect, Anchor, and IPID personnel. The purpose of this investigation was to observe each lake during drawn-down conditions and collect additional data and measurements necessary for completing this feasibility study. Data collected during site investigation included gate operation force measurements. This was performed to establish a baseline for actuator torque and provide as a check on existing gate condition.

The amount of force required to lift or lower gates during drawdown conditions at each lake varies dramatically and is provided in Table 5. The gates at Square, Klonaqua, and Colchuck currently operate using a manual hand wheel operator attached to the gate stem. The estimated torque applied to each of these gate stems to operate the gate was developed based on gear ratios and leverage available at each manual actuator.

[7] Personal communications, telephone conversation, Tony Jantzer and Howard Banks, March 8, 2017.

Table 5. Gate Actuator Force Measurements

Lake Name	Approximate Operating Force (lbs)	Gear Ratio / Description	Estimated Torque Applied to Stem (ft-lbs)
Square	40	18-inch hand crank 3.5-gear 10-inch gear 6-inch gear 18-inch gear to stem	457
Klonaqua	12	24-inch hand crank 5-inch gear 19-inch gear to stem	115
Colchuck	6	28-inch handwheel	7

The stem and hand-wheel operator used to open and close the gate at Eightmile Lake were damaged by ice when the rock-masonry gate tower was destroyed. The damaged hand-wheel operator has since been removed. As a result, opening and closing the gate requires the use of a log as a come along, which is physically challenging.

Eightmile Lake was not visited as part of the October 2016 site investigation since improvements to that structure are being considered under a separate feasibility study. Thsee improvements will likely include replacement of the existing gate and low-level outlet pipe with a new pipeline and valves. Flow from through the low-level outlet will be controlled by a plug valve near the pipe outlet. A gate valve on the pipeline at the dam will allow for isolation of the pipeline below the dam. Additionally, Upper and Lower Snow lakes were not visited as part of the October 2016 site investigation since the USFWS is working directly with Reclamation to replace the outlet control valve as part of maintenance activities.

The gates at Klonaqua, Colchuck, and Eightmile are likely due for replacement; however, IPID's preference is to perform additional inspection of the gate at Square Lake before proceeding with replacement of that gate.

Conceptual Design for Automation

Automation will be accomplished through installation of motorized actuators with onsite power generation (e.g., solar panels). Due to the remote setting in a federally-designated wilderness area, special design criteria and constraints must be considered.

Design Constraints

Various constraints limit the degree and frequency to which adjustments to gates via motorized actuators are made:

Construction Access

The Alpine Lakes are all located in the Alpine Lakes Wilderness Area, so access is limited to foot trails (i.e., there are no roads) and helicopter. Eightmile and Colchuck lakes are accessible by trails that can be hiked within a half-day (less than 5 miles), while Square and Klonoqua lakes are much further (more than 10 miles) from the nearest road or parking area.

In addition to their remote location, gates at Klonoqua and Square lakes are physically constrained: the gate at Klonaqua is located inside a narrow access vault and the gate at Square is located inside a tunnel. The operators are more accessible than the gates themselves. The design of the project will have to consider relatively tight access constraints and limit impact of the proposed improvements on the Wilderness Area.

According to their easement agreement with the USFS, IPID can access the lakes via helicopter for maintenance activities. The USFS completed an Environmental Assessment in 1981 evaluating this access and finding no conflict with the environment (USFS, 1981). In order to limit the cost of constructing the proposed improvements, equipment and materials needed for this Project will likely need to be hauled in via a relatively small helicopter, or by foot.

Construction Equipment

The installation of automating equipment, replacement of gates, placement of solar panels and batteries or other power supply equipment, and installation of enclosures will all likely be completed with hand tools and/or light equipment. Due to the construction access constraints described above, we expect that all work will be completed without the aid of heavy construction equipment.

Construction Timing

Work required to automate the release equipment at each lake is expected to occur when the lakes are fully drawn down, at the end of the summer or early in the fall. The lakes are at high elevations where snow and freezing temperatures typically occur as early as late October and last until May. Therefore, we expect the work window for completing the improvements will be limited to late September and early October.

Power Supply

The remote setting of the lakes in a wilderness area dictates that alternative power supply options be considered for automatic gate operation. At a minimum, battery power is anticipated in conjunction with onsite power generation (e.g., solar, micro-hydropower). Constraints on solar power generation include seasonal direct sunlight (southern exposure) including likely excessive snow cover for much of the year. Constraints on other forms of energy, such as micro-hydropower, include seasonal freezing potential and release period constraints coupled with adequate driving head. Reliability considerations related to power supply should be accounted for commensurate with industry standards (e.g., providing sufficient level of amp-hours supply at adequate voltage to meet certain conditions in the event of onsite power generation failure).

Communications and Controls

The purpose of the Project is to provide for automated and optimized releases from the lakes to enhance the benefit of the releases to instream flows and downstream uses. Therefore, some measure of programable control and logic is necessary. Onsite manual operation of gates is also necessary independent of automation along with a programmed fail-close system. Furthermore, to meet the IWG Guiding Principles, the magnitude and timing of releases from the lakes will depend on Icicle Creek flow conditions, which are monitored outside the wilderness area. For this reason, some frequent measure of communications is necessary to maintain optimized release.

Remote communication options include radio, cellular, and satellite. Constraints related to cellular include poor, weak, or non-existent signal; these constraints cannot be mitigated economically.[8] Satellite communications is constrained by commercial satellite availability and coverage, particularly with respect to obstructions relative to horizon, weather, and other factors. Radio communications is constrained by signal strength / frequency, FCC licensing, relative line of sight, and distance.

Security

Although access to the release sites is limited, security concerns (e.g., vandalism, attractive nuisance) should be considered. At a minimum, facilities should be designed such that equipment cannot be easily adjusted (e.g., actuators and associated controls are either inaccessible or reasonably locked out) or damaged.

Durability

Dramatic climatic conditions are present, including extreme high and low temperatures, deep snow and freezing conditions, high flow and runoff conditions, and wood debris. At a minimum, facilities should be designed to withstand anticipated natural events in addition to a reasonable amount of human tampering.

Aesthetics

Existing visible features associated with manual release from the lakes includes cast iron manual actuators (e.g., Square, Klonaqua, Colchuck), dams (all lakes), concrete / rock-masonry structures (all lakes) and small shed buildings (Snow Lakes). While no discrete minimum measure of aesthetic quality has been established as criteria, aesthetic considerations related to environmental impacts are included under the scope of this

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[8] Cellular was tested during Appraisal Study and was deemed infeasible at that time. Additional cellular towers within the project vicinity may be necessary to accommodate cellular service which cannot be predictably expected within the lifespan of this project.

study. It is anticipated that aesthetic modifications to new or replaced infrastructure should be as natural looking as is feasible. Visual impacts should be similar in nature and magnitude to existing improvements, or otherwise concealed from view or camouflaged to look natural.

Design Criteria for Release Automation

Operations and Maintenance

To justify capital expenditures of this Project, operations and maintenance costs should be minimized to the extent feasible. For example, operations and maintenance costs associated with new infrastructure should not approach the alternative cost needed to achieve the same goal with manual labor (i.e., performing manual periodic adjustments on the lakes in lieu of automation). Mechanical/electrical elements (e.g., actuator, controls, communications equipment) should operate with limited repair and maintenance for at least 10 years, with replacement of equipment not necessary sooner than 15 years.

The existing gates have operated for approximately 50 to 60 years.[9] It is reasonable to expect that new comparable gates or valves would have a design life this long with periodic maintenance (at least every 5 years). Batteries are only expected to last 3 to 5 years with lifespan highly dependent on frequency and manner of use; batteries are expected to be a recurring maintenance expense. Due to the remote setting, ease of repairs of faulty/failed equipment is low, particularly during the winter months as many of the lakes are practically inaccessible between November and May.

Reliability

Automated releases will contribute to increased instream flow quantities in Icicle Creek during the late summer low-flow period, which is intended to mitigate for existing and future water uses as part of the IWG guiding principles. Therefore, the need for reliability of automated releases is relatively high. Reliability risk may be mitigated by redundancy (e.g., redundant batteries, alternative controls).

Release Scenarios

Four operational scenarios are being considered amongst two operational alternatives and two release schemes (Table 6). Within each alternative, two operational schemes were considered (daily adjustment vs. weekly adjustment). These scenarios were primarily developed to establish bookends for the purpose of identifying potential infrastructure sizing / configuration ramifications. Operational Alternative 1 includes seasonal release only whereas Operational Alternative 2 includes the option s for multiple releases year-round.[10]

[9] It is estimated that gates may have been last replaced in the 1960s or 1970s.
[10] It is anticipated that only one or two lakes may be operated during a multiple release operational alternative (e.g., wintertime release) and that release flow quantity may be minimal (e.g., 5 to 10 cfs)

Table 6. Operational Scenarios

Operational Scheme	Alternative 1 (Single Release)	Alternative 2 (Multiple Release)
Operational Scheme A (Daily Adjustment)	Scenario 1A	Scenario 2A
Operational Scheme B (Weekly Adjustment)	Scenario 1B	Scenarios 2B

Ramifications of the two operational scenarios include potential tradeoffs in cost vs benefits and anticipated risk. For example, Scenarios 1A and 1B (single release) would involve higher refill probabilities than Scenarios 2A and 2B (multiple release), which would involve releasing water closer to the end of the refill season. Scenarios 1A and 2A (daily adjustment) will require greater power considerations than Scenarios 1B and 2B (weekly adjustment).

Automation Infrastructure Improvements

It is anticipated that automation is feasible within the prescribed criteria and constraints with adequately sized and configured infrastructure. Typical automation improvement concepts have been developed and are shown in Figure 4. Conceptual design of automation improvements for individual lakes has also been developed, as described below and illustrated in the conceptual engineering drawings (10% design level) in Appendix D. Preliminary equipment selections included in the design are described below[11] and sample equipment information (vendor resources) is provided for reference as Appendix E.

Monitoring Equipment

Automation will rely on automated monitoring of conditions (lake stage and discharge flow). Options for monitoring equipment were explored in the *Appraisal Study Alpine Lakes Automation and Optimization* and have not been progressed as part of this study. Improvements will generally consist of installation of pressure transducers, staff gages, and rated release channel sections.[12] Costs associated with these improvements vary by lake and are included in cost estimates as part of this Project.

Outlet Works Improvements

The outlet works at the lakes being considered for automation and optimization of releases typically consist of some type of low-level outlet conveyance (pipeline or tunnel)

[11] Final equipment selections will be made at time of construction based upon engineering design specifications. Vendor cut sheets provided herein are intended to provide examples of products which may meet preliminary criteria.

[12] Temporary monitoring equipment (staff gates and pressure transducers) were installed during the 2016 pilot release however more permanent solutions will be required in conjunction with automation improvements.

and control infrastructure (gates / valves) needed to manage releases.[13] In some cases, existing outlet works are in suitable operating condition; cost for upgrade or replacement of the equipment is likely to exceed the benefit of replacing the equipment. In other instances, modest improvement to outlet works infrastructure is warranted to improve operation and make the facilities compatible with automation improvements.

Square

Square lake has a well-functioning outlet tunnel and gate. The tunnel was constructed through bedrock and appears to be stable. The gate and operator appear to have been installed within the last 40 to 50 years and are still in very good condition. It is not anticipated that major improvements will be necessary to these facilities to accommodate automation; however, the gate has not been fully inspected. A full inspection of outlet gate should be performed during preliminary design phase, when the lake is fully drawn down, so that full operation of the gate can be observed and both sides of the gate can be inspected.

Three options are available to facilitate automation:

- **Option 1**: equipping the existing manual operator with new motorized actuator. The advantages of this option includes minimal capital cost and utilization of existing gears and leveraging available.
- **Option 2:** replacement of existing manual actuator and stem with new stem and motorized actuator. One advantage of this option includes removal of existing cast iron gears which may be more maintenance intensive. One disadvantage of this option is that the new actuator would likely have to be larger to lift the gate without the use of existing gears and leveraging equipment. New equipment would need to be capable of providing approximately 500 ft-lbs of torque.
- **Option 3:** full gate replacement with new motorized actuator. The challenge to this option is that the existing gate is mounted in a tunnel that is difficult to access. The gate stem extends to the actuator through a small opening drilled in the bedrock above the tunnel. Replacement of the gate and stem could be very difficult, but additional inspection is needed to determine whether replacement is warranted.

We expect that the IPID and IWG would select Option 2, replacement of stem and actuator only, as the preferred option based on IPID’s stated assessment that the existing gate is in satisfactory working condition.

Klonaqua

Klonaqua outlet works consist of a 30-inch diameter concrete pipe (inferred from asbuilt), low-level outlet pipeline, and a positive seating circular canal-style gate installed in a reinforced concrete vertical gate chamber. The condition of this infrastructure is variable with much of the conduit and gate chamber in satisfactory condition. The gate

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[13] Two parallel studies are being performed to explore outlet works improvements at both Eightmile Lakes and Snow Lakes; therefore, upgrades to outlet works associated with those lakes have not been included in this study.

itself does not seal and should be replaced with a similar style gate. IPID has indicated that approximately 20 feet of the outlet pipe (nearest the outlet channel) has partially collapsed and is due for maintenance and repair. IPID has plans to repair the collapsed section of the low-level outlet pipe.

Eightmile

Eightmile lake outlet works consist of a 30-inch diameter low level outlet pipeline constructed of a variety of materials and a circular canal-style gate installed at the inlet to the pipeline. During most conditions, the gate is submerged in the lake and is exposed to ice, floating debris, and other potentially damaging conditions. The gate and low-level outlet pipe inlet are protected by a debris rack. The gate stem was originally supported by a rock-masonry gate tower. A hand-wheel operator mounted on top of the gate tower, above the water surface of the lake, was used to open and close the gate. However, the gate tower was sheared off by ice within the last 20 years. The damaged hand-wheel operator was removed. The gate is now operated by a long chain attached to the gate stem ad a come along. Fully opening and closing the gate is a challenge. In addition, the existing low-level outlet pipe, which consists of segments of corrugated metal, log stave, and wood stave pipe are collapsing. The collapse of portions of wood stave pipe has reduced the capacity of releases from the lake and is a major concern for IPID.

Improvements to the dam, outlet works, and controls at Eightmile Lake are being studied concurrently and recommendations for these facilities will be identified in the *Eightmile Lake Restoration Project Feasibility Study* (Anchor and Aspect, 2018). Recommended improvements will include:

- A new reinforced concrete and earthern/rock embankment dam with a spillway constructed with concrete and rock-filled gabions.
- A new 30-inch diameter low-level outlet pipe constructed of high-density polyethylene pipe that will extend from a point deeper in the lake to an outlet location further down the outlet channel. The low-level outlet pipe will operate by gravity during the early part of the season and will operate as a siphon in the later part of the season, when the water level is drawn down below the elevation of the high point in the pipeline at the dam.
- The pipe will neck down to 24 inches in diameter at the dam and an isolation valve, air-release valve, and vacuum pump/priming equipment will be installed in a valve chamber at the high point in the pipeline on the downstream side of the new dam structure.
- Releases from the pipe will be controlled by a 24-inch plug valve, located in a valve enclosure near the pipe outlet. The plug valve will be throttled to control the release rate. Locating the control valve near the pipe outlet will allow for the pipeline to remain primed when lake levels are low. The valve will include an electronic actuator that will be powered by batteries and a solar panel, similar to power for automation at the other lakes.

Colchuck

The outlet works at Colchuck Lake consist of two segments of low-level outlet pipe of variable size and material (assumed to be corrugated metal pipe based on visible features) with a rectangular style gate positioned in the lake adjacent to a free-standing gate tower. The first segment of pipe extends from a deeper part of the lake to the gate tower, which is installed in a relatively shallow part of the lake adjacent to the dam structure. The rock-masonry gate tower includes a rock-masonry well at the bottom which connects the first segment of low-level outlet pipe to the gate. The gate controls flow to the second segment of outlet pipe, which conveys water from the gate to an outlet in the channel downstream of the lake. The gate is fully submerged in the lake under most operating conditions. When the lake is fully drawn down, the gate tower, gate, and lake bottom around the tower and gate are fully exposed. A manual hand-wheel gate actuator is mounted on top of the gate tower and is accessible by a wooden plank or footbridge from the shoreline of the lake.

Because the gate is positioned in the lake, it is exposed to ice, floating debris (such as logs which often accumulate), and other potentially damaging conditions. Existing conditions do not support winter-time operation as the gate stem is typically encased in ice when the lake freezes over. In spite of the exposure to potentially damaging conditions, the gate is still in relatively good operating condition.

Recommended improvements to the outlet works at Colchuck Lake include:

- Replacement of the gate with a new gate of similar size and operation with an electronic actuator.
- Replacement of the gate tower with a new riser or manhole type structure that will protect and provide access to the new gate, actuator, and controls. The structure could consist of pre-cast manhole sections or a riser pipe with a cast-in-place concrete base and a weathertight, locking lid. The riser or manhole structure would also connect the two segments of low-level outlet pipe.

Upper Snow

Upper Snow Lake controlling works consist of a tunnel (estimated 160 foot deep), an outlet pipe that extends from a block plugging the tunnel to a discharge point on a rocky slope above Nada Lake, a valve house built into the hillside at the end of the tunnel above Nada Lake, and several valves that control flow from the tunnel through the pipeline to Nada Lake. The primary control valve is a 24-inch butterfly valve that is throttled to control flow through the pipeline to Nada Lake. The outlet works are generally in good operating condition; however, the control valve and associated pipe at the discharge end of the system are currently limited to release flows of approximately 55 cfs, which is less than the combined release rights for the lake held by Reclamation and IPID.

The USFWS and Reclamation are exploring options to replace the existing butterfly valve to increase flows to 85 cfs. Additional improvements recommended for automation and optimization of releases from Upper Snow Lake would include installing an electronic actuator with the new valve, control equipment, batteries, and solar power to enable remote control of the valve by the USFWS[14].

[14] Improvements to Snow Lakes controlling works (valve, mechanical actuator, controls, power supply and communications) are being planned by Bureau of Reclamation, Technical Service Center in Denver, Colorado. The scope of improvements considered by Reclamation are generally consistent

Lower Snow

When the low-level outlet from Upper Snow Lake is closed and the water level in Upper Snow Lake is near the full level, water is released from upper Snow Lake to Lower Snow Lake over and through a dam structure between the two lakes. The dam structure includes a flap gate that was originally designed to allow water to flow from Upper Snow Lake to Lower Snow Lake, but prevent flow in the reverse. Water also spills over the dam structure at Upper Snow Lake to Lower Snow Lake. The flap gate is no longer water tight and allows for water to flow through the dam in both directions. When Upper Snow Lake is lowered by opening the low-level outlet to Nada Lake, the water in Lower Snow Lake can be higher than the water level in Upper Snow Lake and water can flow backwards through the dam from Lower Snow Lake to Upper Snow Lake.

Lower Snow Lake also has a small rock-masonry dam at its outlet. No low-level outlet facilities are functioning at this dam, so the water level in Lower Snow Lake is generally controlled by spilling over the dam crest. Under current operation, water levels in Lower Snow Lake only vary a few feet from the dam crest elevation. Consequently, the active storage volume in Lower Snow Lake is small and is really only accessible when Upper Snow lake is drawn-down sufficiently to allow back flow through the existing flap gate at the Upper Snow Lake Dam. No discrete automation or improvement to outlet works is proposed for Lower Snow Lake as part of this Project.

Gate Actuators and Automation

Automation would consist of installing motorized actuators on the release gates and/or valves at each lake. Motorized actuators would be controlled by programable control equipment capable of communicating with a computer or telephone from a remote location.[15]

Actuators

Due to the remote conditions and other power constraints, direct current (DC)-powered actuators would be required. As identified in the Appraisal study, several manufacturers are available, including Auma, Limitorque and Rotork. For the purpose of this study, Rotork actuators were considered; however, a final manufacturer and model would be selected during the detailed design and construction phases. Features associated with Rotork actuator include a self-contained waterproof enclosure, integrated datalogger, manual handwheel actuator (backup), oil bath lubrication, position control, and encapsulated stem.

Conceptual actuator sizing was performed using Rotork design resources. Based upon a 30-inch diameter circular canal style gate with 30 feet of effective head, a thrust of approximately 6,000 lbs thrust was calculated. Required torque (torque applied to gate stem) of approximately 70 ft-lbs was calculated by applying a stem factor of 0.012 (based

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with those presented herein however additional coordination is required to ensure consistency between planning efforts.

[15] Local motorized operator interface manual control override would be provided in addition to remote capabilities.

on 1.5 inches diameter stem, 4 threads per inch and frictional factors provided by manufacturer).

A variety of DC powered actuators are available ranging in voltage, horsepower, torque, speed, etc. The smallest actuator available is 24-volt, 1/3 hp which applies 20 ft-lbs of torque at 18 rpm. Typically, gearboxes ranging from 1:1 ratio up to 6:1 ratio can be added, thereby increasing torque delivered (at lower overall speeds).

Rotork model IQD10 at 48 rpm provides 20 ft-lbs of torque which is increased to 102 ft-lbs with Rotork model IB4 gearbox (6:1 ratio), which would be sufficient for any of the lakes including Square (assuming gate replacement), Klonaqua, Colchuck and Eightmile. The Rotork ID10 actor has a motor horsepower of 1/3 hp with 7 amps motor load.

At 48 rpm, 6:1 gear ratio, and 1/4-inch thread spacing (4 threads per inch), it is estimated that an operation duration of 30 seconds per inch of gate adjustment would be required to adjust the gates. Based upon the results of the 2016 Pilot Release Study, daily adjustments of up to 6 inches may be required (Scenarios 1A and 2A) or weekly adjustment of up to 12 inches for Scenarios 1B and 2B.

An exception to the required sizing may exist at Square Lake, should the existing gate be left in place. Field measurements indicate that approximately 40 ft-lbs of force applied to the handwheel operator is required to raise the gate during lake-empty conditions. Considering current gearing and mechanical advantage, this force translates to approximately 460 ft-lbs of torque, which exceeds the limits of 24V actuators provided by Rotork. In order to provide torque of that magnitude, a 110V model would be necessary, which may be excessive from a power budget perspective (i.e., ten 12V batteries would be required in parallel).

If the gate is left in place, it is recommended that a 24V actuator be selected in conjunction with either the existing gears or with replacement gears that provide similar mechanical advantage. The tradeoff with this approach is significantly longer run-time per adjustment. For example, under this scenario, a 24V, 48 rpm motorized actuator could be installed with standard 6:1 gearbox on existing manual actuator. The existing actuator requires approximately 32 revolutions per inch of stem rise, hence the actuator would operate for approximately 4 minutes per inch of stem adjustment which is within limits of power budget assumptions.

Calculations associated with motorized actuator sizing are provided in Appendix F.

Programable Dataloggers / Controllers

The motorized actuator at each valve or gate would be controlled by a programable data logger/controller. The logger/controller would send and receive signals from the actuator and be connected to external communications, such as a phone or computer modem, as well as other monitoring equipment (e.g., water level/pressure transducers). For the purpose of this Project, Campbell Scientific equipment is being evaluated including a Model CR1000 Controller which provides for logging and control of multiple connected devices, including transducers and actuators. The programmable data logger/controller would be operated through an interface (e.g., RTU) which would include additional logic and programming function.

Operator Interface

Several operator interface options will be available for gate adjustments. The primary method for this application would be remote operation through a remote personal computer positioned at a base station (e.g., remote terminal unit (RTU) at IPID or LNFH). Campbell Scientific Loggernet software (or similar) provides for simplified configuration and programming for CR1000 Controllers and could be used in this application.

Other options for gate operation include the following:

- Automated direct adjustment of each gate using an on-site actuator remote in close proximity (e.g., Rotork remote control);
- Automated direct adjustment of each gate using an on-site terminal unit connected to the data logger/controller. (e.g., laptop computer or tablet wired to the data logger); and
- Manual handwheel adjustment/override.

Communications

Available options for communications include both satellite and radio. A radio repeater analysis was performed by Aspect in 2015 and is considered feasible. No satellite coverage analysis has been performed, but it is anticipated that satellite may also be viable.[16] For the purpose of this study, it has been assumed that communications for remote control of automated valves and gates would be via radio. Radio communications includes the use of base stations at each lake, IPID, and LNFH, and repeater stations.

The primary radio communications method considered for this Project is high frequency (UHF / VHF) radio at IPID and USFS established frequencies, which were evaluated as part of the 2015 Alpine Lakes Appraisal Study (See Figure 3). In general, direct radio communications coverage from the lakes to base stations are inconsistent without benefit of repeaters. IPID often sends and receives radio signals from some lakes, including Colchuck and Eightmile, using their existing repeater at Blag Mountain. However, limitations of this practice have not been explored. As evaluated in the 2015 Alpine Lakes Appraisal Study, radio repeater stations could be installed at intermediate high points outside the Wilderness area but within the Project vicinity to offer line-of-sight communications between lake locations and base station(s).

Radio repeater stations are very common in remote areas and are relatively inexpensive to install. Infrastructure consists of tower (anchored mast or structural frame), omni-

[16] Iridium Communications operates the Iridium satellite constellation which includes 66 active satellites to provide voice and data communications form satellite phones and transceiver units around the globe. In this case, the Iridium transceiver unit 9522B would be used. There would be a required data plan with ongoing fees – however benefits include potential greater flexibility and lower power use than radio options. An alternative vendor (Hughes / Immersat) may also be explored. Iridium is IP based whereas Hughes is not. The primary consideration related to satellite is coverage which, at minimum requires limited obstructions below 30-degree horizon. Sites could also have their own IP address allowing for login from any internet capable workstation.

directional antenna, radio transceiver (estimated 50 watt) and onsite power generation (solar panel and battery).

From a technical perspective, the preferred arrangement of new radio repeater stations includes a new radio repeater station at the Icicle Ridge site, a new radio repeater station at the Wedge Mountain site, and retention of existing IPID radio repeater infrastructure at Blag Mountain. Each new radio repeater station could be operated by IPID and added to the existing IPID FCC license. In addition to radio repeater station(s), a new radio base station could be added to USFWS facilities at LNFH to allow for independent communications and control of Snow Lakes release by USFWS.[17] Use of an IPID repeater at Wedge Mountain could be arranged through inter-agency agreement between USFWS and IPID for joint use of a new Wedge Mountain Repeater for operation of USFWS-managed lakes.[18] As an alternative, a new Wedge Mountain repeater could be owned and operated by the USFWS and licensed under National Telecommunications and Information Administration (NTIA) processing.

While not anticipated, permitting and property ownership constraints may limit the construction of radio repeaters at either of the preferred locations. In this case, radio communications may still be possible to / from the lakes with either repeater using strong base station transmitters (e.g., 25 watt radio transceivers).

It is recommended that additional field radio survey be conducted to test high power (e.g., 25 watt) signals between the more distant lakes and Wedge Mountain and between Snow Lakes and the Icicle Repeater, in conjunction with the Blag Mountain repeater and Peshastin base station.[19]

Power Supply

Due to remote site conditions, onsite power generation (DC) will be necessary. Readily available communications and controls equipment is typically provided in 12V DC, however the smallest DC motorized actuator considered as part of this study is available in 24V DC. This will require power regulation to step down from 24V to 12V which is inefficient but satisfactory.

A power budget was performed to conduct preliminary solar panel sizing and battery bank configuration. Power needs increase as a function of gate adjustment frequency and duration, communications frequency and other factors. Assumptions included in the power budget consist of the following:

- Gate adjustments may be limited to 5 minutes.
- Solar panels may be unavailable or unreliable during winter months.

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[17] Other configurations may be possible. For example, base station at LNFH could be avoided through internet connection and agreement between IPID, or USFW could own / operate the Wedge mountain repeater in lieu of IPID.

[18] IPID and USFW have shared rights associated with Snow Lakes. Currently USFW is performing mainteancne activities on existing release form Snow lakes to resort flows from 55 cfs to 85 cfs historical flows such that both IPID and USFS can have access to existing storage rights in Snow Lakes.

[19] If additional communications survey are performed, scope should include coordination with USFW and possibly be expanded to test satellite communications.

A summary of power loads by equipment type for both active and quiescent are provided in Table 7.

Table 7. Equipment Power Loads

Equipment	Active Draw (A)	Quiescent Draw (A)
Datalogger	0.01	0.0006
Pressure transducer	0.08	0.00008
RotorQ Actuator	7	0
24Vdc to 12Vdc regulator		0.00093
Crydom Solid State Relay	0.01	0
RF320 VHF radio transciever	1.2	0.025
RF500M radio modem	0.015	0.00035

Power consumption varies by the duration of operation of each unit, which varies dependent upon whether daily or weekly gate adjustments are performed. Equipment runtime duration is provided in Table 8.

Table 8. Equipment Runtime Duration

	Daily Adjustment (seconds / day)		Weekly Adjustment (seconds / week)	
Equipment	active	quiescent	active	quiescent
Datalogger	7.08	292.92	5.3	294.7
Pressure transducer	1.5	298.5	1.5	298.5
RotorQ Actuator	300	86100	300	604500
24Vdc to 12Vdc regulator		86400		86400
Crydom Solid State Relay	300	86100	300	604500
RF320 VHF radio transciever	600	85800	600	604200
RF500M radio modem	600	85800	600	604200

Power supply will be provided through onsite solar generation stored in 12V batteries. Power requirements for both daily and weekly adjustments were evaluated for both summer-only and year-round operations. Solar panel sizing was determined by daylight hours available (per month based on latitude, solar exposure, obstructions) and power draw. Further, a power reduction factor was applied to account for reducing rated battery amp-hours due to temperature drop in the winter months.

Daily solar resource availability (kWh/m2/Day) was determined from us of Photovoltaic Solar Resource provided by National Renewable Energy Laboratory (U.S. Department of Energy, 2008), see Figure G1 of Appendix F. Daily average solar resource value by month is provided in Figure 5.

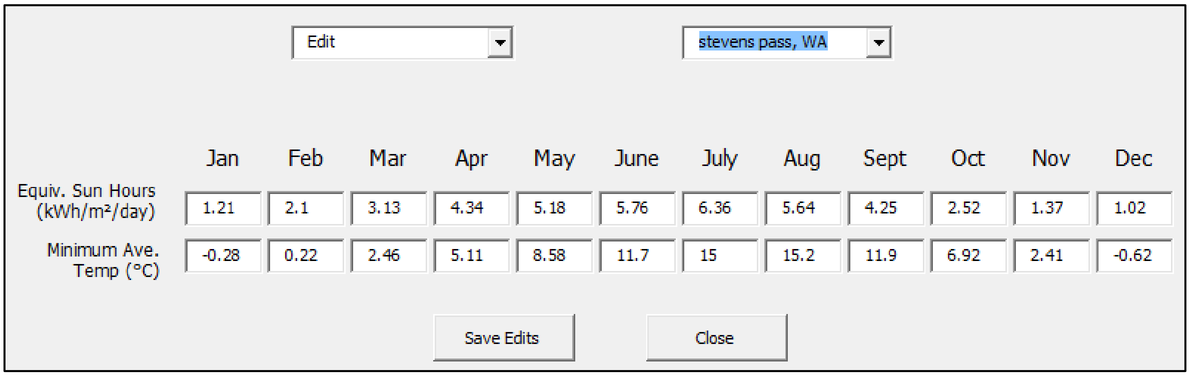

Figure 5. Solar Exposure Analysis

The combination of solar power generation and power consumption based on four scenarios is provided in Table 9.

Table 9. Solar and Battery Sizing for Summer/Fall Operation

Coms/Adjust Frequency	Daily		Weekly	
	Solar Size (Watts)	**Battery Size** (Ahr)	**Solar Size** (Watts)	**Battery Size** (Ahr)
Summer Only	13	29	7	16
Year-round	52	207	27	117

Capital Cost Estimates

Capital Costs

Opinions of probable costs were developed for implementation of the proposed Project and includes both hard costs (costs related to construction) and soft costs (costs related to engineering, planning, and administration). A detailed opinion of probable implementation costs or capital costs with quantities is included in Appendix G.

Hard costs include direct construction costs such as capital improvements and sales tax. Hard costs were estimated at approximately $875,000[20] using detailed quantities in conjunction with unit pricing from several available resources including RS Means (Costworks), APWA/SPU data, WSDOT unit bid tabulation (parametric estimating), experience with similar projects (analogous estimating), and engineering judgement. The following assumptions were made in development of hard costs for this Project:

- Washington state sales tax = 8.2 percent (Washington State Department of Revenue, based on location of project site); and
- Construction Contingency = 25 percent

[20] Costs associated with gate improvements and automation at Eightmile lake are excluded from this study and are covered in the *Feasibility Study Eightmile Lake Improvements (expected 2017).* Furthermore, control valve improvements at Snow Lakes are excluded from these costs – however, automation improvements at Snow Lakes are included in this estimate.

Soft costs include planning, engineering, permitting, miscellaneous overhead, and other administrative and non-construction costs. For purposes of this project, soft costs were estimated as 20 percent of the hard costs.

Operations and Maintenance Costs

Average annual ongoing operations and maintenance (O&M) costs of $37,500 have been estimated based on periodic routine maintenance and replacement of mechanical equipment, staff time required to operate equipment, electrical/power costs needed to operate pump infrastructure. While some O&M costs would be relatively consistent on a yearly basis (e.g., routine exercise of isolation valves), some mechanical items have relatively short life expectancy compared to the design life of the project and will require periodic repair/refurbishment or replacement (e.g., 25-year design life of mechanical equipment). Other equipment is epected to have relatively short life expectancy (e.g., 10 years for electrical equipment and 5-years for batteries). For the purpose of this estimate, O&M costs have been converted to average annual dollar amounts despite likely year over year variations in costs as indicated. The opinion of probable long-term O&M costs is included in Appendix G.

Environmental Considerations, Permitting Strategies and Potential Project Impacts

Property Ownership

Discussions regarding use of both repeater stations have commenced; however, no formal negotiations have taken place. The two repeater sites under consideration are the USFS site and the Johnson's for Icicle Ridge and Wedge Mountain, respectively.

On February 21, 2017, Aspect met with Rob Johnson and Robin John of Post Hotel, who own the Wedge Mountain property. They expressed willingness to engage in future discussions about the use of the property and stated that they are not opposed to the concept. Conditions they expressed consist of access security, market compensation for use of land, aesthetics and not unreasonably encumbering future use of the site. If they choose to utilize the site in the future for another purpose (e.g., a guest amenity such as a lookout), they may request that the radio equipment be installed on any new permeant structure rather than as a standalone site appurtenance.

On March 8, 2017, Tony Jantzer spoke with Howard Banks of the USFS supervisory electronics tech of Region 6. According to Mr. Banks, the existing Icicle Ridge repeater equipment is fully built-out and there is likely no extra room for equipment on the existing mast. The USFS may be open to IPID using adjacent space for a new repeater under a Special Use Permit. Tony is working with Kevin Smith, who is the special use permit writer for Region 6 to discuss permitting. A copy of the special use permit application is provided in Appendix C.

Aesthetic Impacts

Project impacts related to aesthetics are expected with automation improvements. Some impacts may be mitigated through enclosures with natural appearance (e.g., faux rock or decorative enclosures) whereas other improvements may be visible but concealed with natural features (e.g., solar / radio antenna concealed in tree). Improvements are illustrated in Figures 6 through 10.

Communications Equipment

Onsite remote power and communications will be provided by a combination of solar panels and a directional antenna which must remain exposed (thereby visible) to maintain functionality. The most dramatic power supply scenario includes a 50-watt solar panel, which is relatively modest in size (approximately 30 x 24 inches). In most cases, 20-watt solar panels will be sufficient, which are less than half that size. Radio signal will rely on directional yagi antenna which are relatively small in size (approximately 36 inches in length and 12 inches tall). Both the radio antenna and solar panels have an industrial appearance which is unavoidable; however, it is anticipated that both units could be tree mounted, which will aid in concealment.

Enclosure

Many enclosure options are feasible, and consist of a wide variety of materials and configurations. Criteria involved in selection of enclosure type include security, durability, aesthetic value, and fire resistance.

Typical remote site enclosures for monitoring equipment could follow the USGS measurement and computation of streamflow manual which consists of vertical corrugated metal pipe with silo roof. This would be an economical solution for most sites with an appearance that is familiar to outdoors enthusiasts. This configuration however would have an industrialized appearance which may be less favorable than other options.

Another option that may provide high aesthetic value would be decorative stamped reinforced concrete which would provide maximum benefit from multiple perspectives, including security and fire protection. Many modern concrete techniques are available to help create natural appearance including stamping, pigment, and acid stain.

Permitting

A variety of state, local, and federal agency permit authorizations will be required to facilitate construction of automation improvements. These permits are being coordinated through programmatic environmental impact study (PEIS) which is scheduled for comment period in 2018. A summary of key permits is provided below.

Clean Water Act Section 404 review

Work within jurisdictional waters of the US requires a U.S. Army Corps of Engineers (Corps) Nationwide Permit (NWP) / NEPA Categorical Exclusion (CatEx) are the likely level of regulatory compliance for this project. Compliance with General Conditions 20 would require completion of a preconstruction notification (PCN), acknowledging potentially eligible resources pursuant to the National Historic Preservation Act; however, given the nature of the activities, it is anticipated that minimal review would be required and would most likely apply only to activities proposed at Eightmile Lake. PCN is fulfilled by filling out the Washington State Joint Aquatic Resources Permit Application (JARPA).

Corps permit evaluation will address consistency with Endagered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, National Historic Preservation Act, and Fish and Wildlife Coordination Act (federal action) – which are triggerd by Federal action. Review is anticipated to be relatively straightforward for the proposed project activities. USFS would most likely serve as the federal lead agency responsible for demonstrating applicable compliance with federal regulations at lakes where a special use permit is deemed necessary.

USFS Special Use Permit

Work on USFS lands not covered by easement requires special use permit by USFS which is likely required at Snow Lake and Square Lake, use of Icicle Ridge Repeater site and possibly Colchuck Lake.

IPID has requested and obtained copies of special use permit applications regarding use of the Icicle Ridge Repeater site and is in contact with local Forest Service staff who maintain this facility.

CWA Section 401 Water Quality Certification

Project may be subject to Section 401 of CWA. There is a streamlined review process (e.g., approval letter issued when Clean Water Act NWP conditions are adhered to).

Federal Communications Commission

Federal Communications Commission (FCC) approval may be required for radio repeater placement. Federal review consistency likely to be addressed by work completed by Corps or USFS as indicated in Note 3. IPID currently operates existing repeater and base stations under FCC licensure. Relocating existing and adding new repeater and base sites to existing licenses is permissible and processed through

Ecology Water Right Permit

A new water right permit issued by Department of Ecology will be required for adding instream flows as secondary uses.

WDFW Hydraulic Project Approval

Hydraulic Project Approval is required for any work affecting bed/flow of state waters. Jurisdiction and permitting authority is with Washington State Department of Fish and Wildlife.

WDNR Aquatic Use Authorization

Work within state aquatic lands. Compliance handled through the JARPA review process and expected to be minimal.

Chelan County Shoreline Substantial Development Permit/Conditional Use Permit

Work within state shorelands). May not be required. Need to confirm with Chelan County. IPID would be the applicant, but presumably PEIS and related federal permits/approvals would provide information needed to make permit decision if required.

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Limitations

Work for this project was performed for the Chelan County Natural Resources Department (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

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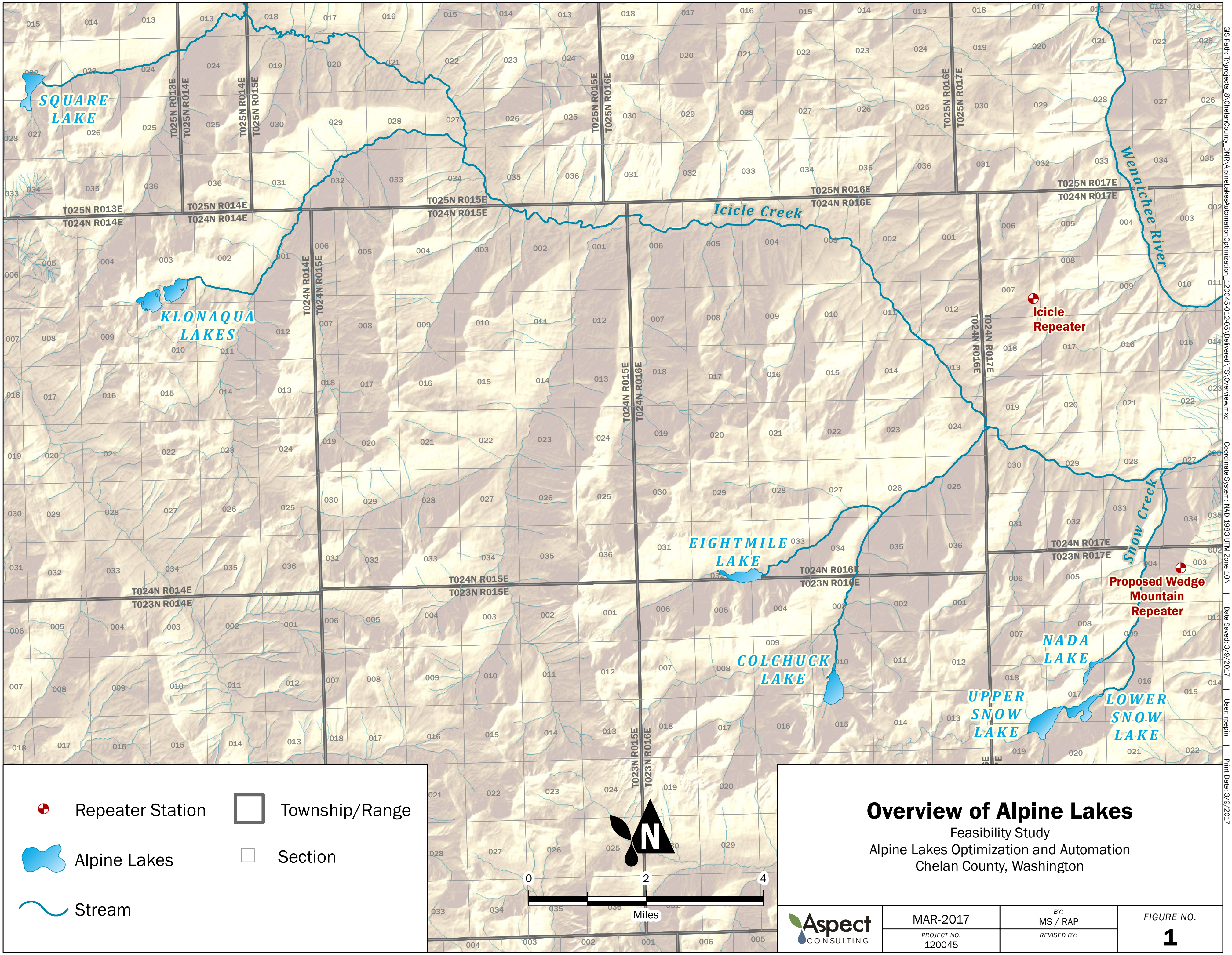
FIGURES



Overview of Alpine Lakes

Feasibility Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

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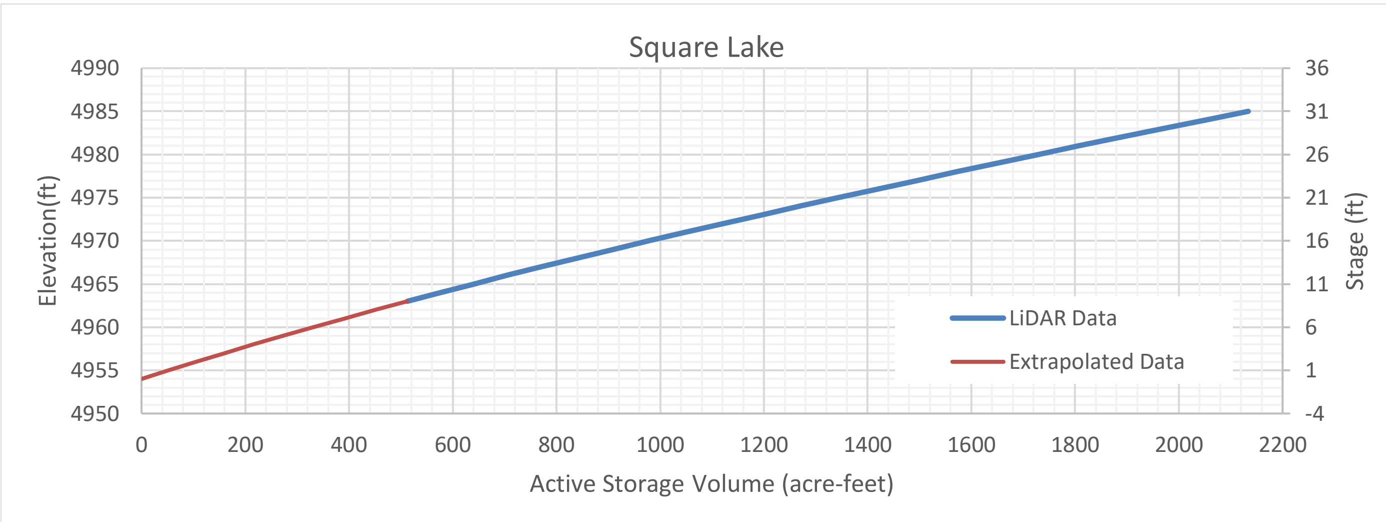
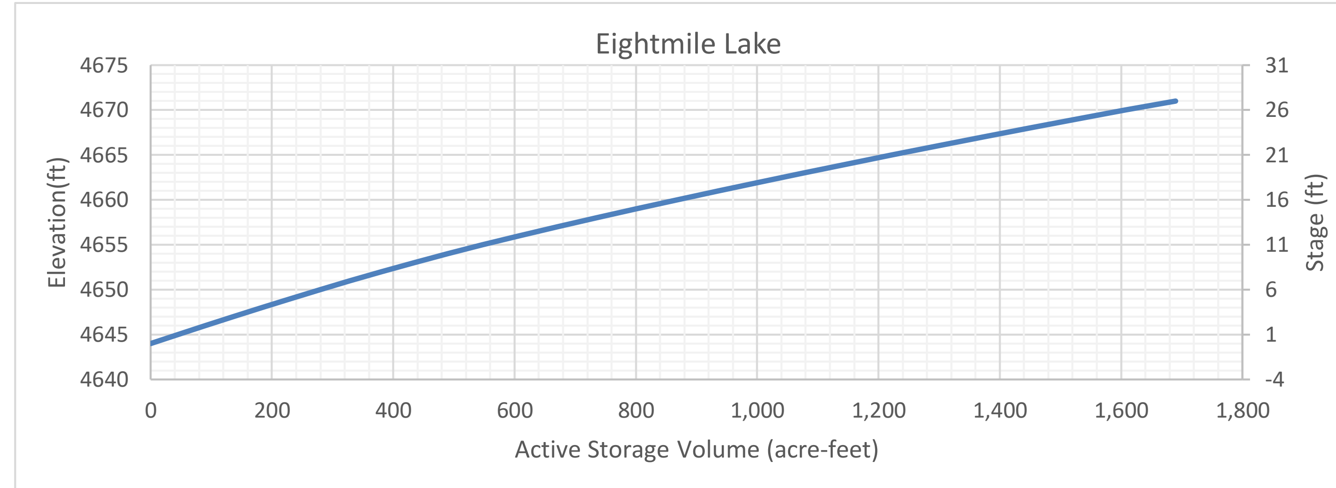
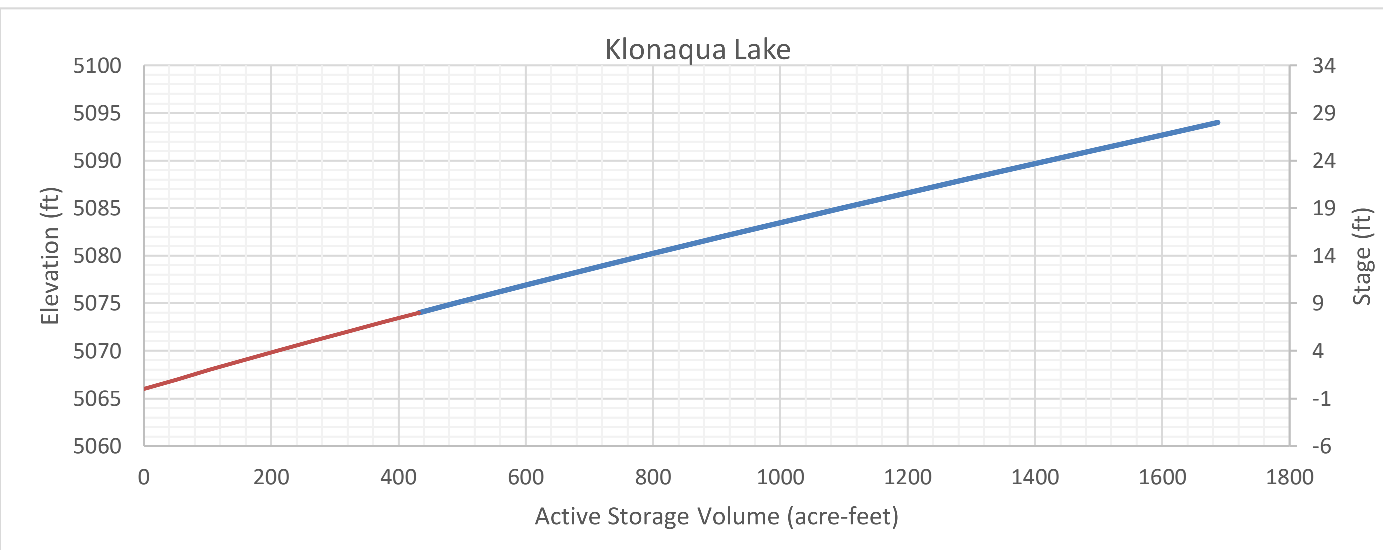
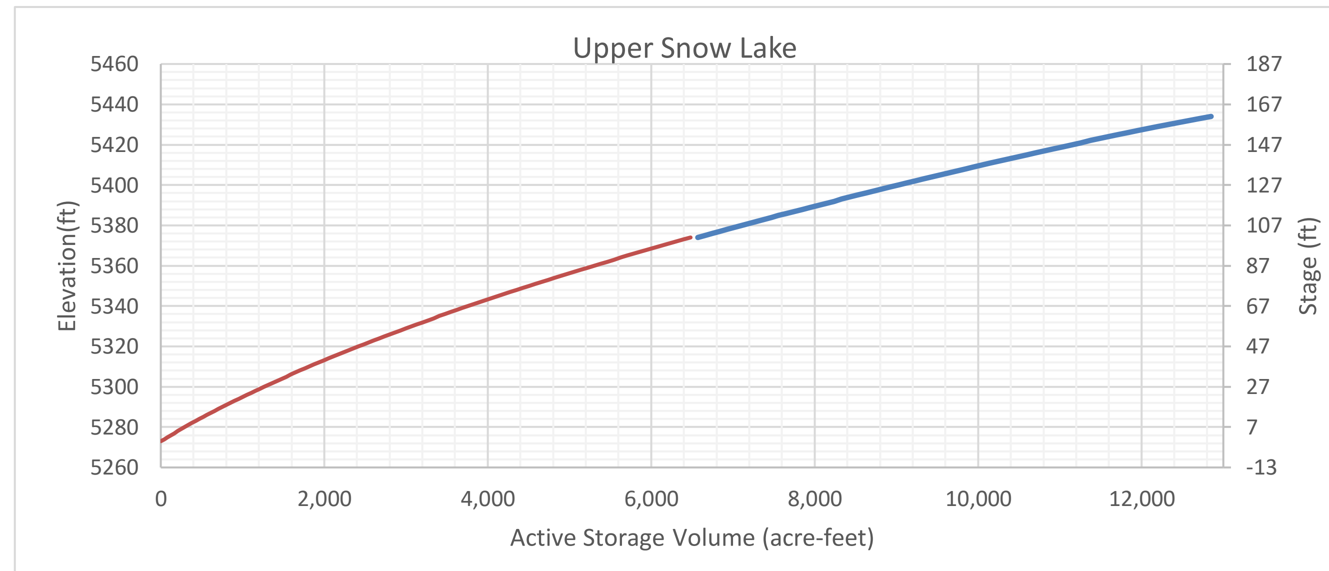
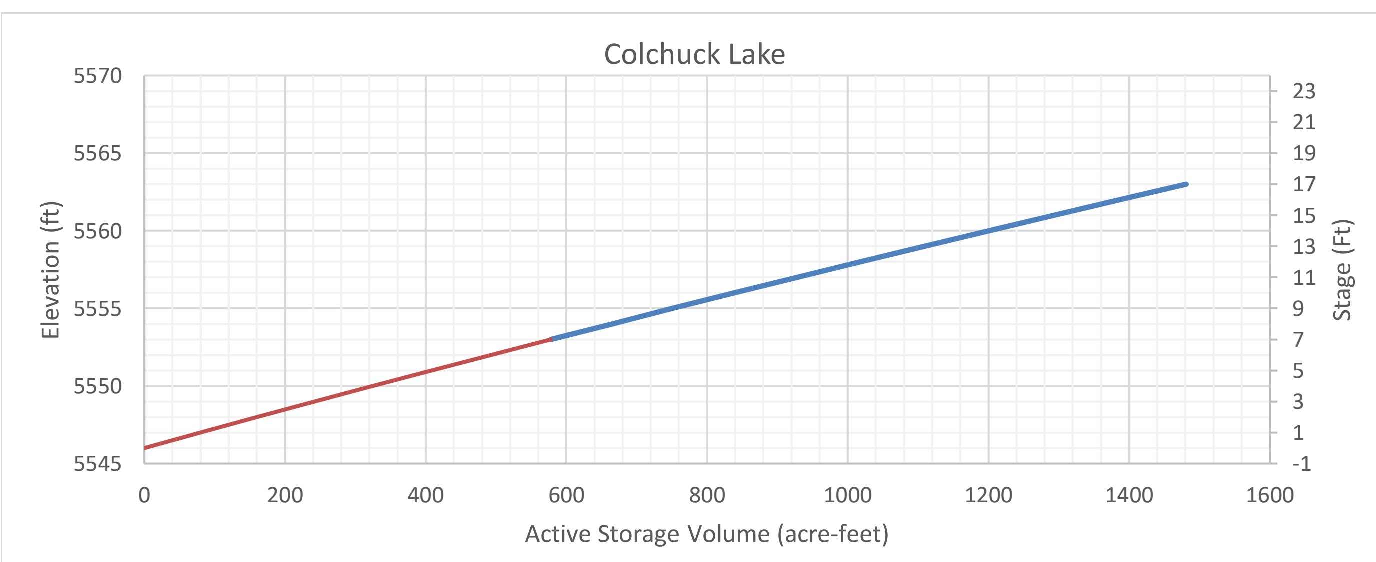
	PROJECT NO. 120045	REVISED BY: - - -	1











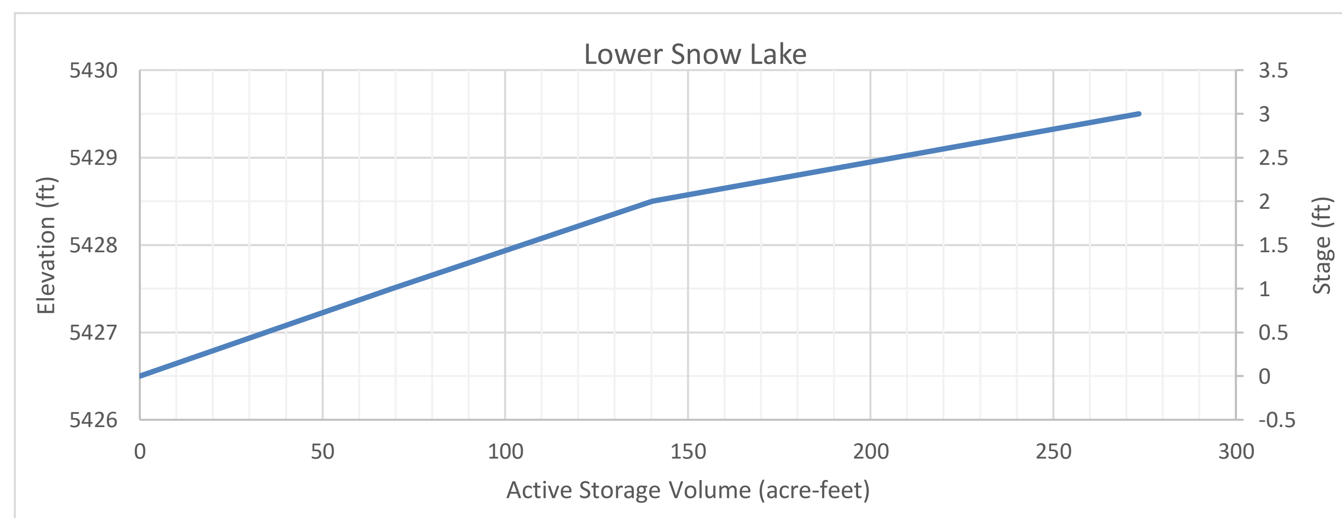


Figure 2
Stage-Storage Relationships
Alpine Lakes Automation Feasibility
Chelan County, WA

Aspect Consulting
4/30/2018
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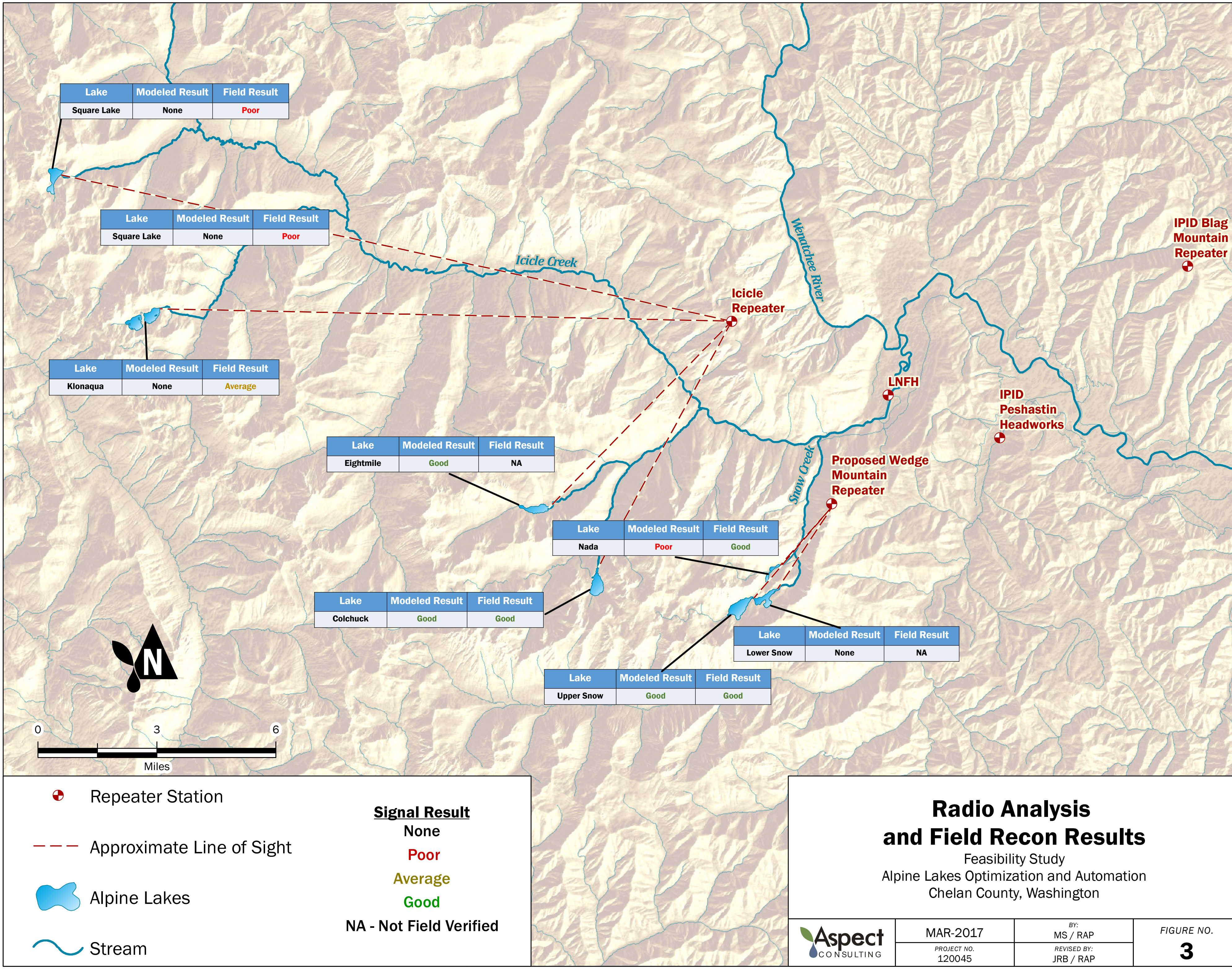

Radio Analysis and Field Recon Results

Feasibility Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

Aspect CONSULTING	MAR-2017	BY: MS / RAP	FIGURE NO.
	PROJECT NO. 120045	REVISED BY: JRB / RAP	3

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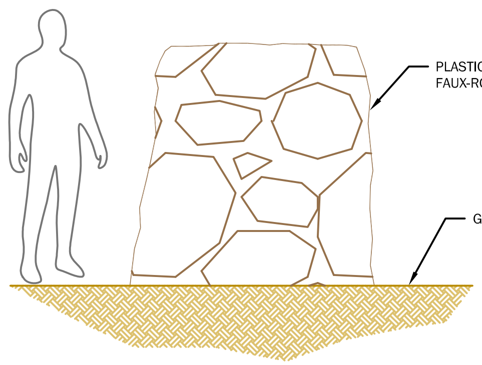
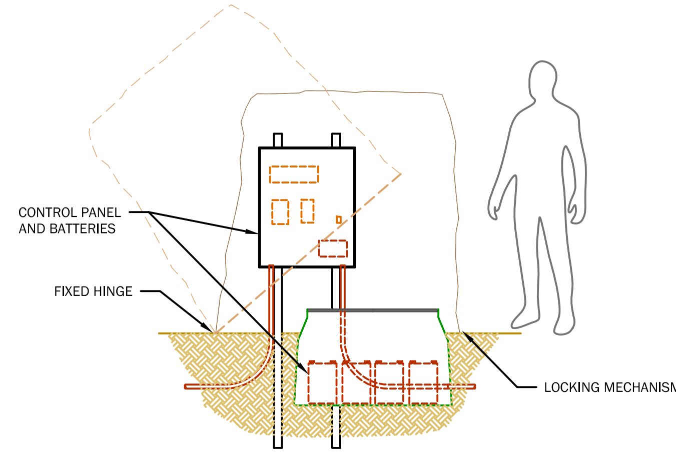


Molded Plastic Rock Enclosure
(FRONT VIEW)



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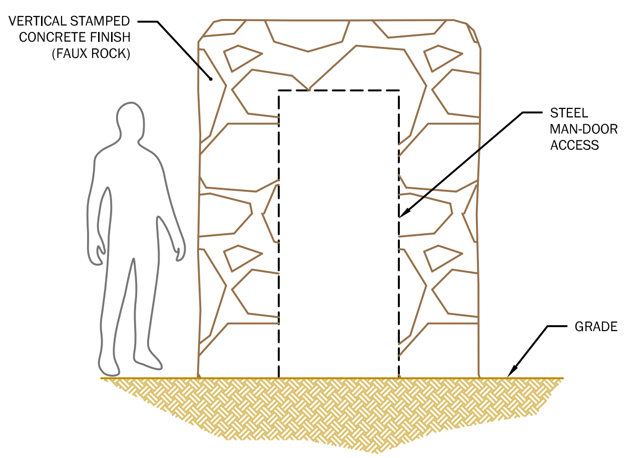
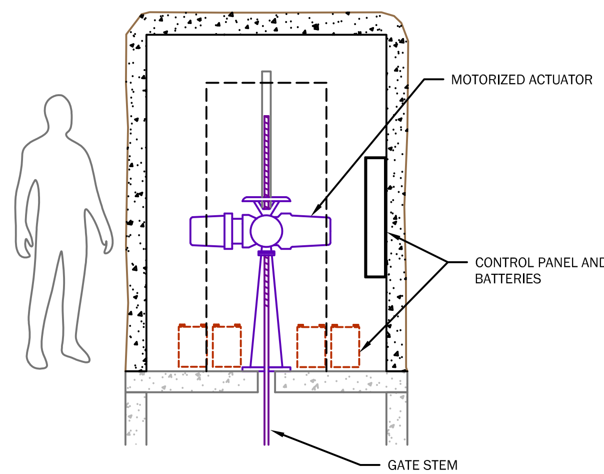
(SECTION VIEW)



Stamped Concrete Enclosure
(FRONT VIEW)



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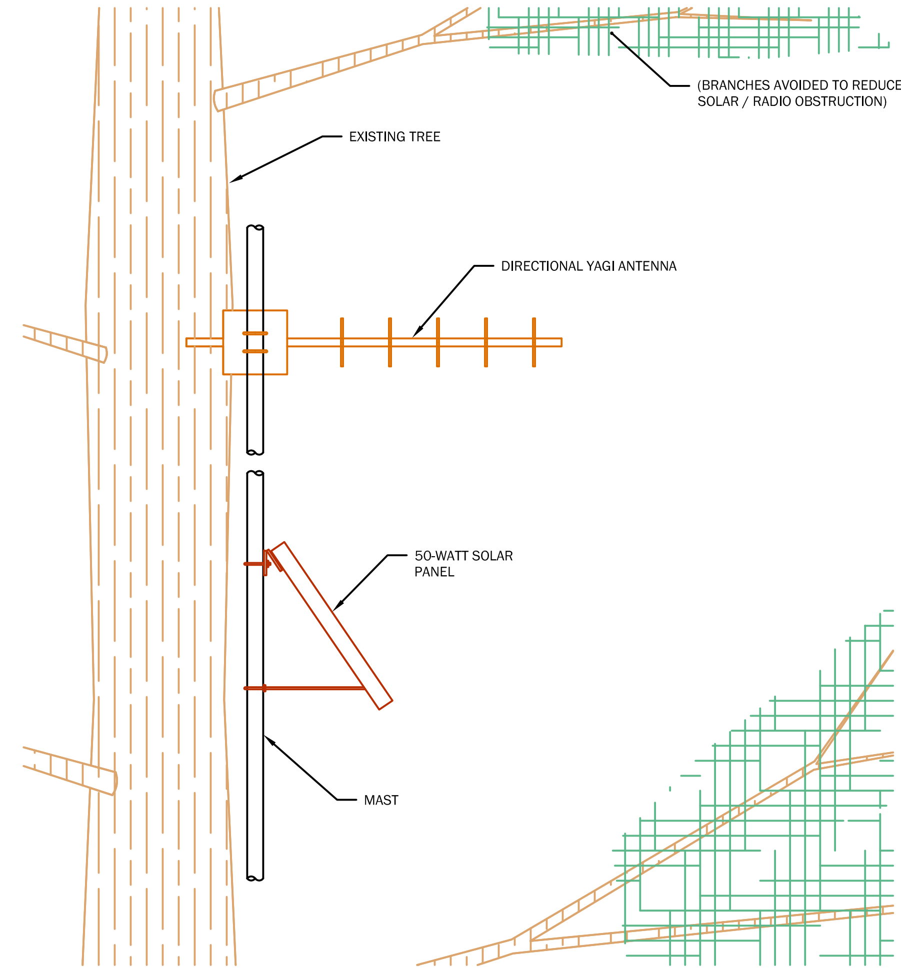
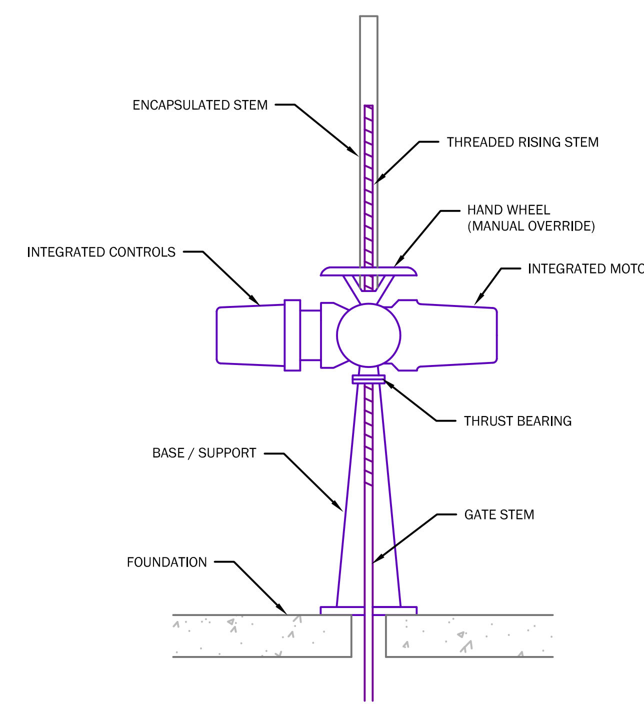
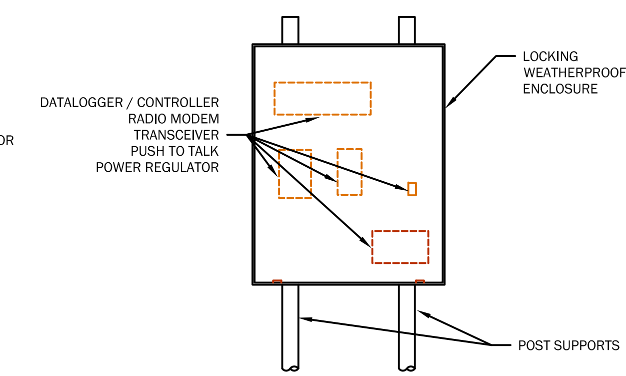


Solar Panel / Antenna



Motorized Actuator



Control Panel

Aspect CONSULTING

DATE: JUL 2016
REVISION: -
PROJECT NUMBER: 000000
DESIGNED BY: -
DRAWN BY: SCC
REVISED BY: -

Typical Improvements

Alpine Lakes Automation
Leavenworth, Washington

SHEET REFERENCE NUMBER:
Fig 4
SHEET OF

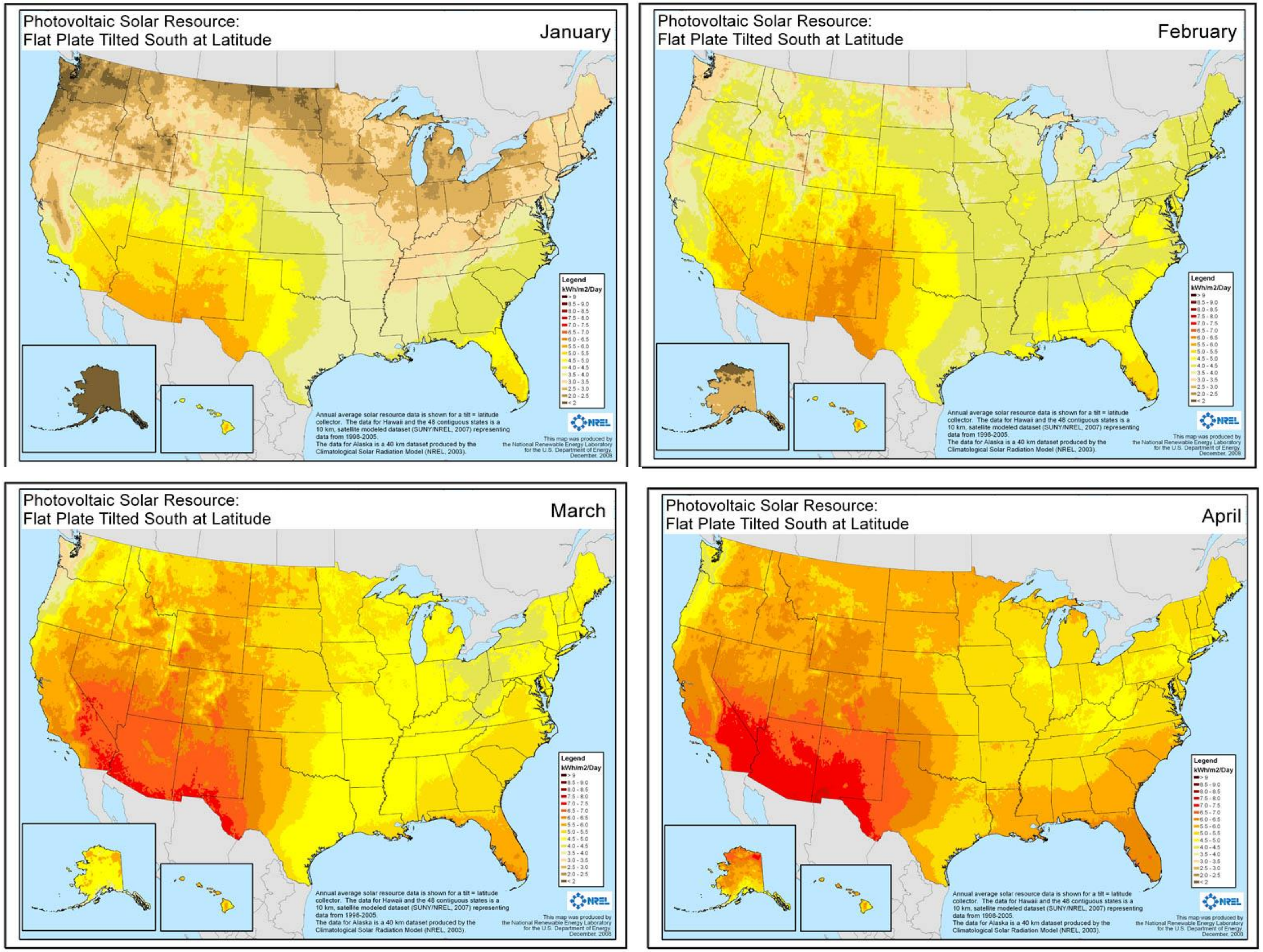
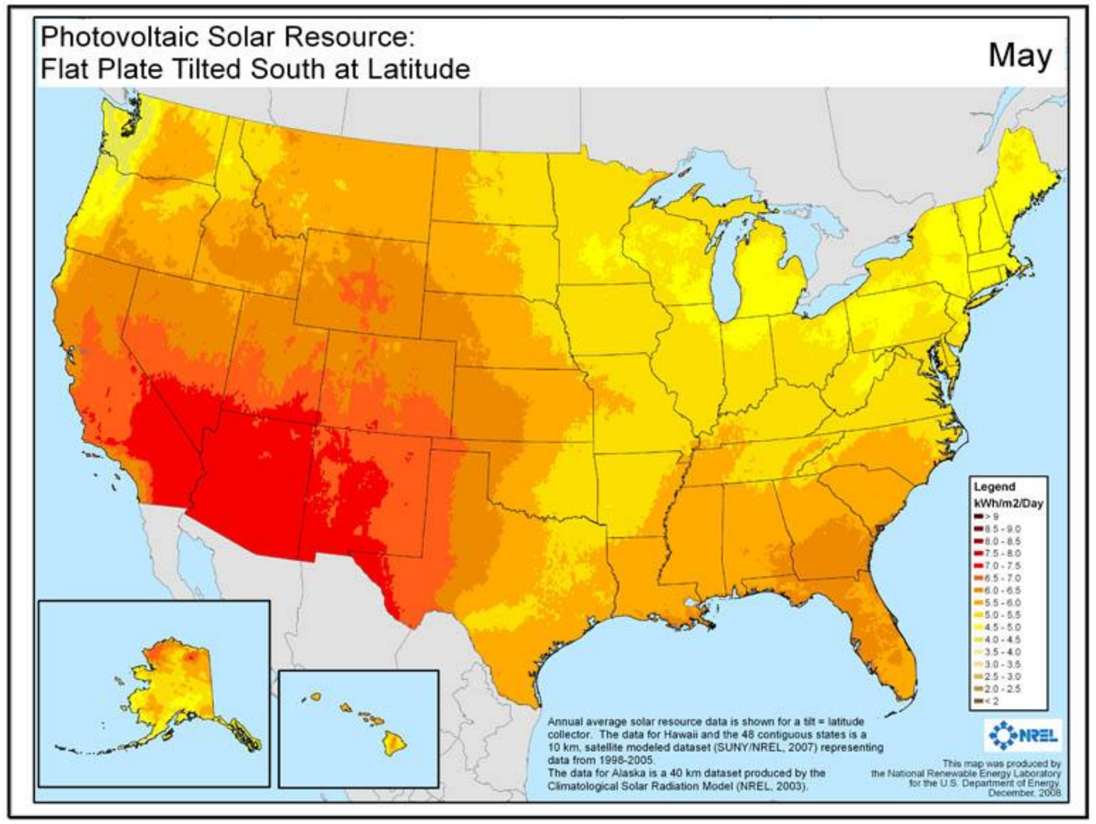
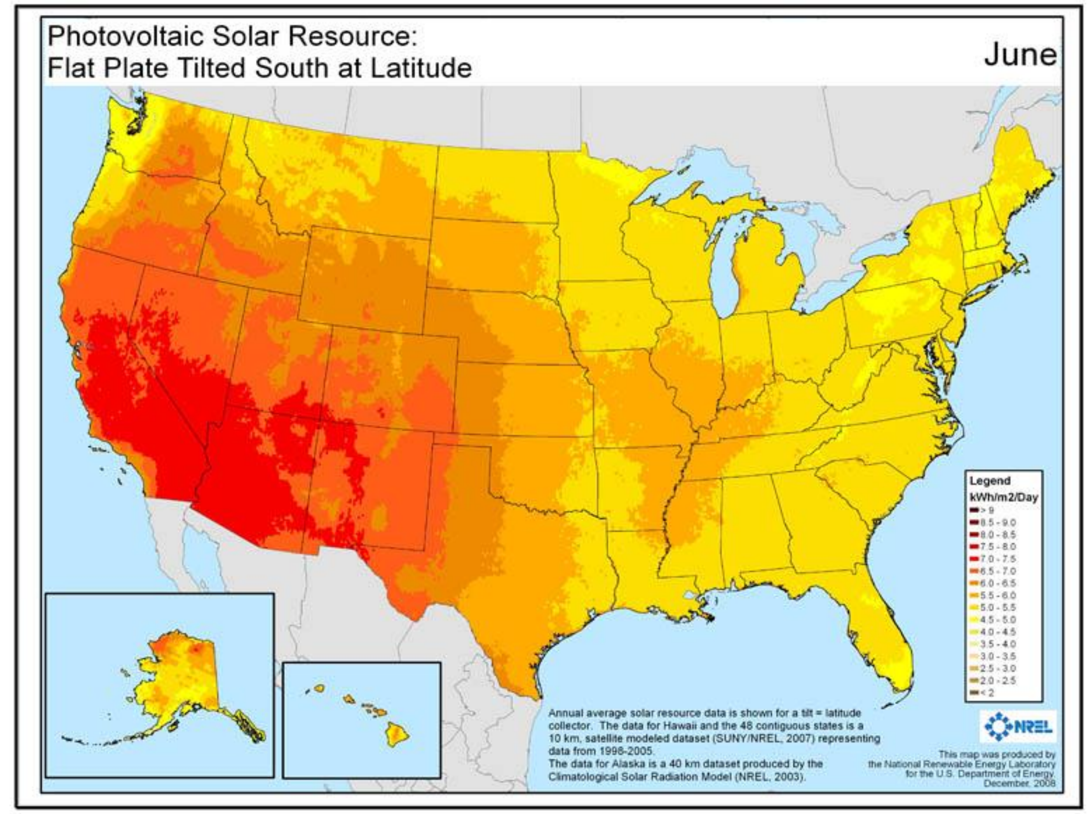
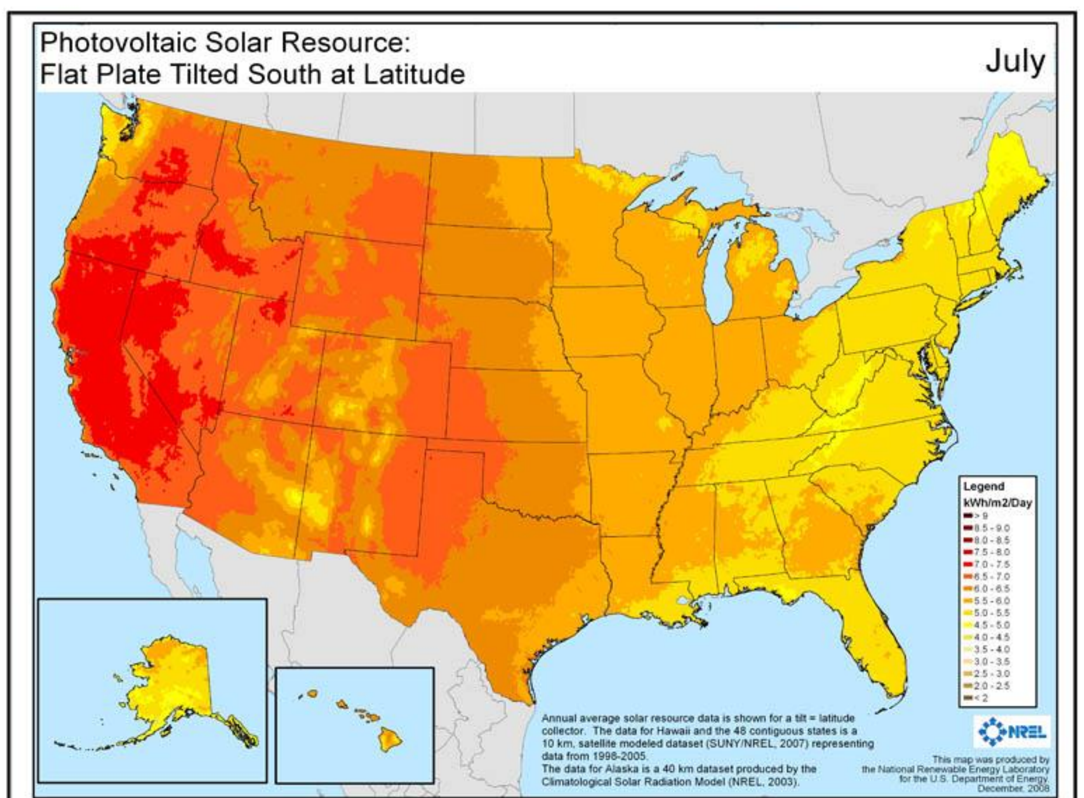


Figure 5
Photovaltaic Solar Data
Alpine Lakes Automation Feasibility
Project No. 120045, Alpine Lakes, Chelan County, WA







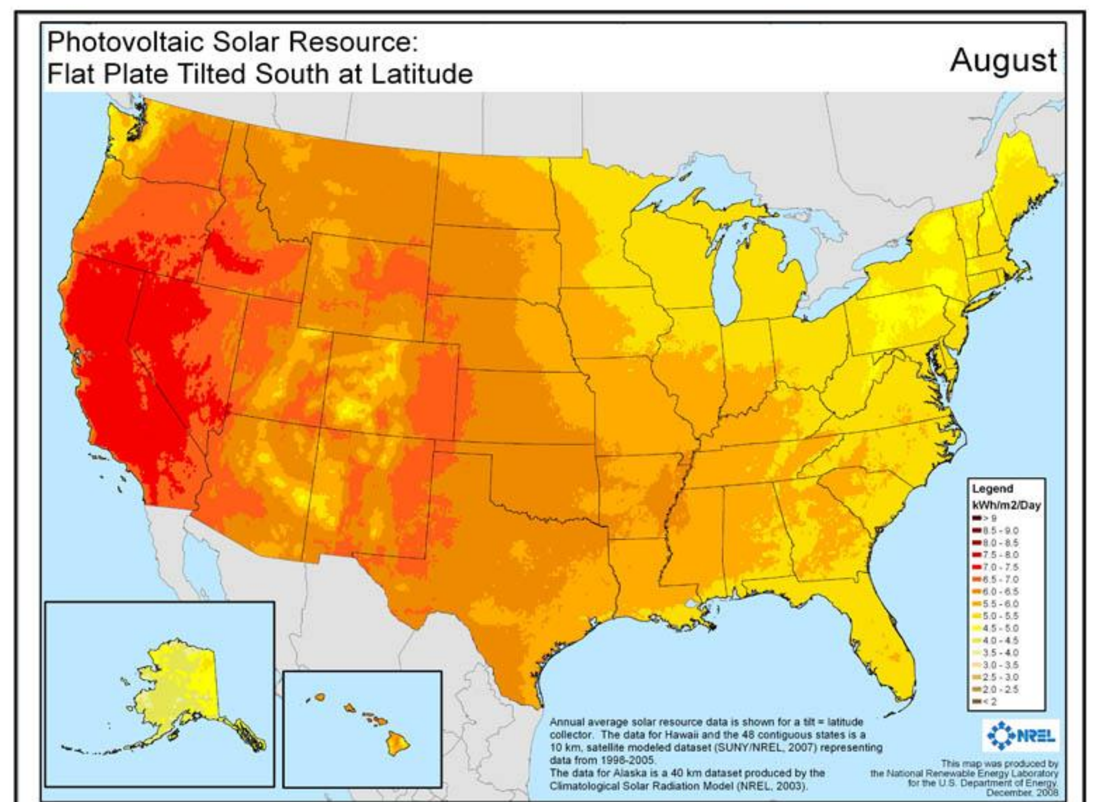
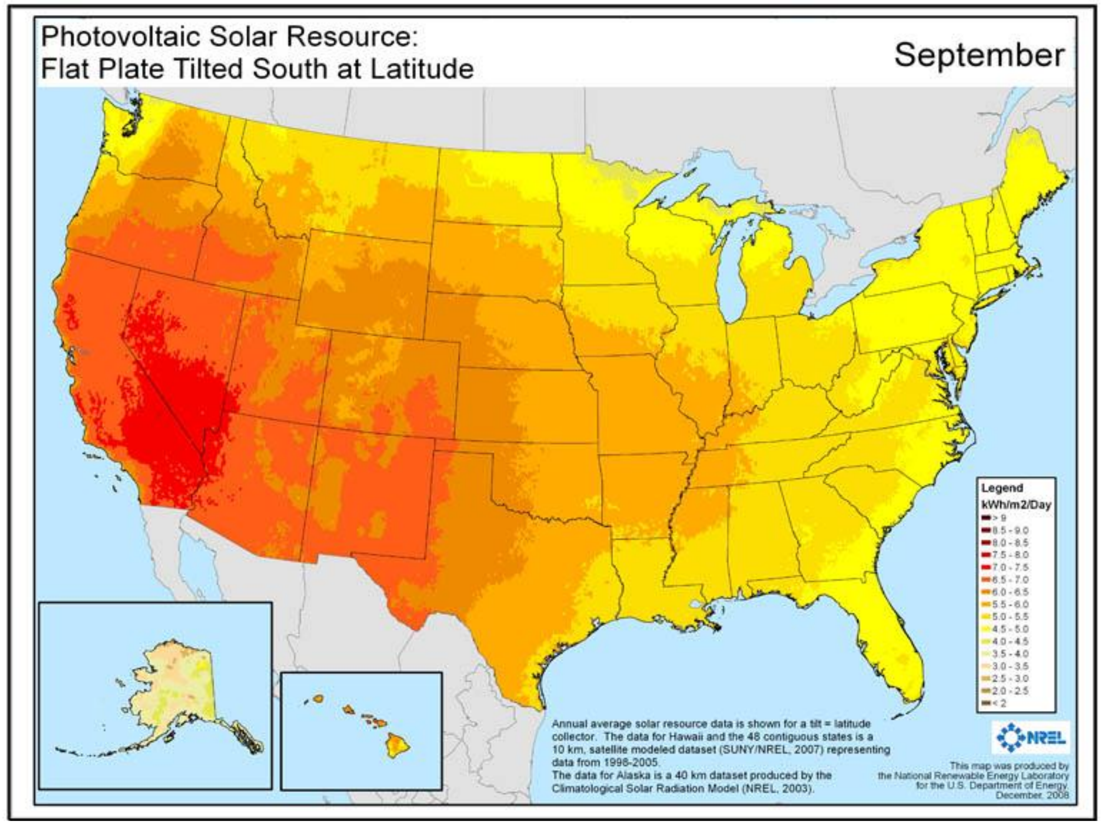
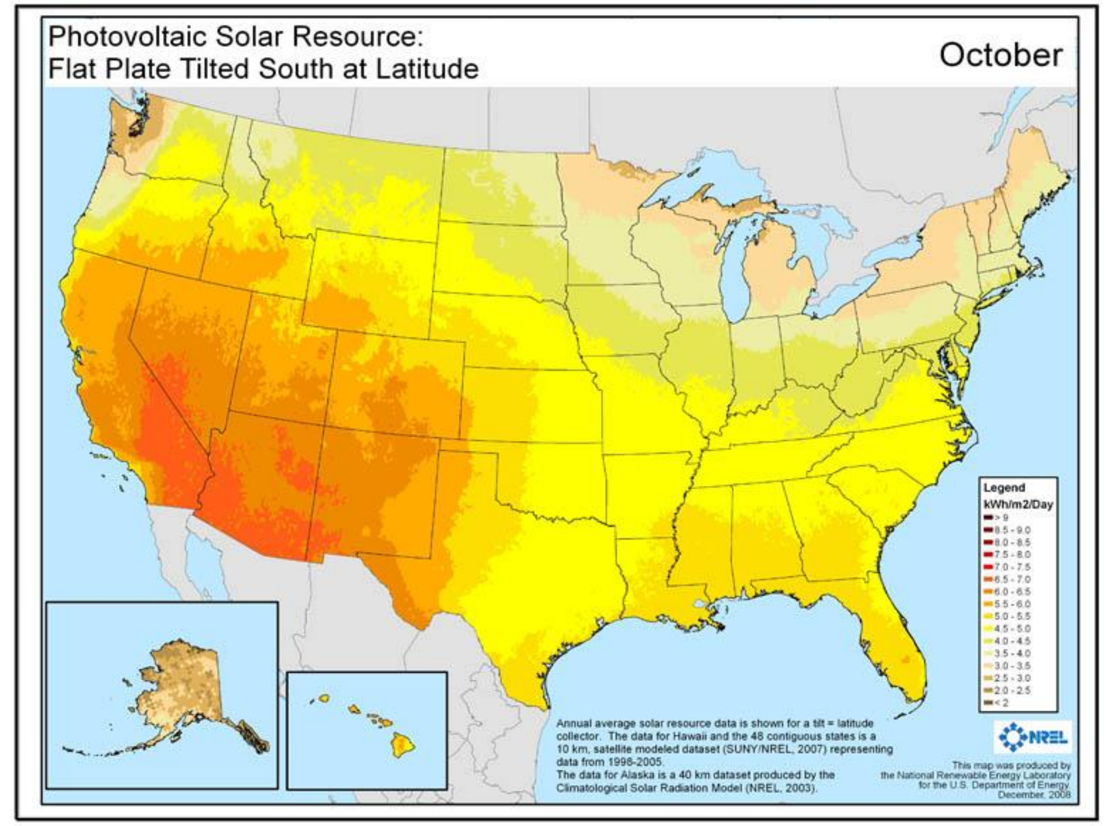
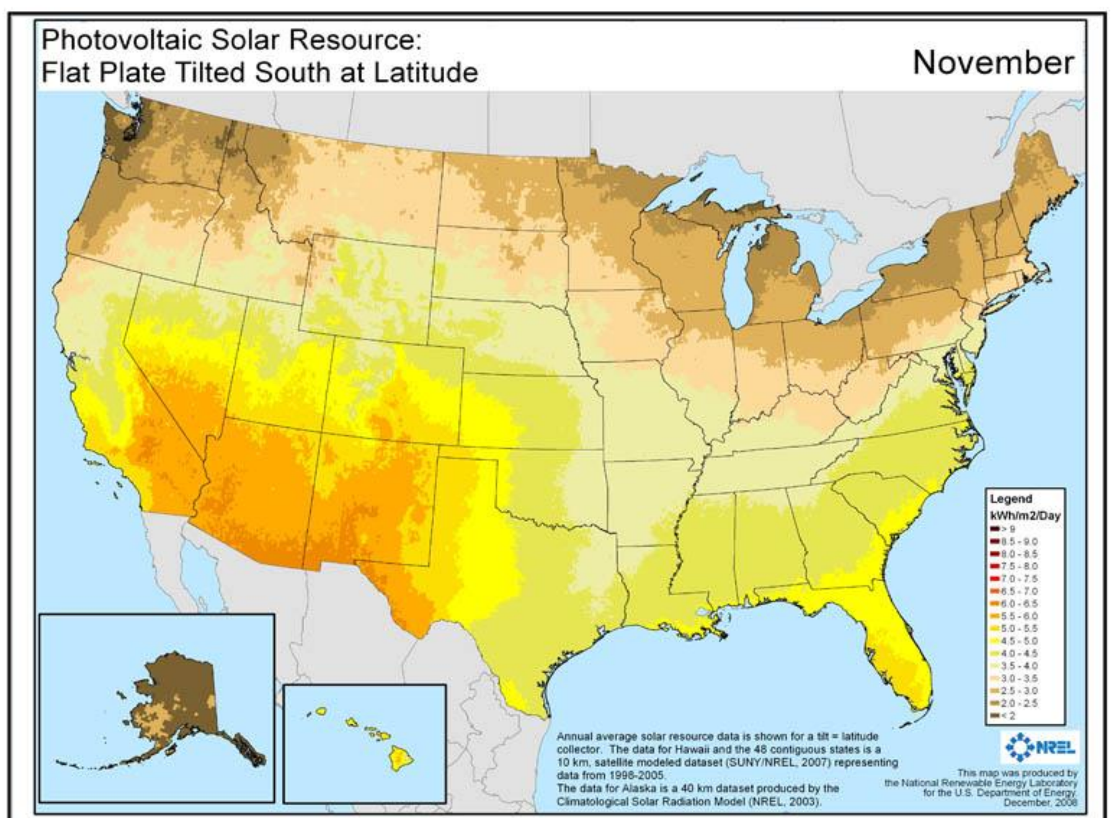


Figure 5
Photovaltaic Solar Data

Alpine Lakes Automation Feasibility
Project No. 120045, Alpine Lakes, Chelan County, WA







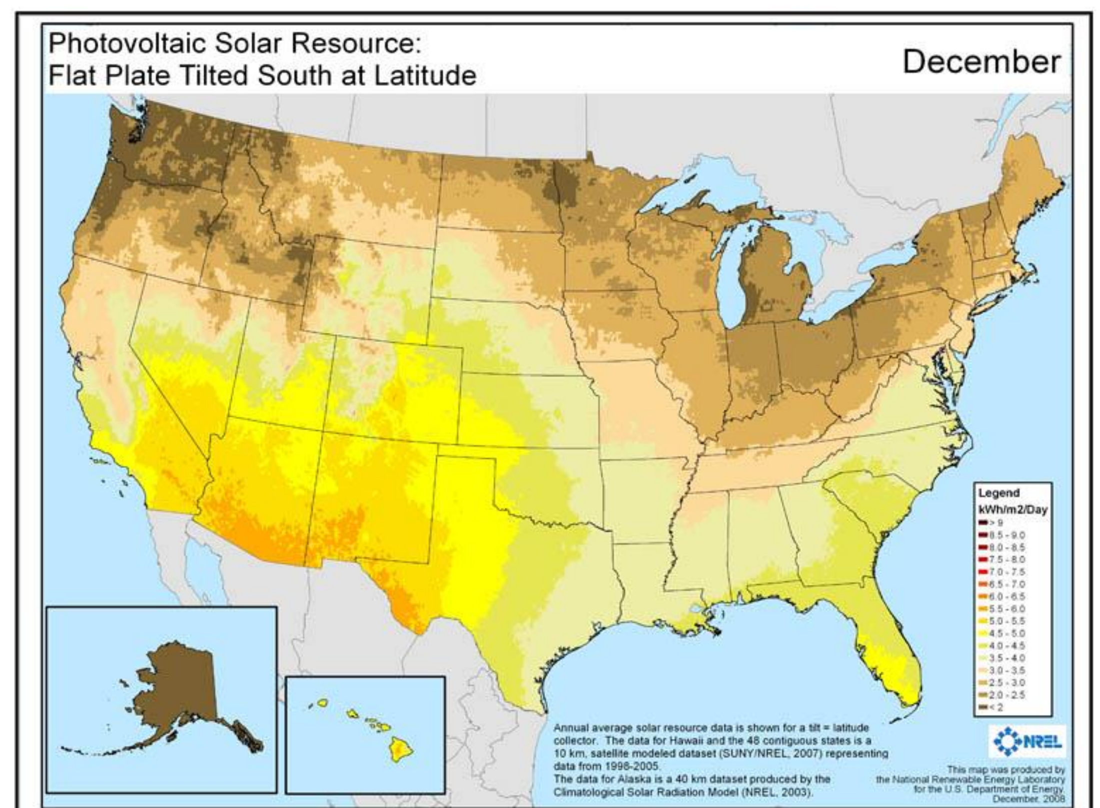


Figure 5
Photovaltaic Solar Data

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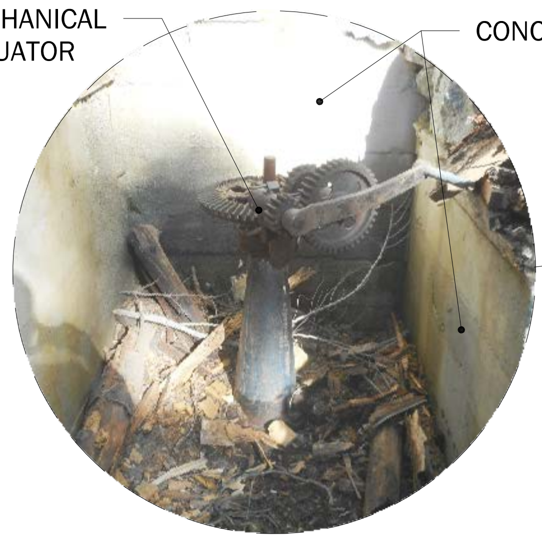

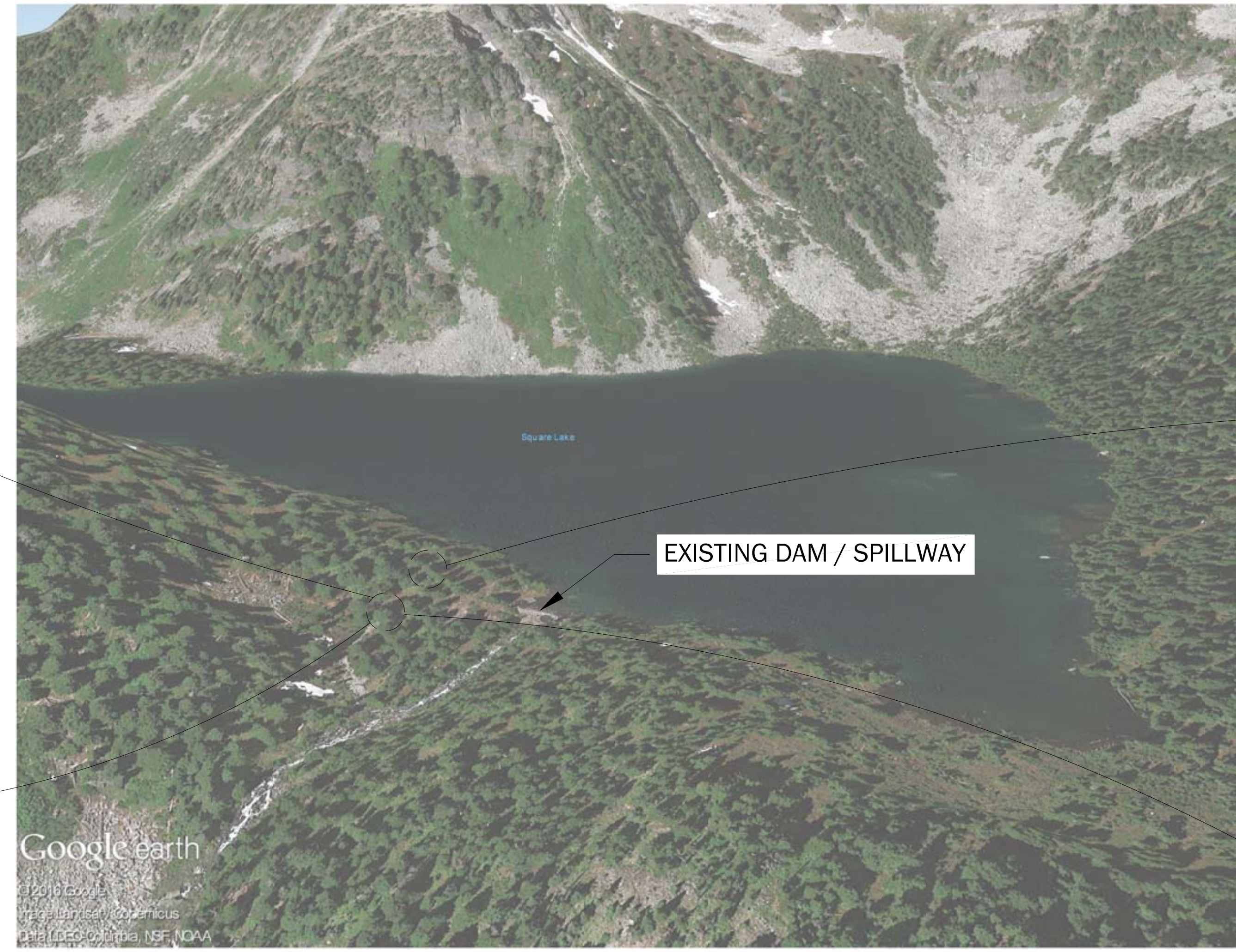

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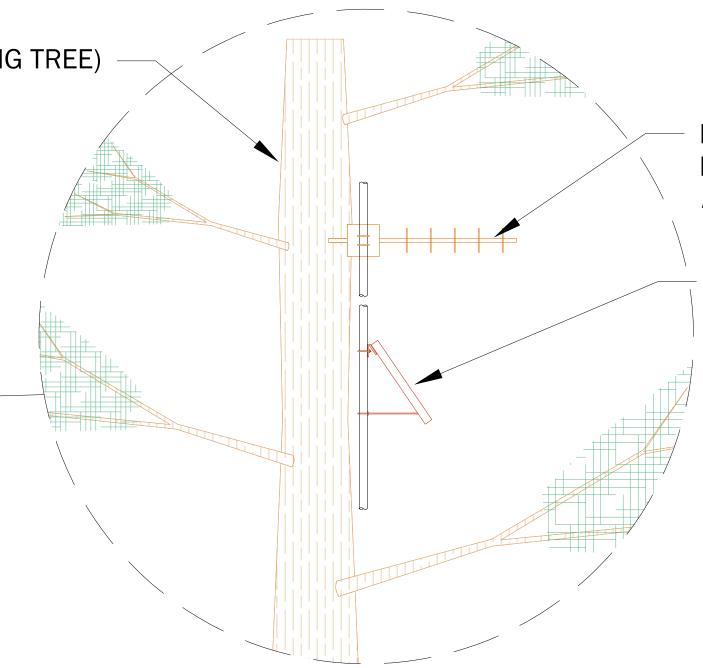

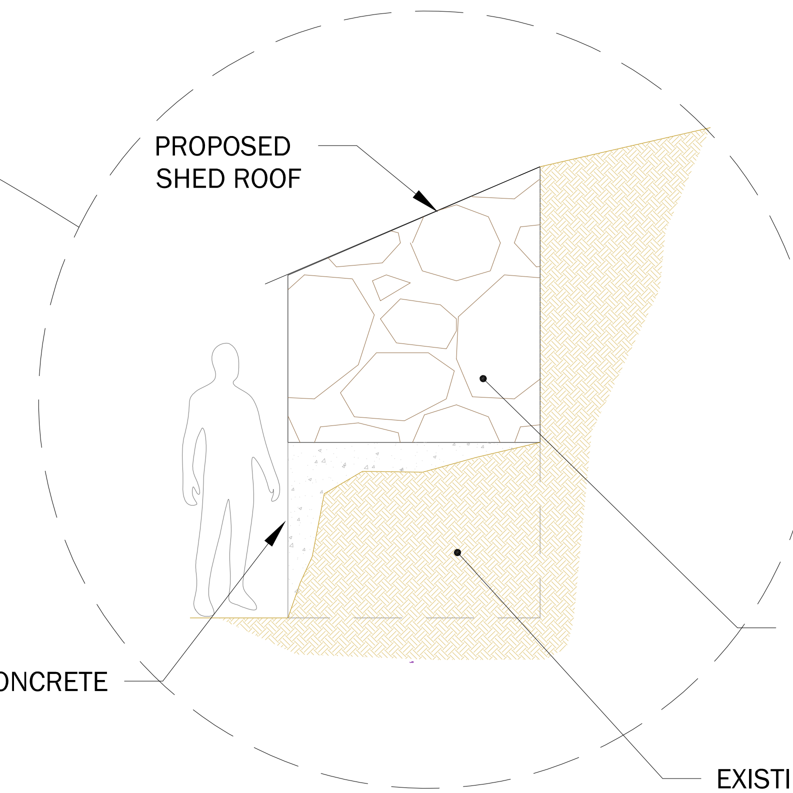

DRAWN-DOWN APPEARANCE

July (Full Stage)

September (Partial Stage)

August (Partial Stage)

October (Empty Stage)

Aesthetic Impacts
Square Lake Automation

Feasibility Study, Alpine Lakes Automation Improvements
Leavenworth, Washington

Aspect CONSULTING	Mar-2017	BY: JRB	FIGURE NO.
	PROJECT NO. 120045	REVISED BY: -	6

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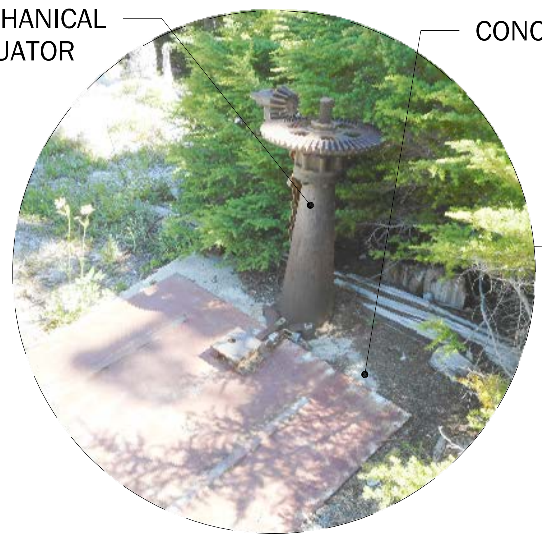

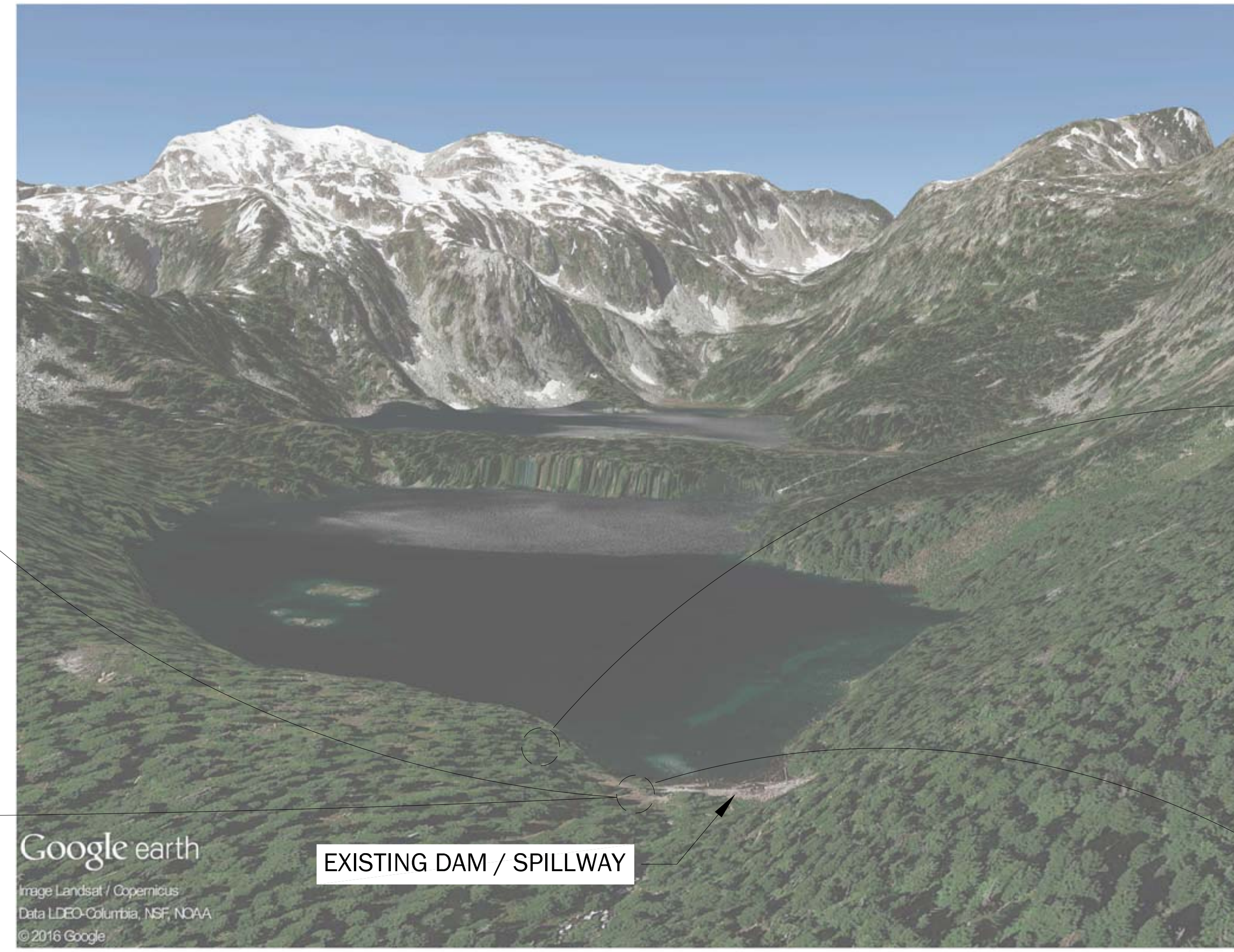

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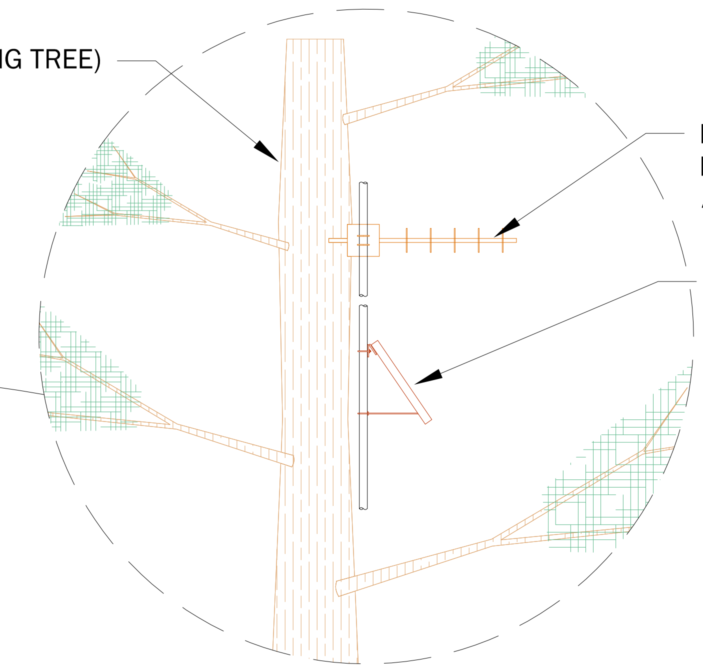

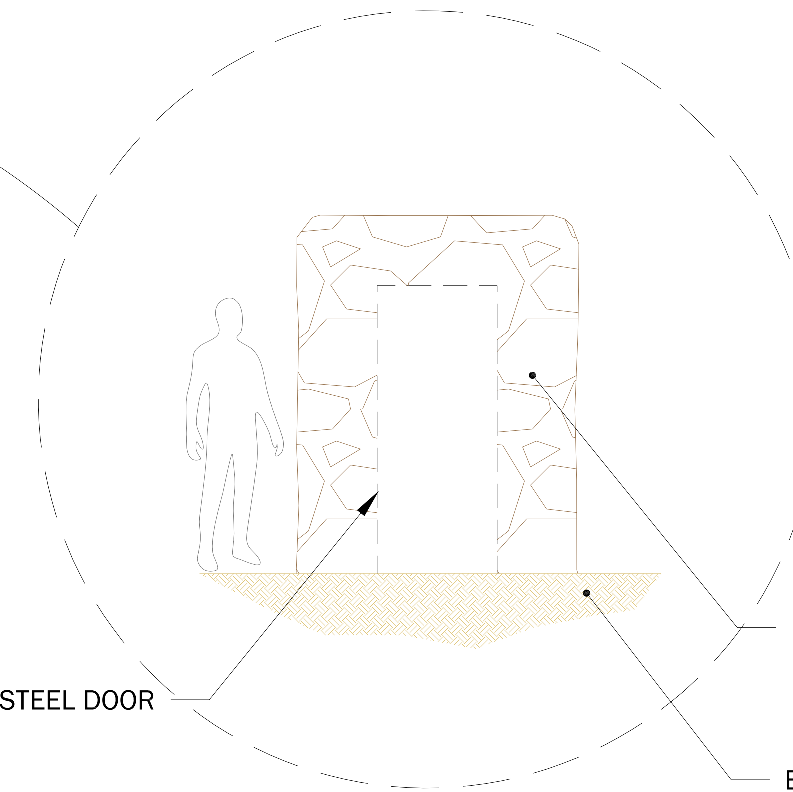

DRAWN-DOWN APPEARANCE

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September (Partial Stage)

August (Partial Stage)

October (Empty Stage)

Aesthetic Impacts
Klonaqua Lake Automation

Feasibility Study, Alpine Lakes Automation Improvements
Leavenworth, Washington

Aspect CONSULTING	Mar-2017	BY: JRB	FIGURE NO.
	PROJECT NO. 120045	REVISED BY: -	7

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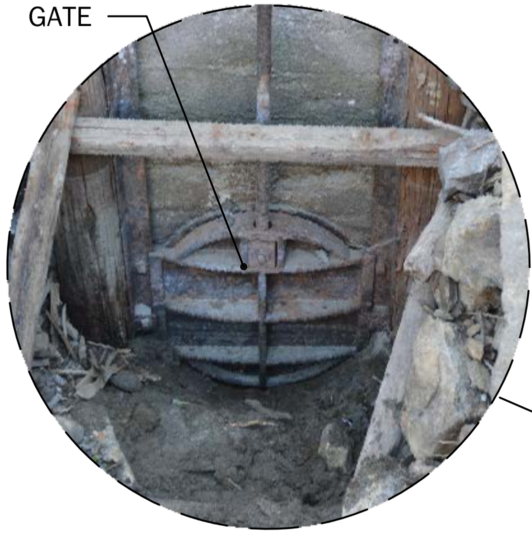

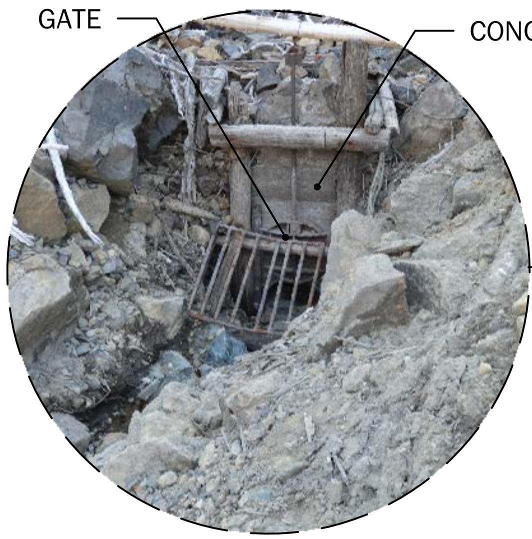

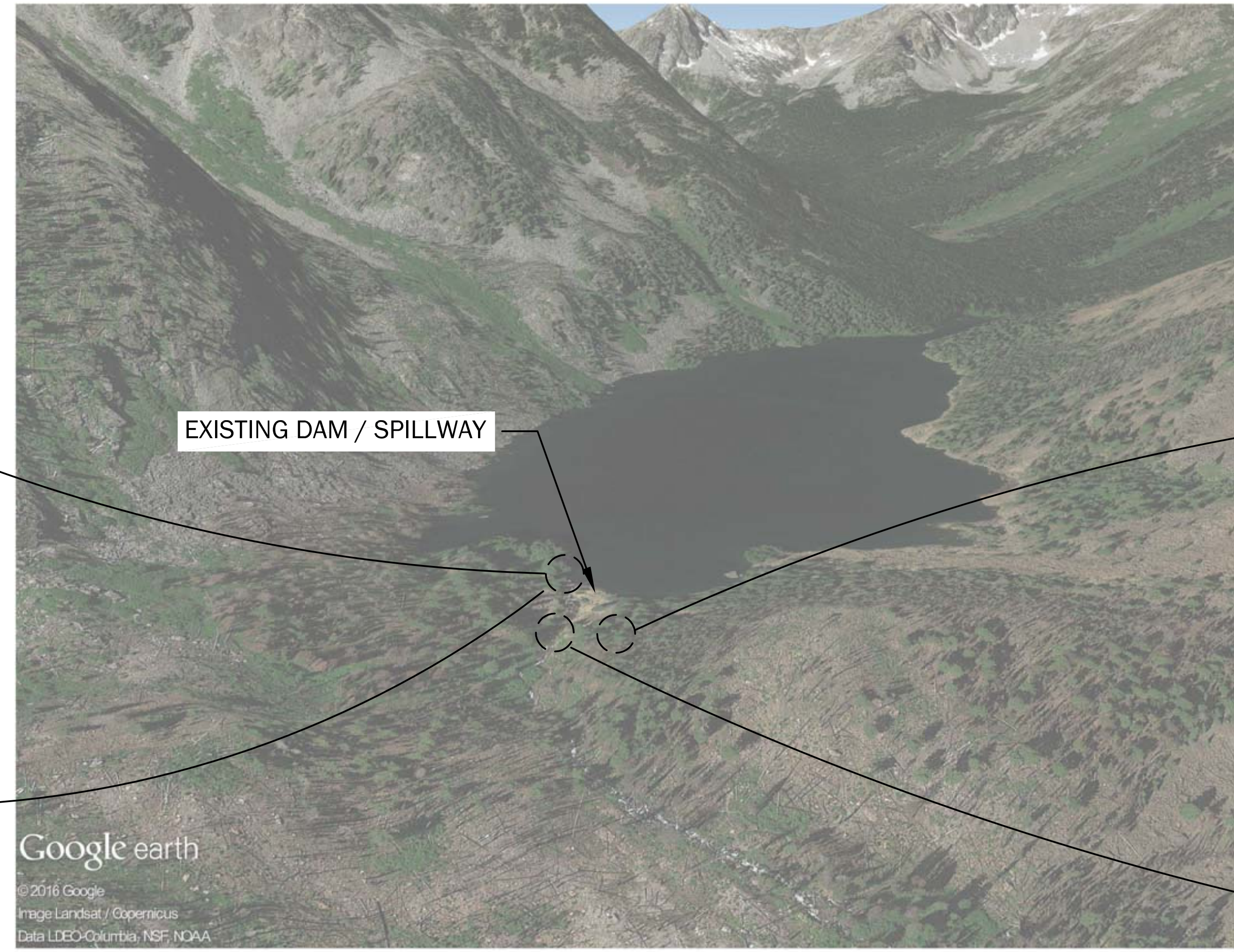

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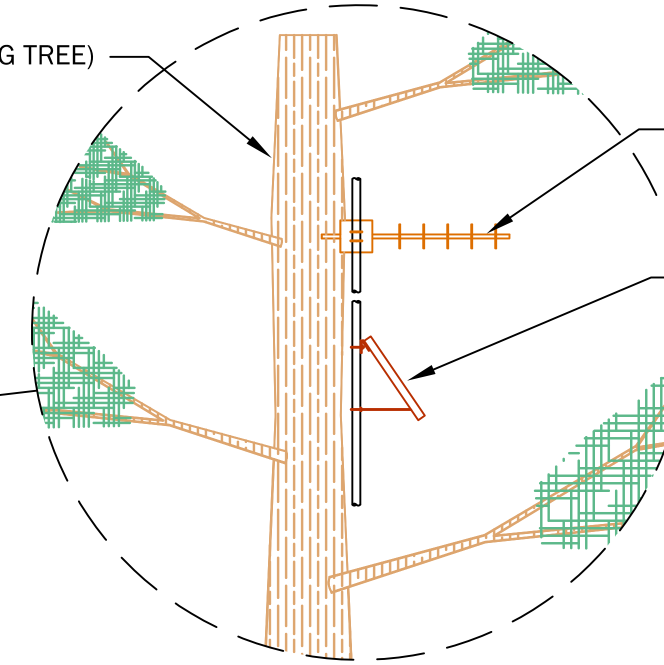

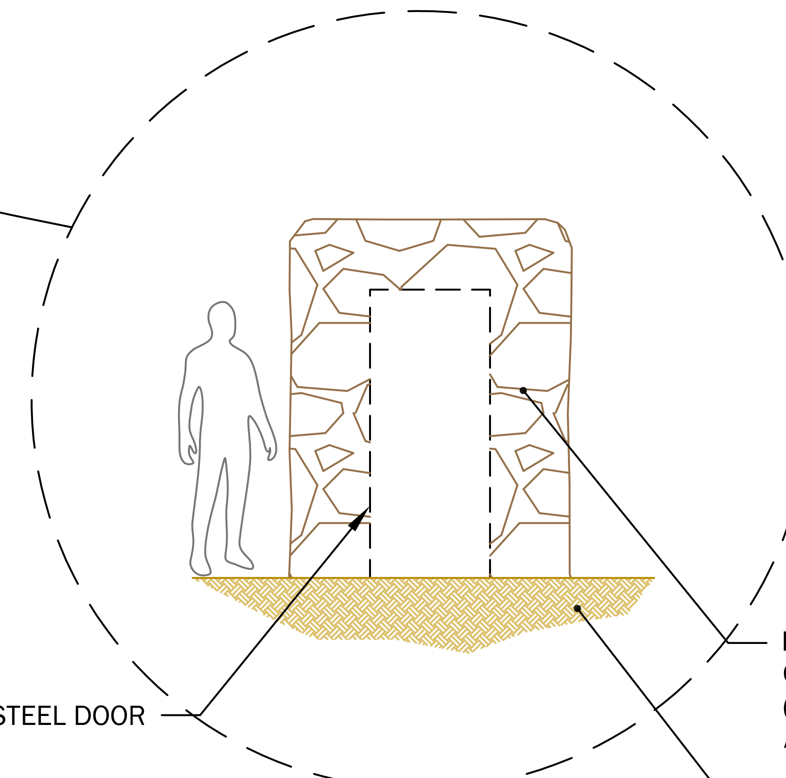

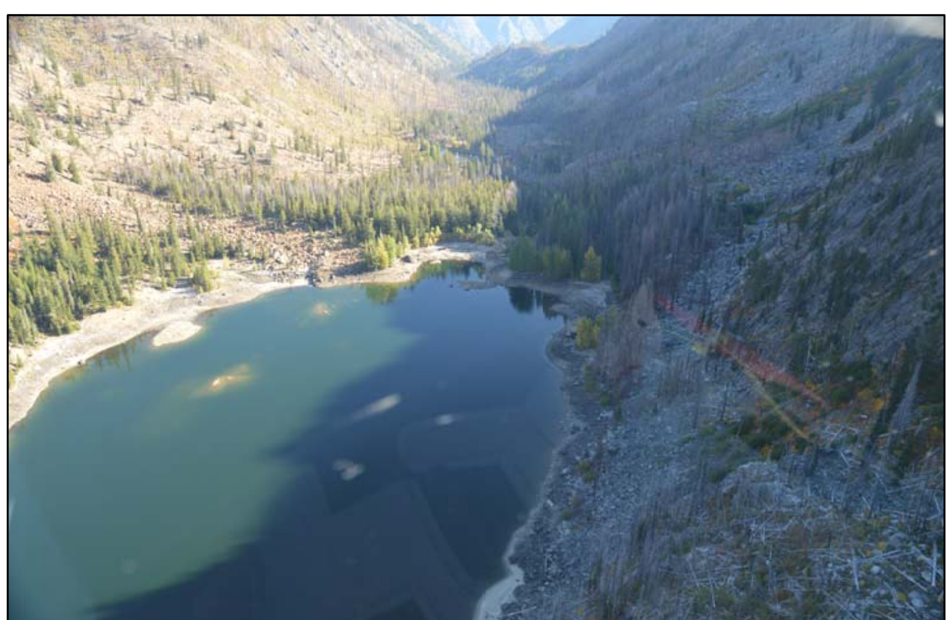

DRAWN-DOWN APPEARANCE

July (Full Stage)

September (Partial Stage)

August (Partial Stage)

October (Empty Stage)

Aesthetic Impacts
Eightmile Lake Automation
Feasibility Study, Alpine Lakes Automation Improvements
Leavenworth, Washington

Aspect CONSULTING	Mar-2017	BY: JRB	FIGURE NO.
	PROJECT NO. 120045	REVISED BY: -	8

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ORTHOGRAPHIC AERIAL SITE VIEW

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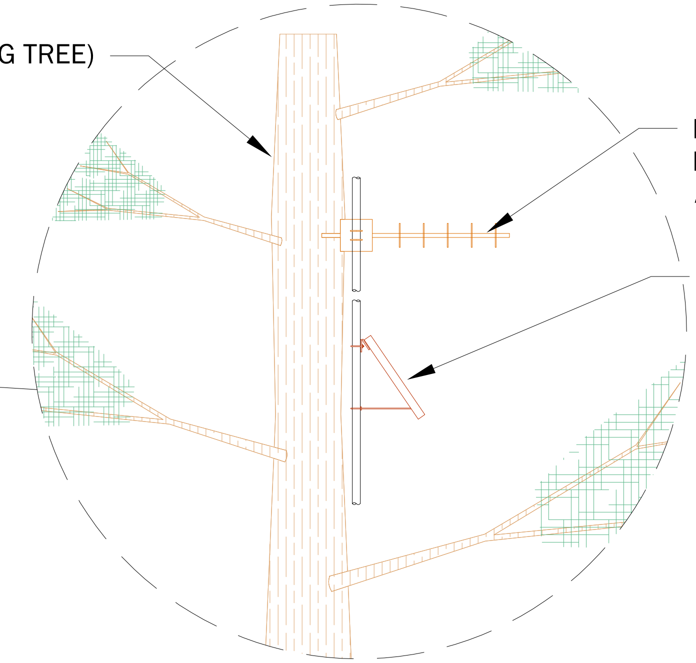

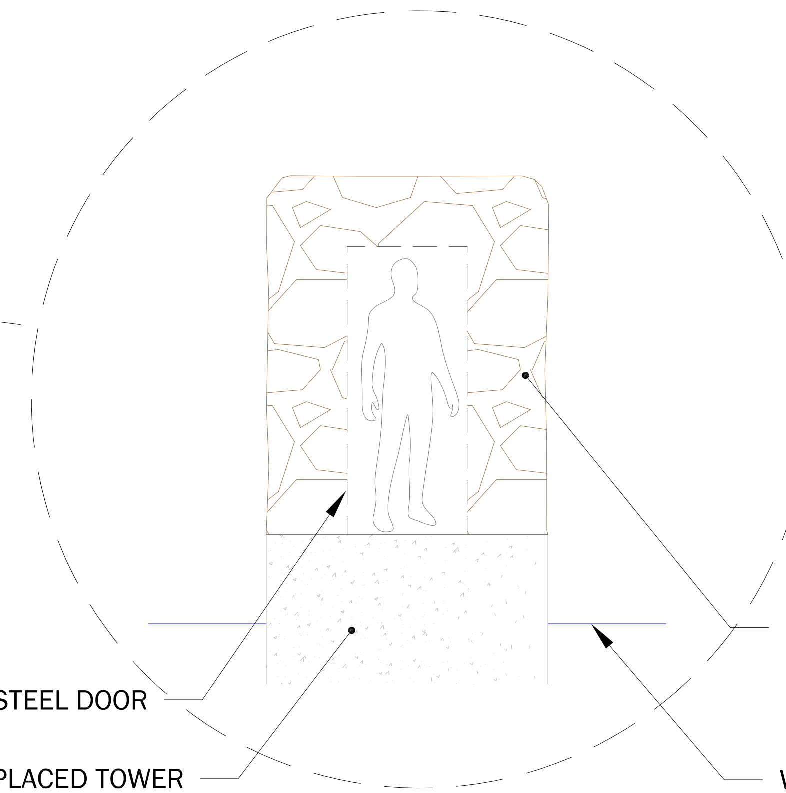

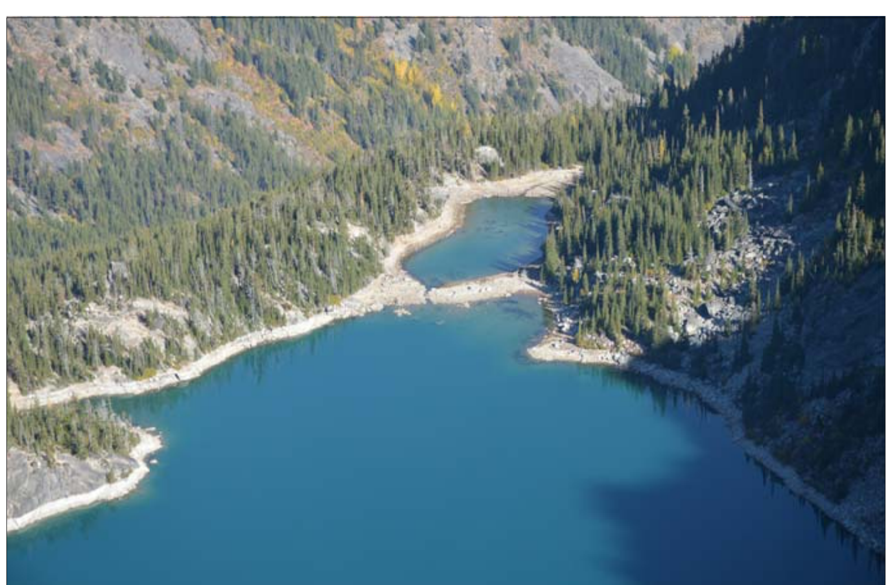

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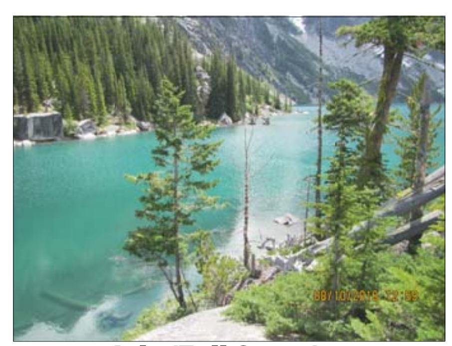

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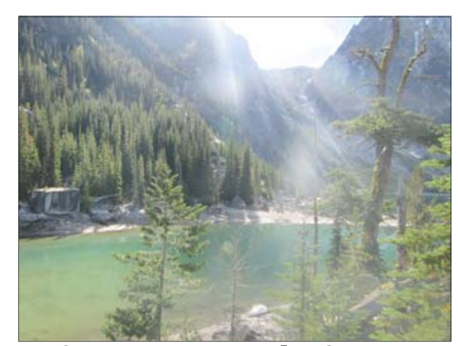

September (Partial Stage)

August (Partial Stage)

October (Empty Stage)

Aesthetic Impacts
Colchuck Lake Automation

Feasibility Study, Alpine Lakes Automation Improvements
Leavenworth, Washington

Aspect CONSULTING	Mar-2017	BY: JRB	FIGURE NO. 9
	PROJECT NO. 120045	REVISED BY: -	

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User: rbrownlee

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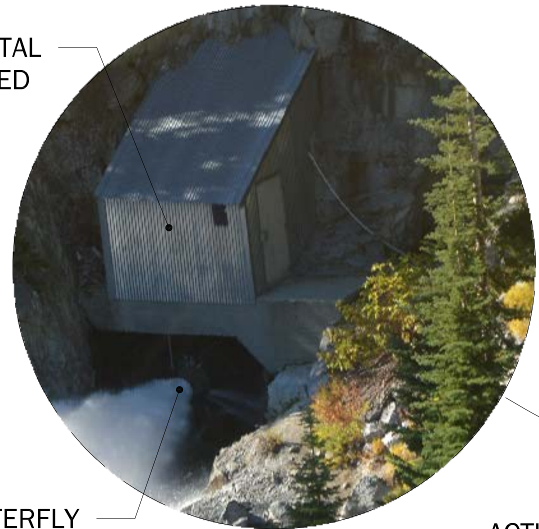

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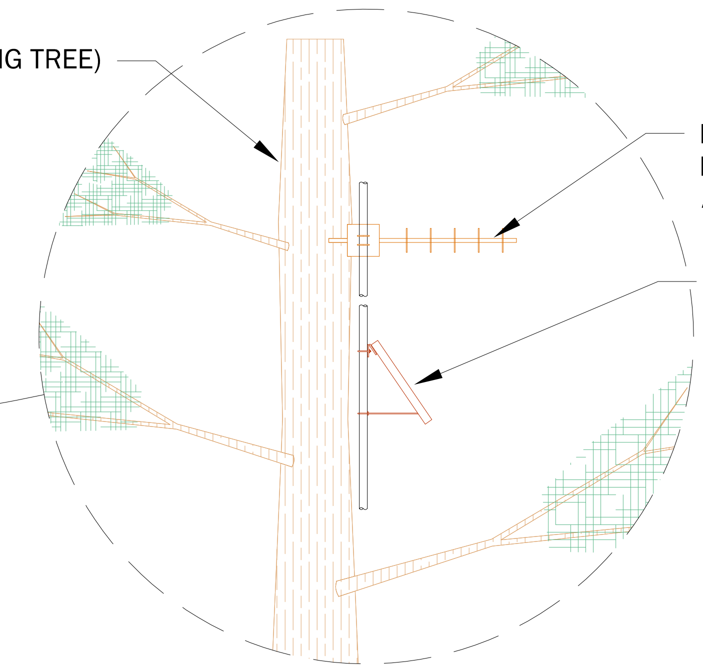

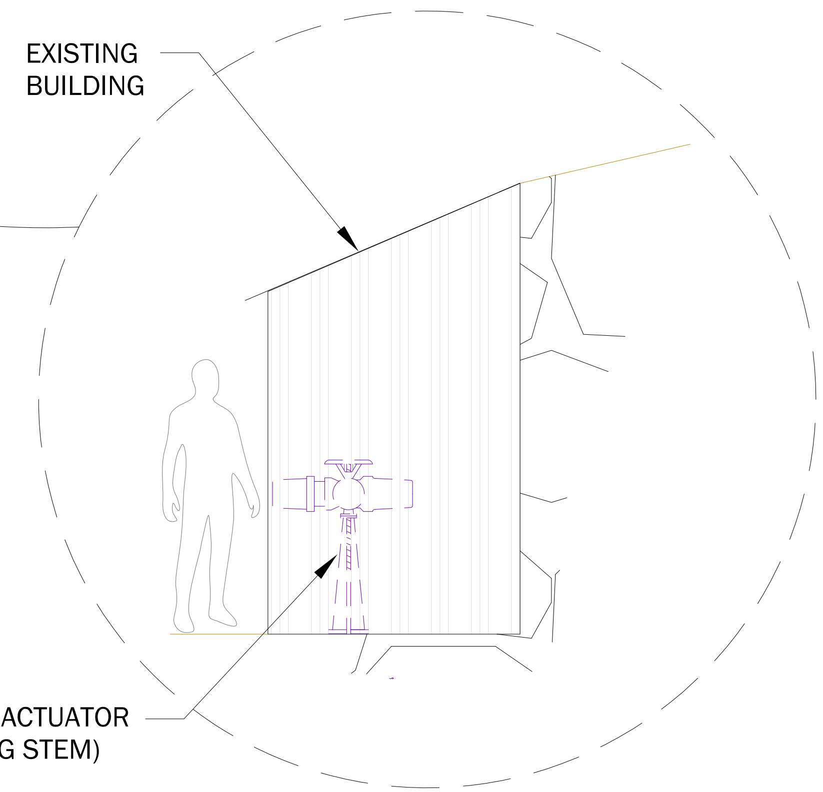

DRAWN-DOWN APPEARANCE

Aesthetic Impacts
Snow Lakes Automation

Feasibility Study, Alpine Lakes Automation Improvements
Leavenworth, Washington

Aspect CONSULTING	Mar-2017	BY: JRB	FIGURE NO.
	PROJECT NO. 120045	REVISED BY: -	10

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User: rbrownlee

APPENDIX A

Technical Memorandums:
2016 and 2017 Alpine Lakes
Flow Augmentation Pilot Studies

MEMORANDUM

Project No.: 120455

May 11, 2017

To: Mike Kaputa, Director, Chelan County Natural Resources Department

From:

Bill Sullivan, LHG, CWRE
Senior Hydrogeologist
bsullivan@aspectconsulting.com

Re: **Alpine Lakes 2016 Flow Augmentation Pilot Study**

Executive Summary

Aspect Consulting, LLC (Aspect) conducted the Alpine Lakes 2016 Flow Augmentation Pilot Study (Study) to assess the effects of augmenting stream flows in Icicle Creek using water stored by the Icicle-Peshastin Irrigation District (IPID) in five mountain reservoirs. It was launched in response to discretionary trust water donations of stored water by IPID coinciding with planned reservoir maintenance activities. The Study was coordinated by Chelan County Natural Resources Department to understand benefits and impacts and potential fatal flaws associated with the proposed Alpine Lakes Optimization, Modernization, and Automation Project (Project).

The Project is being developed by the multi-stakeholder Icicle Work Group's (IWG) as part of the Icicle Creek Water Resource Management Strategy (Strategy) to achieve diverse benefits in the Icicle Creek drainage. A Guiding Principle of the Strategy is achieving adequate stream flows in the Historic Channel of lower Icicle Creek with the goal of maintaining flows in the Historic Channel of at least 100 cubic feet per second (cfs) during average years and 60 cfs during drought years.

The Study included installation of stage and outflow monitoring equipment at four reservoirs to support management of water release from storage to augment stream flows, as well as coordination with the U.S. Fish and Wildlife Service (USFWS) on their operations of Snow and Nada Lakes. Icicle Creek flows were monitored and adjustments were made to augmentation flows on a weekly basis during 14 weeks in Summer and early Fall 2016. Key findings of the Study include:

- Flow augmentation using over 6,400 acre-feet (ac-ft) of water stored in Alpine Lakes reservoirs can significantly enhance stream flows in the Historic Channel of Icicle Creek;
- While flow augmentation is not a total solution for achieving the IWG's flow targets in the Historic Channel, it might account for about one-third of the solution based on 2016 results;

- Augmentation flows up to 90 cfs extended Historic Channel flows above the 100 cfs target for 3 weeks of the 9 week low-flow period in 2016 when flows would have otherwise dropped below the target;
- Augmentation flows equaled between 31 and 78 percent of late season discharge in the Historic Channel; and
- Quantities of water released for flow augmentation are not adequate to reverse or even keep up with the seasonal falling hydrograph. However, flow augmentation can slow the rate of seasonal decline, prolonging the period of time when flows remain above the target.

No fatal flaws were identified and a follow-on study is recommended to confirm and improve on findings of the 2016 Study and to resolve data gaps. Key recommendations for follow on study include:

- Improve accuracy of Icicle Creek discharge estimates in the Historic Channel by obtaining real-time stream flow measurements collected at Structure 2 (located at the head of the Historic Channel);
- Initiate study to assess impacts of release flows on Bull Trout habitat in French and Leland creeks that drain Square and Klonaqua lakes. Determine whether release flows above 10 cfs are detrimental after September 15. These lakes hold nearly half the water physically available for flow augmentation, and releases greater than 10 cfs in late season would provide greater flexibility to manage flow augmentation in Icicle Creek; and
- Improve understanding of the fate of flow augmentation water. Evaluate gaining/losing characteristics of tributaries draining reservoirs and mainstem Icicle Creek. Coordinate with USFWS to improve understanding of releases from Snow Lakes. Coordinate with USFWS, IPID, Cascade Orchards Irrigation Company, and the City of Leavenworth to quantify diversions occurring upstream of the Historic Channel.

A detailed discussion of project background, methods, findings, and conclusions follows.

Introduction

Aspect Consulting, LLC (Aspect) conducted the Alpine Lakes 2016 Flow Augmentation Pilot Study (Study) to assess the effects of augmenting stream flows in Icicle Creek using water stored by the Icicle-Peshastin Irrigation District (IPID) in five mountain reservoirs.

The multi-stakeholder Icicle Work Group (IWG) is comprised of diverse agricultural, conservation, and recreational interests, Tribes, and local, state, and federal agencies. The IWG developed the Icicle Creek Water Resource Management Strategy (Strategy) by consensus of its members to improve instream flows in Icicle Creek. The Strategy outlines nine Guiding Principles to achieve diverse benefits. The Adequate Streamflow principle sets a target flow of 100 cubic feet per second (cfs) during low-flow periods in non-drought years and 60 cfs during drought years in a reach known as the Historic Channel of lower Icicle Creek. The flow target is intended to be measured at the Leavenworth National Fish Hatchery (LNFH) Structure 2, located at river mile (RM) 3.8 that lies at the head of the Historic Channel of Icicle Creek (described below).

One of the proposed actions identified in the Strategy is the Alpine Lakes Reservoir Optimization and Automation Project that involves releasing water from five reservoirs to augment flows in Icicle Creek. These reservoirs are Square, Klonaqua, Eightmile, Colchuck, and Snow lakes.

The Study was launched in response to discretionary trust water donations of stored water by IPID coinciding with planned reservoir maintenance activities. It was coordinated by Chelan County Natural Resources Department to understand benefits and impacts and potential fatal flaws associated with the proposed Alpine Lakes Optimization and Automation Project.

The Study was funded under Grant Number WROCR-VER1-ChCoNR-00002 sourced from the Washington State Department of Ecology (Ecology) Office of Columbia River (OCR).

Background

Basin Description

Icicle Creek drains an area of about 243 square miles of undeveloped mountainous terrain west of Leavenworth in Chelan County, Washington (Subbasin; Figure 1). Icicle Creek drains to the Wenatchee River at Leavenworth. The majority of its drainage area lies within the Alpine Lakes Wilderness Area on land managed by the U.S. Forest Service (USFS). The lowermost section is moderately developed and includes recreational and residential development, agriculture, lodging, and the LNFH.

The Icicle is a snowpack-driven watershed with high flows occurring during spring freshet and low flows in late Summer (primarily September) and Fall. Two stream gauges are present on Icicle Creek (Figure 1). The U.S. Geological Survey (USGS) operates a gauge (12458000) at RM 5.8 located upstream of Snow Creek having a period of record from 1993 to present. Ecology operates a gauge (45B070) at RM 2.2 having a period of record from 2007 to present. Additionally, the USFWS is in the process of establishing stream measurement recording at Structure 2.

Numerous mountain and alpine lakes are present in the Icicle Subbasin. These are naturally formed lakes, the largest of which were modified to store water prior to Wilderness Area designation. The Icicle's major tributaries originate from the larger lakes. These include French Creek draining Klonaqua Lake; Leland Creek draining Square Lake; Mountaineer Creek draining Eightmile Lake and Colchuck Lake; and Snow Creek draining Upper and Lower Snow Lakes. Major lakes and tributaries are shown on Figure 1.

Icicle-Peshastin Irrigation District

The IPID diverts surface water from Icicle and Peshastin Creek drainages for irrigation of lands between Leavenworth and Cashmere. IPID holds diversionary rights from Icicle and Snow Creeks at the IPID diversion located at RM 5.7 (Figure 1) during irrigation season at a rate up to 117.71 cfs under Water Right Certificates S4-35002JC, S4*35002ABBJ, having priority date of 1910 and Certificate 1082 having priority date of 1919.

IPID also has water rights to store water in the five aforementioned reservoirs located within the Alpine Lakes Wilderness Area for the purpose of providing irrigation water during times of drought or when Icicle Creek flows are insufficient to meet IPID's diversionary needs. These reservoirs are discussed below.

Reservoirs

The five naturally-formed lakes within the Alpine Lakes Wilderness Area were modified beginning in the 1920s to store water for irrigation and fish propagation. Locations of the reservoirs are shown on Figure 1.

Four of the reservoirs are operated by IPID (Square, Klonaqua, Eightmile, and Colchuck lakes) and one reservoir is operated by the USFWS and U.S. Bureau of Reclamation (USBOR). Square and Klonaqua Lakes were modified by excavating a tunnel (Square) and buried pipe (Klonaqua) to access water below the natural level of the lakes. Colchuck Lake was modified by excavating a channel connecting two natural lake basins. All four lakes have small dams (5 to 10 feet high) constructed to enhance storage. Upper Snow Lake Reservoir is operated to support the LNFH and also stores water for IPID. Water is accessed in Upper Snow Lake using a tunnel/pipe bored through rock. The outlet lies below the natural water level of Upper Snow Lake. There is no dam.

IPID and USFWS/BOR operate these facilities under easements with USFS that were established when the land was transferred to USFS during the Wilderness Area designation. These easements allow IPID and USFWS staff access and to perform maintenance activities.

Previously, only rough estimates were available for water volumes held in active storage in the reservoirs due to limited information on lake bed bathymetry and freeboard (vertical distance from invert of outlet to overflow).

Reservoir Operations

In average runoff years, water is released on a rotational basis from one of the four reservoirs operated by IPID. IPID typically only receives water from Upper Snow Lake during drought years under a partial subordination agreement with USFWS. Water is typically released from some or all the reservoirs in drought years to augment downstream water supply.

To operate these reservoirs, IPID and USFWS staff hike to their respective lakes to manually turn hand wheels and valves that operate head gates. USFWS demand from Snow Lakes ranges from about 20 cfs in July to about 50 cfs during September. The control valve at the outlet to Upper Snow Lake currently limits the release rate to about 55 cfs.

Because of the time and cost required to adjust head gates, adjustments are generally made infrequently or only at the beginning and end of the season. The hand wheel operator at Eightmile Lake was destroyed when the dam partially washed out several decades ago. Adjusting this gate requires using scuba equipment when the lake is full, which further limits IPID’s ability to adjust outflows. Stored water in Eightmile Lake also seeps through the north end of the lake where an ancient landslide serves as a natural impoundment. For this reason, IPID’s water right includes water stored in Eightmile Lake lying below the invert of the outlet pipe.

Prior to this Study, there was no instrumentation installed to measure reservoir stage or discharge rates at the four lakes managed by IPID. At Upper Snow Lake, USFWS collects reservoir stage and release flow data using existing instrumentation.

Leavenworth National Fish Hatchery

The LNFH is located in the lower section of Icicle Creek at about RM 2.7 (Figure 1). The facility was constructed in the 1930s to mitigate impacts to anadromous fish runs impacted by the construction of Grand Coulee Dam. The LNFH continuously diverts surface and groundwater at a rate of about 50 cfs for fish propagation. Surface water is diverted a rate of about 42 cfs from Icicle Creek using a diversion located at RM 4.5. The balance of water used by LNFH is withdrawn from a well field at the hatchery tapping an aquifer in hydraulic continuity with Icicle Creek.

An artificial channel known as the Hatchery Channel was constructed to periodically divert water from Icicle Creek to hydrate the aquifer supplying the well field. Water is diverted to the Hatchery Channel by a hydraulic control structure (Structure 2) that spans the width of the mainstem Creek at RM 3.8.

Effluent from the hatchery is discharged at a rate of about 50 cfs to the mainstem Icicle Creek below the outlet of the Hatchery Channel at RM 2.7, creating a bypass reach on Icicle Creek of about almost 2 miles. This bypass reach includes the natural channel of Icicle Creek downstream of Structure 2, known as the Historic Channel.

Flow Augmentation

The 2016 Pilot Study provided flow augmentation to Icicle Creek using water donated to trust by IPID for the purpose of benefitting instream flows. Methods used in the Study and findings are discussed below.

Trust Water Donations

In 2016, IPID requested to temporarily donate five of its Alpine Lakes reservoir storage water rights into Ecology's Trust Water Right Program pursuant to RCW 90.42.080 that encourages water right holders to donate water rights for instream flow purpose. In April, Ecology accepted donations for Certificate Nos. 5527, 1227, 1228, 1229, and 1591 for the purpose of benefitting instream flow from July 11 to October 15, 2016. The donated water was to be made available by releasing water from the five lakes managed by IPID and leaving it instream for environmental benefit during the 2016 low-water season. Table 1 shows quantities of water placed into trust.

Table 1. Quantities Donated to Trust Water Program for 2016*

Lake Name	Quantity of Water (acre-feet)
Square Lake	2,000
Klonaqua Lake	2,500
Eightmile Lake	1,600
Colchuck Lake	2,500
Snow Lakes	1,000
Total Donated to Trust	9,600

*Donation period July 11 to October 15, 2016 for instream flow purpose.

The timing of trust water donations was coordinated to align with planned maintenance of IPID reservoirs, which required lake levels to be drawn down by Fall 2016 for repair and inspection. This presented an opportunity to conduct the 2016 Flow Augmentation Pilot Study.

Project Objectives and Constraints

Prior to commencing this Study, IWG's Instream Flow Subcommittee developed and agreed on the following objectives and constraints for the Project:

- Meet a target flow of 100 cfs in the Historic Channel as measured at Structure 2, consistent with IWG's Guiding Principles. Meeting this target was intended to be adaptive based on actual flows verified on a weekly basis;
- Release about 700 ac-ft from Colchuck Lake by September 1 to drawdown the reservoir supporting planned IPID maintenance;
- Release the peak flow from Eightmile Lake early to accommodate design inspection of the submerged head gate structure. This was initially assumed to be about 1,350 ac-ft of storage over the period of about 1 month. The IWG estimated this would accommodate about 250 ac-ft to be released via natural seepage at a rate of about 3 cfs for remainder of season. No weekly adjustments were planned for Eightmile due to the submerged head gate control;
- Limit release flows to about 10 cfs after September 15 from Square and Klonaqua lakes to protect Bull Trout spawning habitat in Leland and French creeks;
- Limit initial flow augmentation release from Upper Snow Lake to about 5 cfs continuously due limitations of the control valve. This would ensure USFWS could release sufficient water for operations at LNFH. This was to be adaptive later in the season, depending on LNFH water needs; and
- Significant ramping changes to the rate of water released from storage at a given reservoir should be avoided and minimized to 5 to 10 cfs per week in late Summer and early Fall.

Additional Project objectives were to release as much donated trust water as possible in support of engineering inspections at each site, and for conducting bathymetric surveys of the lakes.

These criteria were followed to the extent possible during the Study.

Methods

Overview

Key elements of the Study consisted of establishing Project objectives and constraints (described above), installing monitoring instrumentation at the four lakes operated by IPID, management of flow augmentation releases to meet Icicle target flows, and analysis of data to evaluate the effects on instream flows in the Historic Reach. A detailed methodology is contained in the Quality Assurance Project Plan (QAPP) (Aspect, 2016) as submitted to Ecology.

Instrumentation and Monitoring

Prior to this Study, there was no mechanism to measure discharge rates from lakes or monitor changes in lake stage. To prepare for releasing flow augmentation water, Aspect and IPID installed reservoir stage and outflow release rate measurement instrumentation at Square, Klonaqua, Eightmile, and Colchuck lakes during the week of July 11, 2016. Because there are no roads, helicopter support was contracted to perform lifts of equipment and to ferry staff. This work was completed with IPID supervision under its easements to reservoir sites in accordance with a Work Plan submitted by IPID to the USFS.

Reservoir Stage Height Monitoring

Continuous recording instrumentation was installed in each lake to track changes in reservoir stage resulting from flow augmentation releases and inputs from precipitation and runoff. Tracking water level changes supported flow augmentation management by allowing estimates to be made for volumes remaining in storage, and supported the Project objective of ensuring reservoirs were sufficiently drawn down in time for inspection. Lake stage monitoring also enabled development of stage-volume relationships when combined with bathymetric survey data that had already been collected (Eightmile Lake) or were scheduled for collection using LiDAR in October 2016. At the beginning of the Study on July 11, all four reservoirs were full and overflowing from runoff.

Pressure transducer and temperature data loggers were installed for continuous recording. A means to visually record reservoir stage was also installed at each site. Because the pressure transducer data loggers are not barometrically compensated, recording barometer instruments were installed at two sites (Square and Eightmile).

Methods to install lake stage monitoring instruments varied by location. Colchuck and Eightmile lakes have reservoir control structures that enabled affixing a 1.25-inch-diameter galvanized pipe to the concrete head gate tower (Colchuck) and head gate vault (Klonaqua). The pipes were extended to depths at or near the bottom of the headgate. Pressure transducers were placed inside the pipes near the bottom. Holes were drilled at intervals into the pipes to allow free communication with the surrounding lake water. Staff plates were affixed to the outside of the pipes to provide a visual means of recording stage. A water level meter was also stored and used at Klonaqua Lake to manually measure water level changes in the head gate vault.

At Square and Eightmile lakes, pressure transducers were anchored to the lake bed at depths estimated to be at or below the active storage freeboard (below the invert of the outlet). These were connected to the shoreline by a communication cable encased in PVC conduit terminating in a watertight container above the high water mark. Installation of staff gauges was not possible at these lakes. Instead, a benchmark was established as a reference point to visually measure water level changes on the shoreline using a laser level and stadia rod.

Locking metal boxes were established in discrete locations to store equipment needed throughout the Study, including laser level and stadia rod, water level meter, barometer data loggers, and hand tools.

Release Flow Monitoring

Release flow monitoring equipment was installed at the four lakes managed by IPID to establish a means of measuring outflow rates. Water stored in the lakes was released using outlet pipes controlled by head gates. Because outflow rates vary with lake level for a given head-gate position, it was necessary to establish rated stream gauging sections in the outlet channels. This allowed for the head gate position to be adjusted until the desired outflow rate was achieved.

Rated stream gauging sections were established in outlet channels by installing a staff plate affixed to vertical bedrock outcrop or a rod driven into the streambed. Discharge from the lake was measured at varied rates by changing head gate positions to adjust outflow. Discharge was determined using a velocity meter and area-velocity measurement (Rantz, et al.,1982). Staff plate measurements (stage) were recorded for each measured discharge rate to create rating curves.

Rating curves developed for the outlet channels at the four lakes managed by IPID are shown on Figure 2. Rating curves predict discharge from measured stages and discharge rates based on an empirical mathematic formula. Time constraints during the installation period limited the number of measured discharge points that could be collected to three to five points per rating curve. Safety considerations limited the ability to measure high flows at some sites. Additionally, because the reservoirs were overflowing with runoff, there was no opportunity to measure low-discharge conditions at several sites. Discharge rates lying outside the range of measured data in the rating curves shown on Figure 2 were extrapolated.

Using rating curves to predict discharge, desired outflow rates were set by adjusting the head gate until the staff plate read the correct stage.

Flow Augmentation Management

Flow augmentation management followed a weekly cycle consisting of monitoring discharge in Icicle Creek and adaptively adjusting flows released from storage with the goal of maintaining Icicle Creek flows in the Historic Channel above 100 cfs.

Flows in Icicle Creek were originally intended to be measured directly at Structure 2 because it is located at the head of the Historic Channel. However, access to real-time discharge data measured by USFWS at Structure 2 was not available. Instead, real-time flows recorded at Ecology's Gauge located downstream of the LNFH outfall were used as a proxy for flows at Structure 2. We subtracted 50 cfs from Ecology's measurements to account for water used at LNFH that bypasses the Historic Channel.

Lake-specific discharge rates and flow augmentation release plans were developed on a weekly basis during the Study by Aspect and the Chelan County Department of Natural Resources. In setting these rates, we considered the 100 cfs target flow, water remaining in storage, other Project objectives, and constraints. Once a flow augmentation plan was developed for a given week, it was communicated to IWG stakeholders for review a few days prior to implementation. Chelan County staff spent the following week hiking into the lakes to adjust head gates to match desired outflows. Data collected at each lake included outlet channel discharge (upon arrival--before setting desired outflows—and departure), visual measurements, pressure transducer lake level data, photographs, and other observations. These data were used to determine how quickly outflow had decreased since the last head gate adjustment, estimate volumes of water released from storage, and estimate volumes remaining in storage. These data were then considered for developing flow augmentation plans for subsequent weeks.

Findings

Flow augmentation from the five lakes began on July 11 and continued to nearly the end of the trust water donation period on October 6.

Augmentation Flows and Volumes

Estimated volumes of water released from storage, and ranges of augmentation flows during the Study, are shown on Figure 3. A total of approximately 6,427 ac-ft of water was released from storage, providing cumulative augmentation flow to Icicle Creek ranging from 6 to 90 cfs. A hydrograph of cumulative augmentation flows is shown on Figure 4.

Augmentation Flows

Peak cumulative augmentation flow was limited to 90 cfs by reservoir infrastructure and the Project objective to avoid steep ramp-ups/draw-downs of water released into tributaries.

Peak discharge rates from individual lakes during the Study ranged from 12 cfs at Upper Snow Lake to 35 cfs at Square Lake (Figure 3). Peak discharge rates ranged between 20 and 25 cfs at Klonaqua, Eightmile and Colchuck lakes under lake full conditions. Higher outflow rates were temporarily observed at Colchuck Lake during development of the rated sections but were not measured, out of consideration for safety.

At Upper Snow Lake, flow augmentation discharge was limited to 5 cfs for most of the Study because the existing control valve has a capacity of about 55 cfs, of which LNFH operations require up to 50 cfs (i.e., discharge available for flow augmentation was limited to about 5 cfs). However, augmentation flows from Snow Lakes were increased in October to 12 cfs when LNFH demand decreased.

Augmentation Volumes

Volumes of water released from each lake ranged from about 950 ac-ft in Upper Snow Lake to 1,936 ac-ft in Square Lake (Figure 3).

The active storage volume in three of the lakes was nearly or completely drawn down by the end of the Study: Klonaqua (1,006 ac-ft), Eightmile (1,452 ac-ft), and Colchuck (1,083 ac-ft) lakes. Outlet structures in these lakes were exposed or nearly exposed above the water line and outflows had diminished to less than 2 cfs. Although water remained in active storage in Snow Lakes, IPID's trust water donation was exhausted by the end of the Study.

About 250 ac-ft of active storage remained in Square Lake at the end of the Study, and the outlet structure was about 4 to 5 feet below water. Active storage remained in Square Lake because late season outflows were limited, preventing use of all the water in storage. The Project objective of protecting Bull Trout habitat in Leland Creek limited outflows to 10 cfs after September 15.

Approximately 1,300 ac-ft of IPID's trust water donation remained in storage at the end of the study in Klonaqua and Colchuck lakes. Most of this volume was physically inaccessible due to elevations of outlet structures that lie above the stored water.

Lake Drawdown and Effects on Outflow Rates

Figure 5 shows lake hydrographs with stage measured by continuous recording datalogger, periodic manual measurements, and the depth of lake outlet pipe/tunnel inverts estimated from field inspection. Because the depths of outlet inverts were not known when pressure transducers were installed, one of the transducers was placed at a depth a few feet higher than the invert. Water level changes occurring at depths deeper than the transducer were not recorded by transducer dataloggers but were collected by periodic manual measurements. At Colchuck Lake, the transducer was set about 4 feet above the outlet invert due to head gate construction. The Colchuck hydrograph exhibits a flat line beginning the second week of September that is not indicative of lake stage but rather represents the period when the transducer was no longer submerged.

Drawdown characteristics of lakes were identified by examining changes in lake stage. Drawdown characteristics depend on lake bed geometry, lake volume relative to outlet discharge rate, and water inputs to the lake (runoff, groundwater). Drawdown characteristics of Snow Lakes were not assessed.

The steady declining stage drawdown curve observed for Eightmile Lake on Figure 5 was due to its head gate position, which remained fixed throughout the study and permitted continuous seepage of water through the lake bed to Eightmile Creek. Drawdown curves at Square, Klonaqua, and Colchuck lakes were much steeper and became steeper when flow augmentation releases were increased during the third week in August. At the end of the season, lake stage was seen as increasing due to heavy regional precipitation beginning the second week of October.

Table 2 shows drawdown rates for the lakes which can be used to predict how long it will take to draw down active storage. Eightmile Lake drained slowest at a constant rate of 0.2 ft/day for discharge rates between about 3 and 20 cfs. Square Lake also drained slowly at a rate of 0.3 ft/day for a discharge rate of 15 cfs (attributable to its large volume). The drawdown rate at Square lake tripled to 1.0 ft/day when flows increased to 35 cfs.

Table 2. Lake Stage Drawdown Rates

Lake Name	Drawdown Rate (ft/day)	Discharge Rate (cfs)
Square Lake	0.3	15
	1.0	35
Klonaqua Lake	0.7	15
Eightmile Lake	0.2	3 to 20
Colchuck Lake	0.6	20
Snow Lakes	Water levels not measured	n/a

If no adjustments were made to head gates, the rate of discharge from lakes declined with lake stage due to decreased driving head and lake bottom geometry. Figure 4 shows that cumulative augmentation flows began declining immediately after weekly head gate adjustments were made. Figure 4 also shows that augmentation flows declined faster as lake levels were drawn down. When lakes were nearly full in July, the cumulative augmentation flow decreased at a rate of about 0.5 cfs per day from about 27 cfs on July 14 to 17 cfs on August 2 (Figure 4). When lakes were nearly empty in late August and early September, cumulative augmentation flows decreased at a much faster rate of about 3 cfs per day.

Effects of Augmentation on Historic Channel Flows

A hydrograph for the Historic Channel during the study period is shown on Figure 6. This hydrograph includes natural and augmentation flows. Comparing 2016 to the period of record for the USGS gauge, 2016 was approximately an average runoff year. Figure 6 also contains the hydrograph showing the cumulative flow augmentation and a hyetograph for precipitation (as rainfall) occurring at the nearest weather recording station, the Fish lake SNOTEL site located in the adjacent Cle Elum River drainage.

Icicle flows in the Historic Channel were about 300 cfs when the Study began the week of July 11 and decreased to about 120 cfs by the end of the first week in August.

Flow augmentation began the week of July 11 with modest cumulative releases from storage averaging about 22 cfs through July. Flow augmentation was increased the week of August 8 to about 60 cfs and increased again during the week of August 22 to about 90 cfs. Augmentation flows then decreased for the balance of the study primarily due to diminishment of stored water. September augmentation flows that began at about 75 cfs had decreased to 20 cfs during the last two weeks in September and first week of October. Flow augmentation ceased on October 6.

Weekly averages for flow augmentation rates and Historic Channel flows during the study period are shown on Figure 7. Flow augmentation during the low flow months of August and September equaled between 31 and 78 percent of total discharge in the Historic Channel.

Augmentation Increased Historic Channel Flows

Augmentation flows increased Historic Channel flows. Increased augmentation flows are attributed to the “peaks” in the Historic Channel hydrograph seen on Figure 6 during the weeks of August 8 and August 22.

Increases in augmentation flows during the first two weeks in August did not result in a one-for-one increase in Historic Channel flows. During this period, augmentation flows were increased by about 43 cfs, yet the Historic Channel hydrograph shows only a short-lived increase of about 20 cfs occurring the week of August 8. The difference in magnitude between flow augmentation and its effect on streamflow in the Icicle is attributed to a portion of augmentation water going to storage along the miles of creek bed between the storage sites and stream gauge.

The portion of augmentation water going to stream bed storage appears to have decreased by the week of August 22 when augmentation flows were increased by 46 cfs and Historic Channel flows temporarily increased by about 70 cfs. The difference is attributed to the contemporaneous increase of water released by USFWS from Snow Lakes and a temporary decrease in IPID’s diversion rate. There was no precipitation recorded during that week.

Peaks in the Historic Channel hydrograph occurring the weeks of July 18, September 19, and October 3 were attributed to precipitation events. The peak occurring the week of August 29 was also attributed to precipitation; however, the effect on Icicle flows was magnified by the 70 cfs flow augmentation rate occurring at that time.

Augmentation Slowed the Seasonal Falling Hydrograph

Flow augmentation appears to have slowed the rate of the Icicle’s seasonal falling hydrograph.

Figure 8 shows the observed Historic Channel hydrograph, cumulative flow augmentation hydrograph, and an estimate of what the Historic Channel hydrograph might have looked like in the absence of augmentation flows. The latter was derived by subtracting the cumulative augmentation flows from the observed Historic Channel hydrograph.

In the absence of flow augmentation, the Icicle's seasonal falling hydrograph is estimated to have decreased at a rate of about 7 to 8 cfs per day through July into the first week in August. Flow augmentation is estimated to have slowed the seasonal falling hydrograph by about 1 cfs per day to about 6 to 7 cfs per day (Figure 8). The significant increase in augmentation the week of August 8 delayed the timing of when Historic Channel flows would have diminished to below the 100 cfs target by 1 week.

Augmentation Prolonged the Target Flow

Flow augmentation increased the period of time that the target flow was met by about one third.

The estimate hydrograph for Historic Channel flows without flow augmentation indicates discharge would have dropped below the 100 cfs target beginning August 8 and remained below the target until significant precipitation began about October 8—a period of about 9 weeks (Figure 8). The observed Historic Channel hydrograph indicates augmentation flows slowed the seasonal falling hydrograph by about 1 cfs per day, delaying the date when Icicle flows would have otherwise diminished to below the 100 cfs target by one week.

Data Gaps

The following data gaps were identified from the 2016 Pilot Study:

- Real time flows for the Historic Channel measured at Structure 2 were not available. Ecology's Icicle Gauge was used as a proxy by subtracting 50 cfs, estimated to represent diversions by LNFH that bypass the Historic Channel.
- Rating curves developed for lake outlet channels require more streamflow measurements to increase accuracy. Rating curves should contain at least six measured points at various stage/discharge conditions. Existing rating curves are missing measured discharge points for high and low flow conditions. This increases error when using rating curves to record and establish release flows because low flow and high flow conditions must be extrapolated from the portions of the curves that are developed using measured data.
- Interpreting effects of flow augmentation on Icicle Creek was complicated by precipitation events. The nearest precipitation recording station is the Fish Lake Snotel located in the Cle Elum River Basin, which is between 9 and 24 miles from the Study lakes.
- The fate of water released from storage is not fully understood. It appears some portion of augmentation water may be going to storage along the tributary and mainstem Icicle Creek streambeds as indicated by the lack of a one-for-one relationship between water released from storage and the Icicle Creek stream gauges. The effects of inputs from upstream sources and diversions by upstream water users are not fully understood.
- Impacts of flow releases on Bull Trout habitat in French and Leland creeks likely require additional study. The Project objective to avoid releases from storage over 10 cfs into these

creeks after September 15 limited the flow augmentation options available to meet the late season Historic Channel flow target.

Conclusions

The 2016 Pilot Study provided promising results that water stored in Alpine Lakes reservoirs can be used to effectively enhance stream flows in the Historic Channel. There were no fatal flaws identified. While flow augmentation is not a total solution for achieving the IWG's flow targets in the Historic Channel, it may account for about one third of the solution based on the results of this Study. A follow on study is recommended to confirm and improve on findings of the 2016 Pilot Study and to resolve data gaps:

- No fatal flaws were identified.
- Augmentation flows of up to 90 cfs extended Icicle Creek flows in the Historic Channel above the 100 cfs target for 3 weeks. This represents about one third of the nine-week low flow period during 2016, which is considered an average runoff year. Augmentation flows equaled between 31 and 78 percent of late season discharge in the Historic Channel.
- Increased augmentation flows during the weeks of August 8 and August 22 resulted in higher flows in the Icicle as indicated by temporary peaks in the hydrograph.
- Quantities of water released for flow augmentation are not adequate to reverse or even keep up with the seasonal falling hydrograph. However, flow augmentation can slow the rate of decline, prolonging the period when flows remain above the target. Augmentation flows slowed the seasonal falling hydrograph by about 1 cfs per day, delaying the date when Icicle flows would have otherwise diminished to below the 100 cfs target by one week.
- Over 6,400 ac-ft of water was released from storage for flow augmentation between July 11 and October 6. Nearly all physically available water was used for flow augmentation (about 250 ac-ft remained in Square Lake). About 1,300 ac-ft of trust water quantity was not physically accessible from both Klonaqua and Colchuck lakes.

Recommendations

The following are recommended for a follow-on study:

- Improve accuracy of accounting for discharge in the Historic Channel by measuring flows at Structure 2, as opposed to using the Ecology Gauge as a proxy. USFWS is currently in the process of equipping Structure 2 for access to real time flows.
- Improve rating curves. Collect additional streamflow measurements at lake outlets to increase accuracy of rating curves for rated sections at low and high flow conditions. High flows should be collected in the Spring when water is available to release from storage and low flows should be collected in the Fall when baseflows are present.
- Establish a precipitation recording station closer to the reservoirs (preferably within the Alpine Lakes Wilderness) to improve measurement of the magnitude and timing of precipitation to understand its effects on stream flows.
- Initiate study to determine impacts of release flows on Bull Trout habitat in French and Leland Creeks that drain Square and Klonaqua Lakes and whether release flows exceeding 10 cfs could be tolerated after September 15. These lakes hold nearly half the physically

available water for flow augmentation. Releases greater than 10 cfs in late season would provide greater flexibility to manage flow augmentation to Icicle Creek during the low flow month of September.

- Improve understanding of the fate of flow augmentation water. Evaluate gaining/losing characteristics of tributaries draining reservoirs and mainstem Icicle Creek. Coordinate with USFWS to improve understanding of releases from Snow Lakes. Coordinate with USFWS, IPID, Cascade Orchards Irrigation Company, and the City of Leavenworth to quantify diversions occurring upstream of the Historic Channel.
- Account for declining outflow rates from reservoirs as the lakes are drawn down. Cumulative outflow rates decreased at a rate of 0.5 cfs per day when lakes were full. This rate increased to about 3 cfs per day as the lakes neared empty. Because these lakes are remote and can reasonably be visited on foot only once per week, flow augmentation planning should consider adjusting outflow rates to account for these changes. Automating control structures to make minor adjustments to head gates every few days would mitigate decreasing outflow rates.
- In average water years, consider limiting early season releases from storage to save water for later in the season. However, more water should be released earlier from Square Lake to avoid water remaining in storage at the end of the season due to flow in Leland Creek that are limited to 10 cfs after September 15. Leakage and the inability to control the submerged head gate at Eightmile Lake limit options for retaining stored water. Repairing the Eightmile Lake dam may increase conservation of stored water allowing greater flexibility for water management to meet late season flow targets.

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Rantz, S.E. et al., 1982, Measurement and Computation of Streamflow: Volume 1, Measurement of Stage and Discharge, Geological Survey Water-Supply Paper 2175, USGS, Washington.

Limitations

Work for this project was performed for Chelan County Natural Resources Department (Client), and this memorandum was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

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Attachments: Figure 1 – Icicle Creek Sub-Basin
Figure 2 – Outlet Channel Rating Curves
Figure 3 – Flow Augmentation, Volumes, and Flow Rates
Figure 4 – Cumulative Augmentation Flow
Figure 5 – Lake Hydrographs
Figure 6 – Historic Channel Hydrograph
Figure 7 – Augmentation Contribution to Historic Channel
Figure 8 – Effects of Augmentation on Historic Channel Flow

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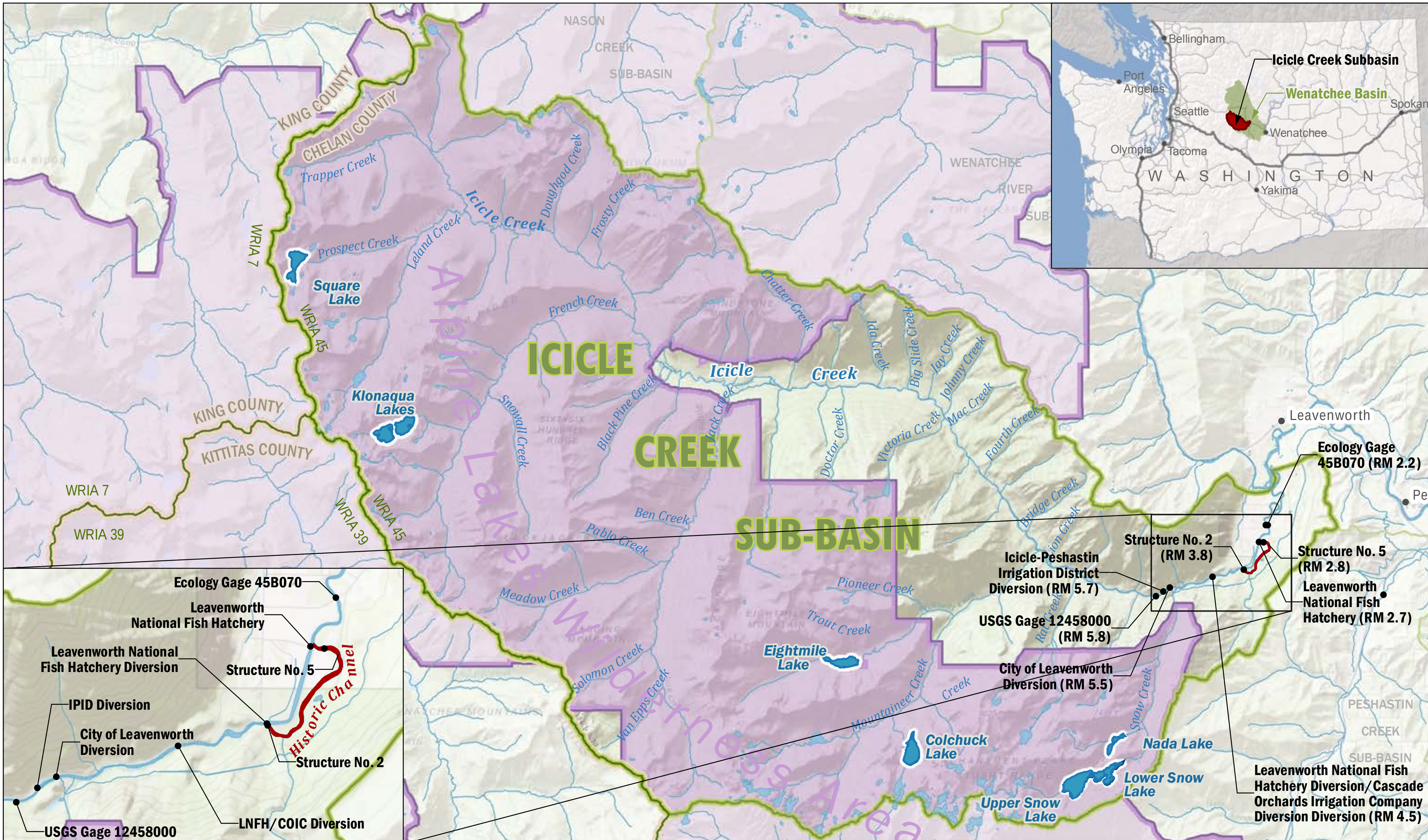
FIGURES



Icicle Creek Sub-Basin

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

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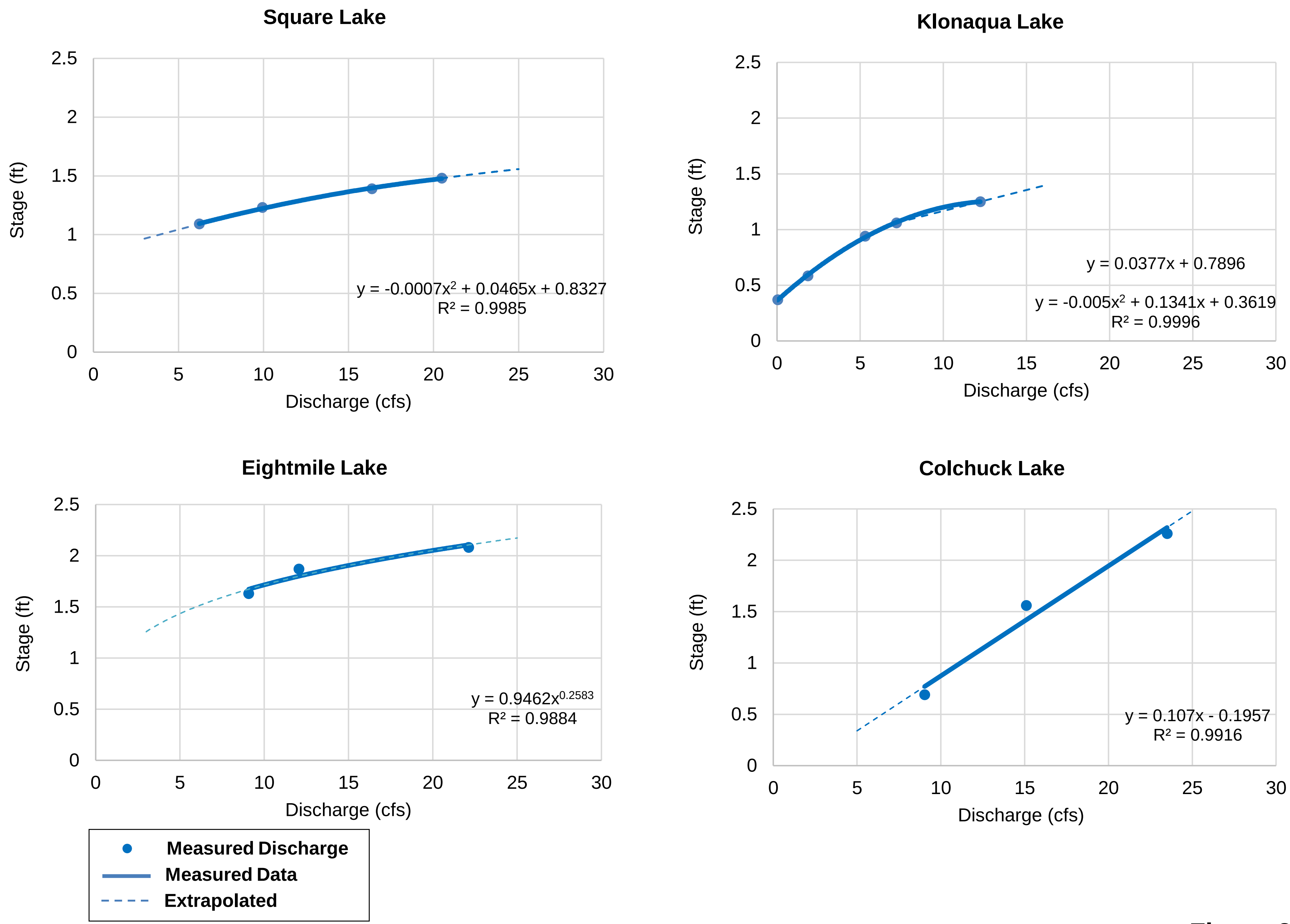

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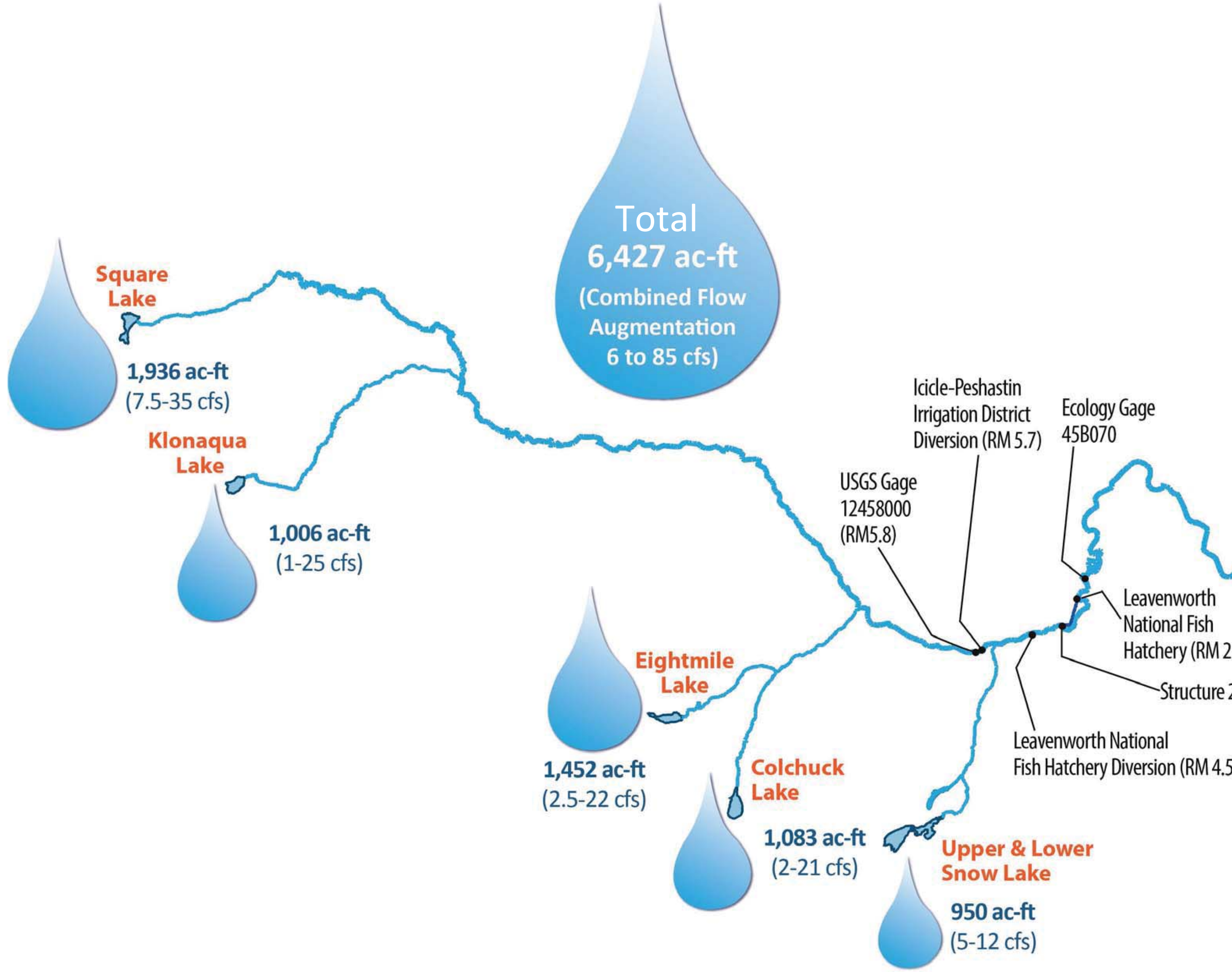
Figure 2
Outlet Channel Rating Curves
Project No. 120045, Alpine Lakes Optimization and Automation, Chelan County, WA



Flow Augmentation, Volumes, and Flow Rates

Feasibility Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

Aspect CONSULTING

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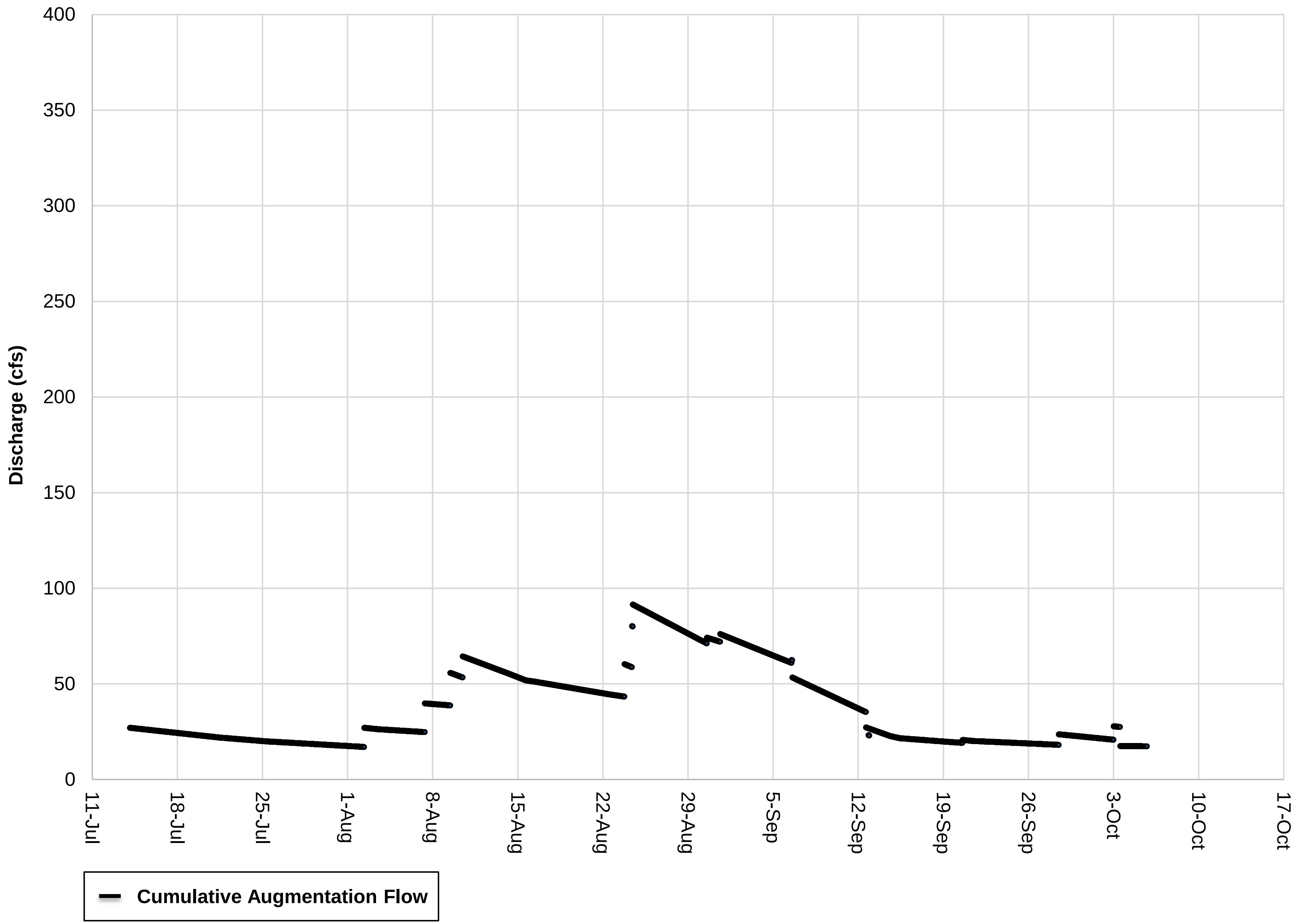

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Figure 4
Cumulative Augmentation Flow
Project No. 120045, Alpine Lakes Optimization and Automation, Chelan County, WA

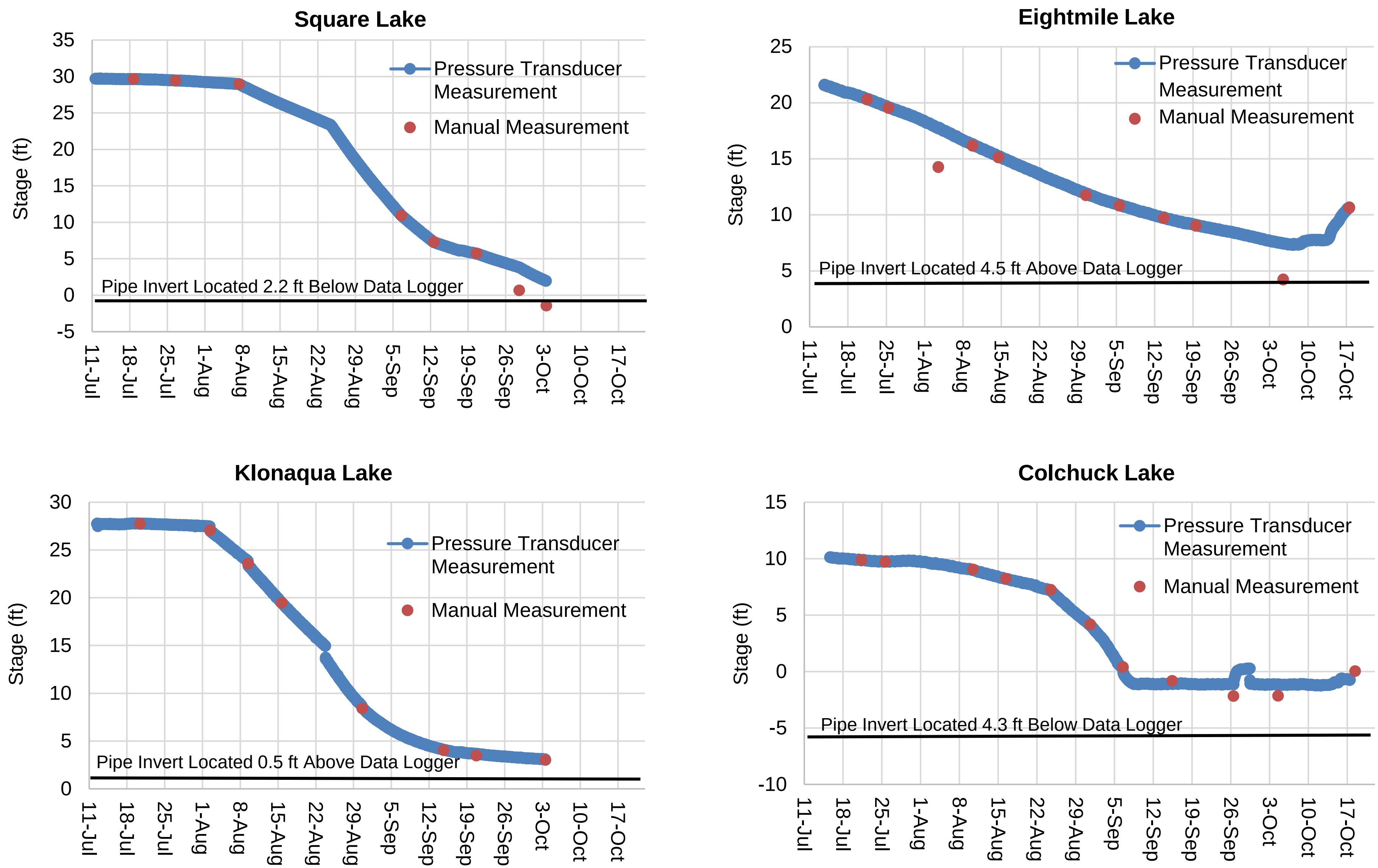

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Figure 5
Lake Hydrographs
Project No. 120045, Alpine Lakes Optimization and Automation, Chelan County, WA

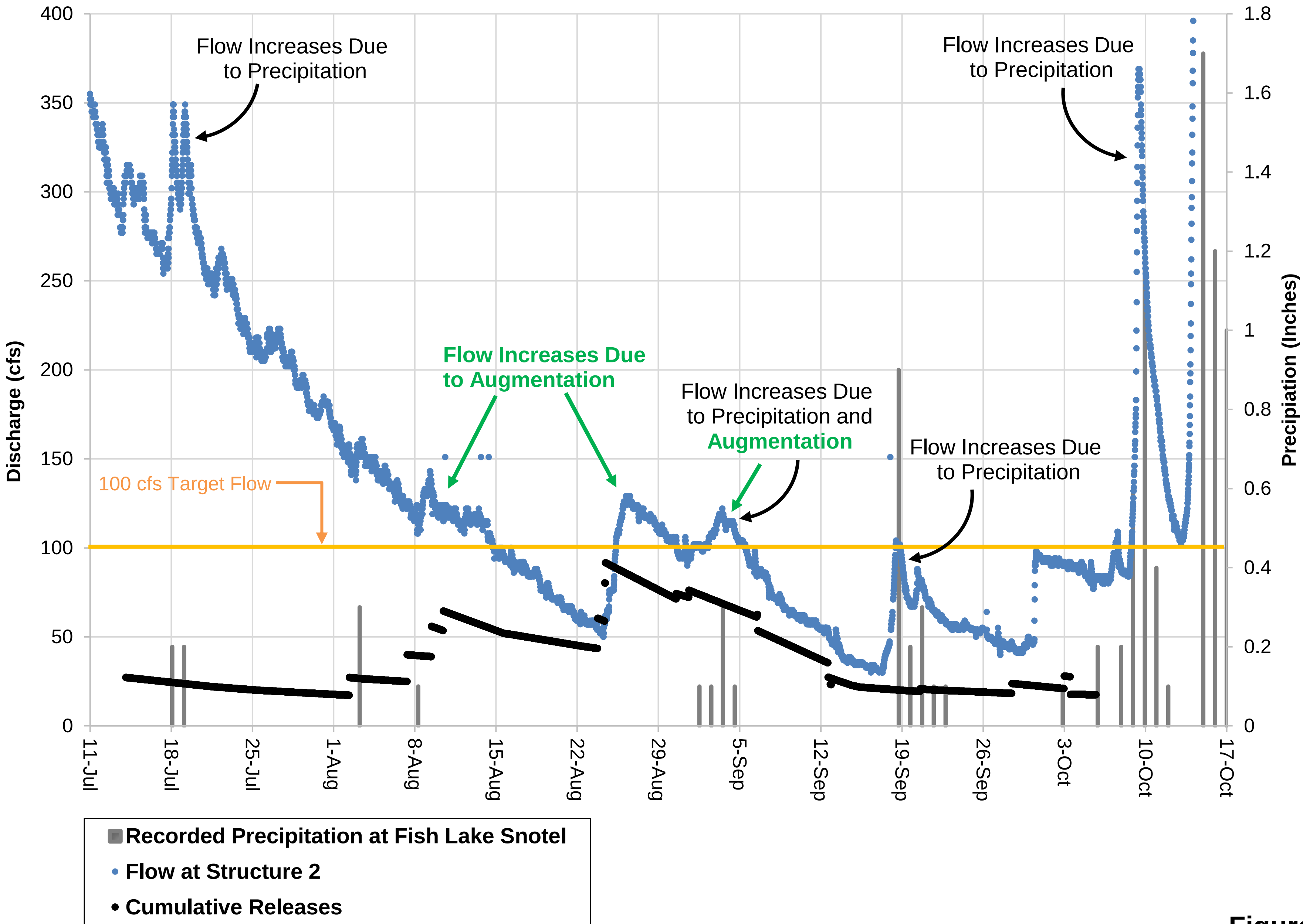

Figure 6
Historic Channel Hydrograph
Alpine Lakes Optimization and Automation Chelan County, WA

Aspect Consulting
4/28/2017
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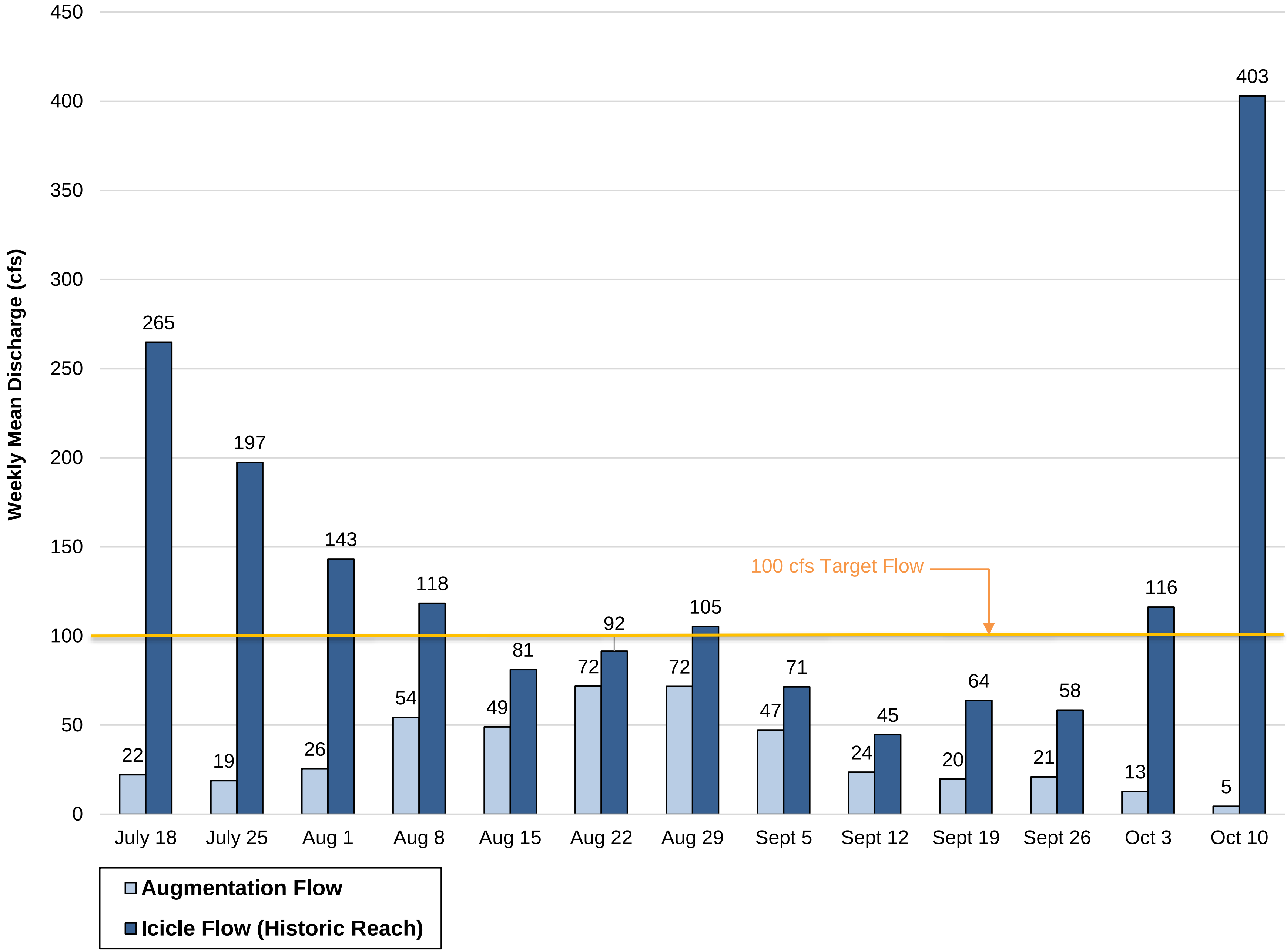

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Figure 7
Augmentation Contribution to Historic Channel
Project No. 120045, Alpine Lakes Optimization and Automation, Chelan County, WA

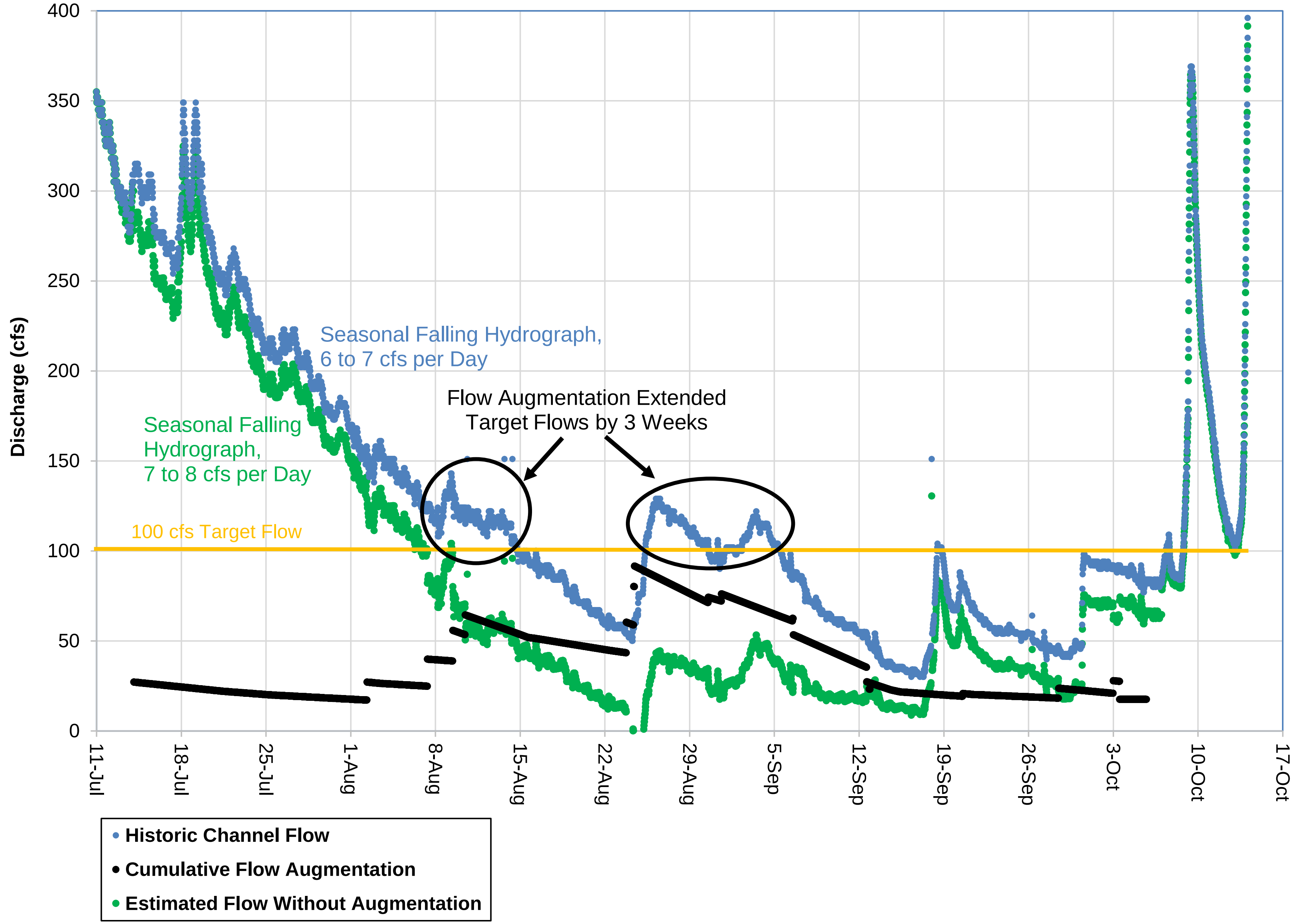

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Figure 8
Effects of Augmentation on Historic Channel Flow
Project No. 120045, Alpine Lakes Optimization and Automation, Chelan County, WA

MEMORANDUM

Project No.: 120455

April 17, 2018

To: Mike Kaputa, Director, Chelan County Natural Resources Department

From:

Bill Sullivan, LHG, CWRE
Senior Hydrogeologist
bsullivan@aspectconsulting.com

Dan Haller, PE, CWRE
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Re: **Alpine Lakes 2017 Flow Augmentation Pilot Study**

Executive Summary

Aspect Consulting, LLC (Aspect) conducted the Alpine Lakes 2017 Flow Augmentation Pilot Study (2017 Pilot Study) as a continuation to the 2016 Flow Augmentation Pilot Study (2016 Pilot Study). The 2016 Pilot Study (Aspect, 2017a) demonstrated that managed release of water stored in five Alpine Lakes reservoirs substantially benefits late-season instream flows in the Historic Channel of Icicle Creek (Figure 1). The 2017 Pilot Study was conducted to confirm the benefit of flow augmentation on instream flows in the Historic Channel and to address data gaps and implement recommendations from the 2016 Pilot Study.

Both the 2016 and 2017 Pilot Studies were coordinated by the Chelan County Natural Resources Department (County) to understand benefits and impacts and potential fatal flaws associated with the proposed Alpine Lakes Optimization, Modernization, and Automation Project (Project). The Project is being developed by the multi-stakeholder Icicle Work Group (IWG) as part of the Icicle Creek Water Resource Management Icicle Strategy (Icicle Strategy) to achieve diverse benefits in the Icicle Creek drainage. A Guiding Principle of the Icicle Strategy is achieving adequate stream flows in the Historic Channel of lower Icicle Creek with the goal of maintaining at least 100 cubic feet per second (cfs) during average years and 60 cfs during drought years.

The 2017 Pilot Study was conducted in response to the Icicle-Peshastin Irrigation District (IPID) electing to donate up to 9,600 acre-feet of water stored in five Alpine Lakes reservoirs to Washington State's Trust Water Program for instream flow benefit. The Trust Water Donation period ran from July through October and coincided with planned reservoir maintenance activities.

The 2017 Pilot Study included maintenance and repair of reservoir stage and outflow monitoring equipment at four reservoirs to support management of water released from storage to augment stream flows, as well as coordination with the U.S. Fish and Wildlife Service (USFWS) on their operations of Snow and Nada Lakes and the Leavenworth National Fish Hatchery (LNFH). Icicle Creek flows were monitored and augmentation flows were adjusted on a weekly basis for 12 weeks during the Summer and early Fall of 2017.

Key findings of the 2017 Pilot Study include:

- Findings of the 2016 Pilot Study were generally confirmed. No fatal flaws were identified.
- Flow augmentation releases available from storage in Alpine Lakes nearing 6,500 acre-feet (ac-ft), were confirmed to significantly enhance stream flows in the Historic Channel of Icicle Creek.
- While flow augmentation is not a total solution for achieving the IWG's flow targets in the Historic Channel, it may account for over one half the volume needed to meet the target.
- Quantities of water released for flow augmentation are not adequate to reverse or even keep up with the seasonally falling hydrograph. However, flow augmentation can slow the rate of decline, prolonging the period when flows remain above the target. Specifically, during the 2017 Pilot Study:
  - Augmentation flows of up to 75 cfs improved flows in the Historic Channel by about one half during critical low flow periods.
  - Augmentation flows increased flows in the Historic Channel of Icicle Creek to above the 100 cfs target for about 10 days.
  - Augmentation flows equaled up to 95 percent of discharge in the Historic Channel during critical low flow periods.
- Winter augmentation opportunities are limited by lack of sufficient inflows to replace summer and fall storage releases and, at Eightmile Lake, by seepage losses from storage.

Although no fatal flaws were identified, a follow-on study is recommended to confirm and improve on findings of the 2016 and 2017 Pilot Studies and to resolve remaining data gaps. Key recommendations include:

- Improve accuracy of Icicle Creek discharge estimates in the Historic Channel by collecting manual stream flow measurements to validate/calibrate existing methods of estimating discharge. This could preclude the need to obtain real-time data from Structure 2.
- Continue providing support to the Washington Department of Fish and Wildlife (WDFW) in assessing impacts of augmentation release flows on Bull Trout habitat in French and Leland creeks, which drain Square and Klonaqua lakes. WDFW initiated a study in 2017 to assess impacts of release flows and identified several data gaps in its summary report (WDFW, 2018; Appendix A).
  - Evaluate opportunities to provide greater temperature benefits in Icicle tributaries by performing lake depth temperature profiles.
  - Conduct additional habitat and fish presence studies to create an adaptive release model that can aid in timing and magnitude of release for both tributary and mainstem Icicle Creek benefit
- Improve understanding of the fate of flow augmentation water, including lag effects due to stream channel storage:

- Evaluate gaining/losing characteristics of the tributaries draining reservoirs and the mainstem Icicle Creek.
- Coordinate with USFWS to improve understanding of releases from Snow Lakes.
- Coordinate with USFWS, IPID, Cascade Orchards Irrigation Company, and the City of Leavenworth to quantify diversions occurring upstream of the Historic Channel.

Introduction

Aspect Consulting, LLC (Aspect) conducted the Alpine Lakes 2017 Flow Augmentation Pilot Study (2017 Pilot Study) to assess the effects of augmenting stream flows in Icicle Creek using water stored by the Icicle-Peshastin Irrigation District (IPID) in five mountain reservoirs. The 2017 Pilot Study was conducted as a continuation of the 2016 Flow Augmentation Pilot Study (2016 Pilot Study; Aspect, 2017a) in response to discretionary trust water donations of stored water by IPID coinciding with planned reservoir maintenance activities.

Both the 2016 and 2017 Pilot Studies were coordinated by the Chelan County Natural Resources Department (County) to understand benefits and impacts and potential fatal flaws associated with the proposed Alpine Lakes Optimization, Modernization, and Automation Project (Project).

The Project is being developed by the multi-stakeholder Icicle Work Group (IWG), which is comprised of diverse agricultural, conservation, and recreational interests, Tribes, and local, state, and federal agencies. The IWG developed the Icicle Creek Water Resource Management Icicle Strategy (Icicle Strategy) by consensus of its members to improve instream flows in Icicle Creek. The Icicle Strategy outlines nine Guiding Principles to achieve diverse benefits. The Adequate Streamflow principle sets a target flow of 100 cubic feet per second (cfs) during low-flow periods in non-drought years and 60 cfs during drought years in the Historic Channel of lower Icicle Creek. The flow target is intended to be measured at the Leavenworth National Fish Hatchery (LNFH) Structure 2, located at river mile (RM) 3.8 that lies at the head of the Historic Channel of Icicle Creek (described below).

The 2017 Pilot Study was funded under Grant Number WROCR-VER1-ChCoNR-00002 sourced from the Washington State Department of Ecology (Ecology) Office of Columbia River (OCR).

Background

The first flow augmentation pilot study was completed in 2016 (Aspect, 2017a). As part of the 2016 Pilot Study, outflow and lake level monitoring equipment was installed at the four Alpine Lakes managed as reservoirs by IPID (Square, Klonaqua, Eightmile, and Colchuck lakes). Water released from those reservoirs, and from Snow Lakes, contributed to instream flows in Icicle Creek under IPID's trust water donation. Key findings of the 2016 study included:

- Over 6,400 ac-ft of water released from storage at peak rates up to 90 cfs.
- Augmentation flows equaled between 31 and 78 percent of discharge in the Historic Channel during critical low flow periods.
- Augmentation was found to be insufficient to keep up with the seasonally falling hydrograph and will not present a total solution for achieving the IWG's flow targets in the Historic

Channel. However, augmentation did slow the rate of seasonally decline, prolonging the period when flows remained above the target by about one third, or 3.5 weeks.

Based on the success of the 2016 Pilot Study in demonstrating beneficial impacts of augmentation on Historic Channel flows, the 2017 Pilot Study was implemented to confirm findings, address data gaps, and implement recommendations.

Basin Description

Icicle Creek drains an area of about 243 square miles of undeveloped mountainous terrain west of Leavenworth in Chelan County, Washington (Subbasin; Figure 1). Icicle Creek drains to the Wenatchee River at Leavenworth. The majority of its drainage area lies within the Alpine Lakes Wilderness Area on land managed by the U.S. Forest Service (USFS). The lowermost section is moderately developed and includes recreational and residential development, agriculture, lodging, and the LNFH.

The Icicle is a snowpack-driven watershed with high flows occurring during spring freshet and low flows in late Summer (primarily September) and Fall. Two stream gauges are present on Icicle Creek (Figure 1). The U.S. Geological Survey (USGS) operates a gauge (12458000) at RM 5.8 located upstream of Snow Creek having a period of record from 1993 to present. Ecology operates a gauge (45B070) at RM 2.2 having a period of record from 2007 to present. Additionally, the USFWS is in the process of establishing stream measurement recording at Structure 2.

Numerous mountain and alpine lakes are present in the Icicle Subbasin. These are naturally formed lakes, the largest of which were modified to store water prior to Wilderness Area designation. The Icicle's major tributaries originate from the larger lakes. These include French Creek draining Klonaqua Lake; Leland Creek draining Square Lake; Mountaineer Creek draining Eightmile Lake and Colchuck Lake; and Snow Creek draining Upper and Lower Snow Lakes. Major lakes and tributaries are shown on Figure 1.

Icicle-Peshastin Irrigation District

The IPID diverts surface water from Icicle and Peshastin Creek drainages for irrigation of lands between Leavenworth and Cashmere. IPID holds diversionary rights from Icicle and Snow Creeks at the IPID diversion located at RM 5.7 (Figure 1) during irrigation season at a rate up to 117.71 cfs under Water Right Certificates S4-35002JC, S4*35002ABBJ, having priority date of 1910 and Certificate 1082 having priority date of 1919.

IPID also has water rights to store water in the five aforementioned reservoirs located within the Alpine Lakes Wilderness Area for the purpose of providing irrigation water during times of drought or when Icicle Creek flows are insufficient to meet IPID's diversionary needs. These reservoirs are discussed below.

Reservoirs

The five naturally-formed lakes within the Alpine Lakes Wilderness Area were modified beginning in the 1920s to store water for irrigation and fish propagation. Locations of the reservoirs are shown on Figure 1.

Four of the reservoirs are operated by IPID (Square, Klonaqua, Eightmile, and Colchuck lakes) and one reservoir is operated by the USFWS and U.S. Bureau of Reclamation (USBOR). Square and Klonaqua Lakes were modified by excavating a tunnel (Square) and buried pipe (Klonaqua) to access water below the natural level of the lakes. Colchuck Lake was modified by excavating a channel connecting two natural lake basins. All four lakes have small dams (5 to 10 feet high) constructed to enhance storage. Upper Snow Lake Reservoir is operated to support the LNFH and also stores water for IPID. Water is accessed in Upper Snow Lake using a tunnel/pipe bored through rock. The outlet lies below the natural water level of Upper Snow Lake. There is no dam.

IPID and USFWS/BOR operate these facilities under easements with USFS that were established when the land was transferred to USFS during the Wilderness Area designation. These easements allow IPID and USFWS staff access and to perform maintenance activities.

The 2016 Pilot Study provided updated estimates for active storage volumes based on monitoring of discharge rates released from storage (Aspect, 2017a) and improved bathymetry derived from LiDAR data collected in Fall of 2016 after active storage in reservoirs had been drained down (Aspect, 2017b).

Reservoir Operations

In average runoff years, water is released on a rotational basis from one of the four reservoirs operated by IPID. IPID typically only receives water from Upper Snow Lake during drought years under a partial subordination agreement with USFWS. Water is typically released from some or all the reservoirs in drought years to augment downstream water supply.

To operate these reservoirs, IPID and USFWS staff hike to their respective lakes to manually turn hand wheels and valves that operate head gates. USFWS demand from Snow Lakes ranges from about 20 cfs in July to about 50 cfs during September. The control valve at the outlet to Upper Snow Lake currently limits the release rate to about 55 cfs.

Because of the time and cost required to adjust head gates, adjustments are generally made infrequently or only at the beginning and end of the season. The hand wheel operator at Eightmile Lake was destroyed due to erosion and log debris. Adjusting this gate requires using scuba equipment when the lake is full, which further limits IPID's ability to adjust outflows. Stored water in Eightmile Lake also seeps through the north end of the lake where an ancient landslide serves as a natural impoundment. For this reason, IPID's water right includes water stored in Eightmile Lake lying below the invert of the outlet pipe.

Prior to the 2016 Pilot Study, there was no instrumentation installed to measure reservoir stage or discharge rates at the four lakes managed by IPID. At Upper Snow Lake, USFWS collects reservoir stage and release flow data using existing instrumentation.

Leavenworth National Fish Hatchery

The LNFH is located in the lower section of Icicle Creek at about RM 2.7 (Figure 1). The facility was constructed in the 1930s to mitigate impacts to anadromous fish runs impacted by the construction of Grand Coulee Dam. The LNFH continuously diverts surface and groundwater at a rate of about 50 cfs for fish propagation. Surface water is diverted a rate of about 42 cfs from Icicle

Creek using a diversion located at RM 4.5. The balance of water used by LNFH is withdrawn from a well field at the hatchery tapping an aquifer in hydraulic continuity with Icicle Creek.

An artificial channel known as the Hatchery Channel was constructed to periodically divert water from Icicle Creek to hydrate the aquifer supplying the well field. Water is diverted to the Hatchery Channel by a hydraulic control structure (Structure 2) that spans the width of the mainstem Creek at RM 3.8.

Effluent from the hatchery is discharged at a rate of about 50 cfs to the mainstem Icicle Creek below the outlet of the Hatchery Channel at RM 2.7, creating a bypass reach on Icicle Creek of about almost 2 miles. This bypass reach includes the natural channel of Icicle Creek downstream of Structure 2, known as the Historic Channel.

Flow Augmentation

The 2017 Pilot Study provided flow augmentation to Icicle Creek using water donated to trust by IPID for the purpose of benefitting instream flows.

Trust Water Donations

In April 2017, IPID temporarily donated five of its Alpine Lakes reservoir storage water rights into Ecology's Trust Water Right Program, pursuant to RCW 90.42.080 that encourages water right holders to donate water rights for instream flow purpose. In April 2017, Ecology accepted donations for Certificate Nos. 5527, 1227, 1228, 1229, and 1591 for the purpose of benefitting instream flow through March 2018. The donated water was to be made available by releasing water from the five lakes managed by IPID and USFWS and leaving it instream for environmental benefit during the 2017 low-water season. Table 1 shows quantities of water placed into trust.

Table 1. Quantities Donated to Trust Water Program in 2017

Lake Name	Annual Quantity of Water (acre-feet)	Instantaneous Rate (cfs)
Square Lake	2,000	40*
Klonaqua Lake	2,500	25
Eightmile Lake	1,600	25
Colchuck Lake	2,500	50
Snow Lakes	1,000	25
Total Donated to Trust	9,600	-

*Increased from 10 cfs for 2017.

The timing of trust water donations was coordinated to align with planned maintenance of IPID-operated reservoirs, which required lake levels to be drawn down by Fall 2017 for repair and inspection.

The instantaneous quantities donated represent the filling rates of the certificated water rights. Water can be released by IPID at higher rates under RCW 90.03.030. Higher releases were documented during the pilot to achieve downstream flow augmentation goals.

Project Objectives and Constraints

Objectives of the **2017** Pilot Study included:

- Maintain/repair existing monitoring equipment installed at lakes for the 2016 Pilot Study to measure outflow channel discharge and lake stage.
- Collect additional stream flow measurements to improve rating curves developed for outflow channels and define maximum operational discharge rates from outlet structures.
- Download data loggers and analyze lake stage data from October 2016 to July 2017.
- Assess the assumption that flows through the Historic Channel can be reliably estimated from discharge measured at Ecology's gauge located downstream of LNFH by subtracting 50 cfs from the recorded flows to account for hatchery diversions and return flows that bypass the Historic Channel.
- Draw down active storage in Square Lake for inspection by IPID.
- Maintain County staff safety in remote and difficult environment.
- Support the Washington Department of Fish and Wildlife (WDFW) monitoring of stream flows and temperatures in French and Leland Creeks (tributaries draining Klonaqua and Square Lakes) during periods when water is released form storage to assess impacts of releases on Bull Trout habitat.

The 2017 Pilot Study adhered to the goals and constraints agreed by the IWG's Instream Flow Subcommittee, to the extent practicable:

- Meet a target flow of 100 cfs in the Historic Channel as measured at Structure 2, consistent with IWG's Guiding Principles. Meeting this target was intended to be adaptive based on actual flows verified on a weekly basis.
- Release peak flow from Eightmile Lake early to accommodate design inspection and natural seepage. No weekly discharge adjustments could be made due to the submerged headgate.
- Limit release flows to about 10 cfs after September 15 from Square and Klonaqua lakes to protect Bull Trout spawning habitat in Leland and French creeks.
- Limit initial flow augmentation releases from Upper Snow Lake to about 5 cfs continuously due to limitations of the control valve that is shared with USFWS to support operations at LNFH. This was to be adaptive later in the season, depending on LNFH water needs.
- Avoid significant ramping changes to the rate of water released from storage at a given reservoir to about 5 to 10 cfs per week in late Summer and early Fall.

Methods

Key elements of the Study consisted of establishing Project objectives and constraints (described above), maintaining monitoring instrumentation at the four lakes operated by IPID, management of flow augmentation releases, and analysis of data to evaluate the effects of augmentation on instream flows in the Historic Reach. A detailed methodology is contained in the Quality Assurance Project Plan (QAPP) (Aspect, 2017c) as submitted to Ecology. Additional details regarding monitoring equipment installation and initial streamflow rating curve development are detailed in the 2016 Pilot Study (Aspect, 2017a).

Pre-season Reconnaissance

Aspect conducted a reconnaissance trip to Eightmile and Colchuck lakes on July 8, 2017, to assess the condition of monitoring equipment installed in 2016, and to support planning for the one-day site visit.

One-Day Site Visit and Pilot Startup

On July 19, 2017, Aspect and IPID staff visited each of the four reservoirs managed by IPID. Helicopter support was contracted to perform lifts of equipment and to ferry staff. This work was completed with IPID supervision under its easements to reservoir sites in accordance with a Work Plan submitted by IPID to the USFS.

At each reservoir, monitoring equipment installed in 2016 was inspected and repaired (as needed), and onsite data loggers monitoring lake level, water temperature, and barometric pressure were downloaded and redeployed (these were left in place at the end of the 2016 Pilot Study). Discharge was measured at each lake outlet over a range of flow rates to improve rating curves developed in 2016 for the outlet channels. Maximum operational discharge rates were also estimated from manual stream flow measurements. At Square Lake, the data logger used to record lake level was relocated to a location deeper than the invert of the lake outlet. Finally, head gates were opened as needed to support flow augmentation.

Reservoir Monitoring

Water level (stage) and volume in each reservoir were recorded continuously from July 2016 to October 2017. This period includes the entire duration of the 2016 and 2017 Pilot Studies and the interval between, when active storage releases ceased and reservoir levels were allowed to recover.

Changes in reservoir stage were measured in each of the four Alpine Lakes managed as reservoirs by IPID using continuous recording pressure transducer data loggers backed up by visual measurements during the Study. Pressure transducer data loggers were located underwater, near or below the invert elevation of the lake outlets. Because the pressure transducer data loggers were not barometrically compensated, continuous recording barometers were installed at two sites (Square and Eightmile). Visual water level measurements involved reading staff gauges installed at Klonaqua and Colchuck lakes and using a laser level/stadia rod at Square and Eightmile lakes where staff gauges could not be used.

Access to Colchuck and Eightmile lakes was restricted during much of the 2017 Pilot Study due to the Jack Creek Fire. When access to the lakes was restored in October, the pressure transducer and staff gauge at Colchuck Lake were exposed above the water and a tape measure was used during the final visual measurement taken on October 14. Lake stage-volume relationships (Aspect, 2017b) were used throughout the 2017 Pilot Study to monitor volumes remaining in active storage based on lake level measurements. Tracking volumes in storage was important to balance leaving sufficient water for flow augmentation later in the Study while ensuring lake levels were drawn down for facility inspection. At the beginning of the Study on July 19, all five reservoirs were full and overflowing from runoff. To support maintenance and inspection, IPID did not install stop logs at Eigthmile Lake, resulting in an initial lake level more than 1 foot lower than 2016.

Data loggers installed in the lakes also recorded water temperature. Temperature data were provided to WDFW to better understand temperatures of water being released to tributaries from Square and Klonaqua lakes (WDFW, 2018; Appendix A). WDFW found that water temperatures recorded by these data loggers appeared to be colder than water discharging to the outlet channels. Possible explanations for this include 1) the data logger at Square Lake was about 8 feet lower than the invert to the outlet and 2) the data logger at Klonaqua Lake was located inside an access vault (i.e., shaded from the sun).

Augmentation Flow Monitoring

Water stored in the lakes was released using outlet pipes controlled by head gates. Outflow rates from storage were estimated using rated stream gauging sections at the four outflow channels managed by IPID. Rated sections consist of a staff gauge and rating curve developed from several manual streamflow measurements collected at varying discharge rates.

Rated stream gauging sections were established in each outlet channel in 2016 by installing a staff plate affixed to vertical bedrock outcrop or a rod driven into the streambed. Discharge from the lake was measured at varied rates by changing head gate positions to adjust outflow. Discharge was determined using a velocity meter and area-velocity measurement (Rantz, et al.,1982). Staff plate measurements (stage) were recorded for each measured discharge rate to create rating curves. Refer to Aspect (2017a) for further background and discussion about developing these rating curves.

Rating curves developed from the 2016 Pilot Study data were updated with additional discharge data collected during the 2017 Pilot Study (Figure 2). The staff gauge and rating curves were used to determine discharge at a given outlet. Desired outflow rates were set by adjusting the head gate until the staff gauge read the stage corresponding to the desired flow.

Flow Augmentation Management

Prior to the 2017 Pilot Study, a plan was developed to release water from storage based on stream flow conditions observed in Icicle Creek during the 2016 Pilot Study and storage volume and outflow rate characteristics at each lake. Findings from the 2016 Pilot Study indicate the total volume of water stored in the lakes was not sufficient to prevent Historic Channel flows from dropping below the 100 cfs target for most of the low flow season. With this in mind, the 2017 Pilot Study approach to flow augmentation management was focused on conserving stored water so more would be available later in the season.

Consistent with the 2016 Pilot Study, lake-specific discharge rates and flow augmentation release plans were developed on a weekly basis by Aspect and the County. In setting these rates, we considered the 100 cfs target flow, water remaining in storage, and other Project objectives and constraints. Once a flow augmentation plan was developed for a given week, it was communicated to IWG stakeholders for review prior to implementation. County staff spent the following week hiking into the lakes to adjust head gates to match desired outflows and collect data. Data collected at each lake included outlet channel discharge (upon arrival—before setting desired outflows—and departure), visual measurements, pressure transducer lake level data, photographs, and other observations. These data were used to determine how quickly outflow had decreased since the last head gate adjustment, estimate volumes of water released from storage, and estimate volumes remaining in storage. These data were then considered when developing flow augmentation plans for subsequent weeks.

In 2017, access to Square Lake was impeded by hazardous trail conditions requiring two County staff during a single trip which limited the number and timing of site visits due to staffing constraints. Additionally, access to Colchuck and Eightmile lakes were restricted during much of the study period due to the Jack Creek Fire.

Findings

Flow augmentation from the five lakes began on July 19 and continued until the planned completion date of October 11 (85 days).

Augmentation Flows and Volumes

Estimated volumes of water released from storage, and ranges of augmentation flows during the Study are shown on Figure 3. A total of approximately 6,470 ac-ft of water was released from storage during the Study, providing cumulative augmentation flow rates to Icicle Creek ranging from 8 to 75 cfs per week. A hydrograph of cumulative augmentation flows from all five lakes is shown on
Figure 4.

Augmentation Flows

Peak cumulative augmentation flow was limited to 75 cfs to conserve stored water for later in the season and to comply with the Study objective to avoid steep ramp ups/drawdowns of water released into tributaries.

Flow augmentation began on July 19 with modest cumulative releases from storage, averaging about 12 cfs through the remainder of July (Figure 4). Augmentation was increased in the first week of August to 25 and then about 46 cfs. Releases were maintained at approximately this level until the third week of August, when they were increased to a peak of 75 cfs. Augmentation flows then decreased for the remainder of the Study due to declining driving head in the lakes (lake stage) as storage depleted. Declining augmentation flows were increased twice in September. Augmentation flows declined to about 23 cfs by the end of September. Augmentation flows were accounted for through October 11.

Peak augmentation flows from each lake are shown on Figure 3. Up to 35 cfs was released at Square Lake, 25 cfs at Klonaqua Lake, 12 cfs at Eightmile Lake, and 20 cfs at Colchuck Lake.

At Upper Snow Lake, flow augmentation discharge was limited to 5 cfs for most of the 2017 Pilot Study because the existing control valve has a capacity of about 55 cfs, of which LNFH operations require up to 50 cfs (i.e., discharge available for flow augmentation was limited to about 5 cfs). After LNFH demand had ceased, flows from Snow Lakes continued for 3 days ending October 4 so that about 50 cfs was attributed to augmentation flows to allow IPID to release the full volume donated to trust (Figure 4).

Maximum Operational Discharge Rates

A goal of the 2017 Pilot Study was to estimate maximum operational discharge rates at each of the lake outlets to determine the peak rate at which flow augmentation could feasibly occur under lake-full conditions. These were used to plan augmentation release rates. Discharge rates were estimated during the site visit on July 19 by collecting a manual stream flow measurement at the highest discharge that could be safely measured given channel conditions. The maximum flow rates measured were 33 cfs at Square Lake, 37 cfs at Klonaqua Lake, and 29 cfs at Colchuck Lake. Because the initial water level was lower in 2017, the maximum discharge rate at Eightmile Lake was based on the peak discharge measured in 2016, estimated at 22 cfs.

Augmentation Volumes

The total volume of water released from storage during the Study was estimated from outflow monitoring to be 6,470 ac-ft, which was similar to the 6,427 ac-ft released during the 2016 study.

Water volumes released from each lake are shown on Figure 3. The active storage volume in each of the lakes was nearly drawn down by the end of the Study: Square Lake (2,211 ac-ft), Klonaqua Lake (956 ac-ft), Eightmile Lake (981 ac-ft), and Colchuck Lake (1,321 ac-ft). Outlet structures in these lakes were at or within several feet of the water line and individual lake outflows had diminished.

An estimated total of about 400 ac-ft remained in active storage in Square, Klonaqua, and Colchuck Lakes at the end of the 2017 Pilot Study. About half of the remaining water left in storage was in Colchuck Lake, which was inaccessible for much of the season due to the Jack Creek Fire.

Although total volumes released were similar between 2016 and 2017, volumes released from individual lakes varied. In 2017, about 275 ac-ft more was released from Square Lake (about 2 feet of additional drawdown); about 238 ac-ft more was released from Colchuck Lake, which had a higher initial water level and was drawn down about 1 foot lower than in 2016; and about 471 ac-ft less was released from Eightmile Lake, which had an initial water level more than 1 foot lower than in 2016. Additionally, a storm in October 2016 increased Eightmile Lake levels to the point where the lake discharged through the head gate, increasing the volume of water released from storage; this did not occur in 2017.

Considering active storage volumes were nearly completely drawn down in each of the lakes, results of the 2017 Pilot Study confirm the total active storage among the five lakes is in the range of about 6,500 to 7,000 ac-ft including IPID's trust donation volume of 1,000 ac-ft in Snow Lakes. The higher range of estimated volume considers about 400 ac-ft remained in storage at the end of the Study. Active storage volumes estimated using bathymetric surveys derived from LiDAR and acoustical data (Aspect, 2017b) are about 7,700 ac-ft, including the trust volume at Snow Lakes. The difference in active storage volume estimated using outflow monitoring and bathymetry is about 10 percent when water remaining in storage at the end of the Study is considered. Contributing to this difference is error associated with:

- Streamflow measurement equipment used to build rating curves
- Analytical methods used to develop rating curves
- Interpretation of rating curves
- Lake stage estimates
- Outlet pipe elevation estimates
- Bathymetry data collection methods
- Bathymetry data analysis and volumetric estimates

Despite about 400 ac-ft remaining in active storage among the lakes, cumulative augmentation flows had decreased to less than 10 cfs by the end of the Study. This suggests the instream flow benefit of accessing the final few hundred acre feet of stored water could be limited.

Assuming the five lakes contain between 6,500 to 7,000 ac-ft of active storage, about 2,600 to 3,100 ac-ft of IPID's 9,600 ac-ft trust water donation could be inaccessible in an average water year due to elevations of outlet structures that lie above the stored water. However, multiple fill opportunities in some years, or IPID options during drought years to siphon water from lower than normal inlet elevations, could increase this volume.

Lake Stage and Drawdown

At the beginning of the 2017 Pilot Study, lake levels were full, which was consistent with the start with the 2016 Pilot Study (except for Eightmile Lake, which was slightly more than one foot lower in 2017 than in 2016). Active storage in the lakes was nearly completely drawn down during the Study. Table 2 shows total drawdown levels for both study years and estimated active storage height at each lake. Active storage height was estimated by collecting manual measurements during low water at Square, Klonaqua, and Colchuck lakes and estimates from 2016 were updated as needed. Active storage height at Eightmile Lake was estimated based on information from IPID. Active storage height at Snow Lakes was not assessed.

Table 2. Maximum Drawdown During 2016 and 2017 Studies

Lake Name	Estimated Active Storage Height (ft)	Maximum Drawdown in 2016 (ft)	Maximum Drawdown in 2017 (ft)
Square Lake	32	27.9	30.0
Klonaqua Lake	28	24.7	24.7
Eightmile Lake	17	14.1	13.9
Colchuck Lake	16.5	12.0	13.1
Snow Lake	Not Measured	N/A	N/A

In 2017, Square and Colchuck lakes were drawn down by about 2 feet and 1 foot more, respectively than in 2016. The other lakes were drawn down about the same as in 2016. After the head gate becomes exposed above the water line, drawdown in Eightmile Lake is controlled by seepage only.

Figure 5 shows lake hydrographs for the 2017 Pilot Study with stage measured by continuous recording datalogger, periodic manual measurements, and the depth of lake outlet pipe/tunnel inverts estimated from field inspection. Lake hydrographs shown on Figure 6 encompass the 2016 Pilot Study, 2017 Pilot Study, and the interval between studies.

Drawdown characteristics of lakes were identified by examining changes in lake stage. Drawdown characteristics depend on lake bed geometry, lake volume relative to outlet discharge rate, and water inputs to the lake (runoff, groundwater). Drawdown characteristics of Snow Lakes were not assessed. The steady declining stage drawdown curve observed for Eightmile Lake (Figure 5) was due to its head gate position, which remained fixed throughout the study and continuous seepage of water occurring through the lake bed to Eightmile Creek.

Drawdown curves at Square, Klonaqua, and Colchuck lakes were steeper than Eightmile Lake and became steeper when flow augmentation releases were increased. Compared to 2016, lake hydrographs during the 2017 Pilot Study show a more gradual drawdown, consistent with efforts to decrease peak release flows and conserve stored water for flow augmentation later in the season (Figure 6). Unlike 2016, lake stage did not increase toward the end of the 2017 Pilot Study, as no significant precipitation occurred during this period.

At Colchuck Lake, the transducer was set about 4 feet above the outlet invert due to the head gate configuration. No data were recorded once the water level dropped below 4 feet above the outlet invert. Additionally, restricted access to Eightmile Lake due to the Jack Creek fire prevented retrieval of barometric data, which was needed to adjust continuous water level data at Colchuck Lake. This resulted in no reliable water level record at Colchuck Lake for October (Figure 5). Water level in Colchuck Lake during October was interpolated based on the last available barometrically-compensated transducer data point and the final visual measurement.

The Jack Creek Fire also resulted in less water being released from Colchuck Lake than planned, as lack of access precluded head gate adjustments needed to maintain targeted outflow rates. At the end of the study, the water level in Colchuck Lake was approximately 3.4 feet above the outlet invert.

Lake Drawdown and Effects on Outflow Rates

Table 3 shows drawdown rates for the five reservoirs, which can be used along with the 2016 study results (Aspect, 2017a) to estimate how long it will take to draw down active storage.

Table 3. Lake Stage Drawdown Rates

Lake Name	Average Drawdown Rate (ft/day)	Average Discharge Rate (cfs)
Square Lake	0.4	16
Klonaqua Lake	0.5	9
Eightmile Lake	0.2	7
Colchuck Lake	0.3	12
Snow Lakes	Water levels not measured	n/a

Eightmile Lake drew down slowest at a rate of about 0.2 ft/day with an average discharge rate of about 7 cfs. Klonaqua Lake drained fastest, at a rate of about 0.5 feet per day and an average discharge of 9 cfs.

If no adjustments were made to head gates, the rate of discharge from the lakes declined with lake stage due to decreased driving head and lake bottom geometry. Figure 4 shows that cumulative augmentation flows began declining immediately after weekly head gate adjustments were made. Following the start of peak cumulative augmentation flow on August 21, flows decreased by about 3 cfs per day. Figure 4 also shows that augmentation flows declined faster as lake levels were drawn down. When lakes were relatively full in early August, the cumulative augmentation flows decreased at a rate of about 1.0 cfs per day, from about 46 cfs on August 6 to about 40 cfs on August 12 (Figure 4). When lakes were nearly empty in mid to late September, cumulative augmentation flows initially set at about 44 cfs, similar to early August augmentation flows, decreased at a faster rate of about 1.6 cfs per day.

Year-Round Lake Stage

The pressure-transducer data loggers also recorded lake stage during the period between studies (October 2016 to July 2017; Figure 7). Following closure of the head gates in October 2016, water levels in Square, Klonaqua, and Colchuck lakes recovered gradually. The lakes did not fill to overflow levels until February (Klonaqua Lake) and May (Square and Colchuck lakes).

Lake stage in Eightmile Lake recovered more rapidly than the other three lakes in response to precipitation (increase of approximately 14 feet in 2 weeks). However, by mid-November, seepage from Eightmile Lake overcame the inflow rate and the lake level began to drop, falling about 12 feet until lake levels began to recover in February. Declining water levels during the winter are assumed to be the result of precipitation transitioning to snow, limiting runoff to the lake while seepage from the lake continued.

The potential for Eightmile Lake to draw down significantly in winter due to seepage losses despite the head gate being closed could limit its value as a source for winter augmentation flows. Square and Colchuck lakes may only fill completely after the snow melts in spring, potentially limiting the ability to use these lakes as winter flow augmentation sources, especially when below-average precipitation accumulations are expected.

Effects of Augmentation on Historic Channel Flows

A hydrograph of estimated flows in the Historic Channel at Structure 2 during the 2017 Pilot Study is shown on Figure 7. This hydrograph was developed based on recorded flow measurements at the Ecology Gauge at RM 2.2 and subtracting 50 cfs to account for LNFH withdrawals and diversions upstream of this gauge. The hydrograph reflects ambient and augmentation flows. Based on the period of record from the USGS gauge, 2017 was an average runoff year in Icicle Creek. Figure 7 also contains the hydrograph showing the cumulative flow augmentation and a hyetograph for precipitation (as rainfall) occurring at the nearest weather station, the Fish Lake SNOTEL site located in the adjacent Cle Elum River drainage.

Icicle flows in the Historic Channel were about 200 cfs when the 2017 Pilot Study began on July 19 and decreased to about 100 cfs in mid-August.

Weekly averages for flow augmentation rates and Historic Channel flows during the 2017 Pilot Study period are shown on Figure 8. Flow augmentation during the low flow months of August and September equaled between 15 and 95 percent of total discharge in the Historic Channel.

Augmentation Increased Historic Channel Flows

Consistent with the 2016 Pilot Study, augmentation flows increased Historic Channel flows in 2017. Increased augmentation flows are indicated by the small “peaks” in the Historic Channel hydrograph during the weeks of August 2, 16, and 30 (Figure 7). Although not intended for flow augmentation, the peak in the Historic Channel hydrograph of about 45 cfs occurring the week of July 26 is the result of USFWS initiating releases from Snow Lakes. Augmentation releases also contributed to Historic Channel flows by slowing the naturally-declining hydrograph, prolonging the target flow period, and improving overall discharge. This decreased the difference between the estimate hydrograph for conditions without augmentation and the 100 cfs minimum flow target.

Increases in augmentation flows in August did not result in a one-for-one increase in Historic Channel flows. For example, when augmentation flows were increased by 31 cfs the week of August 2, 36 cfs the week of August 16, and 21 cfs the week of August 30, the Historic Channel hydrograph responded with short-lived increases (peaks) of 23 cfs, 15 cfs, and 12 cfs, respectively, before returning to pre-augmentation-increase levels and gradually declining flow trends (Figure 7). The difference in magnitude between flow augmentation and its effect on streamflow in Icicle Creek is attributed primarily to a portion of augmentation water going to storage along the miles of creek bed between the reservoirs and the Ecology Gauge. Some of this water is temporarily stored in channels and wetlands and as shallow groundwater in the hyporheic zone. A portion of the water is also likely lost to evaporation and transpiration by riparian vegetation.

The peaks observed in the hydrograph for the Historic Channel during 2017 are smaller than observed during the 2016 study. This is consistent with the different augmentation management approach for 2017 that initiated smaller increases in augmentation flows to minimize significant ramp-ups, and to conserve stored water for the late season.

Late-season precipitation events had a much greater influence on the hydrograph than the August increases to augmentation flows. Peaks in the Historic Channel hydrograph occurring the weeks of September 20 and 27, and October 4, were attributed to precipitation events (Figure 7). Precipitation events increased Historic Channel flows by about 47 to 63 cfs. The hydrograph peak occurring the week of September 27 appears considerably higher than peaks resulting from the other two precipitation events; much of this increase was because IPID had ceased its approximately 100 cfs diversion in the 2 days prior to the precipitation event. As with increased augmentation flows, precipitation events had only short-term impacts to stream flows, and flows quickly returned to a low flow state. For the 2017 Pilot Study, there were no circumstances when augmentation flows were intentionally reduced to conserve stored water.

Augmentation Slowed the Seasonally Falling Hydrograph

Consistent with the 2016 Pilot Study, flow augmentation appears to have slowed the rate of Icicle Creek's natural, seasonally falling hydrograph. Figure 9 shows the observed Historic Channel hydrograph (estimated based on the Ecology Gauge minus 50 cfs), cumulative flow augmentation hydrograph, and an estimate of what the Historic Channel hydrograph might have looked like in the absence of augmentation flows (estimated hydrograph). The latter was derived by subtracting the cumulative augmentation flows from the observed Historic Channel hydrograph. While the estimated hydrograph is generally consistent with average year flows based on the Ecology gauge period of record, it appears to underestimate the lowest flows that remain above 25 cfs during average years.

In the absence of flow augmentation, the seasonally falling hydrograph is estimated, based on the estimated hydrograph to have decreased at a rate of about 13 cfs per day from July 19 through the end of July (Figure 9). This rate is estimated to have decreased to about 4 cfs per day through August as discharge approaches base flows.

With limited augmentation through the end of July, the rate of decline of the seasonally falling hydrograph was effectively unchanged from the estimated (non-augmentation) hydrograph, with decreases in augmented flows of about 13 cfs per day. As releases were progressively increased starting in August, there was an improvement in the rate of decline of the augmented flow hydrograph relative to the estimated (non-augmentation) hydrograph of about 1 cfs per day, from an estimated 4 cfs per day without augmentation to about 3 cfs per day observed with augmentation (Figure 9).

Augmentation Prolonged the Target Flow

Flow augmentation increased the period of time that the target flow was met by about 10 days, or about 15 percent of the time when flows were estimated to have otherwise been below the target.

The estimated hydrograph for Historic Channel flows without flow augmentation indicates discharge would have dropped below the 100 cfs target beginning August 5 and largely remained below the target until a week after the 2017 Pilot Study had concluded, when significant precipitation began—a period of about 10 weeks (Figure 9). The observed Historic Channel hydrograph indicates augmentation flows slowed the seasonally falling hydrograph by about 1 cfs per day, delaying the date when Icicle Creek flows would have otherwise diminished to below the 100 cfs target by 10 days.

The 10-day period that augmentation is estimated to have prolonged target flows is less than the period estimated in 2016. This difference is partly explained by a change in the approach to augmentation management that sought to conserve stored water for later in the season during the 2017 Pilot Study. Additionally, the period when flows are estimated have been below the target in 2017 (10 weeks) is longer than in 2016 (9 weeks) due to the onset of significant precipitation occurring earlier in 2016.

Augmentation Decreased the Target Flow Deficit

Augmentation improved overall discharge in the Historic Channel, decreasing the difference between the estimated hydrograph without augmentation and the 100 cfs target.

Evaluation of the estimated, non-augmentation hydrograph indicates about 10,300 ac-ft would have been required to sustain flows at the 100 cfs target during the low flow period between August 5 and the end of the Study on October 11. About 6,000 ac-ft of augmentation water flowed through the Historic Channel during this period. With flow augmentation, the deficit between observed flows and the 100 cfs target decreased to approximately 4,300 ac-ft over this period—augmentation water made up over half the volume needed to meet the flow target. This improvement to Historic Channel flows is consistent with results of the 2016 Pilot Study that estimated augmentation increased the period flows are above the target by about one third.

Further beneficial effects of augmentation on Historic Channel flows could be realized by minimizing releases from storage in July and early August that were initiated before flows dropped below the 100 cfs target. Between 400 and 500 ac-ft of augmentation water was released from storage at the start of the 2017 Pilot Study before flows dropped below the 100 cfs target on August 5. Had that 400 to 500 ac-ft been retained, augmentation releases could have been increased later in the season by 10 cfs for about 20 to 25 days.

Estimating Flows through the Historic Channel

An objective of the 2017 Pilot Study was to confirm assumptions used to estimate stream flows in the Historic Channel.

Real time flows for the Historic Channel measured at Structure 2 were not available. The Ecology Gauge at RM 2.2 was used as a proxy by subtracting 50 cfs from the recorded flow measurements, estimated to represent diversions by LNFH that bypass the Historic Channel and return downstream. Upon conclusion of the Study, USFWS provided 2017 daily mean discharge data for the Historic Channel measured through Structure 2. These data were compared to our assumption of the Ecology Gauge minus 50 cfs.

Figure 10 contains hydrographs for our estimated flows through the Historic Channel using the Ecology Gauge minus 50 cfs assumption and USFWS measurements at Structure 2. The data sets show strong agreement until flows dropped to about 130 cfs on August 10. From that point, USFWS-estimated flows were generally higher by up to about 20 cfs through August and September.

A single manual streamflow measurement was collected on August 25 in the Historic Channel, about 100 feet downstream of Structure 2 (Figure 10). The manual measurement indicated discharge of 87 cfs, compared to our estimate of 80 cfs and the USFWS estimate of 90 cfs (daily mean). These limited data suggest our assumption using the Ecology Gauge minus 50 cfs may underestimate flows in the Historic Channel, especially when flows are near or below the 100 cfs flow target. Considering that the USFWS estimates are daily mean values, include rounding error and error associated with manual streamflow measurement of at least 3 percent, our assumption appears to be sufficiently valid (and conservative) for analyzing effects of augmentation on Historic Channel flows. Additional data collection will be required to refine this conclusion and to resolve differences between the methods used to estimate flows.

Data Gaps

The following data gaps were identified based on the 2016 and 2017 Pilot Studies:

- **Real-time flows for the Historic Channel measured at Structure 2 were not available.** Ecology's Icicle Creek Gauge at RM 2.2 was used as a proxy by subtracting 50 cfs from the recorded flow, to account for estimated diversions by LNFH that bypass the Historic Channel. It is not clear why there were differences between Historic Channel flows based on our estimates using the Ecology Gauge and the USFWS measurements at Structure 2.
- **The fate of flow augmentation water is not fully understood.** Lag effects due to stream channel storage reduce the impact of augmentation flows in the Historic Channel. The effects of inputs from upstream sources and diversions by upstream water users are not fully understood.
- **The effects of augmentation water on stream flow in Icicle Creek are not fully understood.** Interpretation of the data were complicated by precipitation events and the absence of precipitation-recording stations within the Icicle Creek basin. The nearest precipitation recording station is the Fish Lake SNOTEL located in the Cle Elum River Basin, which is between 9 and 24 miles from the Alpine Lakes reservoirs.

- **Evaluation of impacts of flow releases on Bull Trout habitat** in French and Leland creeks is ongoing and will require additional study (WDFW, 2018).

Conclusions

The 2017 Pilot Study, in combination with data collected during the 2016 Pilot Study, provided promising results that water stored in the Alpine Lakes reservoirs can be used to effectively enhance stream flows in the Historic Channel. There were no fatal flaws identified. While flow augmentation from the Alpine Lakes reservoirs is not a total solution for achieving the IWG's flow targets in the Historic Channel, these studies indicate it may increase the period flows are above the target by about one third and account for over one half the volume required to meet the flow target. A follow up study is recommended to confirm and improve on findings of the 2017 Pilot Study and to resolve data gaps.

The following is a summary of conclusions from the 2017 Pilot Study, with comparisons to the 2016 Pilot Study:

- No fatal flaws were identified.
- Between 6,500 and 7,000 ac-ft are available for release from storage. An estimated total of 6,470 acre-feet was released from storage, which is about the same as that released during the 2016 Pilot Study.
- Nearly all the water in active storage was released, and active storage in all lakes was nearly drawn down. About 400 ac-ft remained in active storage amongst the lakes. Storage volumes estimated in 2016 were confirmed in 2017.
  - Storages volumes estimated by monitoring outflow rates in 2017 (~6,500 ac-ft) are within 10 percent of volumes previously estimated using bathymetric survey based on LiDAR and acoustical data (~7,700 ac-ft; Aspect, 2017b) when the volume remaining in active storage at the end of the Study (~400 ac-ft) is considered.
- The full volume in active storage may not be available for effective flow augmentation. Although about 400 ac-ft remained available in storage amongst the lakes, cumulative augmentation flows had decreased to less than 10 cfs when lake levels were drawn down at the end of the Study. This augmentation rate is not sufficient to substantially close the gap between late season low flows in Icicle Creek and the 100 cfs.
- Between 2,600 and 3,100 ac-ft of water donated to trust was not physically accessible from the lakes using existing reservoir infrastructure.
- While total volumes released in 2017 were about the same as in 2016, release volumes differed significantly at several lakes.
  - About 300 ac-ft more was released from Square Lake than in 2016 and the lake was drawn to within 2 feet of the outlet invert. Drawing down Square Lake was a priority to support inspection of the facility.
  - About 200 ac-ft more was released from Colchuck Lake primarily because a higher water level at the beginning of the study in 2017 allowed more releases.

  - About 500 ac-ft less was released from Eightmile Lake than in 2016. Outflows from Eightmile in the late season are controlled by natural seepage and the headgate that was set to a fixed position at the beginning of the Study. The lower volume released in 2017 is attributed to initiating the study more than 1 week later than the 2016 Pilot Study, an initial water level 1 foot lower than in 2016, and decreased inflows (precipitation and runoff) during the study period.
- Planned augmentation was not optimized due to limited access to lakes. This delayed making adjustments, contributing to about 400 ac-ft remaining in active storage at the end of the Study. Access to Square Lake by foot was inhibited by hazardous trail conditions, and access to Colchuck and Eigthmile lakes was limited for much of the season by the Jack Creek Fire.
- Quantities of water released for flow augmentation are not adequate to reverse or even keep up with the seasonally falling hydrograph. However, flow augmentation can slow the rate of decline, prolonging the period when flows remain above the target. Augmentation flows slowed rate of the seasonally falling hydrograph by an average of about 1 cfs per day, delaying the date when Icicle flows would have otherwise diminished to below the 100 cfs target by approximately 10 days.
- Augmentation flow rates were managed to conserve stored water so more would be available later in the season than in 2016. While this approach improved late season flows, it resulted in a lower peak augmentation rate and fewer days when flows were maintained above the 100 cfs target.
  - Augmentation flows of up to 75 cfs improved flows in the Historic Channel by about one half during critical low flow periods.
  - Augmentation extended Icicle Creek flows in the Historic Channel above the 100 cfs target for about 10 days compared to 3 weeks in 2016.
  - Augmentation flows equaled between 15 and 95 percent of discharge in the Historic Channel during critical low flow periods.
  - Augmentation releases account for over one half the volume needed to meet the 100 cfs flow target in the Historic Channel. The total volume of augmentation water flowing through the Historic Channel during the low flow period of about 6,000 ac-ft made up over half the difference between the estimate hydrograph without augmentation and the 100 cfs target of 10,300 ac-ft.
- Data gaps identified in 2016 were addressed, including:
  - Rating curves for outlet channels were improved by collecting additional discharge measurements to increase the accuracy of outflow rates and volume estimates. Rating curves still require improvement, specifically at the lower end of flow ranges.
  - Informing impacts of flow releases on Bull Trout habitat in French and Leland Creeks (WDFW, 2018).
- The method used to estimate flow in the Historic Channel during 2016 and 2017 appears valid for the purpose of this Study. However, differences between flows estimated using the Ecology Gauge (minus 50 cfs) and those estimated by the USFWS at Structure 2 require further refinement, validation, and calibration.

- Lag effects due to stream channel storage reduce the effects of augmentation flows in the Historic Channel. Flows released from storage were not proportional to changes observed in the Historic Channel hydrograph, and peaks in the hydrograph resulting from significant increases to augmentation flows were relatively small. More study is needed to understand the fate and timing of water released from storage.
- Minimal head gate operation may be required to maintain augmentation flows. Precipitation events had only short-term impacts to stream flows, suggesting there may be no need to close gates to conserve water following precipitation events. Once opened, head gates remained open for the duration of the study but required periodic adjustment (opened more) to maintain augmentation flow rates.
- Winter augmentation opportunities are limited. Lake hydrographs for the winter of 2016-2017 suggest storage volumes are less than 6,500 ac-ft. After filling in response to precipitation, Eightmile Lake emptied due to seepage in mid-winter, when precipitation turned to snow, and did not fill again until spring. Square and Colchuck lakes did not fill completely until the spring snow melt.

Recommendations

The following are recommended for a follow-on study to improve confidence in findings of the 2016 and 2017 Pilot Studies:

- With additional study, our assumption for using the Ecology Gauge minus 50 cfs could be used to accurately estimate flows in the Historic Channel, precluding the need to equip Structure 2 to collect real-time data. Data collection, including LNFH surface and groundwater diversion rates and discharge rates of return flows to Icicle Creek, could be used in conjunction with additional streamflow measurements taken downstream of Structure 2 to refine our assumption, especially during low-flow periods.
- Improve understanding of the fate of flow augmentation water. Lag effects due to stream channel storage reduce the impact of augmentation flows in the Historic Channel. Evaluate gaining/losing characteristics of tributaries draining the reservoirs and of mainstem Icicle Creek. Coordinate with USFWS to improve understanding of releases from Snow Lakes. Continue coordination with USFWS, IPID, Cascade Orchards Irrigation Company, and the City of Leavenworth to quantify diversions occurring upstream of the Historic Channel.
- Establish a precipitation recording station closer to the reservoirs (preferably within the Alpine Lakes Wilderness) to improve measurement of the magnitude and timing of precipitation to understand its effects on stream flows.
- Continue improving rating curves. Increase the accuracy of outlet channel discharge rate estimates for low flows by measuring stream flows in the fall.
- Account for declining outflow rates from reservoirs due to drawdown. Flow augmentation planning should consider adjusting outflow rates to account for changes on at least a weekly basis. Automating control structures to make minor adjustments to head gates every few days would mitigate decreasing outflow rates.
- Consider limiting early season releases from storage to save water for later in the season. Both the 2016 and 2017 studies showed there is not enough augmentation water in storage to meet

the 100 cfs target for the entire low-flow season. Therefore, substantial augmentation occurring before flows drop below the 100 cfs target should be avoided to conserve water for later in the season:

  - Releases from Square Lake should be prioritized earlier in the augmentation season to avoid water remaining in storage at the end of the season. Flows in Leland Creek, which drains Square Lake, are limited to 10 cfs after September 15.
  - Leakage and the inability to control the submerged head gate at Eightmile Lake limit options for retaining stored water. Repairing the Eightmile Lake dam may increase conservation of stored water allowing greater flexibility for water management to meet late season flow targets.

- Augmentation could be increased by improving infrastructure to access the full trust donation volume. Additional study will be required to evaluate potential improvements to infrastructure.
- Continue to support WDFW in assessing impacts of release flows on Bull Trout habitat in French and Leland creeks that drain Square and Klonaqua lakes based on WDFW (2018):
  - Evaluate opportunities to provide greater temperature benefits in Icicle tributaries by performing lake depth temperature profiles.
  - Conduct additional habitat and fish presence studies to create an adaptive release model that can aid in timing and magnitude of release for both tributary and mainstem Icicle Creek benefit

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Washington Department of Fish and Wildlife (WDFW), 2018, Alpine Lakes Flow Augmentation Pilot Study 2017, Icicle Creek Tributary Monitoring Report, Washington Department of Fish and Wildlife Water Science Team Habitat Program- Science Division, January 2018.

Limitations

Work for this project was performed for the Chelan County Natural Resources Department (Client), and this memorandum was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

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Attachments: Figure 1 – Icicle Creek Sub-Basin
Figure 2 – Stage-Flow Curves
Figure 3 – 2017 Flow Augmentation, Volumes, and Flow Rates
Figure 4 – Cumulative Augmentation Flow
Figure 5 – 2017 Lake Hydrographs
Figure 6 – Year Round Hydrograph
Figure 7 – Historic Channel Hydrograph
Figure 8 – Augmentation Contribution to Historic Channel
Figure 9 – Effects of Augmentation on Historic Channel Flow
Figure 10 – USFWS Measured Flows at Structure 2
Appendix A – WDFW (2018) Icicle Creek Tributary Monitoring Report

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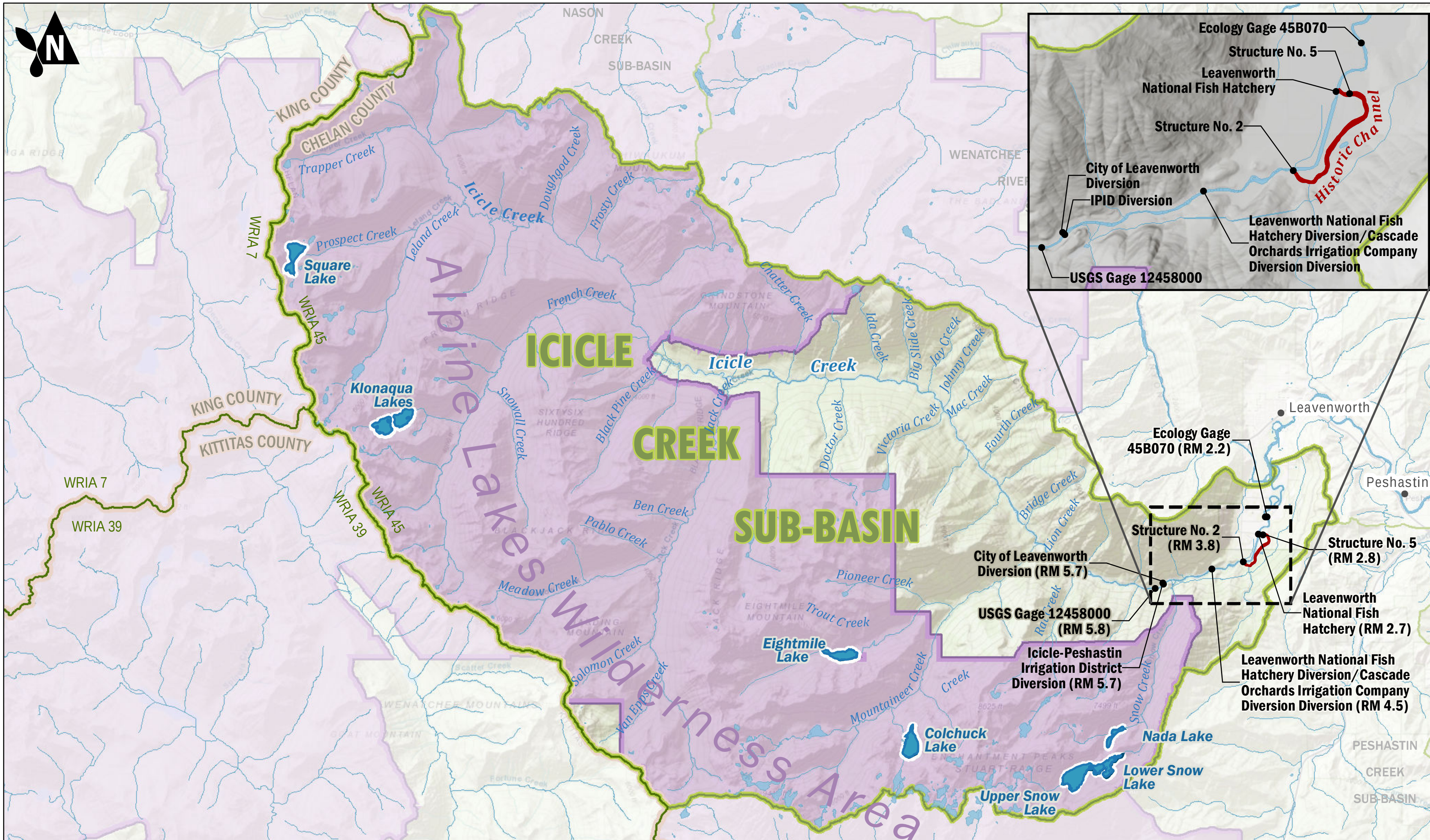
FIGURES



- Alpine Lakes Wilderness Area
- WRIA Boundary
- Subbasin
- Icicle Creek Subbasin
- County

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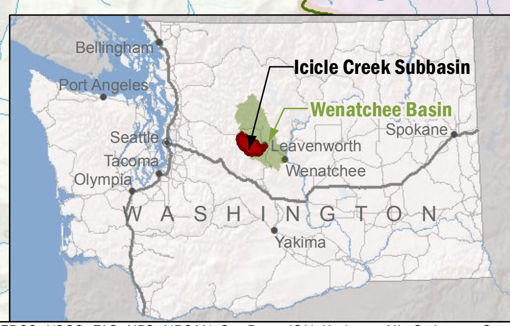

Icicle Creek Sub-Basin

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

Aspect CONSULTING	FEB-2018 PROJECT NO. 120045	BY: WMS / RAP REVISED BY: - - -	FIGURE NO. 1

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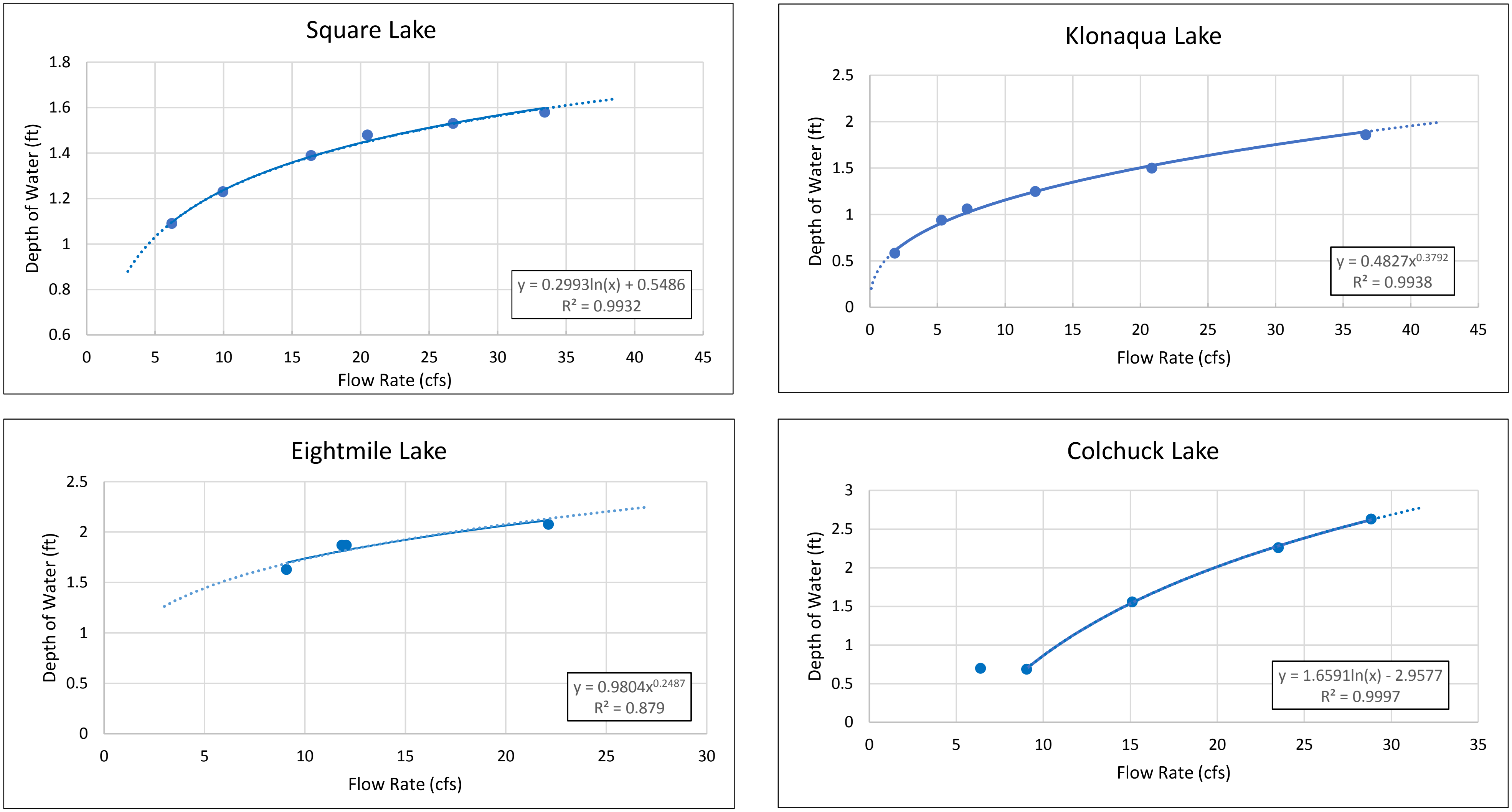

● Measured Discharge — Measured Discharge Curve - - - Extrapolated

Stage-Flow Curves

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

Aspect CONSULTING	FEB-2018	BY: WMS / RAP	FIGURE NO.
	PROJECT NO. 120045	REVISED BY: - - -	2

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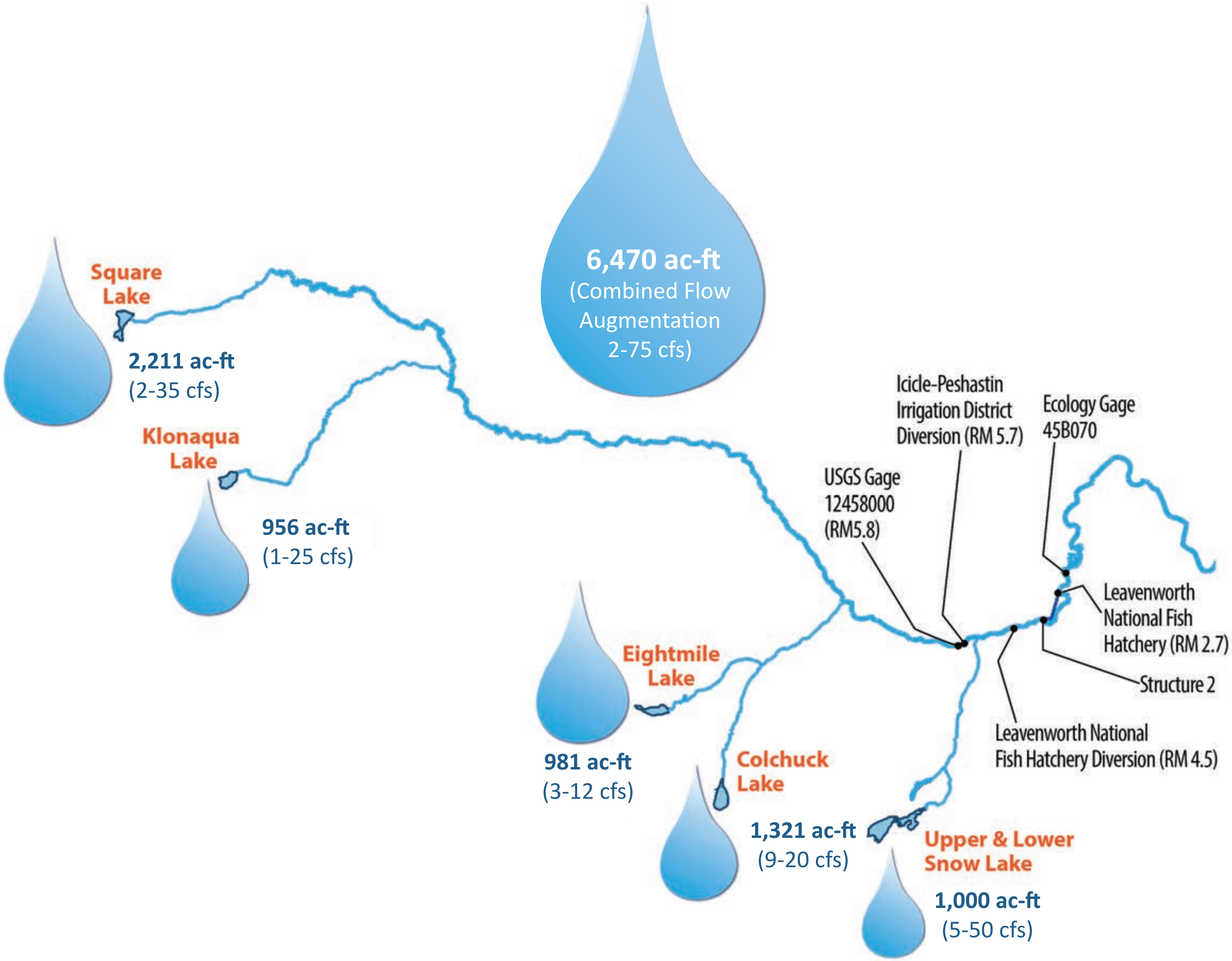

2017 Flow Augmentation, Volumes and Flow Rates

Feasibility Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

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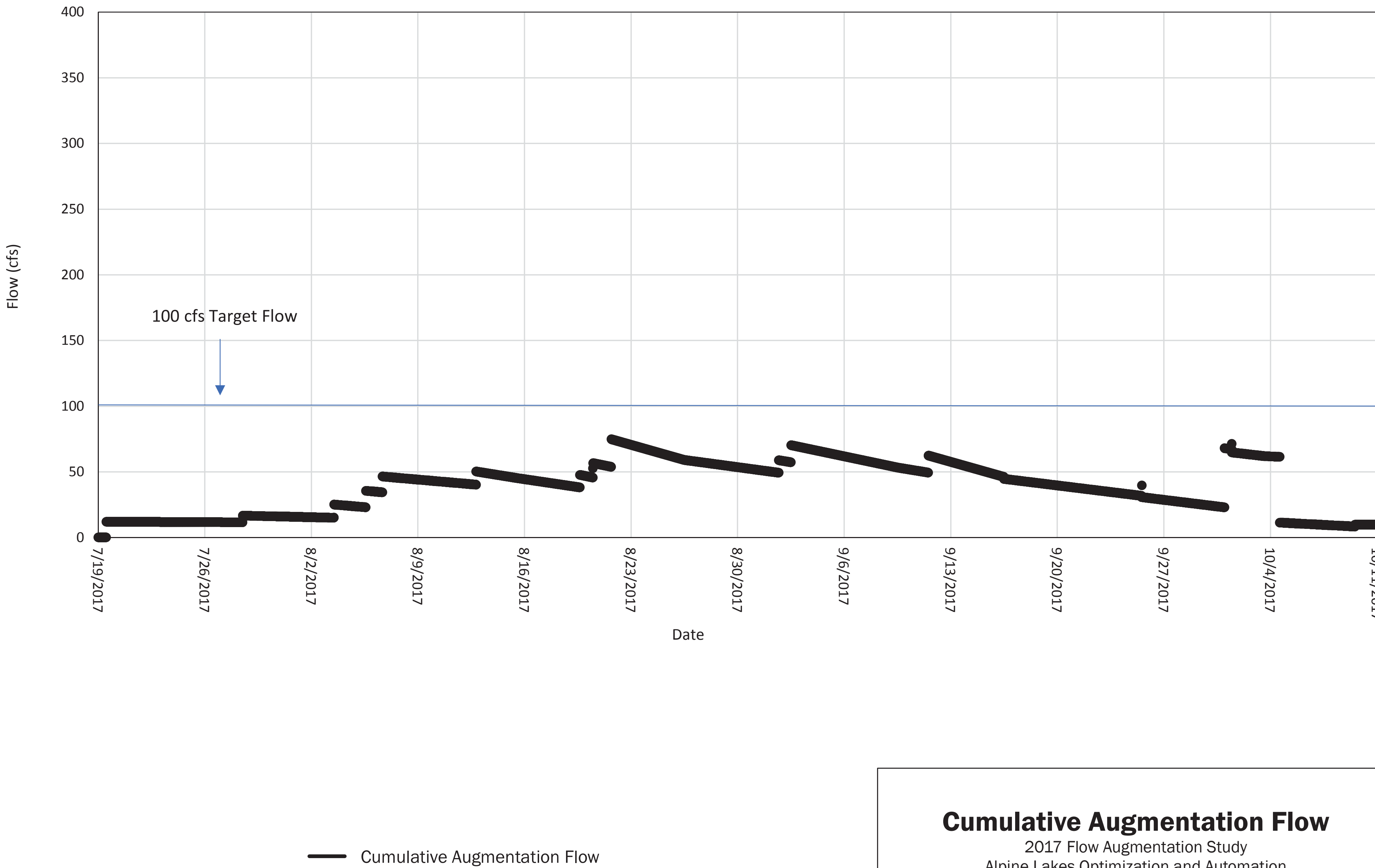

Cumulative Augmentation Flow

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

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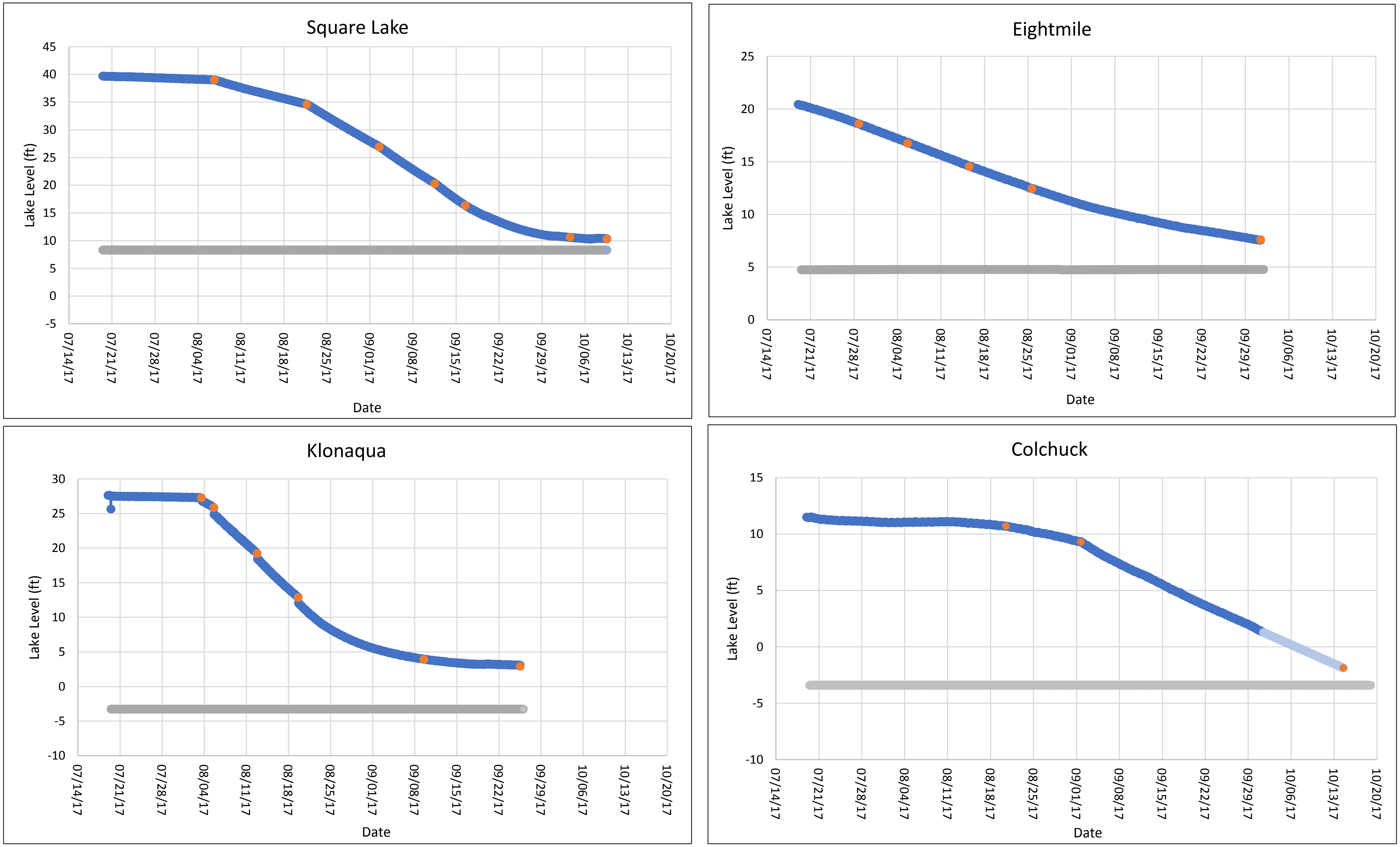

Pressure Transducer Measurement

Manual Measurement

Estimated Lake Stage

Invert

Note: Transducers are located at y = 0 for all hydrographs.

2017 Lake Hydrographs

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

Aspect CONSULTING	FEB-2018	BY: WMS / RAP	FIGURE NO.
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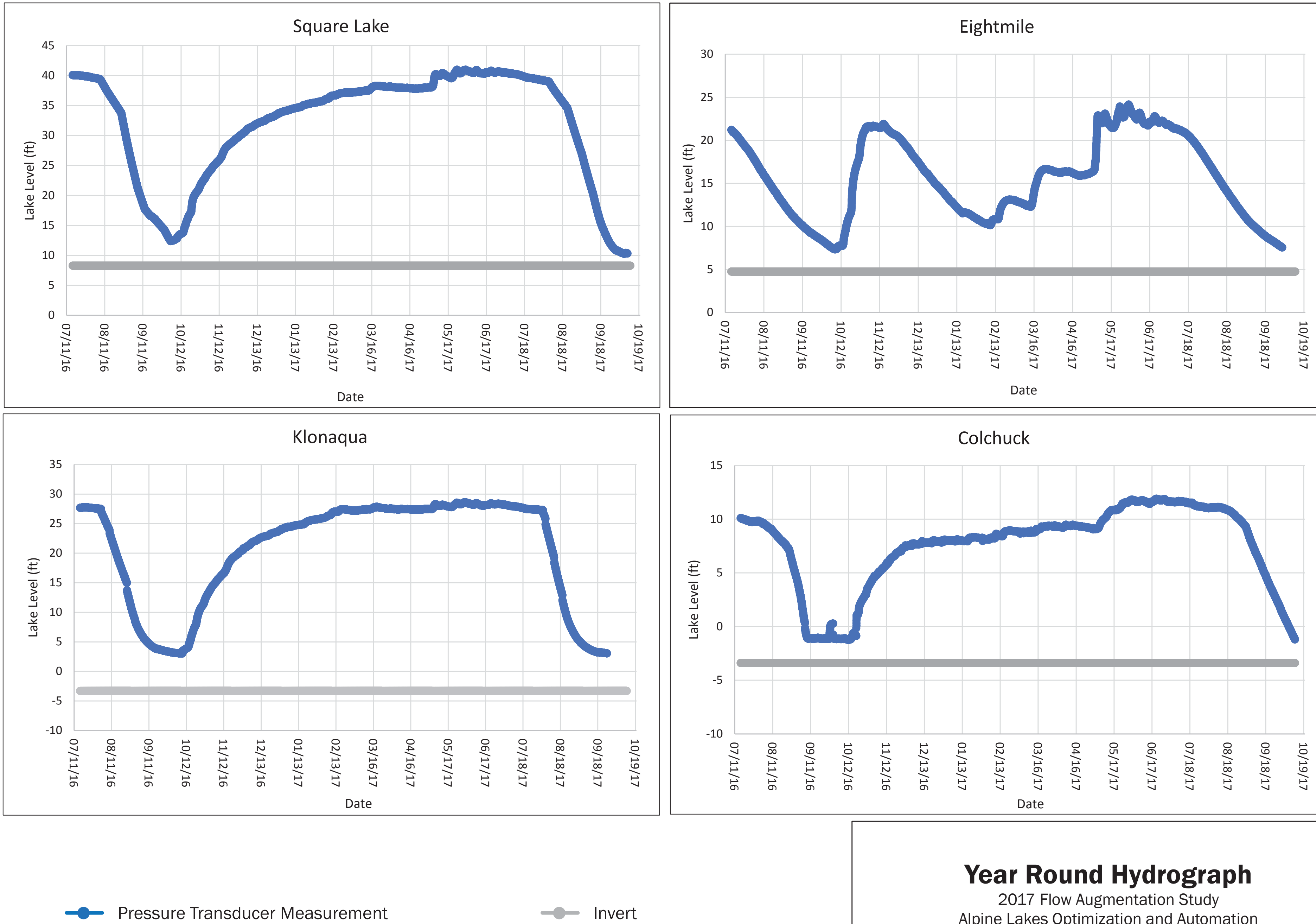

Year Round Hydrograph

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

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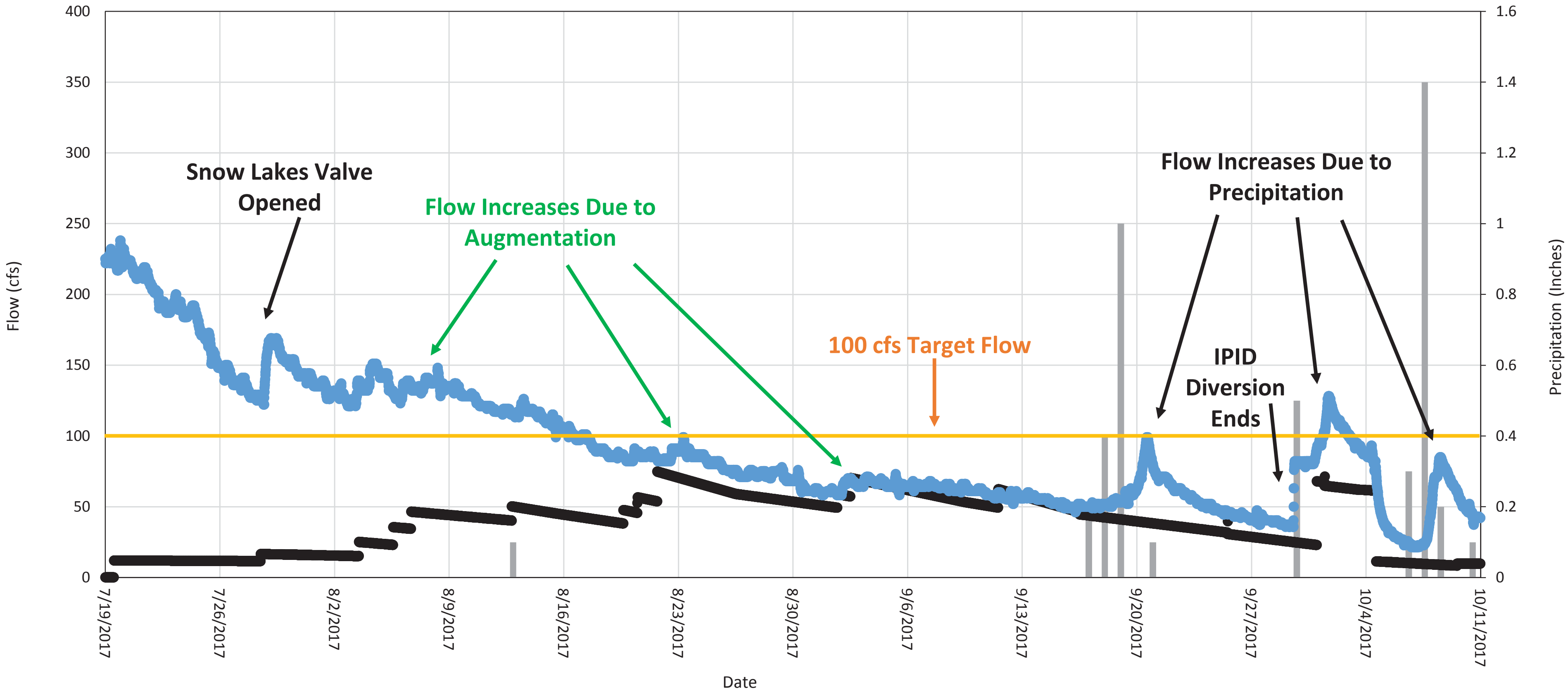
	PROJECT NO. 120045	REVISED BY: - - -	



Recorded Precipitation at Fish Lake Snotel

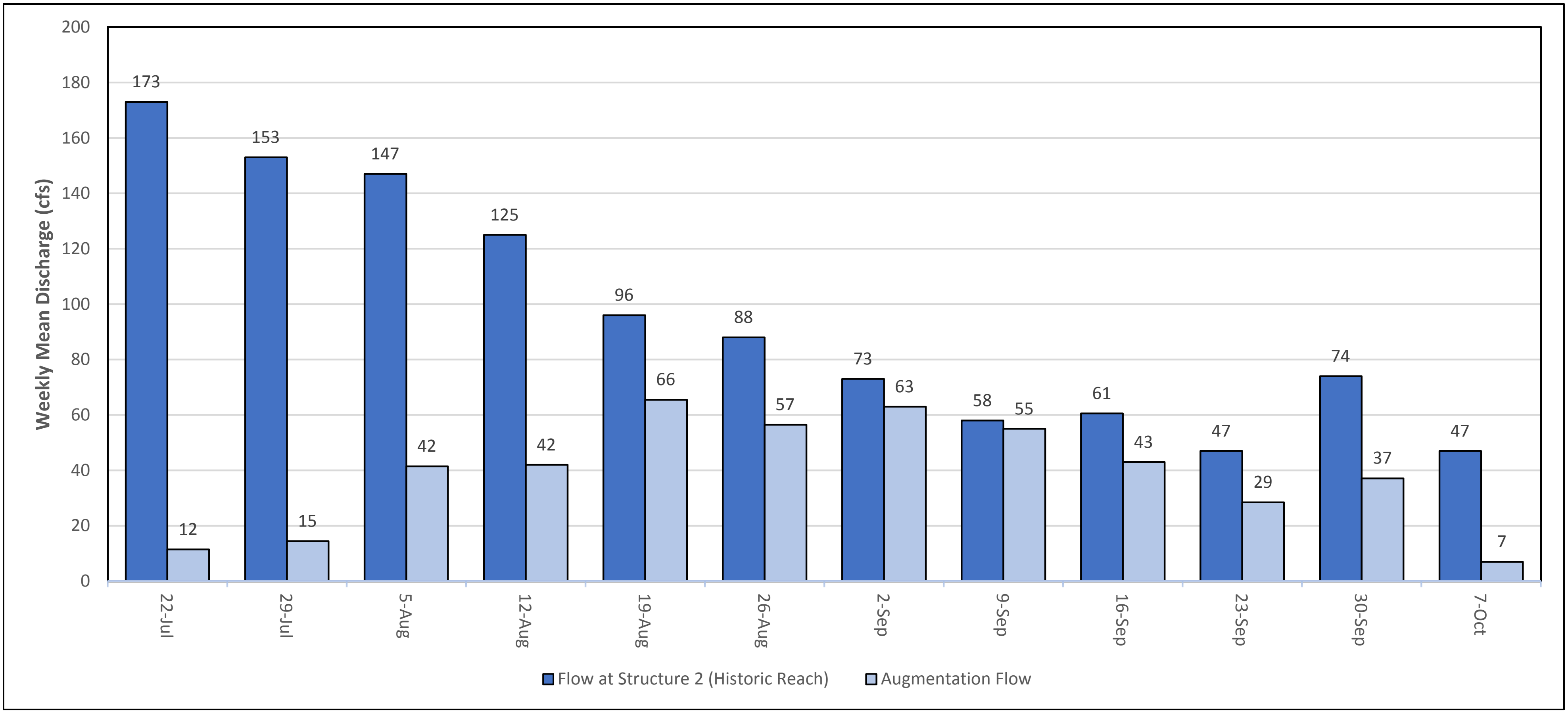
Flow at Structure 2

Cumulative Augmentation Flow

Historic Channel Hydrograph

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

Aspect CONSULTING	FEB-2018	BY: WMS / RAP	FIGURE NO. 7
	PROJECT NO. 120045	REVISED BY: - - -	



Augmentation Contribution to Historic Channel

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

Aspect CONSULTING

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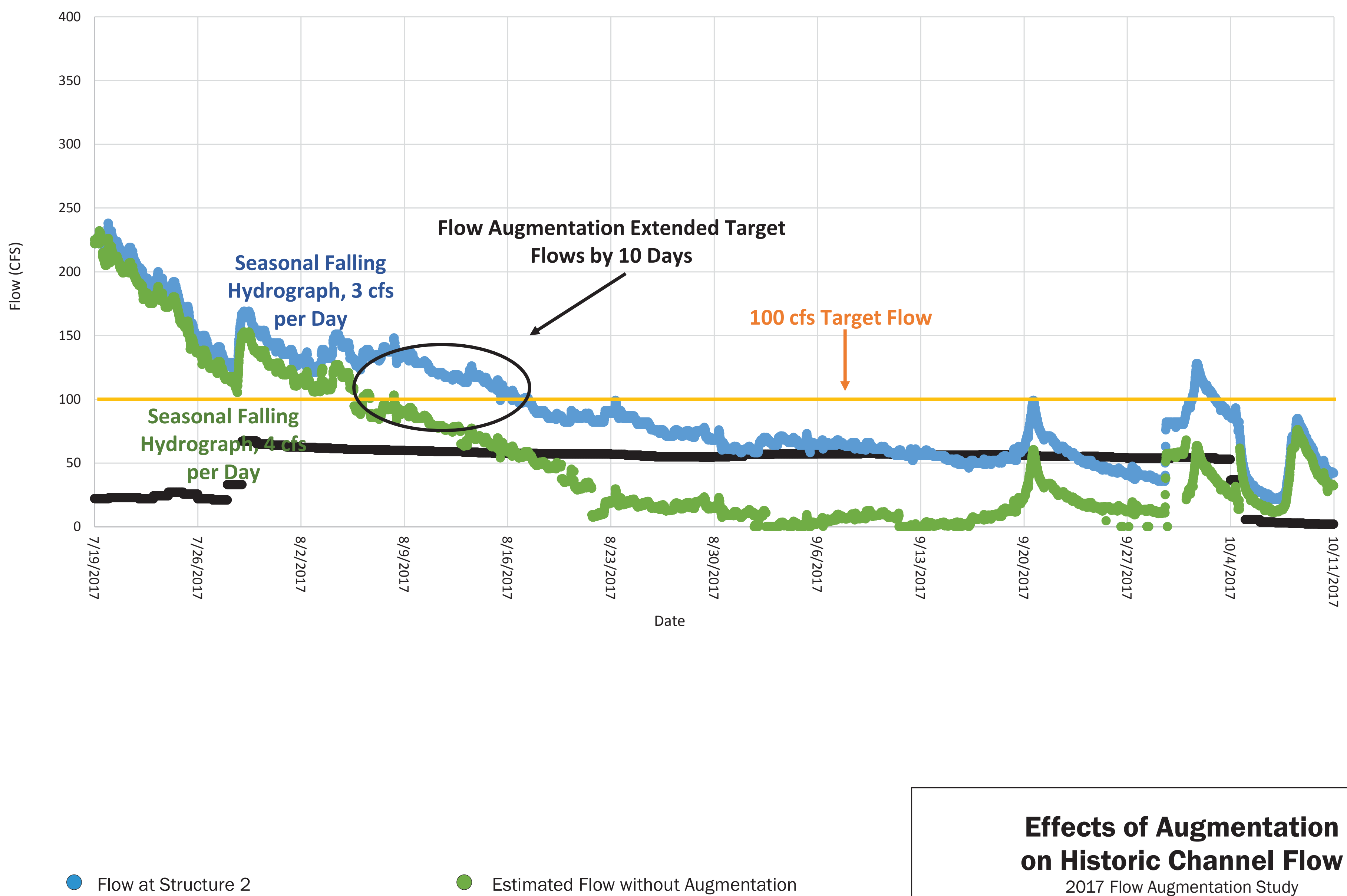

Effects of Augmentation on Historic Channel Flow

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

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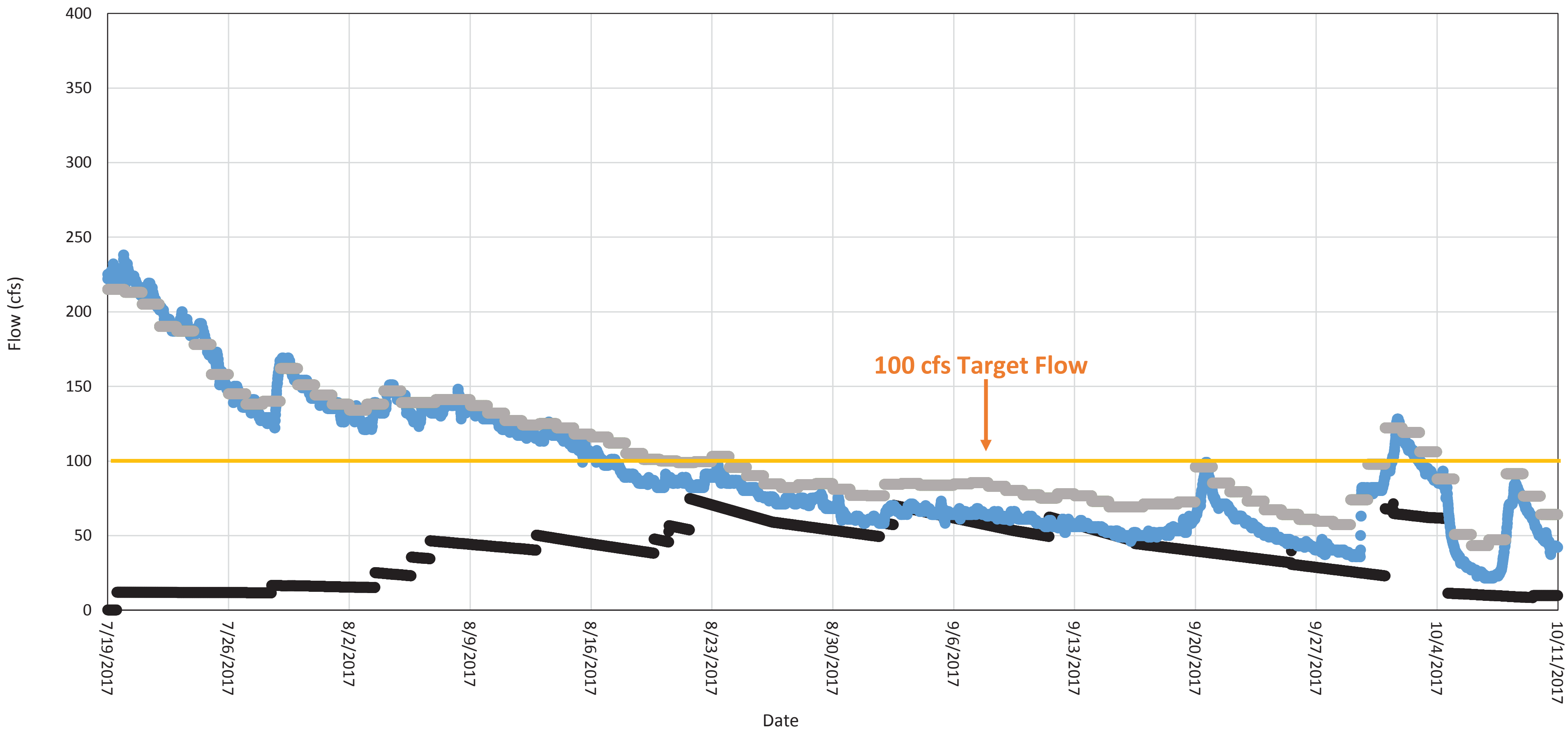
GIS Path: T:\projects_8\ChelanCounty_DNR\AlpineLakesAutomationOptimization_120045-012-05\Delivered\PilotStudy2017\Figure 9 Augmentation Contribution to Historic Channel.mxd || Date Saved: 2/2/2018 || User: rpepin || Print Date: 2/2/2018



Structure 2 Flows Estimated from Ecology Gauge

USFWS Measured Flows at Structure 2

Cumulative Augmentation Flow

USFWS Measured Flows at Structure 2

2017 Flow Augmentation Study
Alpine Lakes Optimization and Automation
Chelan County, Washington

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APPENDIX A

WDFW (2018)
Icicle Creek Tributary Monitoring Report

Alpine Lakes Flow Augmentation Pilot Study 2017

Icicle Creek Tributary Monitoring Report

Washington Department of Fish and Wildlife
Water Science Team
Habitat Program – Science Division

Robert Granger

Javan Bailey, Steven Boessow, Kiza Gates, Jonathan Kohr, and Cole Provence

January 17, 2018

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Introduction

Following preliminary data collection efforts during the Alpine Lakes Flow Augmentation Pilot Study in 2016, it was determined that additional data was needed in order to gain a better understanding of the influence of augmentation flows on tributaries to Icicle Creek. Two tributaries (French and Leland Creek), which deliver flow to Icicle Creek from Klonaqua and Square Lake (respectively) were identified as priorities in the data collection effort. Prior to the 2016 augmentation effort, concerns regarding bull trout populations residing in these Icicle Creek tributaries prompted discussions regarding additional data needs to inform management decisions of flow releases from the Alpine Lakes. In response to those discussions, and preliminary monitoring and observations in 2016, a monitoring strategy was developed for the 2017 Pilot Study.

The primary goals of the monitoring strategy were to better understand the natural flow and temperature regimes in French and Leland creeks, and to identify how augmentation flows influence those regimes. To achieve this, the monitoring strategy incorporated a network of continuous flow and water temperature monitoring devices deployed at key sites intended to capture the range of conditions throughout the French and Leland creek watersheds. Additional data collection included spot measurements of various water chemistry parameters as well as manual flow and water temperature measurements.

In late-July of 2017, WDFW Water Science Team staff implemented the monitoring strategy, which began prior to augmentation releases from Klonaqua and Square lakes, and continued through mid-October after augmentation was completed for the season. Note that all River Mile (RM) estimates are approximate.

2016 Monitoring Data

In 2016 monitoring efforts were minimal, but provided initial orientation of the French and Leland Creek watersheds, and were necessary in developing a more robust monitoring strategy for the 2017 Pilot Study. Discharge, water temperature, and water chemistry data were collected at several sites in the French and Leland Creek drainages (including one site on Icicle Creek). Table 1 provides a summary of flow and water temperature data collected at transect locations. Table 2 provides water chemistry data collected at those same locations. The 2016 data are limited in nature and are not used for comparison to 2017 data in this report, however are provided for reference.

Table 1. 2016 flow data for the French and Leland Creek watersheds.

Icicle Creek Tributary Flow Monitoring 2016				
Date	Creek Name	River Mile	Discharge (cfs)	Water Temp (°C)
09/19/16	French Creek	0.10	12.56	8.70
09/19/16	French Creek	2.85	13.53	8.50
09/19/16	French Creek	5.50	6.50	8.10
09/19/16	Klonaqua Creek	0.10	2.98	8.60
09/20/16	Leland Creek	1.60	10.30	7.60
09/20/16	Prospect Creek	0.20	8.92	8.60
09/21/16	Leland Creek	0.10	19.24	5.90
09/21/16	Icicle Creek	28.0	7.86	6.00
10/25/16	French Creek	2.85	83.50	4.80
10/25/16	French Creek	4.45	47.91	5.10
11/04/16	Leland Creek	0.10	53.81	4.40
11/04/16	Icicle Creek	28.0	50.98	4.80

Table 2. 2016 water chemistry data for the French and Leland Creek watersheds.

Icicle Creek Tributary Water Chemistry Monitoring 2016								
Date	Stream	River Mile	pH	Conductivity (µS)	Total Dissolved Solids (ppm)	Salinity (ppm)	DO %	DO mg/L
09/19/16	French Creek	0.10	8.58	51.50	36.50	25.00	N/A	N/A
09/19/16	French Creek	2.85	8.16	51.60	36.60	25.00	N/A	N/A
09/19/16	French Creek	5.50	8.22	35.60	25.20	17.80	N/A	N/A
09/19/16	Klonaqua Creek	0.10	7.91	22.20	14.30	12.20	N/A	N/A
09/20/16	Leland Creek	1.60	8.24	43.80	31.10	21.10	N/A	N/A
09/20/16	Prospect Creek	0.20	8.13	27.60	19.60	14.60	N/A	N/A
09/21/16	Leland Creek	0.10	8.26	36.50	25.90	16.90	N/A	N/A
09/21/16	Icicle Creek	28.0	8.09	31.50	22.30	14.80	N/A	N/A
10/25/16	French Creek	2.85	8.16	40.20	28.60	19.50	93.60	11.98
10/25/16	French Creek	4.45	7.99	28.90	20.50	14.30	92.50	11.79
11/04/16	Leland Creek	0.10	8.98	32.30	22.90	14.10	92.00	11.93
11/04/16	Icicle Creek	28.0	8.08	21.80	15.40	9.80	89.50	11.40

2017 Study Area

French Creek Watershed

French Creek is a right bank tributary to Icicle Creek at RM 21.6. The reach of primary interest was from the confluence with Icicle Creek to just upstream of the confluence with Klonaqua Creek, which is a left bank tributary to French Creek at RM 5.35. Locations were selected for continuous flow and water temperature monitoring to capture the influence of augmentation flows delivered from Klonaqua Lake via Klonaqua Creek into French Creek, and ultimately Icicle Creek (Table 3 and Figure 1). Additional monitoring was conducted in Snowall Creek, a right bank tributary to French Creek at RM 4.35.

Table 3. French Creek watershed data logger locations.

Creek Name	Location	Data Logger Type
Icicle Creek	100 meters DS of French Creek	Water Temperature
Icicle Creek	50 meters US of French Creek	Water Temperature
French Creek	RM 0.10	Water Temperature
French Creek	RM 4.25	Water Level and Temperature
French Creek	RM 4.25	Barometric Pressure and Temperature
Snowall Creek	25 meters US of French Creek	Water Temperature
French Creek	RM 4.45	Water Temperature
French Creek	RM 5.50	Water Temperature
Klonaqua Creek	RM 0.10	Water Temperature

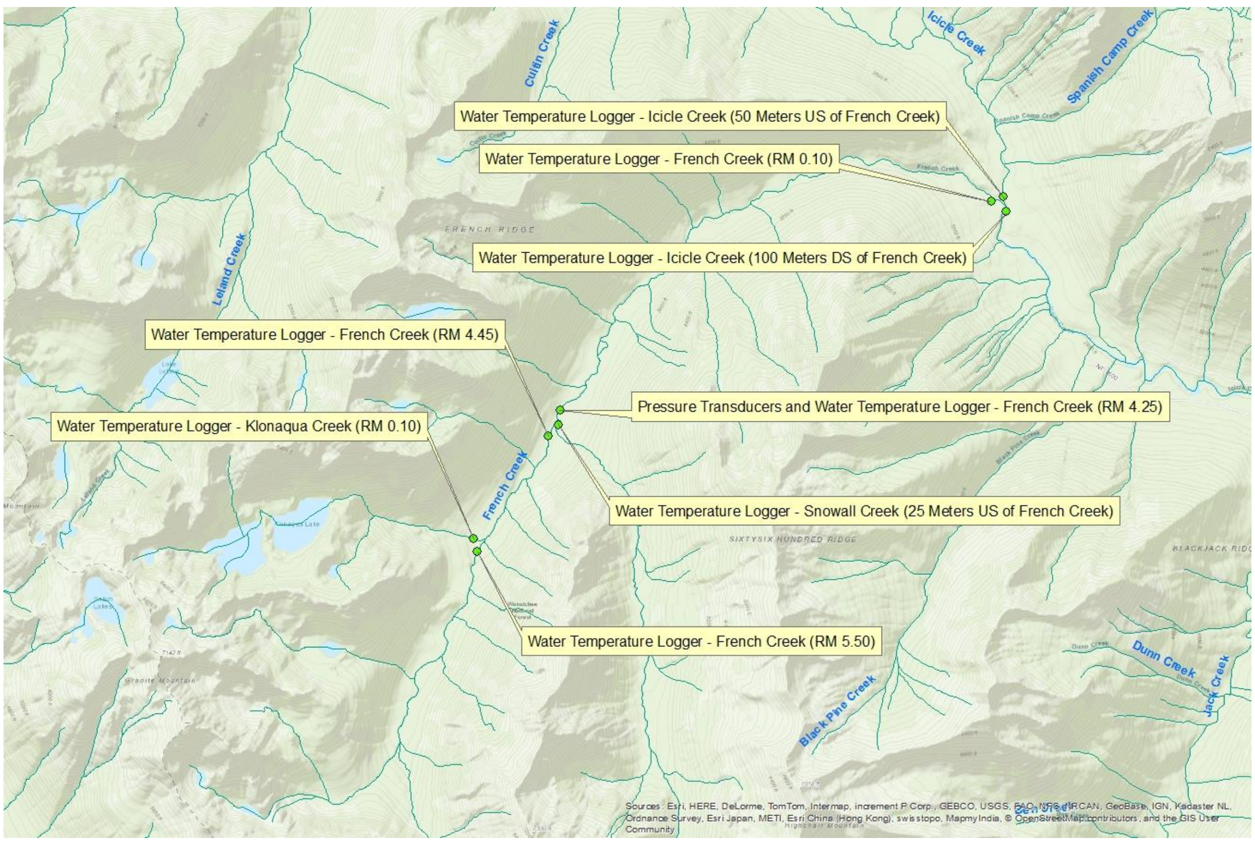

Figure 1. Map of the French Creek watershed including monitoring locations.

Leland Creek Watershed

Leland Creek is a right bank tributary to Icicle Creek at RM 27.9. The primary reach of interest was from the confluence with Icicle Creek to just upstream of the confluence with Prospect Creek, which is a left bank tributary to Leland Creek at RM 1.50. The following locations (Table 4 and Figure 2) were selected for continuous flow and water temperature monitoring to capture the influence of augmentation flows delivered from Square Lake via Prospect Creek into Leland Creek, and ultimately Icicle Creek.

Table 4. Leland Creek watershed data logger locations.

Creek Name	Location	Data Logger Type
Icicle Creek	25 meters DS of Leland Creek	Water Temperature
Icicle Creek	40 meters US of Leland Creek	Water Temperature
Leland Creek	RM 0.10	Water Level and Temperature
Leland Creek	RM 0.10	Barometric Pressure and Temperature
Leland Creek	RM 1.40	Water Temperature
Leland Creek	RM 1.60	Water Temperature
Prospect Creek	RM 0.20	Water Temperature

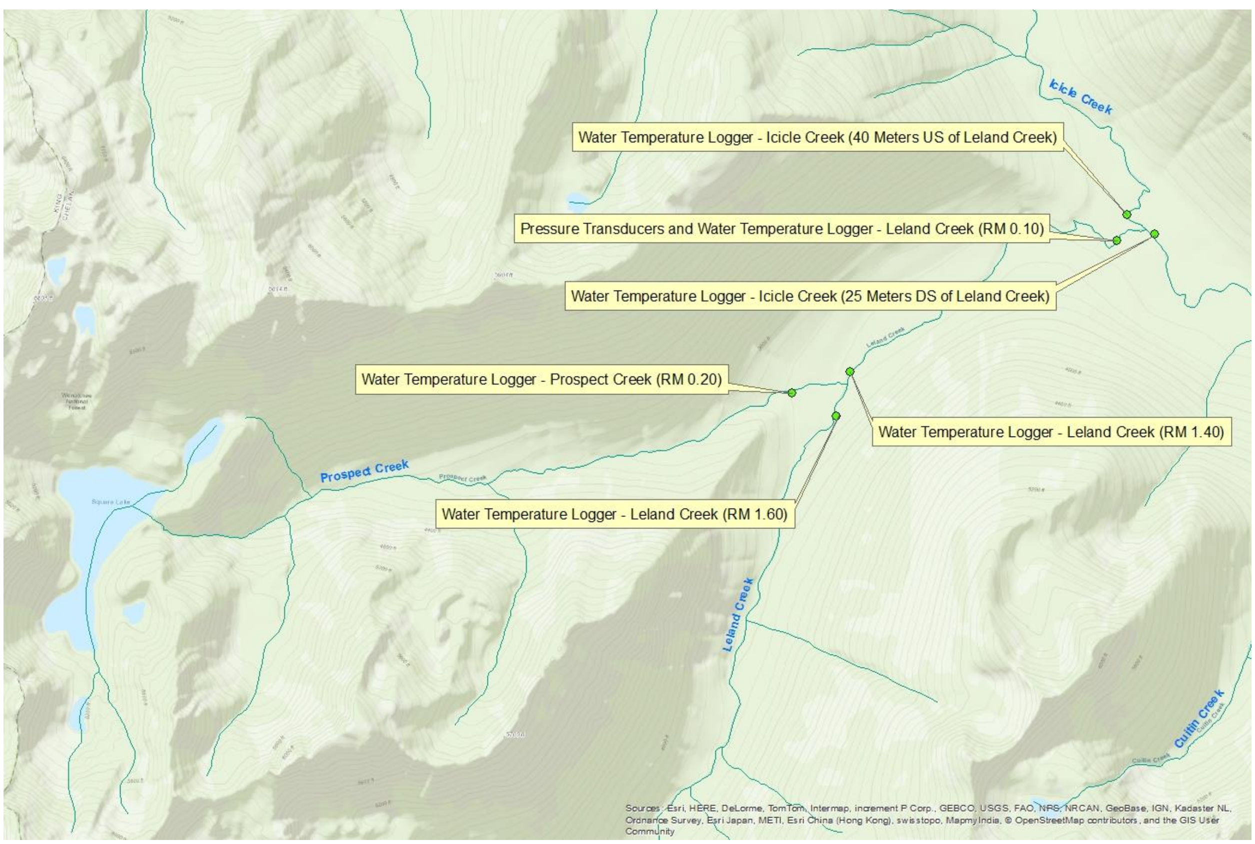

Figure 2. Map of the Leland Creek watershed including monitoring locations.

Methods

Continuous Discharge

Continuous discharge was obtained for French Creek (RM 4.25), and Leland Creek (RM 0.10). HOBO U20-001-04 Water Level Loggers (pressure transducers) were deployed instream for absolute pressure and water temperature readings (15-minute logging intervals) at locations determined to be of suitable depth, and not subject to becoming dewatered or lost to a high flow event. HOBO U20-001-04 Water Level Loggers were also deployed out of water at both locations, and adjacent to instream data loggers for barometric pressure and ambient temperature readings (15-minute logging intervals). Barometric pressure compensation was used to correct for error in water level readings associated with changes in atmospheric conditions.

Pressure transducers were deployed in French Creek during the initial site visit on July 27, and retrieved on October 17, 2017. Pressure transducers were deployed in Leland Creek on July 25, and retrieved on October 18, 2017. A total of five site visits were conducted throughout the deployment period for both French and Leland creeks to obtain manual discharge measurements. In addition, a reference water level measurement was obtained during each site visit for; 1) conversion of pressure data to water level (stage height), and 2) establishing discharge rating curves for each location.

Manual discharge measurements were obtained by extending a 100 ft. measuring tape perpendicular to the flow, and secured to both stream banks (Figures 3 and 4). Twenty-five to thirty depth and velocity measurements were collected along the transect using a HACH FH950 portable flow meter and graduated top setting wading rod. Depth and velocity measurements were then used to calculate total discharge (Cubic Feet per Second). Reference water level measurements, and the manual discharge calculations were used to obtain a stage/discharge relationship (rating curve). The rating curve was then applied to the continuous stage data to develop hydrographs for each of the two sites.

Figure 3. Cole Provence measuring discharge on French Creek (RM 4.25) October 17, 2017.

Figure 4. Kiza Gates (left) and Javan Bailey (right) measuring discharge on Leland Creek (RM 0.10) July 25, 2017.

Water Temperature Monitoring

Eight sites in the French Creek watershed were selected for continuous water temperature monitoring, and six sites were selected in the Leland Creek watershed. At each of the fourteen sites, either one or two HOBO Pro v2 water temperature loggers were deployed and programmed to record at 15-minute logging intervals. At sites where pressure transducers were deployed and already recording water temperature, an additional temperature logger was deployed as a secondary in the event of lost or failed equipment. Water temperature data was compared between each pair of data loggers deployed at a given site for reading accuracy. Only two sites had a single temperature logger deployed; Snowall Creek near the mouth and French Creek at RM 4.45.

Temperature loggers were secured to an object on the bank with a lightweight nylon rope then submerged below the water surface utilizing anything that was naturally available (Figures 5 and 6). Temperature loggers in the French Creek watershed were deployed between July 26 and 27, and retrieved on October 17, 2017. Temperature loggers in the Leland Creek watershed were deployed between July 25 and 26, and retrieved on October 18, 2017.

Figure 5. Jonathan Kohr (left) and Javan Bailey (right) deploying a water temperature logger in Icicle Creek downstream of French Creek July 26, 2017.

Figure 6. Robert Granger preparing a water temperature logger for deployment in Icicle Creek upstream of Leland Creek July 26, 2017.

Water Chemistry

Water chemistry data was collected when manual discharge measurements were conducted, and included water temperature (°C), dissolved oxygen (mg/L), pH, conductivity (µS), total dissolved solids (ppm), and salinity (ppm). Either a SPER SCIENTIFIC Dissolved Oxygen Pen – 855045, or a YSI 550A Dissolved Oxygen meter was used for DO measurements depending on availability. The other water chemistry parameters (pH, conductivity, total dissolved solids, and salinity) were collected using an Oakton PCTestr 35 Multi-Parameter pocket tester. All instrumentation was calibrated prior to collecting measurements and compared for accuracy. Single point measurements were obtained with each manual discharge measurement.

Results

French Creek Discharge

Continuous stage data was collected for French Creek (RM 4.25) from July 27 through October 17, 2017 (Figure 7). The peaks in the hydrograph during the month of August are associated with valve adjustments for augmentation flow releases from Klonaqua Lake. The first valve adjustment occurred on August 3, 2017 with additional adjustments occurring periodically throughout August and into September. Peak daily mean flow occurred on August 6 at 48.27 cfs when approximately 20.31 cfs (daily mean) was released from Klonaqua Lake. The receding limbs of the hydrograph between peaks are associated with a drop in lake levels and head pressure between valve adjustments. Peaks in the hydrograph in the months of September and October are associated with natural events and not augmentation releases.

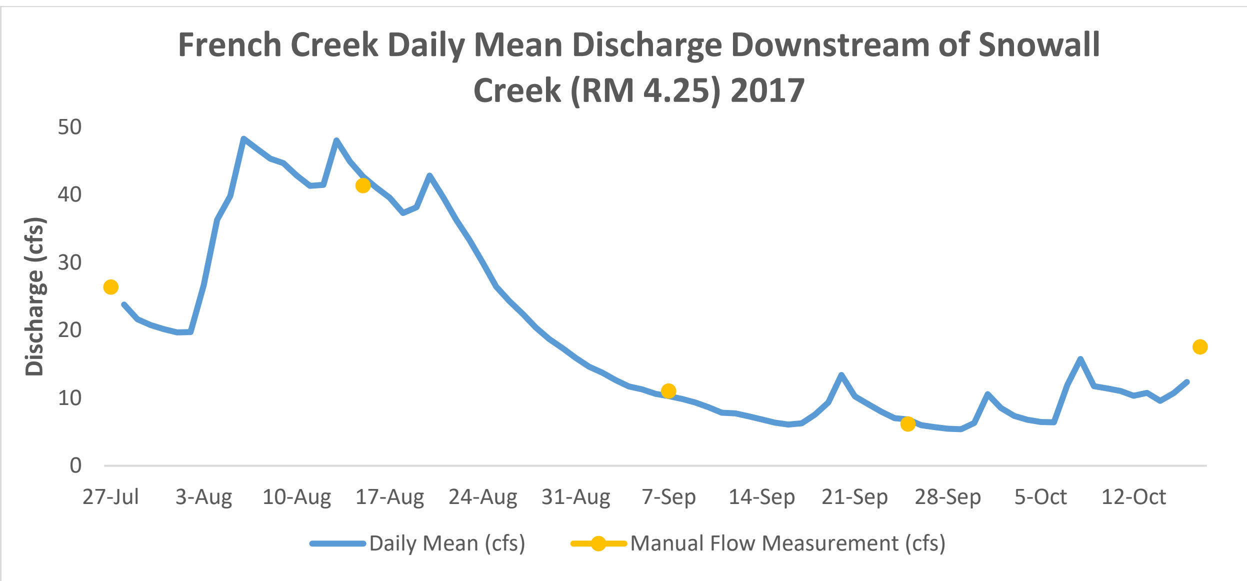

Figure 7. French Creek daily mean discharge hydrograph at RM 4.25. Manual discharge measurements used to develop the rating curve are indicated by yellow dots.

Discharge and flow rate data were provided by Aspect Consulting for augmentation releases from Klonaqua Lake in 2017 (Figure 8). Peak flow releases occurred in the month of August and tapered off into the month of September, with the greatest daily mean volume of water (24.43 cfs) being released on August 13.

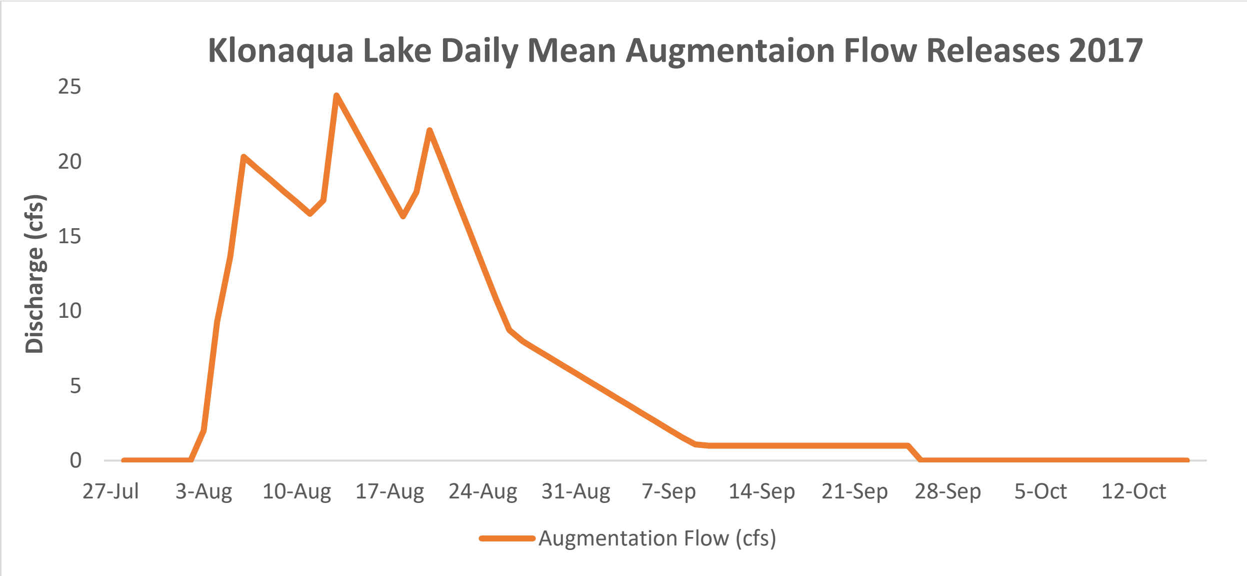

Figure 8. Klonaqua Lake daily mean augmentation flow release hydrograph (data courtesy of Aspect Consulting).

To estimate the natural hydrograph, daily mean augmentation discharge data were deducted from the daily mean discharge data collected at French Creek at RM 4.25 (Figure 9). Essentially, the estimated natural hydrograph is the expected discharge in Leland Creek without augmentation flows. Three hydrographs of daily mean discharge were developed; 1) French Creek at RM 4.25, 2) Klonaqua Lake augmentation flow releases, and 3) an estimated natural hydrograph for French Creek at RM 4.25.

As expected the estimated natural hydrograph follows a typical pattern seen in snowmelt-driven systems in which higher flows in early summer gradually taper off to base flows later in the season as snowpack declines. An estimated natural base flow of around 5.0 cfs was reached mid-September with flow increases occurring due to natural events in late-September to mid-October.

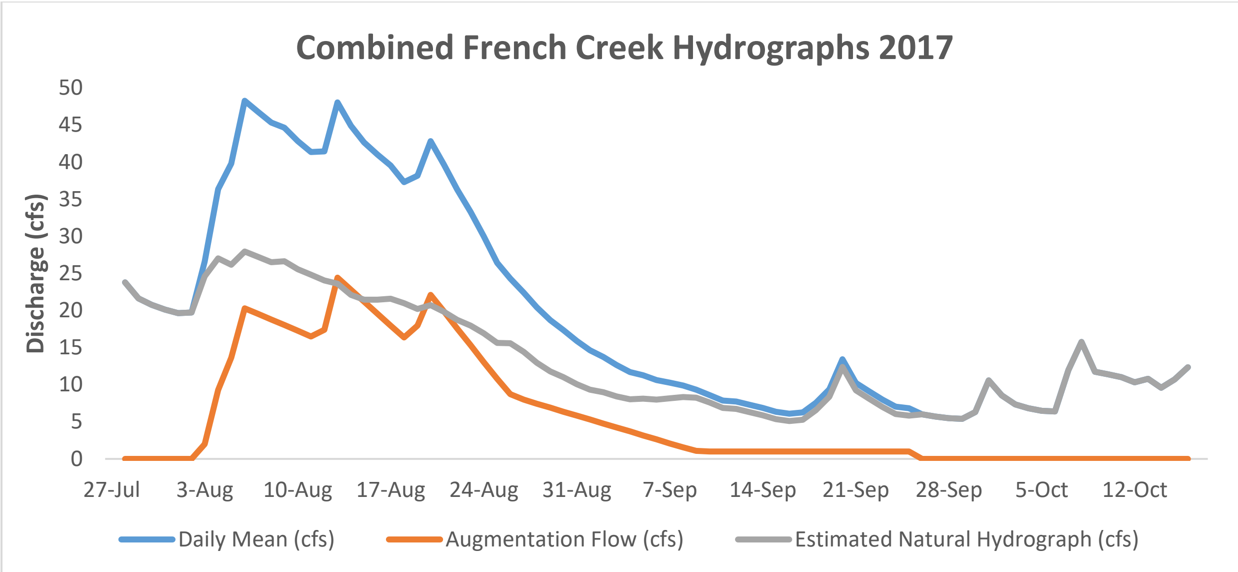

Figure 9. Combined hydrographs for French Creek (RM 4.25), Klonaqua Lake augmentation flow releases, and estimated natural hydrograph for French Creek at RM 4.25.

French Creek Water Temperature

To determine the influence of augmentation flow releases on water temperature in French Creek, water temperature data loggers were deployed within French Creek upstream and downstream of the confluence with Klonaqua Creek, as well as in Klonaqua Creek at RM 0.10. There was an increase in water temperature in French Creek downstream of Klonaqua Creek during the augmentation period (Figure 10). Although there is generally a slight warming trend in French Creek downstream of Klonaqua Creek prior to the augmentation period, the degree of warming is much greater during augmentation.

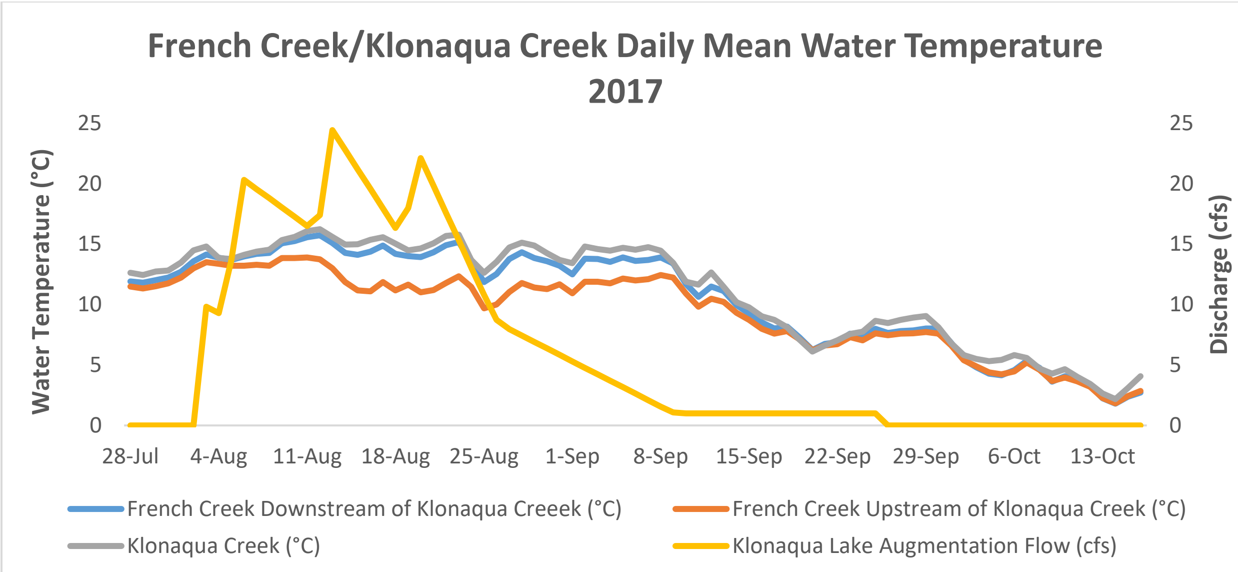

Figure 10. French Creek and Klonaqua Creek daily mean water temperature near confluence. The yellow line indicates the augmentation flow from Klonaqua Lake.

The warming trend observed in French Creek can be explained by an increase in water temperature in Klonaqua Lake during the augmentation period. Lake temperature data (provided by Aspect Consulting) suggests a relationship between lowering of lake levels associated with augmentation releases, and an increase in water temperature (Figure 11). Daily mean water temperature in Klonaqua Lake reached a high of 17.74° C in mid-August during the peak of augmentation releases. Increased water temperature in Klonaqua Lake resulted in a warming trend in French Creek downstream of Klonaqua Creek by more than 3.0° C (daily mean) at times during this period, and daily mean peaks between 15.0° and 16.0° C from August 9 through August 13.

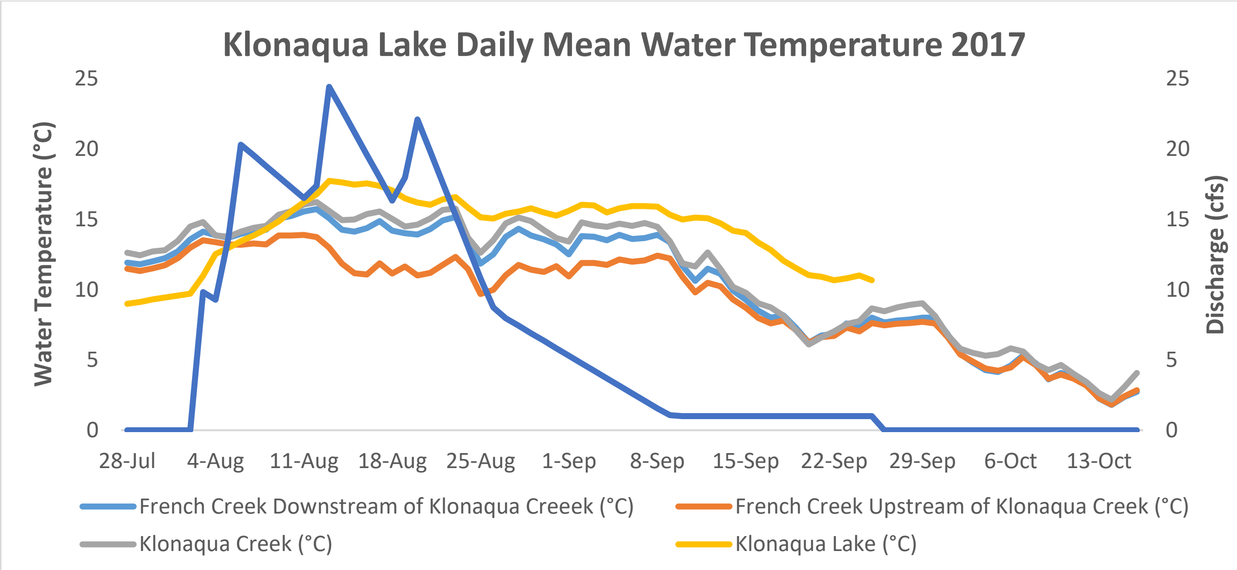

Figure 11. Water temperature of augmentation flow releases from Klonaqua Lake, French Creek, and Klonaqua Creek (lake temperature data courtesy of Aspect Consulting). The blue line indicates the augmentation flow from Klonaqua Lake.

Snowall Creek

Snowall Creek appears to contribute significant flows to French Creek. Manual discharge measurements during the 2017 monitoring period indicated, at times, more than thirty percent of the flow in French Creek at RM 4.25 could be attributed to Snowall Creek (Table 5).

Table 5. Snowall Creek and French Creek manual discharge measurements.

Date	Snowall Creek Discharge Near Mouth (cfs)	French Creek Discharge at RM 4.25 (cfs)	Snowall Creek Percent of French Creek Discharge
07/27/17	8.85	26.37	34
08/15/17	3.76	41.35	9
09/07/17	2.43	11.03	22
09/26/17	1.92	6.16	31
10/17/17	3.83	17.55	22

In addition, Snowall Creek daily mean water temperature was considerably cooler than any of the French Creek temperature monitoring sites (Figure 12). It was thought that Snowall Creek would have had a cooling effect on French Creek, compensating for the warming trend associated with augmentation flows. However, Snowall Creek had very little influence on French Creek water temperature during peak augmentation releases (Figure 12).

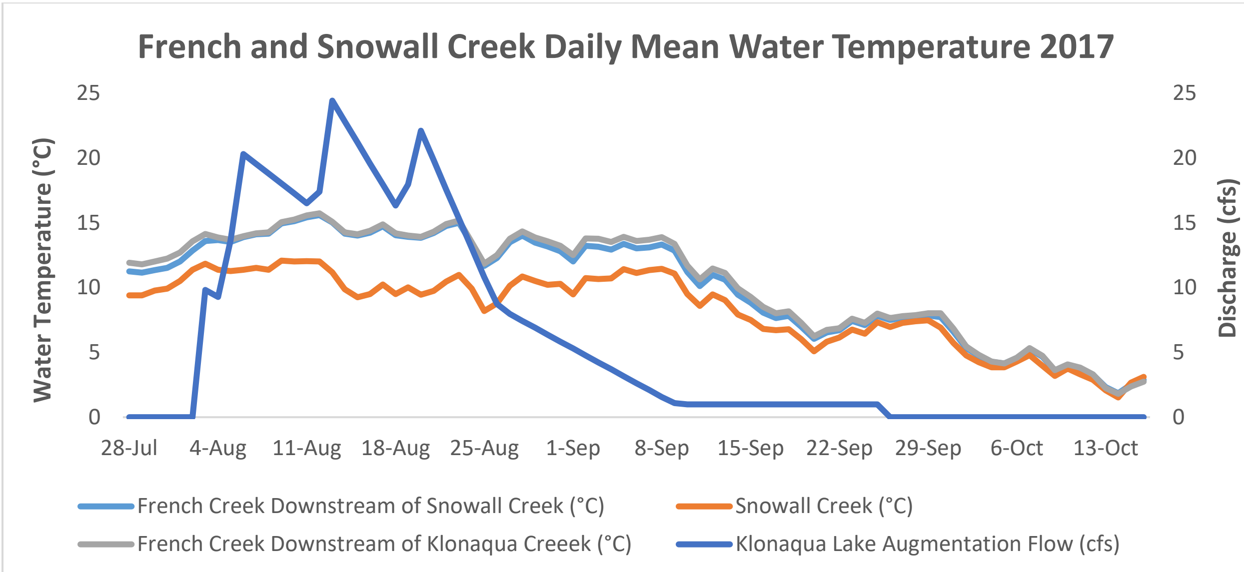

Figure 12. Klonaqua lake augmentation flow, Snowall Creek water temperature, and French Creek water temperature. The blue line indicates the augmentation flow from Klonaqua Lake.

Icicle Creek water temperature was relatively unaffected by augmentation flow releases from Klonaqua Lake (Figure 13). During peak augmentation releases (early-to-late August), water temperature remained relatively consistent among sites with around 1.0° C of variability. Outside of the augmentation period, French Creek generally remained slightly cooler than either Icicle Creek sites.

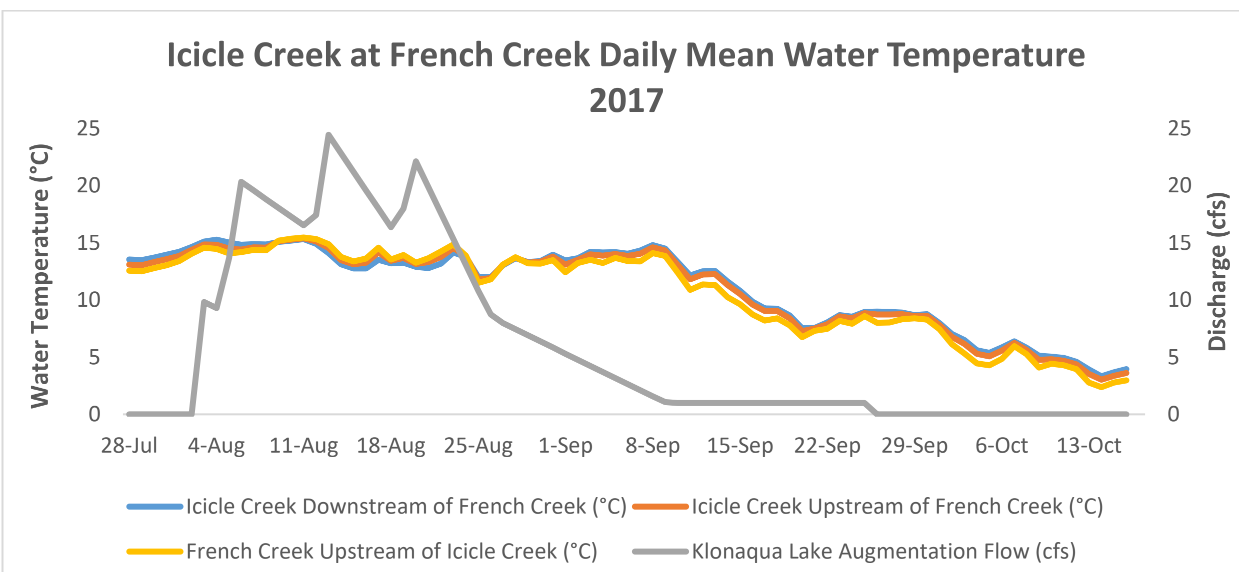

Figure 13. Icicle Creek daily mean water temperature near confluence with French Creek (RM 0.10). The grey line indicates the augmentation flow from Klonaqua Lake.

French Creek Water Chemistry
Water chemistry data collection in the French Creek watershed represents spot measurements of water chemistry and is purely informational at this time (Table 6). Water temperature data was collected in French Creek upstream of Klonaqua Creek on only one occasion (07/27/17), and this was outside of the augmentation period. To detect a change in water chemistry associated with augmentation flow releases, additional data collection is required in French Creek upstream of Klonaqua Creek during augmentation.

Table 6. French Creek watershed water chemistry.

Date	Creek Name	Location	DO (%)	DO (mg/L)	pH	EC (µS)	TDS (ppm)	Salinity (ppm)
07/27/17	French Creek	RM 4.25		11.4	8.00	36.10	25.50	20.60
07/27/17	Snowall Creek	25 meters US of French Creek		11.9	8.22	63.80	45.30	33.20
07/27/17	Klonaqua Creek	RM 0.10		11.2	7.82	22.40	15.90	15.60
07/27/17	French Creek	RM 5.50		10.3	7.78	24.80	17.60	16.10
08/15/17	French Creek	RM 4.25		10.6	7.80	33.80	23.80	20.80
08/15/17	Snowall Creek	25 meters US of French Creek		11.3	8.26	83.50	59.30	43.30
08/15/17	Klonaqua Creek	RM 0.10		9.9	7.72	13.00	9.20	12.10
09/07/17	French Creek	RM 4.25		*8.6	8.00	47.40	33.70	27.20
09/07/17	Snowall Creek	25 meters US of French Creek		10.4	8.36	93.70	66.60	49.50
09/07/17	Klonaqua Creek	RM 0.10		*9.1	7.54	18.60	13.20	14.60
09/26/17	French Creek	RM 4.25	84.5	10.1	8.02	65.50	46.60	33.60
09/26/17	Snowall Creek	25 meters US of French Creek	89.2	10.8	8.46	102.00	72.50	51.20
09/26/17	Klonaqua Creek	RM 0.10	88.3	10.4	7.99	33.80	24.00	18.40
10/17/17	French Creek	RM 4.25	91.7	11.5	6.99	51.80	36.70	23.70
10/17/17	Snowall Creek	25 meters US of French Creek	94.3	11.9	7.33	86.70	61.40	39.10
10/17/17	Klonaqua Creek	RM 0.10	88.5	11.1	6.60	39.70	28.20	18.60

*Relatively low values are likely attributable to an un-calibrated dissolved oxygen meter.

Leland Creek Discharge
Continuous discharge data was collected for Leland Creek (RM 0.10) from July 25 through October 18, 2017 (Figure 14). The peaks in the hydrograph in the month of August through mid-September are associated with valve adjustments for augmentation flow releases from Square Lake. Peak daily mean flow occurred on August 22 at 36.98 cfs when approximately 32.28 cfs (daily mean) of augmentation flow was released from Square Lake. The first valve adjustment occurred on August 6, 2017, with additional adjustments occurring periodically through the latter part of September. The receding limbs of the hydrograph between peaks are associated with a drop in lake levels and head pressure between valve adjustments. Peaks in the hydrograph in the

latter part of September and during October are associated with natural events and not augmentation releases.

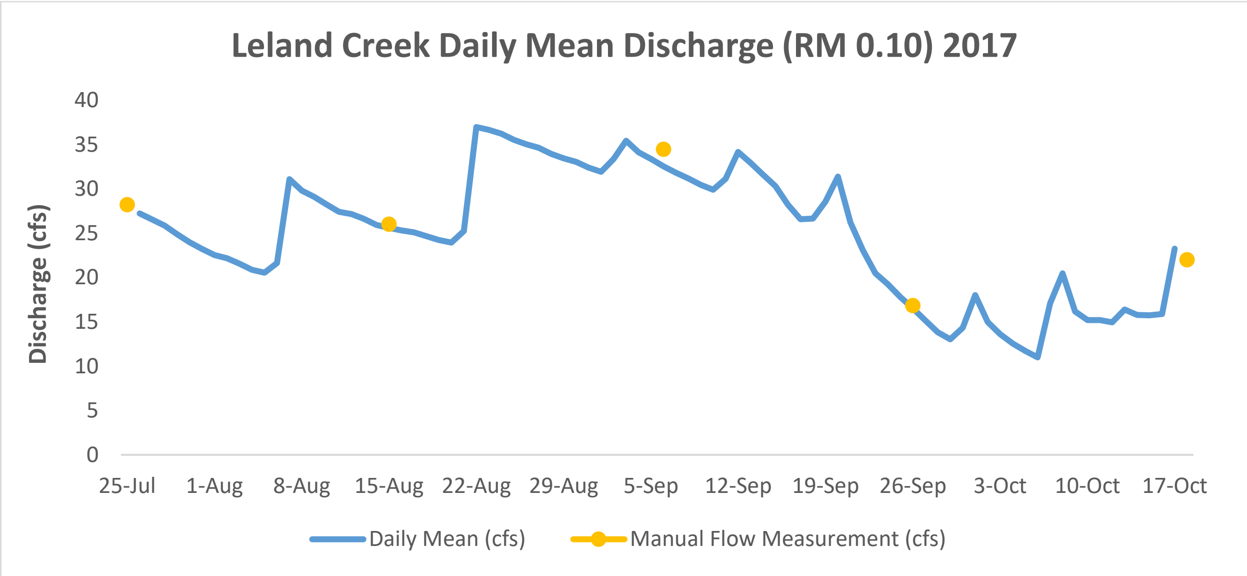

Figure 14. Leland Creek daily mean discharge hydrograph at RM 0.10. Manual discharge measurements used to develop the rating curve are indicated by yellow dots.

Discharge and flow rate data were provided by Aspect Consulting for augmentation releases from Square Lake in 2017 (Figure 15). Peak flow releases occurred during the latter part of August through mid-September, with the greatest daily mean volume of water (approximately 33.6 cfs) being released on September 3.

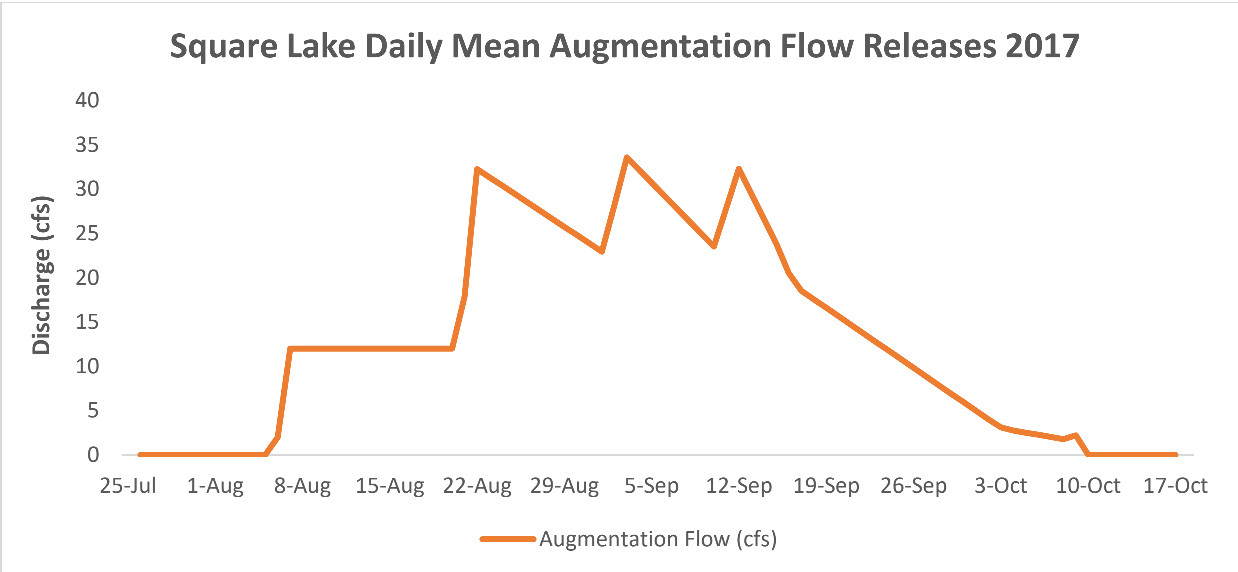

Figure 15. Square Lake daily mean augmentation flow release hydrograph (data courtesy of Aspect Consulting).

To estimate the natural hydrograph, augmentation discharge data from Square Lake were deducted from the discharge data collected at Leland Creek at RM 0.10 (Figure 16). The estimated hydrograph is the expected discharge in Leland Creek without augmentation flows. Three hydrographs of daily mean discharge were developed; 1) Leland Creek at RM 0.10, 2) Square Lake augmentation flow releases, and 3) an estimated natural hydrograph for Leland Creek at RM 0.10.

Unlike French Creek, deducting the augmentation discharge data from the Leland Creek discharge data did not produce a hydrograph representative of what is expected under natural conditions. Review of the hydrographs, and the discharge data used to develop them indicates a delay in travel time of augmentation flow from Square Lake to lower Leland Creek. A probable explanation for this is the presence of side channels and wetlands in Prospect and Leland Creek that increased retention time for the augmentation flow before it reached the downstream data logger at RM 0.10. Based on manual field measurements and known augmentation releases from Square Lake, a reasonable estimate of a natural base flow in Leland is 6 to 7 cfs occurring mid-to-late September. A manual discharge measurement on September 26 indicated 16.81 cfs in lower Leland Creek. On that date approximately 9.83 cfs (daily mean) of augmentation flow was being delivered from Square Lake, which equates to an estimated 6.98 cfs of natural flow.

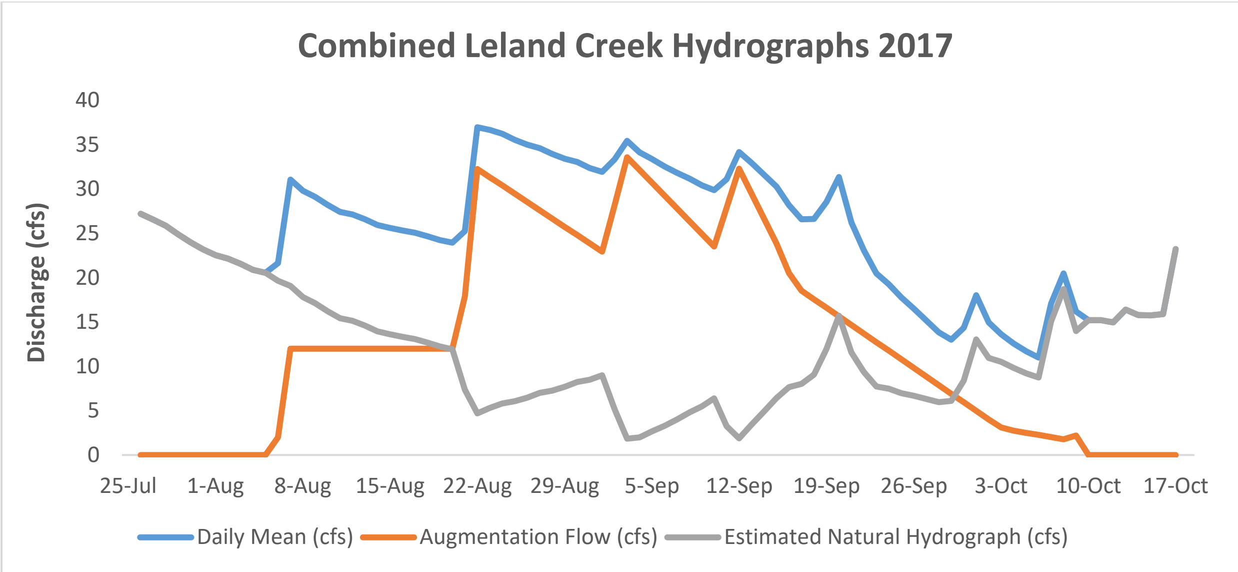

Figure 16. Combined daily mean hydrographs for Leland Creek (RM 0.10), Square Lake augmentation flow releases, and estimated natural hydrograph for Leland Creek at RM 0.10.

Leland Creek Water Temperature

To determine the influence of augmentation flow releases from Square Lake on Leland Creek water temperature, data loggers were deployed in Leland Creek upstream and downstream of the confluence with Prospect Creek, as well as in Prospect Creek at RM 0.20. There was an initial decrease in water temperature in Leland Creek downstream of Prospect Creek when approximately 12 cfs of augmentation flow was released from Square Lake on August 6 (Figure 17). Following this brief period of cooling, water temperature in Leland Creek increased considerably when augmentation flow was increased to approximately 32 cfs on August 22. This trend continued until late-September when augmentation flow began to diminish.

Although there appears to be a slight natural warming trend in Leland Creek downstream of Prospect Creek prior to the augmentation period, the degree of warming is much greater during peak augmentation. Water temperature data for Leland Creek downstream of Prospect Creek indicate an increase in water temperature (daily mean), at times, approaching 5.0° C during peak augmentation. On September 7, Leland Creek water temperature upstream of Prospect Creek was 10.78° C, while downstream at RM 0.10 the daily mean water temperature was 15.51° C.

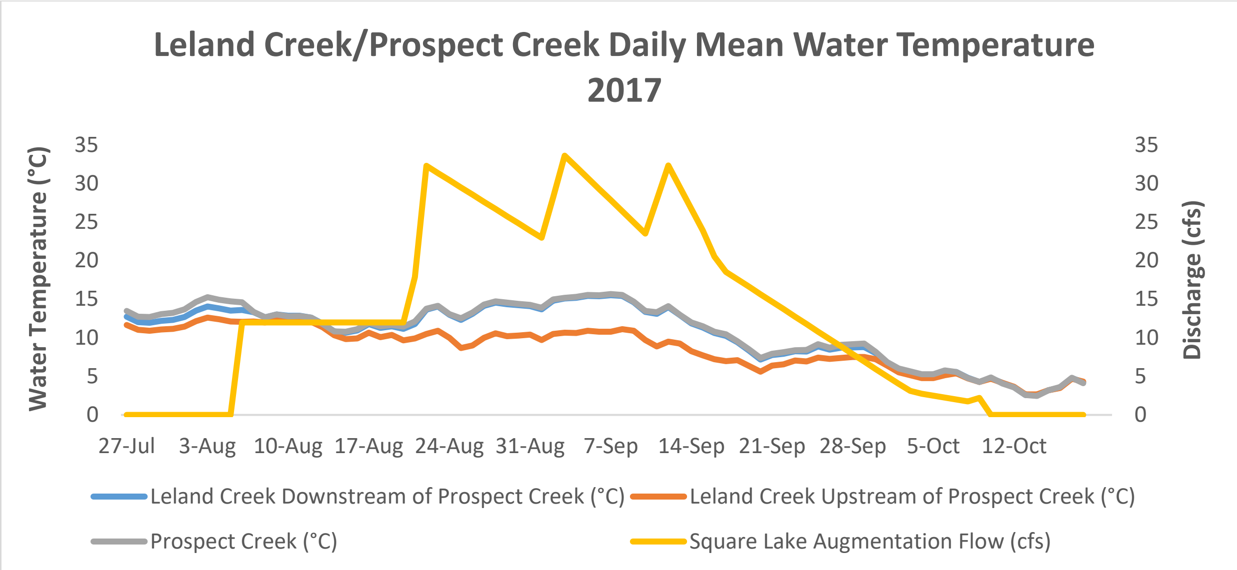

Figure 17. Square Lake augmentation flow, Leland Creek water temperature, and Prospect Creek water temperature near confluence.

Square Lake water temperature data (provided by Aspect Consulting) suggests there are questions remaining about the warming trend observed in Leland Creek during the augmentation period. Lake water temperatures were considerably cooler than either creek throughout much of the augmentation period (Figure 18). The large difference in water temperature readings between Square Lake, and Prospect and Leland creeks may be explained by the location of the temperature logger relative to the outflow of the lake.

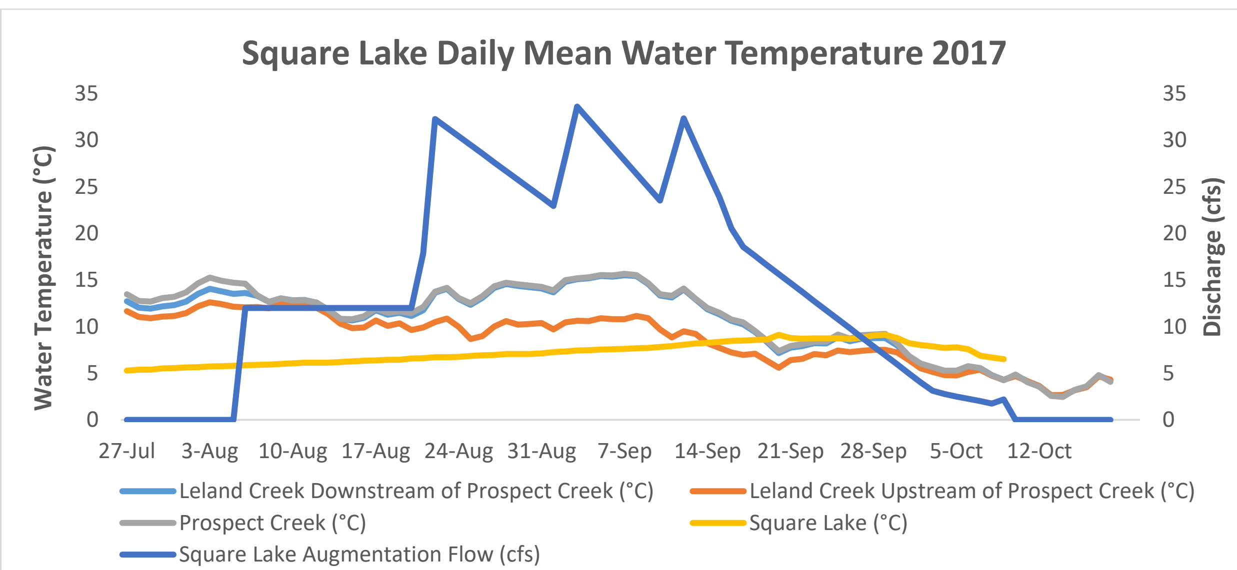

Figure 18. Augmentation flow releases from Square Lake, Leland Creek water temperature, and Prospect Creek water temperature (lake temperature data courtesy of Aspect Consulting).

Icicle Creek water temperature was relatively unaffected by augmentation releases from Square Lake, other than some initial cooling during the first two weeks of augmentation as seen in Leland Creek (Figure 19). During peak augmentation releases (late-August through mid-September), water temperature in Icicle Creek and Leland Creek remained relatively consistent among sites with around 1.0° C of variability. Near the end of the augmentation period water temperature appeared to equilibrate between sites.

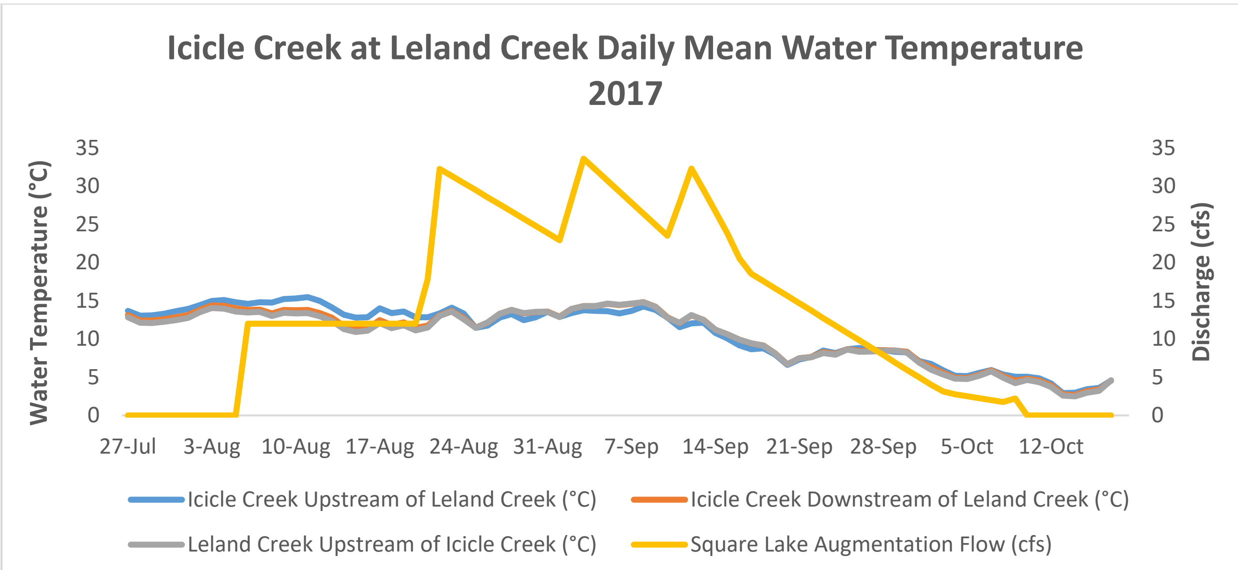

Figure 19. Icicle Creek daily mean water temperature near confluence with Leland Creek. The yellow line indicates the augmentation flow from Square Lake.

Leland Creek Water Chemistry

Water chemistry data collected in the Leland Creek watershed represents spot measurements of water chemistry and is purely informational at this time (Table 7). Water chemistry data was collected in Prospect Creek, and Leland Creek upstream of Prospect on only two dates (07/25/17 and 10/18/17), both of which were outside of the augmentation period. Additional data collection is required to perform an in-depth analysis of the effects of augmentation flow releases from Square Lake on Leland Creek water chemistry.

Table 7. Leland Creek watershed water chemistry.

Date	Creek Name	Location	DO (%)	DO (mg/L)	pH	EC (µS)	TDS (ppm)	Salinity (ppm)
07/25/17	Leland Creek	RM 0.10		11.0	8.50	33.70	23.90	21.40
07/25/17	Leland Creek	RM 1.60		9.5	7.96	37.10	26.30	22.60
07/25/17	Prospect Creek	RM 0.20		9.6	7.69	21.70	15.50	16.10
08/15/17	Leland Creek	RM 0.10	91.2	10.2	7.94	35.30	25.10	19.20
09/06/17	Leland Creek	RM 0.10		10.0	8.05	28.00	19.80	19.10
09/26/17	Leland Creek	RM 0.10		n/a	7.21	37.70	26.70	18.90
10/18/17	Leland Creek	RM 0.10		12.8	8.24	37.70	26.70	17.70
10/18/17	Leland Creek	RM 1.60		12.8	8.47	39.30	27.80	18.40
10/18/17	Prospect Creek	RM 0.20		12.4	9.68	32.90	22.80	14.90

Icicle Creek at confluence with Leland Creek

Additional measurements were obtained on Icicle Creek upstream of the confluence with Leland Creek that were not included in the initial monitoring strategy, but were collected out of relative convenience when accessing Leland (Table 8). Of particular interest is that this reach of Icicle Creek experienced extremely low flows from mid-August through late-September in 2017. On September 6 a manual flow measurement indicated less the 3.0 cfs in this reach of Icicle Creek. On the same date Leland Creek was contributing 34.47 cfs to Icicle Creek downstream of this site, with approximately 29.27 cfs (daily mean) of that value being attributed to augmentation flow from Square Lake.

Table 8. Icicle Creek discharge and water chemistry data summary upstream of confluence with Leland Creek.

Icicle Creek (upstream of Leland Creek) Discharge and Water Chemistry Data 2017							
Date	Discharge (cfs)	Water Temperature (°C)	DO (mg/L)	pH	EC (µS)	TDS (ppm)	Salinity (ppm)
07/26/17	10.32	11.3	8.9	8.00	25.30	17.90	16.00
08/15/17	4.77	11.2	10.1	8.00	30.40	21.70	17.50
09/06/17	2.87	13.8	9.7	8.00	33.70	23.90	21.10
09/26/17	3.73	9.0	n/a	7.70	34.40	24.40	18.10
10/18/17	25.64	4.4	12.6	8.62	26.70	18.80	11.90

Discussion

French Creek

Discharge from Klonaqua Lake augmentation releases, and French Creek were used to develop an estimated natural hydrograph. There may be some imprecision with volume of flow, but the general shape of the estimated hydrograph appears to follow a pattern expected in a naturally functioning snowmelt-driven system. Some general suggestions can be made of how lake releases might be managed in the future.

Sharp increases and rapid declines in the hydrograph associated with augmentation releases drove conditions away from what is expected to be a normative hydrograph, particularly in the month of August. During peak augmentation releases the estimated natural discharge was as much as doubled. This creates the potential for side channels and wetlands to be watered and subsequently dewatered as flows rapidly decline. Fish that move into these habitats may be at risk of being isolated from the main channel with the erratic behavior in the hydrograph. Augmentation releases that mimic the natural hydrograph are preferable, and may allow fish to move volitionally to and from these habitats.

An increase in water temperature in French Creek downstream of Klonaqua Creek appears to be associated with lowering of lake levels during the augmentation period. Klonaqua Lake water temperature increased dramatically during the peak of augmentation releases. This resulted in a temperature increase in French Creek downstream of Klonaqua Creek of more than 3.0° C (daily mean) at times, with daily mean peaks reaching as high as 15.7° C. Bull trout require water temperatures of less than 15.0° C (59.0° F) for rearing, and less than 9.0° C (48.0° F) for spawning (Wydoski and Whitney 2003). Future augmentation efforts will, ideally, maintain water temperatures that are well within the requirements for all bull trout life stages and not disrupt the natural temperature regime. While a temperature increase in French Creek was observed, augmentation flows appear to have had little effect on Icicle Creek water temperature at the monitoring sites.

Spot measurements of water chemistry in French Creek indicated DO and pH were maintained at levels within the tolerable range of salmonids during the augmentation period. Ideal DO levels are greater than 11 ppm (or mg/L) year-round and become lethal at levels less than 6 ppm, while the ideal range for pH is between 6.0 and 8.5 (Kidd 2011). However, with a warming trend such as seen in French Creek during augmentation, there is potential for DO levels to drop with increased water temperature. Additional data are needed to detect a change in water chemistry associated with augmentation flows, and routine water chemistry monitoring should be conducted during future augmentation releases to ensure any changes are minimal.

Leland Creek

An attempt to derive a hydrograph representing natural conditions for Leland Creek using the available discharge data was unsuccessful. However, the discharge data obtained for Square Lake augmentation releases, and lower Leland Creek provide insight into how this system functions hydrologically. There was clearly a delay in the timing of flow from the point of release at Square Lake to lower Leland Creek that can likely be explained by the presence of side channels and wetlands that increase the retention period of augmentation flows. Similar to observations in French Creek, sharp increases and rapid declines in the hydrograph associated with valve adjustments and lowering lake levels resulted in erratic flow and water level changes that may be detrimental to fish. Managing flow releases to better mimic a natural hydrograph may be a better option, and allow movement of fish freely to and from side channel habitats that can become isolated as flows decline. This may be more complex in Leland Creek as there are still questions remaining about travel time of augmentation flows and a natural hydrograph.

While Square Lake water temperature remained significantly cooler than either Leland Creek or Prospect Creek throughout much of the augmentation period, Leland Creek water temperature downstream of Prospect Creek increased by nearly 5.0° C (daily mean) at times during peak augmentation. It is possible that the water temperature logger in Square Lake was at a different depth relative to the of outflow of Square Lake resulting in temperature readings much lower than observed in Prospect and Leland creeks. Further evaluation is needed to determine the source of this warming trend and how this increase might be mitigated in the event augmentation continues in the future. As with French Creek, maintaining a water temperature regime in the Leland Creek watershed that is within the requirements for bull trout is of the utmost importance during any future augmentation efforts. The observed water temperature increase in Leland Creek associated with augmentation flows appeared to have little influence on Icicle Creek at monitoring sites near the confluence of the two creeks.

Spot measurements of water chemistry collected in the Leland Creek were limited to site visits at RM 0.10 during the augmentation period. Additional data is needed in Prospect Creek, and Leland upstream of Prospect to detect potential changes in water chemistry associated with augmentation flows. However, the water chemistry data collected indicates DO and pH levels remained within the tolerable range for salmonids. As with French Creek, water chemistry should be routinely monitored during future augmentation efforts to ensure levels remain within the tolerable range for bull trout.

References

(Kidd) Holmen, S.A., R. Beaston, and J. St. Pierre. 2011. Scappoose bay watershed water quality monitoring report 2008-2010. Scappoose Bay Watershed Council Water Quality Report June 2011, Warren, OR. www.scappoosebay-wc.org

Wydoski, R. S., and R. R. Whitney. 2003. Inland Fishes of Washington. 2nd ed. American Fisheries Society and University of Washington Press, Seattle, Washington, pp. 94-97.

APPENDIX B

LiDAR Technical Data Report, Alpine Lake, Washington

December 2, 2016

Alpine Lakes, Washington

LiDAR Technical Data Report

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Cover Photo: A view looking south at Colchuck Lake in the North Cascades. The image was created from the LiDAR bare earth model overlaid with the LiDAR point cloud and colored by NAIP imagery.

INTRODUCTION

This photo taken by QSI acquisition staff shows a view of Snow Lake within the Alpine Lakes Area of Interest.

In July 2016, Quantum Spatial (QSI) was contracted by Aspect Consulting to collect Light Detection and Ranging (LiDAR) data in the fall of 2016 for four areas of interest (AOIs)comprising the Alpine Lakes project area in Washington State. Data were collected to aid Aspect Consulting in assessing the topographic and geophysical properties of the study area to support the Alpine Lakes Optimization and Automation Appraisal Study.

This report accompanies the delivered LiDAR data and documents contract specifications, data acquisition procedures, processing methods, and analysis of the final dataset including LiDAR accuracy and density. Acquisition dates and acreage are shown in Table 1, a complete list of contracted deliverables provided to Aspect Consulting is shown in Table 2, and the project extent is shown in Figure 1.

Table 1: Acquisition dates, acreage, and data types collected on the Alpine Lakes, Washington site

Project Site	Contracted Acres	Buffered Acres	Acquisition Dates	Data Type
Alpine Lakes, Washington	1,500	2,022	10/19/2016	LiDAR

Deliverable Products

Table 2: Products delivered to Aspect Consulting for the Alpine Lakes, Washington site

Alpine Lakes Products Projection: Washington State Plane North – FIPS Zone 4601 Horizontal Datum: NAD83(HARN) Vertical Datum: NAVD88 (GEOID09) Units: U.S. Survey Feet	
Points	LAS v 1.2 • All Classified Returns (Ground, Default, Water)
Rasters	3.0 Foot ESRI Grids • Bare Earth Model • Highest Hit Model
Vectors	Shapefiles (*.shp) • Project Boundary • LiDAR Tile Index • Total Area Flown Shape • Water's Edge Polygon Drawing Files (*.dwg) • Contours (2 ft)

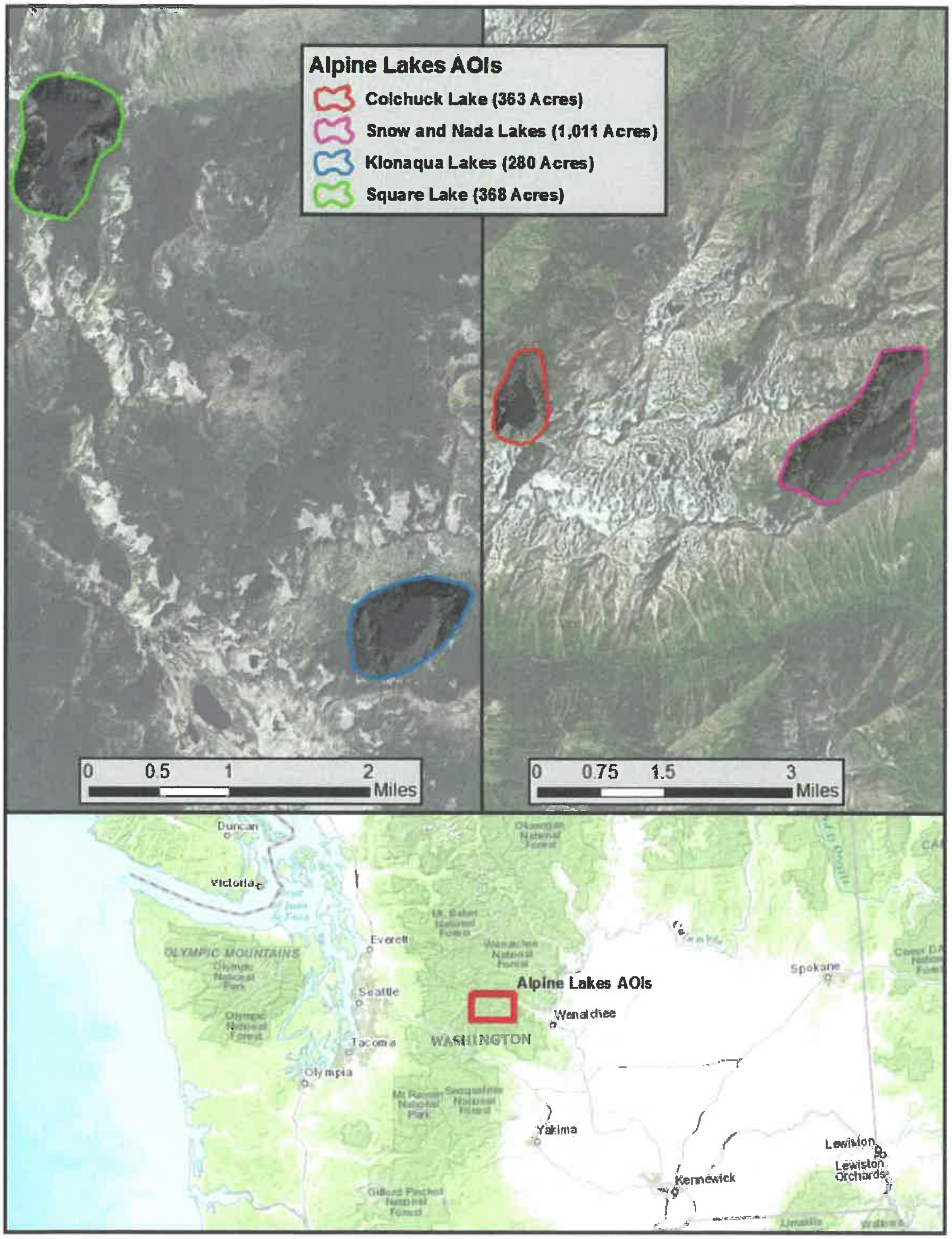

Figure 1: Location map of the Alpine Lakes site in Washington State

QSI's Cessna Caravan

Planning

In preparation for data collection, QSI reviewed the project area and developed a specialized flight plan to ensure complete coverage of the Alpine Lakes LiDAR study area at the target point density of ≥8.0 points/m^2 (0.74 points/ft^2). Acquisition parameters including orientation relative to terrain, flight altitude, pulse rate, scan angle, and ground speed were adapted to optimize flight paths and flight times while meeting all contract specifications.

Factors such as satellite constellation availability and weather windows must be considered during the planning stage. The survey was not conducted until late October when lakes were in full drawdown, yet before the onset of snow in the project area. Any weather hazards or conditions affecting the flight were continuously monitored due to their potential impact on the daily success of airborne and ground operations. In addition, logistical considerations including ground survey access to the remote location, and potential air space restrictions were reviewed. Due to the extremely remote nature of the project site, QSI utilized WSRN[1] CORS station QMAR in combination with one newly established monument to achieve 13 nautical mile GPS baselines.

[1]Washington State Reference Network http://www.wsrn3.org/

Airborne LiDAR Survey

The LiDAR survey was accomplished using a Leica ALS80 system mounted in a Cessna Caravan. Table 3 summarizes the settings used to yield an average pulse density of ≥8 pulses/m^2 over the Alpine Lakes project area. The Leica ALS80 laser system can record unlimited range measurements (returns) per pulse. It is not uncommon for some types of surfaces (e.g., dense vegetation, water, or snow) to return fewer pulses to the LiDAR sensor than the laser originally emitted. The discrepancy between first return and overall delivered density will vary depending on terrain, land cover, and the prevalence of water bodies. All discernible laser returns were processed for the output dataset.

Table 3: LiDAR specifications and survey settings

LiDAR Survey Settings & Specifications	
Acquisition Dates	October 19, 2016
Aircraft Used	Cessna Caravan
Sensor	Leica ALS80
Survey Altitude (AGL)	1600 m
Swath Width	857 m
Target Pulse Rate	142.8 - 346.6 kHz
Pulse Mode	Multiple Pulses in Air (MPiA)
Laser Pulse Diameter	35 cm
Mirror Scan Rate	52.0 Hz
Field of View	40°
GPS Baselines	≤13 nm
GPS PDOP	≤3.0
GPS Satellite Constellation	≥6
Maximum Returns	Unlimited
Intensity	8-bit, scaled to 16-bit
Resolution/Density	Average 8 pulses/m^2
Accuracy	$RMSE_Z \leq 15$ cm

Leica ALS80 LiDAR sensor

All areas were surveyed with an opposing flight line side-lap of ≥50% (≥100% overlap) in order to reduce laser shadowing and increase surface laser painting. To accurately solve for laser point position (geographic coordinates x, y and z), the positional coordinates of the airborne sensor and the attitude of the aircraft were recorded continuously throughout the LiDAR data collection mission. Position of the aircraft was measured twice per second (2 Hz) by an onboard differential GPS unit, and aircraft attitude was measured 200 times per second (200 Hz) as pitch, roll and yaw (heading) from an onboard inertial measurement unit (IMU). To allow for post-processing correction and calibration, aircraft and sensor position and attitude data are indexed by GPS time.

Ground Control

QSI-Established Monument

Ground control surveys, including monumentation and ground survey points (GSPs) were conducted to support the airborne acquisition. Ground control data were used to geospatially correct the aircraft positional coordinate data and to perform quality assurance checks on final LiDAR data.

Monumentation

The spatial configuration of ground survey monuments provided redundant control within 13 nautical miles of the mission areas for LiDAR flights. Monuments were also used for collection of ground survey points using real time kinematic (RTK) survey techniques.

Monument locations were selected with consideration for satellite visibility, field crew safety, and optimal location for GSP coverage. QSI utilized one existing CORS station and established one new monument for the Alpine Lakes, Washington LiDAR project (Table 4, Figure 2). New monumentation was set using 5/8" x 30" rebar topped with stamped 2 ½ " aluminum caps. QSI's professional land surveyor, Evon Silvia (WAPLS#53957) oversaw and certified the establishment of all monuments.

Table 4: Monuments established for the Alpine Lakes, Washington acquisition. Coordinates are on the NAD83 (HARN) datum.

Monument ID	Latitude	Longitude	Ellipsoid (meters)
ALPINE_01	47° 28' 33.92814"	-120° 39' 18.63201"	501.273
WSRN CORS Station QMAR	47° 46' 30.34411"	-120° 57' 55.97402"	812.470

To correct the continuously recorded onboard measurements of the aircraft position, QSI concurrently conducted multiple static Global Navigation Satellite System (GNSS) ground surveys (1 Hz recording frequency) over each monument. During post-processing, the static GPS data were triangulated with nearby Continuously Operating Reference Stations (CORS) using the Online Positioning User Service (OPUS[2]) for precise positioning. Multiple independent sessions over the same monument were processed to confirm antenna height measurements and to refine position accuracy.

Monuments were established according to the national standard for geodetic control networks, as specified in the Federal Geographic Data Committee (FGDC) Geospatial Positioning Accuracy Standards for geodetic networks.[3] This standard provides guidelines for classification of monument quality at the 95% confidence interval as a basis for comparing the quality of one control network to another. The monument rating for this project is shown in Table 5.

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[2] OPUS is a free service provided by the National Geodetic Survey to process corrected monument positions. http://www.ngs.noaa.gov/OPUS.

[3] Federal Geographic Data Committee, Geospatial Positioning Accuracy Standards (FGDC-STD-007.2-1998). Part 2: Standards for Geodetic Networks, Table 2.1, page 2-3. http://www.fgdc.gov/standards/projects/FGDC-standards-projects/accuracy/part2/chapter2

Table 5: Federal Geographic Data Committee monument rating for network accuracy

Direction	Rating
1.96 * St Dev$_{NE}$:	0.020 m
1.96 * St Dev$_{z}$:	0.020 m

For the Alpine Lakes, Washington LiDAR project, the monument coordinates contributed no more than 2.8 cm of positional error to the geolocation of the final ground survey points and LiDAR, with 95% confidence.

Ground Survey Points (GSPs)

Ground survey points were collected using real time kinematic (RTK) survey techniques. A Trimble R7 base unit was positioned at a nearby monument to broadcast a kinematic correction to a roving Trimble R6 GNSS receiver. All GSP measurements were made during periods with a Position Dilution of Precision (PDOP) of ≤ 3.0 with at least six satellites in view of the stationary and roving receivers. When collecting RTK data, the rover records data while stationary for five seconds, then calculates the pseudorange position using at least three one-second epochs. Relative errors for any GSP position must be less than 1.5 cm horizontal and 2.0 cm vertical in order to be accepted. See Table 6 for Trimble unit specifications.

GSPs were collected in areas where good satellite visibility was achieved on paved roads and other hard surfaces such as gravel or packed dirt roads. GSP measurements were not taken on highly reflective surfaces such as center line stripes or lane markings on roads due to the increased noise seen in the laser returns over these surfaces. GSPs were collected within as many flightlines as possible; however the distribution of GSPs depended on ground access constraints and monument locations and may not be equitably distributed throughout the study area (Figure 2).

Table 6: Trimble equipment identification

Receiver Model	Antenna	OPUS Antenna ID	Use
Trimble R6 GNSS	Integrated GNSS Antenna R6	TRMR6	Rover
Trimble R7	Zephyr GNSS Geodetic Model 2 RoHS	TRM57971.00	Static

Lack of access and the remote nature of the project area prevented GSP collection within the project area of interest. GSPs were recorded in a nearby area meeting the requirements described above (Figure 2), and the LiDAR acquisition was adjusted to include coverage of that area. Because adjustments to ground control are generally consistent within a single mission, these GSPs could be used to vertically control the LiDAR despite being outside the project area of interest.

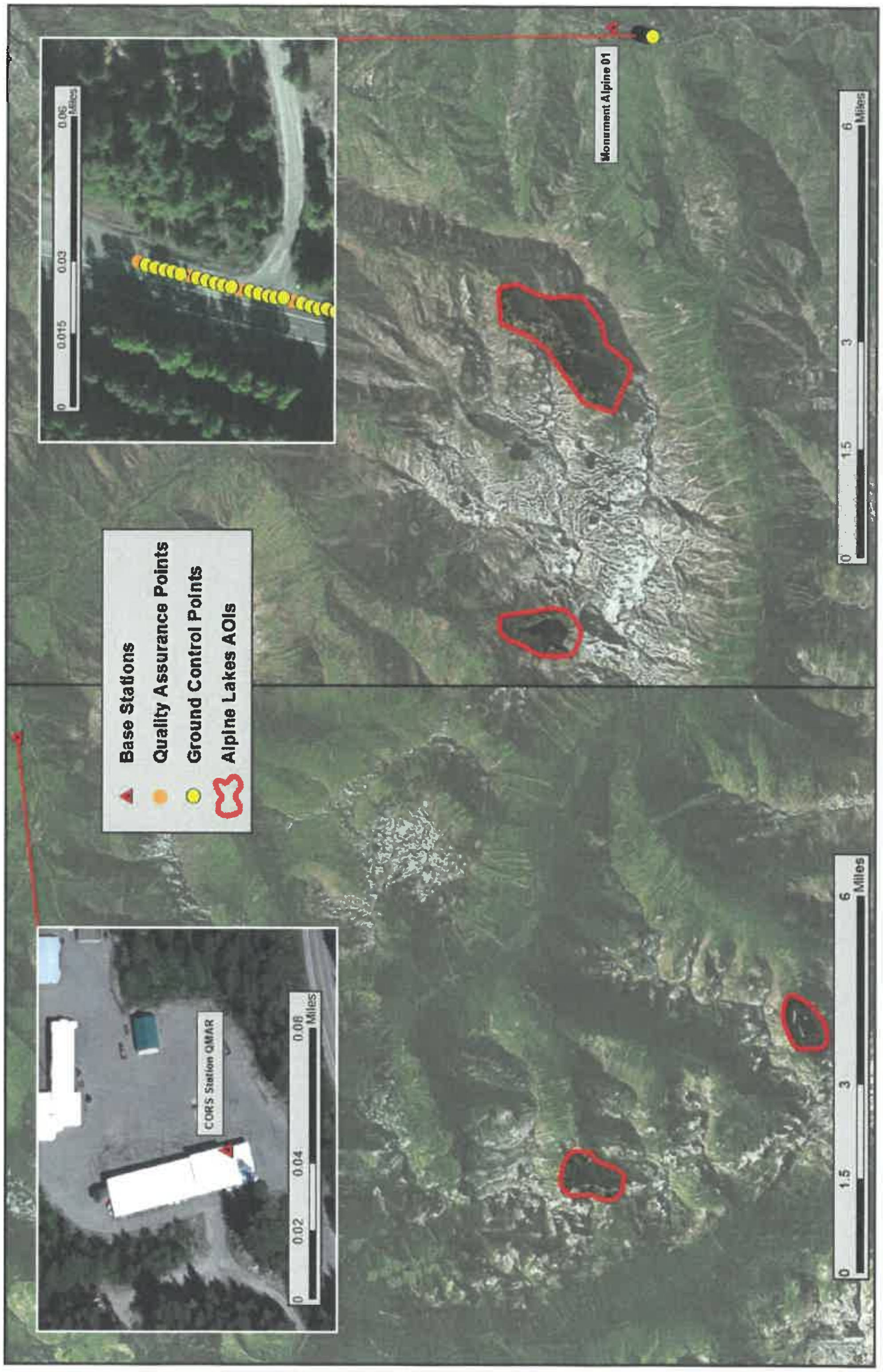
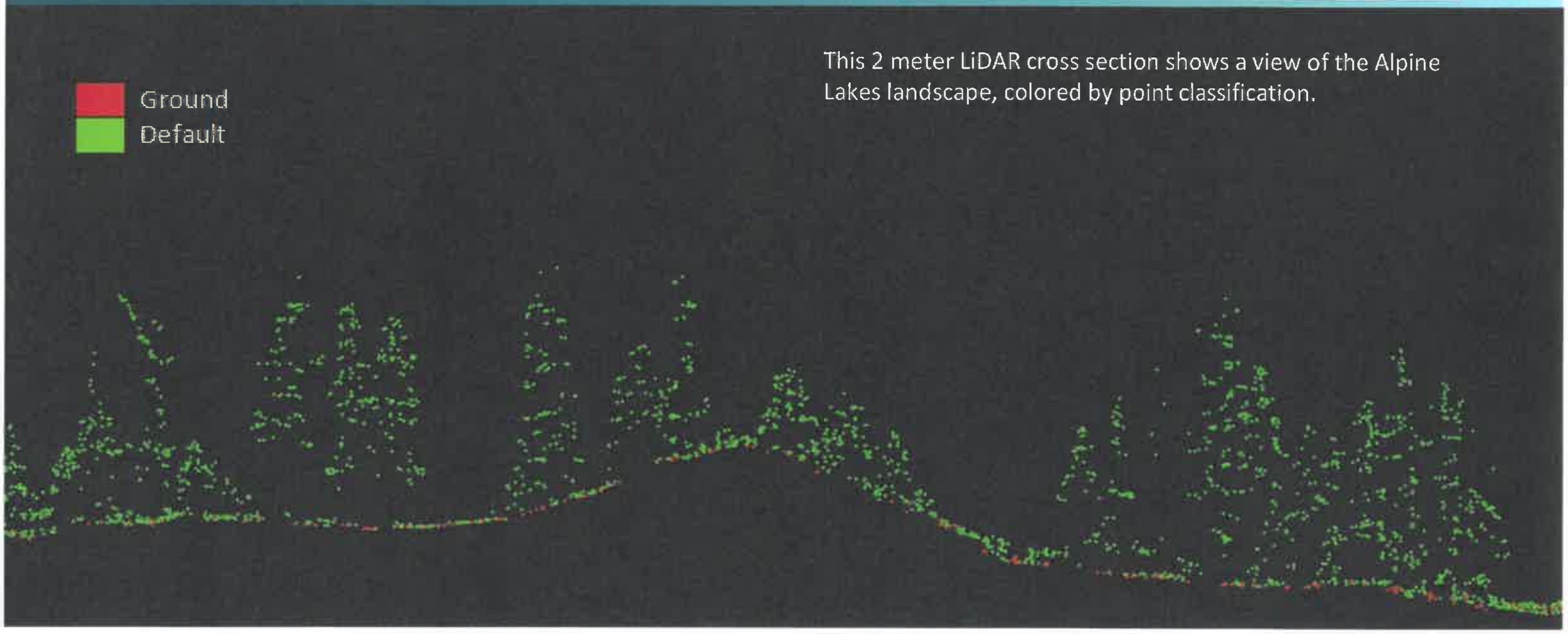


Figure 2 : Ground Survey Location Map



This 2 meter LiDAR cross section shows a view of the Alpine Lakes landscape, colored by point classification.

LiDAR Data

Upon completion of data acquisition, QSI processing staff initiated a suite of automated and manual techniques to process the data into the requested deliverables. Processing tasks included GPS control computations, smoothed best estimate trajectory (SBET) calculations, kinematic corrections, calculation of laser point position, sensor and data calibration for optimal relative and absolute accuracy, and LiDAR point classification (Table 7). Processing methodologies were tailored for the landscape. Brief descriptions of these tasks are shown in Table 8.

Table 7: ASPRS LAS classification standards applied to the Alpine Lakes, Washington dataset

Classification Number	Classification Name	Classification Description
1	Default/Unclassified	Laser returns that are not included in the ground class, composed of vegetation and anthropogenic features
2	Ground	Laser returns that are determined to be ground using automated and manual cleaning algorithms
9	Water	Laser returns that are determined to be water using automated and manual algorithms

Table 8: LiDAR processing workflow

LiDAR Processing Step	Software Used
Resolve kinematic corrections for aircraft position data using kinematic aircraft GPS and static ground GPS data. Develop a smoothed best estimate of trajectory (SBET) file that blends post-processed aircraft position with sensor head position and attitude recorded throughout the survey.	Waypoint Inertial Explorer v.8.6
Calculate laser point position by associating SBET position to each laser point return time, scan angle, intensity, etc. Create raw laser point cloud data for the entire survey in *.las (ASPRS v. 1.2) format. Convert data to orthometric elevations by applying a geoid correction.	Waypoint Inertial Explorer v.8.6 Leica Cloudpro v. 1.2.2
Import raw laser points into manageable blocks (less than 500 MB) to perform manual relative accuracy calibration and filter erroneous points. Classify ground points for individual flight lines.	TerraScan v.16
Using ground classified points per each flight line, test the relative accuracy. Perform automated line-to-line calibrations for system attitude parameters (pitch, roll, heading), mirror flex (scale) and GPS/IMU drift. Calculate calibrations on ground classified points from paired flight lines and apply results to all points in a flight line. Use every flight line for relative accuracy calibration.	TerraMatch v.16
Classify resulting data to ground and other client designated ASPRS classifications (Table 7). Assess statistical absolute accuracy via direct comparisons of ground classified points to ground control survey data.	TerraScan v.16 TerraModeler v.16
Generate bare earth models as triangulated surfaces. Generate highest hit models as a surface expression of all classified points. Export all surface models as ESRI GRIDs format at a 3.0 foot pixel resolution.	TerraScan v.16 TerraModeler v.16 ArcMap v. 10.2

Feature Extraction

Contours

Contour generation from LiDAR point data required a thinning operation in order to reduce contour sinuosity. The thinning operation reduced point density where topographic change is minimal (i.e., flat surfaces) while preserving resolution where topographic change was present. Contour key points were selected from the ground model every 20 feet with the spacing decreased in regions with high surface curvature. Generation of contour key points eliminated redundant detail in terrain representation, particularly in areas of low relief, and provided for a more manageable dataset. Contours were produced through TerraModeler by interpolating between the contour key points at even elevation increments.

Elevation contour lines were then intersected with ground point density rasters and a confidence field was added to each contour line. Contours which crossed areas of high ground point density have high confidence levels, while contours which crossed areas of low ground point density have low confidence levels. Areas with low ground point density are commonly beneath buildings and bridges, in locations with dense vegetation, over water, and in other areas where laser penetration to the ground surface was impeded (Figure 3). Special care was taken to exclude false contours triangulating across lakes within the project area. Water's edge breaklines were drawn to enforce contour generation up to the water's edge, as well as to classify water within the LiDAR point cloud.

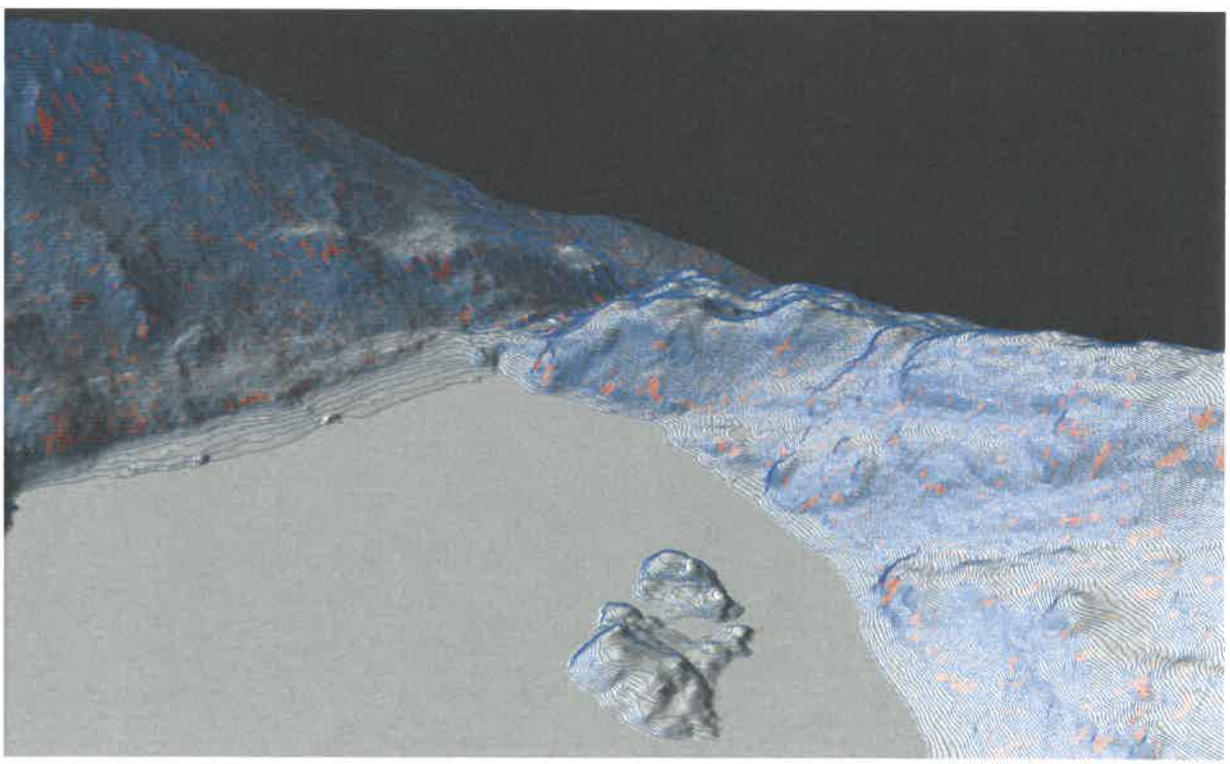
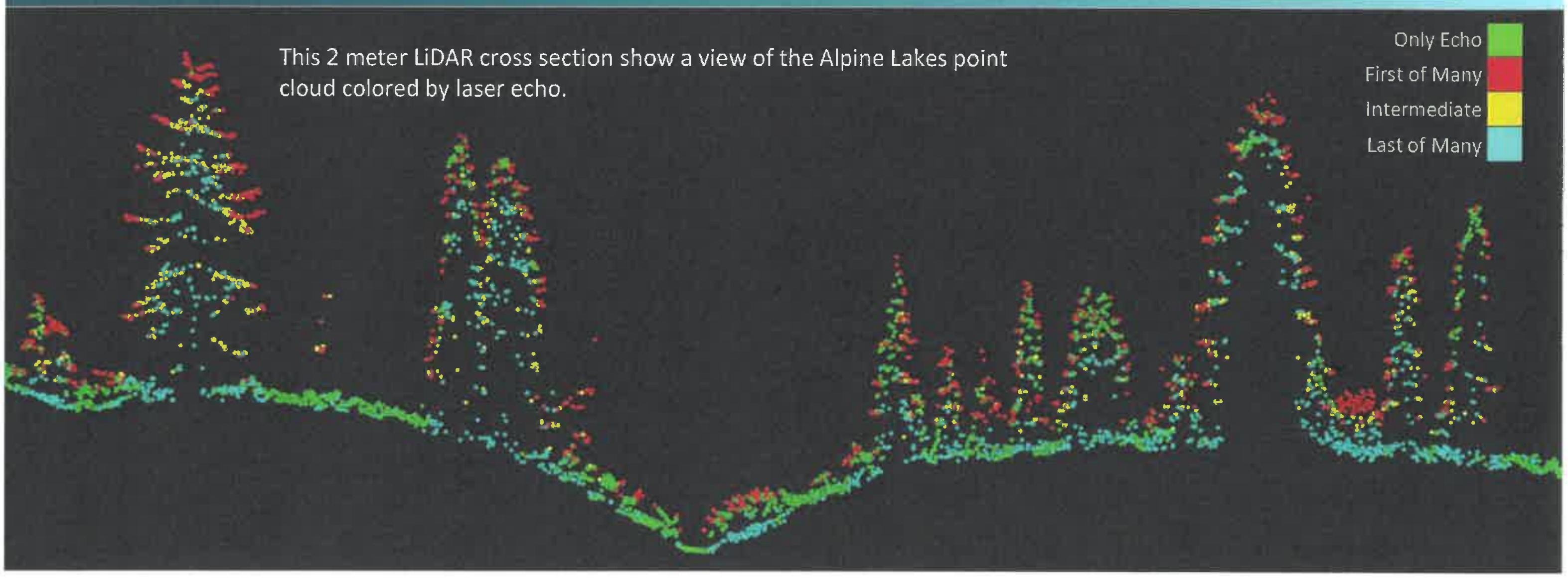


Figure 3: Contours draped over the Alpine Lakes, Washington bare earth elevation model. Blue contours represent high confidence while the red contours represent low confidence.



LiDAR Density

The acquisition parameters were designed to acquire an average first-return density of 8 points/m^2 (0.74 points/ft^2). First return density describes the density of pulses emitted from the laser that return at least one echo to the system. Multiple returns from a single pulse were not considered in first return density analysis. Some types of surfaces (e.g., breaks in terrain, water and steep slopes) may have returned fewer pulses than originally emitted by the laser. First returns typically reflect off the highest feature on the landscape within the footprint of the pulse. In forested or urban areas the highest feature could be a tree, building or power line, while in areas of unobstructed ground, the first return will be the only echo and represents the bare earth surface.

The density of ground-classified LiDAR returns was also analyzed for this project. Terrain character, land cover, and ground surface reflectivity all influenced the density of ground surface returns. In vegetated areas, fewer pulses may penetrate the canopy, resulting in lower ground density.

The average first-return point density value of LiDAR data for the Alpine Lakes project was 1.16 points/ft^2 (12.52 points/m^2) while the average ground classified point density value was 0.18 points/ft^2 (1.98 points/m^2) (Table 9). The statistical and spatial distributions of first return densities and ground classified return densities per 100 m x 100 m cell are portrayed in Figure 4 through Figure 7.

Table 9: Average LiDAR point densities

Classification	Point Density
First-Return	1.16 points/ft^2 12.52 points/m^2
Ground Classified	0.18 points/ft^2 1.98 points/m^2

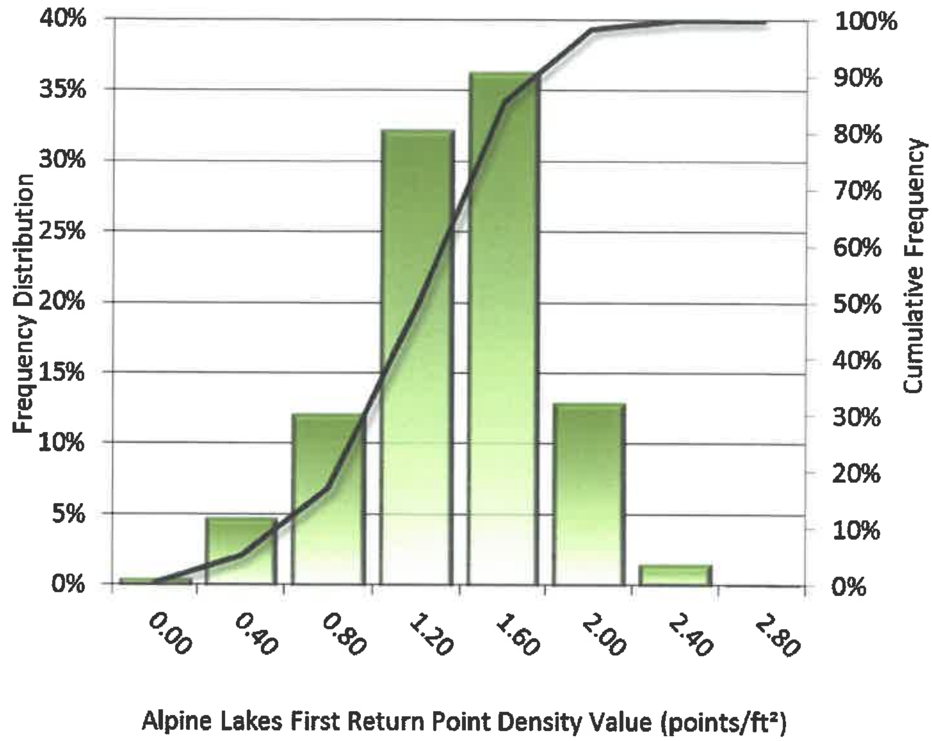


Figure 4: Frequency distribution of first return point density values per 100 x 100 m cell

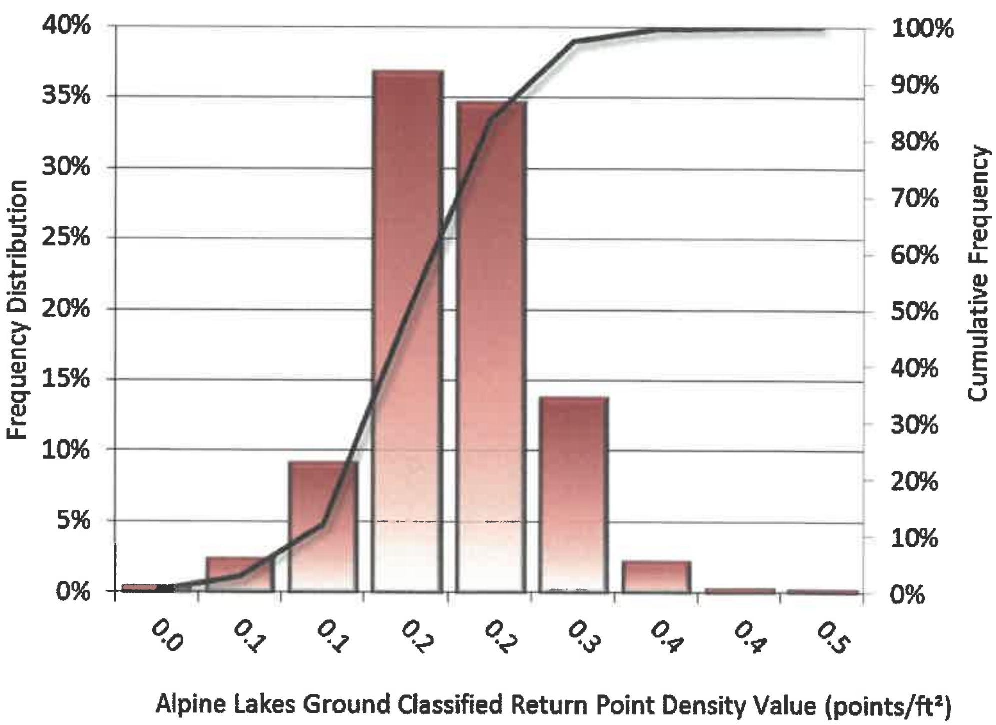


Figure 5: Frequency distribution of ground-classified return point density values per 100 x 100 m cell

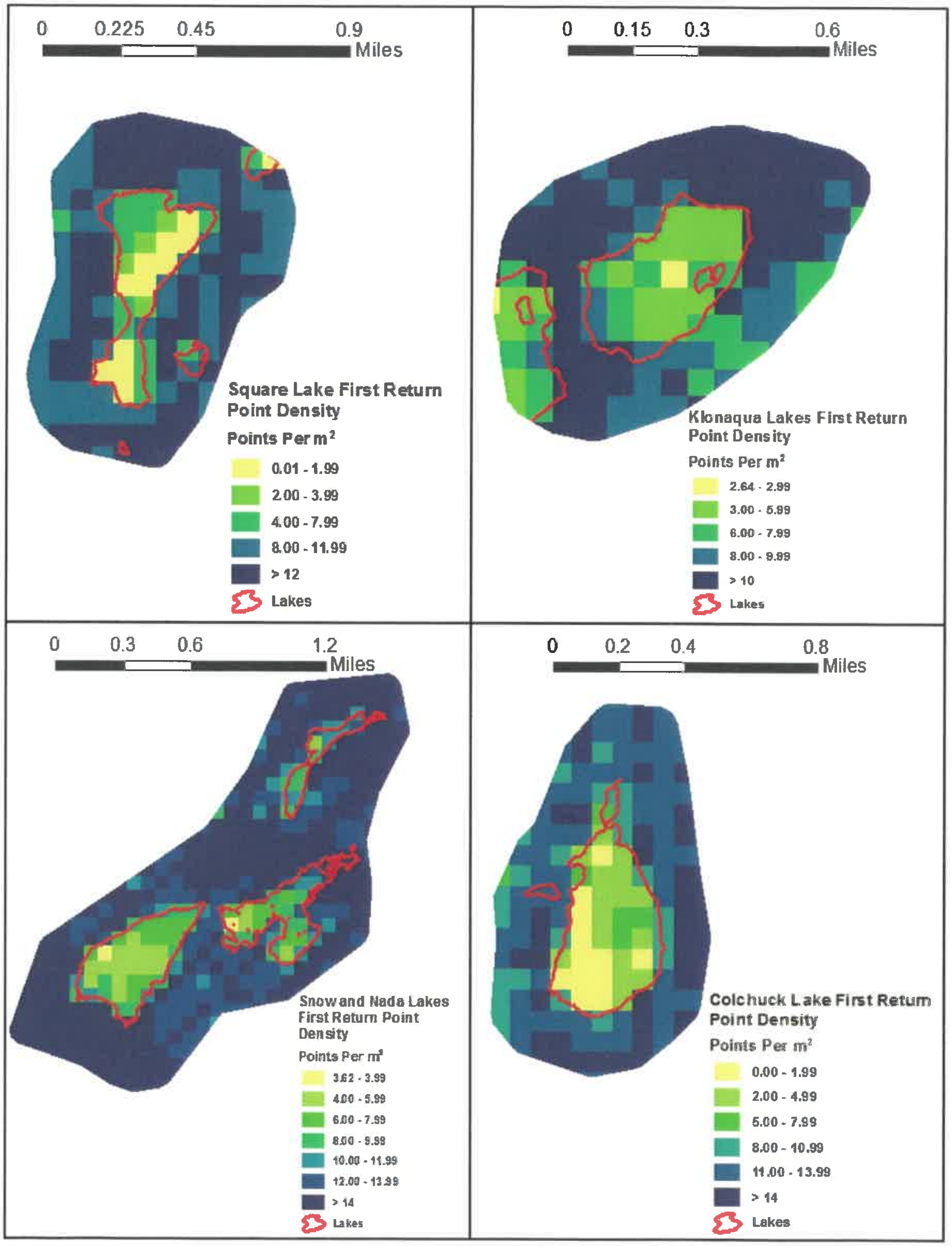


Figure 6: First return point density map for the Alpine Lakes, Washington sites (100 m x 100 m cells)

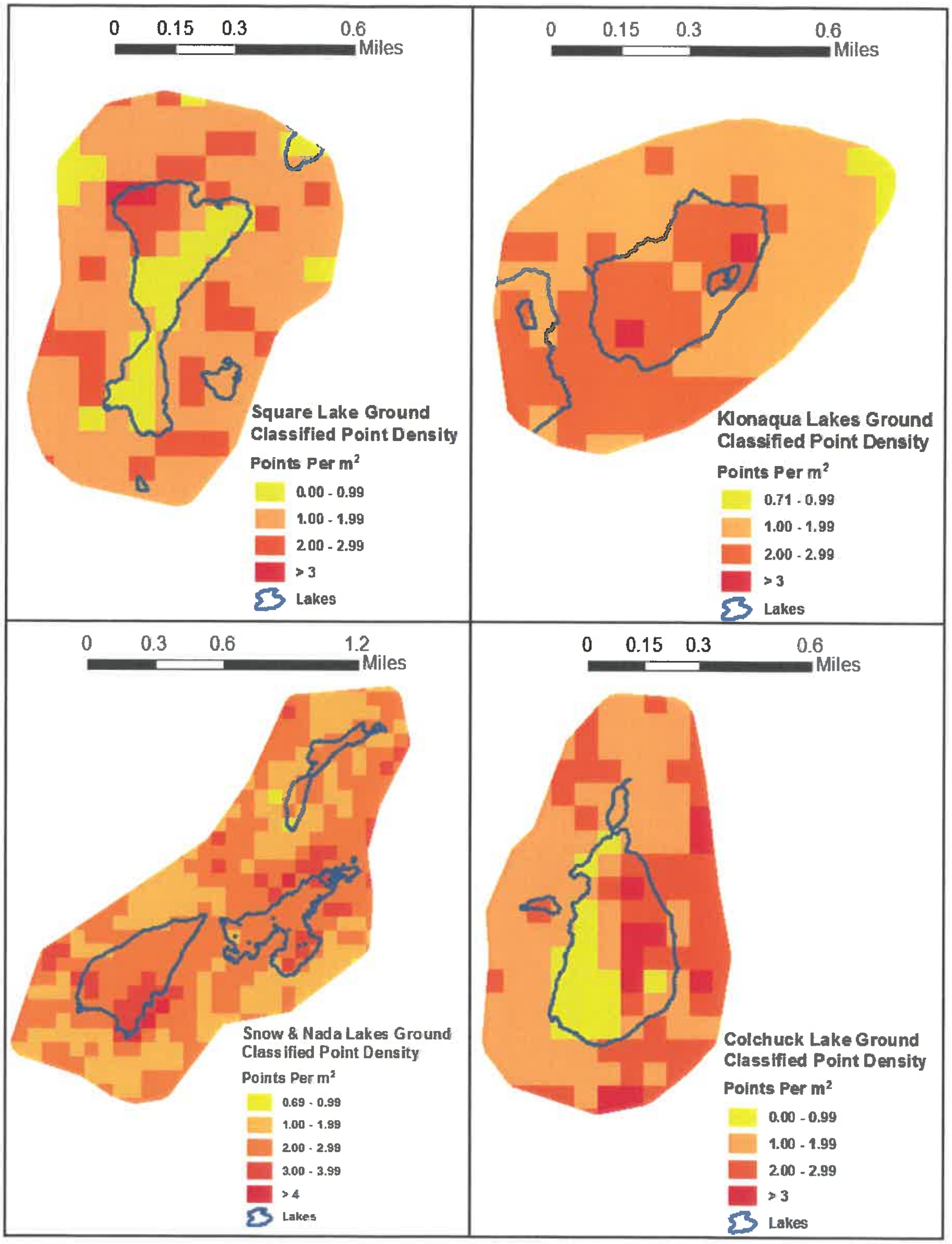


Figure 7: Ground point density map for the Alpine Lakes, Washington sites (100 m x 100 m cells)

LiDAR Accuracy Assessments

The accuracy of the LiDAR data collection can be described in terms of absolute accuracy (the consistency of the data with external data sources) and relative accuracy (the consistency of the dataset with itself). See Appendix A for further information on sources of error and operational measures used to improve relative accuracy.

LiDAR Absolute Accuracy

Absolute accuracy was assessed using Non-Vegetated Vertical Accuracy (NVA) reporting designed to meet guidelines presented in the FGDC National Standard for Spatial Data Accuracy[4]. NVA compares known ground quality assurance point data collected on open, bare earth surfaces with level slope (<20°) to the triangulated surface generated by the LiDAR points. NVA is a measure of the accuracy of LiDAR point data in open areas where the LiDAR system has a high probability of measuring the ground surface and is evaluated at the 95% confidence interval (1.96 * RMSE), as shown in Table 10.

The mean and standard deviation (sigma σ) of divergence of the ground surface model from quality assurance point coordinates are also considered during accuracy assessment. These statistics assume the error for x, y and z is normally distributed, and therefore the skew and kurtosis of distributions are also considered when evaluating error statistics. For the Alpine Lakes survey, 21 quality assurance points were withheld in total resulting in a non-vegetated vertical accuracy of 0.120 feet (0.037 meters) (Figure 8).

QSI also assessed absolute accuracy using 104 ground control points. Although these points were used in the calibration and post-processing of the LiDAR point cloud, they still provide a good indication of the overall accuracy of the LiDAR dataset, and therefore have been provided in Table 10 and Figure 9.

Table 10: Absolute accuracy results

Absolute Accuracy		
	Quality Assurance Points (NVA)	Ground Control Points
Sample	21 points	104 points
NVA (1.96*RMSE)	0.120 ft 0.037 m	0.146 ft 0.044 m
Average	0.003 ft 0.001 m	0.011 ft 0.003 m
Median	0.000 ft 0.000 m	0.011 ft 0.004 m
RMSE	0.061 ft 0.019 m	0.074 ft 0.023 m
Standard Deviation (1σ)	0.063 ft 0.019 m	0.074 ft 0.023 m

[4] Federal Geographic Data Committee, ASPRS POSITIONAL ACCURACY STANDARDS FOR DIGITAL GEOSPATIAL DATA EDITION 1, Version 1.0, NOVEMBER 2014. http://www.asprs.org/PAD-Division/ASPRS-POSITIONAL-ACCURACY-STANDARDS-FOR-DIGITAL-GEOSPATIAL-DATA.html.

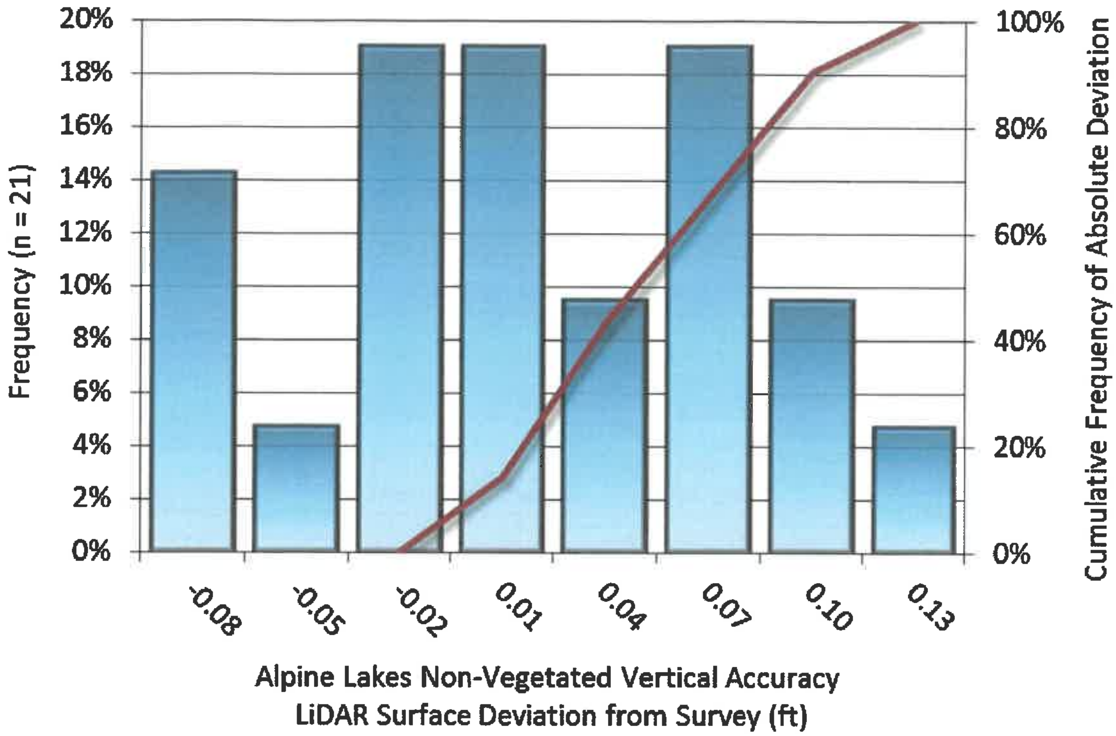


Figure 8: Frequency histogram for LiDAR surface deviation from quality assurance point values

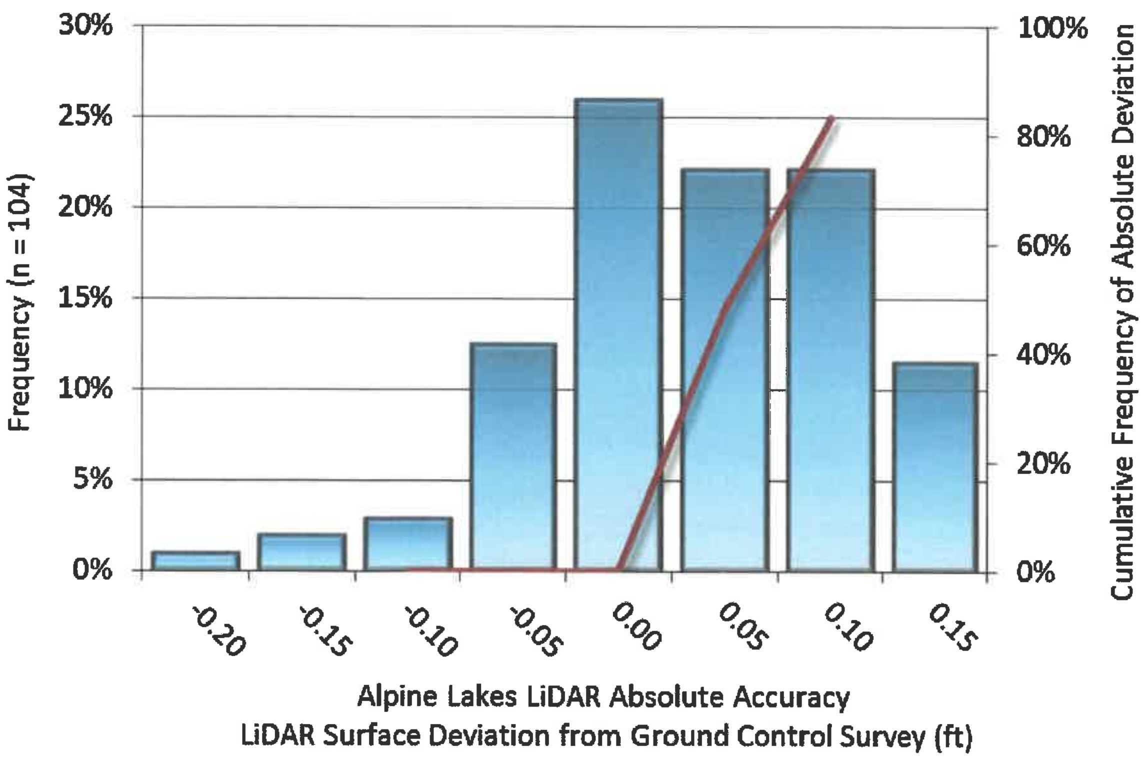


Figure 9: Frequency histogram for LiDAR surface deviation from ground control point values

LiDAR Relative Vertical Accuracy

Relative vertical accuracy refers to the internal consistency of the data set as a whole: the ability to place an object in the same location given multiple flight lines, GPS conditions, and aircraft attitudes. When the LiDAR system is well calibrated, the swath-to-swath vertical divergence is low (<0.10 meters). The relative vertical accuracy was computed by comparing the ground surface model of each individual flight line with its neighbors in overlapping regions. The average (mean) line to line relative vertical accuracy for the Alpine Lakes LiDAR project was 0.215 feet (0.066 meters) (Table 11, Figure 10).

Table 11: Relative accuracy results

Relative Accuracy	
Sample	25 surfaces
Average	0.215 ft 0.066 m
Median	0.217 ft 0.066 m
RMSE	0.216 ft 0.066 m
Standard Deviation (1σ)	0.022 ft 0.007 m
1.96σ	0.043 ft 0.013 m

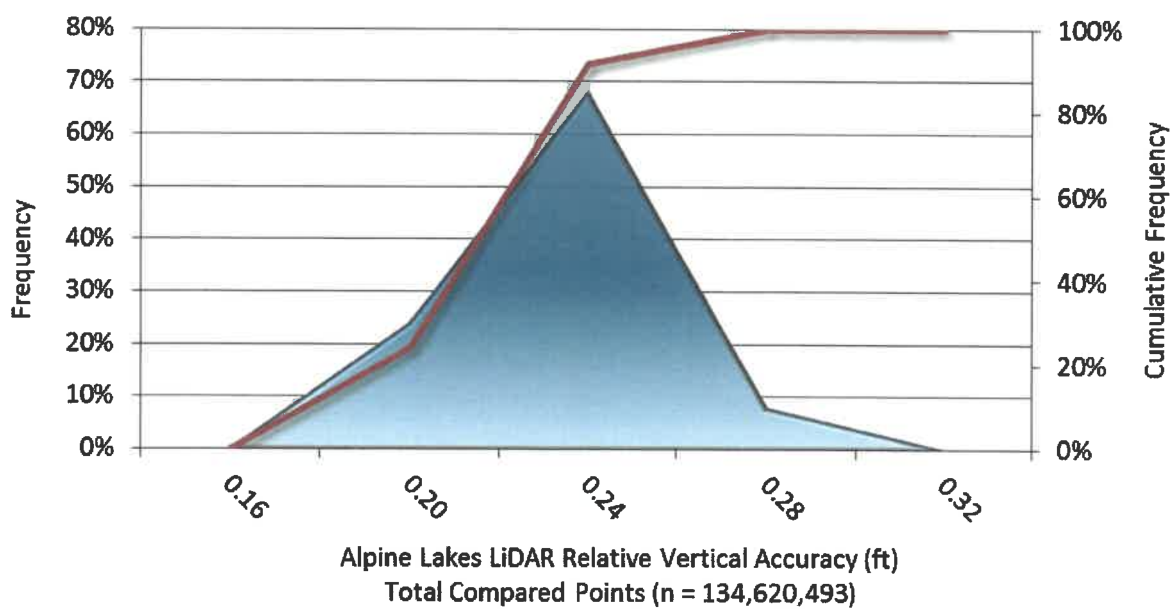


Figure 10: Frequency plot for relative vertical accuracy between flight lines

CERTIFICATIONS

Quantum Spatial, Inc. provided LiDAR services for the Alpine Lakes, Washington project as described in this report.

I, Adam Meyer, have reviewed the attached report for completeness and hereby state that it is a complete and accurate report of this project.

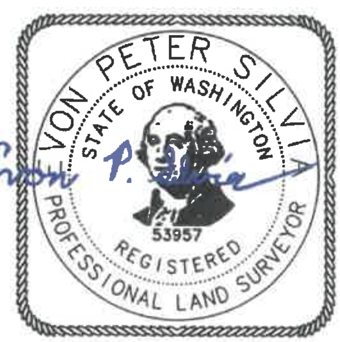
Adam Meyer Dec 1, 2016

Adam Meyer
Project Manager
Quantum Spatial, Inc.

I, Evon P. Silvia, PLS, being duly registered as a Professional Land Surveyor in and by the state of Washington, hereby certify that the methodologies, static GNSS occupations used during airborne flights, and ground survey point collection were performed using commonly accepted Standard Practices. Field work conducted for this report was conducted on October 15, 2016.

Accuracy statistics shown in the Accuracy Section of this Report have been reviewed by me and found to meet the "National Standard for Spatial Data Accuracy".

Evon P. Silvia Dec 1, 2016



Evon P. Silvia, PLS
Quantum Spatial, Inc.
Corvallis, OR 97333

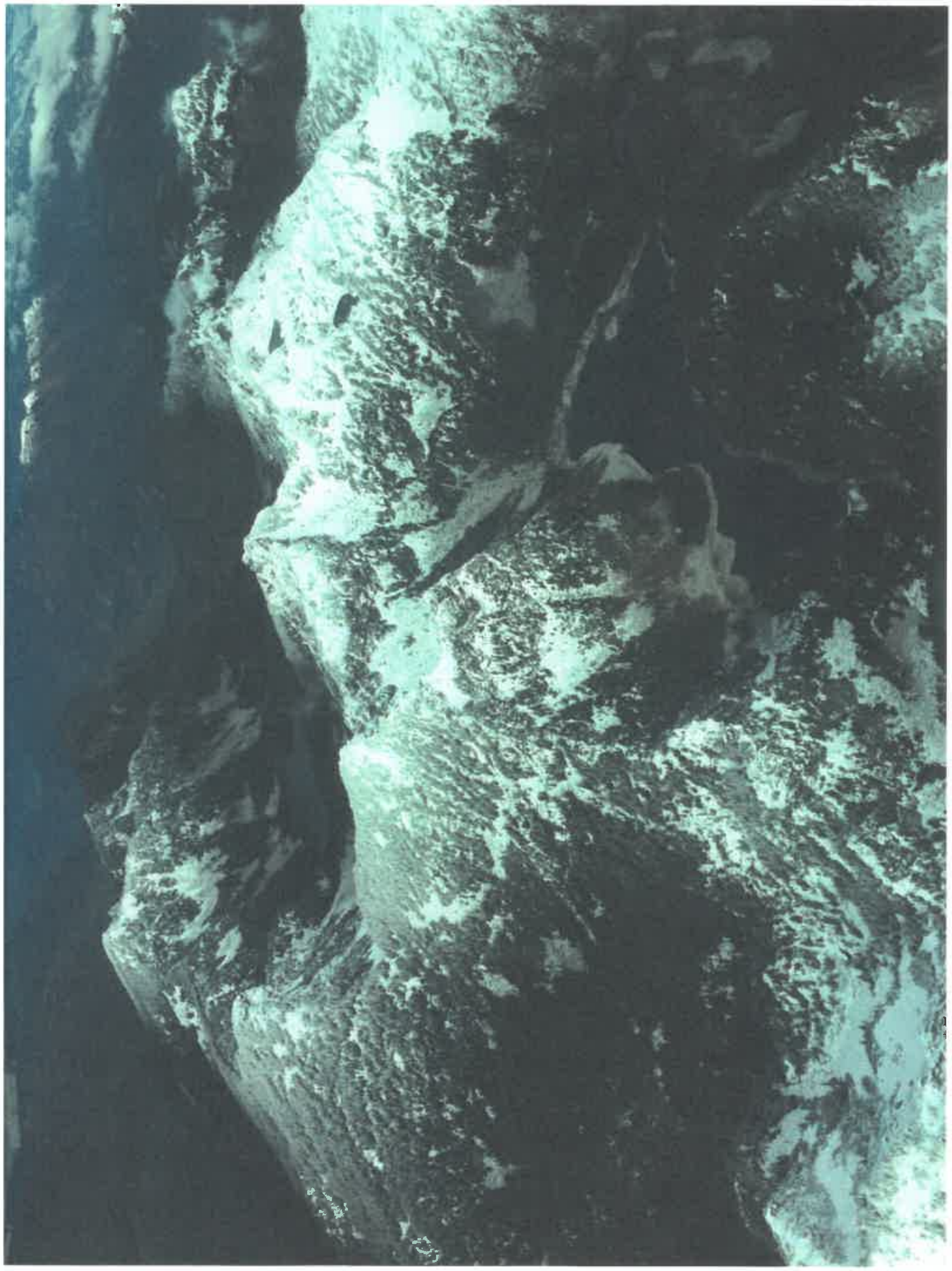


Figure 11: The above image is an aerial photo of Square Lake in the Alpine Lakes AOI. The photo was taken by QSI acquisition staff.

Figure 12: The above image is an aerial photo of Upper Snow Lake taken by the QSI acquisition team.

1-sigma (σ) Absolute Deviation: Value for which the data are within one standard deviation (approximately 68th percentile) of a normally distributed data set.

1.96 * RMSE Absolute Deviation: Value for which the data are within two standard deviations (approximately 95th percentile) of a normally distributed data set, based on the FGDC standards for Non-vegetated Vertical Accuracy (NVA) reporting.

Accuracy: The statistical comparison between known (surveyed) points and laser points. Typically measured as the standard deviation (sigma σ) and root mean square error (RMSE).

> **Absolute Accuracy:** The vertical accuracy of LiDAR data is described as the mean and standard deviation (sigma σ) of divergence of LiDAR point coordinates from ground survey point coordinates. To provide a sense of the model predictive power of the dataset, the root mean square error (RMSE) for vertical accuracy is also provided. These statistics assume the error distributions for x, y and z are normally distributed, and thus we also consider the skew and kurtosis of distributions when evaluating error statistics.

> **Relative Accuracy:** Relative accuracy refers to the internal consistency of the data set; i.e., the ability to place a laser point in the same location over multiple flight lines, GPS conditions and aircraft attitudes. Affected by system attitude offsets, scale and GPS/IMU drift, internal consistency is measured as the divergence between points from different flight lines within an overlapping area. Divergence is most apparent when flight lines are opposing. When the LiDAR system is well calibrated, the line-to-line divergence is low (<10 cm).

> **Root Mean Square Error (RMSE):** A statistic used to approximate the difference between real-world points and the LiDAR points. It is calculated by squaring all the values, then taking the average of the squares and taking the square root of the average.

Data Density: A common measure of LiDAR resolution, measured as points per square meter.

Digital Elevation Model (DEM): File or database made from surveyed points, containing elevation points over a contiguous area. Digital terrain models (DTM) and digital surface models (DSM) are types of DEMs. DTMs consist solely of the bare earth surface (ground points), while DSMs include information about all surfaces, including vegetation and man-made structures.

Intensity Values: The peak power ratio of the laser return to the emitted laser, calculated as a function of surface reflectivity.

Nadir: A single point or locus of points on the surface of the earth directly below a sensor as it progresses along its flight line.

Overlap: The area shared between flight lines, typically measured in percent. 100% overlap is essential to ensure complete coverage and reduce laser shadows.

Pulse Rate (PR): The rate at which laser pulses are emitted from the sensor; typically measured in thousands of pulses per second (kHz).

Pulse Returns: For every laser pulse emitted, the number of wave forms (i.e., echos) reflected back to the sensor. Portions of the wave form that return first are the highest element in multi-tiered surfaces such as vegetation. Portions of the wave form that return last are the lowest element in multi-tiered surfaces.

Real-Time Kinematic (RTK) Survey: A type of surveying conducted with a GPS base station deployed over a known monument with a radio connection to a GPS rover. Both the base station and rover receive differential GPS data and the baseline correction is solved between the two. This type of ground survey is accurate to 1.5 cm or less.

Post-Processed Kinematic (PPK) Survey: GPS surveying is conducted with a GPS rover collecting concurrently with a GPS base station set up over a known monument. Differential corrections and precisions for the GNSS baselines are computed and applied after the fact during processing. This type of ground survey is accurate to 1.5 cm or less.

Scan Angle: The angle from nadir to the edge of the scan, measured in degrees. Laser point accuracy typically decreases as scan angles increase.

Native LiDAR Density: The number of pulses emitted by the LiDAR system, commonly expressed as pulses per square meter.

Relative Accuracy Calibration Methodology:

Manual System Calibration: Calibration procedures for each mission require solving geometric relationships that relate measured swath-to-swath deviations to misalignments of system attitude parameters. Corrected scale, pitch, roll and heading offsets were calculated and applied to resolve misalignments. The raw divergence between lines was computed after the manual calibration was completed and reported for each survey area.

Automated Attitude Calibration: All data were tested and calibrated using TerraMatch automated sampling routines. Ground points were classified for each individual flight line and used for line-to-line testing. System misalignment offsets (pitch, roll and heading) and scale were solved for each individual mission and applied to respective mission datasets. The data from each mission were then blended when imported together to form the entire area of interest.

Automated Z Calibration: Ground points per line were used to calculate the vertical divergence between lines caused by vertical GPS drift. Automated Z calibration was the final step employed for relative accuracy calibration.

LiDAR accuracy error sources and solutions:

Type of Error	Source	Post Processing Solution
GPS (Static/Kinematic)	Long Base Lines	None
	Poor Satellite Constellation	None
	Poor Antenna Visibility	Reduce Visibility Mask
Relative Accuracy	Poor System Calibration	Recalibrate IMU and sensor offsets/settings
	Inaccurate System	None
Laser Noise	Poor Laser Timing	None
	Poor Laser Reception	None
	Poor Laser Power	None
	Irregular Laser Shape	None

Operational measures taken to improve relative accuracy:

Low Flight Altitude: Terrain following was employed to maintain a constant above ground level (AGL). Laser horizontal errors are a function of flight altitude above ground (about 1/3000th AGL flight altitude).

Focus Laser Power at narrow beam footprint: A laser return must be received by the system above a power threshold to accurately record a measurement. The strength of the laser return (i.e., intensity) is a function of laser emission power, laser footprint, flight altitude and the reflectivity of the target. While surface reflectivity cannot be controlled, laser power can be increased and low flight altitudes can be maintained.

Reduced Scan Angle: Edge-of-scan data can become inaccurate. The scan angle was reduced to a maximum of ±15° from nadir, creating a narrow swath width and greatly reducing laser shadows from trees and buildings.

Quality GPS: Flights took place during optimal GPS conditions (e.g., 6 or more satellites and PDOP [Position Dilution of Precision] less than 3.0). Before each flight, the PDOP was determined for the survey day. During all flight times, a dual frequency DGPS base station recording at 1 second epochs was utilized and a maximum baseline length between the aircraft and the control points was less than 13 nm at all times.

Ground Survey: Ground survey point accuracy (<1.5 cm RMSE) occurs during optimal PDOP ranges and targets a minimal baseline distance of 4 miles between GPS rover and base. Robust statistics are, in part, a function of sample size (n) and distribution. Ground survey points are distributed to the extent possible throughout multiple flight lines and across the survey area.

50% Side-Lap (100% Overlap): Overlapping areas are optimized for relative accuracy testing. Laser shadowing is minimized to help increase target acquisition from multiple scan angles. Ideally, with a 50% side-lap, the nadir portion of one flight line coincides with the swath edge portion of overlapping flight lines. A minimum of 50% side-lap with terrain-followed acquisition prevents data gaps.

Opposing Flight Lines: All overlapping flight lines have opposing directions. Pitch, roll and heading errors are amplified by a factor of two relative to the adjacent flight line(s), making misalignments easier to detect and resolve.

APPENDIX C

Radio Repeater Background Information

REFERENCE COPY

Federal Communications Commission

Wireless Telecommunications Bureau

RADIO STATION AUTHORIZATION

LICENSEE: ICICLE IRRIGATION DISTRICT

ATTN: JOEL TEELEY
ICICLE IRRIGATION DISTRICT
5594 WESCOTT DRIVE
PO BOX 371
CASHMERE, WA 98815

Call Sign	File Number
WQKR961	

Radio Service
IG - Industrial/Business Pool, Conventional

Regulatory Status
PMRS

Frequency Coordination Number

FCC Registration Number (FRN): 0018582478

Grant Date	Effective Date	Expiration Date	Print Date
08-27-2009	08-27-2009	08-27-2019	

STATION TECHNICAL SPECIFICATIONS

Fixed Location Address or Mobile Area of Operation

Loc. 1 **Address:** 5594 Wescott Drive
City: Cashmere **County:** CHELAN **State:** WA
Lat (NAD83): 47-31-09.0 N **Long (NAD83):** 120-29-47.0 W **ASR No.:** **Ground Elev:** 276.0

Loc. 2 **Address:** Blagg Mountain
City: Cashmere **County:** CHELAN **State:** WA
Lat (NAD83): 47-36-25.0 N **Long (NAD83):** 120-30-35.0 W **ASR No.:** **Ground Elev:** 1180.0

Loc. 3 **Area of operation**
Operating within a 32.0 km radius around fixed location 2

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meter	Construct Deadline Date
1	1	000456.67500000	FX1	1		11K0F2D 11K0F3D 11K0F3E	40.000	40.000	20.0	**s**-387.0	08-27-2010
2	1	000451.67500000	FB2	1		11K0F2D 11K0F3D 11K0F3E	45.000	45.000	40.0	395.0	08-27-2010

Conditions:
Pursuant to §309(h) of the Communications Act of 1934, as amended, 47 U.S.C. §309(h), this license is subject to the following conditions: This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized herein. Neither the license nor the right granted thereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. See 47 U.S.C. § 310(d). This license is subject in terms to the right of use or control conferred by §706 of the Communications Act of 1934, as amended. See 47 U.S.C. §606.

FCC 601-LM
August 2007

Licensee Name: ICICLE IRRIGATION DISTRICT

Call Sign: WQKR961 **File Number:** **Print Date:**

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
3	1	000456.67500000	MO	30		11K0F2D 11K0F3D 11K0F3E	6.000	6.000			08-27-2010
3	1	000451.67500000	MO	30		11K0F2D 11K0F3D 11K0F3E	6.000	6.000			08-27-2010

Control Points

Control Pt. No. 1

Address: 5594 Wescott Drive

City: Cashmere **County:** CHELAN **State:** WA **Telephone Number:** (509)782-2561

Associated Call Signs

Waivers/Conditions:

NONE

Federal Communications Commission

Wireless Telecommunications Bureau

RADIO STATION AUTHORIZATION

LICENSEE: ICICLE IRRIGATION DISTRICT

ATTN: JOEL TEELEY
ICICLE IRRIGATION DISTRICT
5594 WESCOTT DRIVE
PO BOX 371
CASHMERE, WA 98815

Call Sign	File Number
WQKS355	

Radio Service
IG - Industrial/Business Pool, Conventional

Regulatory Status
PMRS

Frequency Coordination Number

FCC Registration Number (FRN): 0018582478

Grant Date	Effective Date	Expiration Date	Print Date
08-31-2009	08-31-2009	08-31-2019	

STATION TECHNICAL SPECIFICATIONS

Fixed Location Address or Mobile Area of Operation

Loc. 1 **Address:** RTU #1 - .89 mi NE of
City: Peshastin **County:** CHELAN **State:** WA
Lat (NAD83): 47-34-41.8 N **Long (NAD83):** 120-35-43.8 W **ASR No.:** **Ground Elev:** 406.0

Loc. 2 **Address:** RTU #2 - 1.81 mi S of
City: Peshastin **County:** CHELAN **State:** WA
Lat (NAD83): 47-32-29.4 N **Long (NAD83):** 120-36-49.8 W **ASR No.:** **Ground Elev:** 354.0

Loc. 3 **Address:** RTU #3 - .98 mi SE of
City: Peshastin **County:** CHELAN **State:** WA
Lat (NAD83): 47-33-18.0 N **Long (NAD83):** 120-35-42.0 W **ASR No.:** **Ground Elev:** 339.0

Loc. 4 **Address:** RTU #4 - 3.69 mi E of
City: Peshastin **County:** CHELAN **State:** WA
Lat (NAD83): 47-31-40.8 N **Long (NAD83):** 120-32-00.6 W **ASR No.:** **Ground Elev:** 427.0

Loc. 5 **Address:** RTU #5 - 4.84 mi SE of
City: Peshastin **County:** CHELAN **State:** WA
Lat (NAD83): 47-31-08.4 N **Long (NAD83):** 120-31-45.6 W **ASR No.:** **Ground Elev:** 333.0

Loc. 6 **Address:** RTU #6 - 1.21 mi W of
City: Peshastin **County:** CHELAN **State:** WA
Lat (NAD83): 47-31-01.3 N **Long (NAD83):** 120-29-44.8 W **ASR No.:** **Ground Elev:** 268.0

Conditions:
Pursuant to §309(h) of the Communications Act of 1934, as amended, 47 U.S.C. §309(h), this license is subject to the following conditions: This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized herein. Neither the license nor the right granted thereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. See 47 U.S.C. § 310(d). This license is subject in terms to the right of use or control conferred by §706 of the Communications Act of 1934, as amended. See 47 U.S.C. §606.

Licensee Name: ICICLE IRRIGATION DISTRICT

Call Sign: WQKS355 **File Number:** **Print Date:**

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
1	1	000456.67500000	FXO	1		11K0F2D 11K0F3D 11K0F3E	6.000	6.000	3.0	-428.0	08-31-2010
2	1	000456.67500000	FXO	1		11K0F2D 11K0F3D 11K0F3E	6.000	6.000	3.0	-435.0	08-31-2010
3	1	000456.67500000	FXO	1		11K0F2D 11K0F3D 11K0F3E	6.000	6.000	3.0	-464.0	08-31-2010
4	1	000456.67500000	FXO	1		11K0F2D 11K0F3D 11K0F3E	6.000	6.000	3.0	-312.0	08-31-2010
5	1	000456.67500000	FXO	1		11K0F2D 11K0F3D 11K0F3E	6.000	6.000	3.0	-393.0	08-31-2010
6	1	000456.67500000	FXO	1		11K0F2D 11K0F3D 11K0F3E	6.000	6.000	3.0	-409.0	08-31-2010

Control Points

Control Pt. No. 1

Address: 5594 Wescott Drive

City: Cashmere **County:** CHELAN **State:** WA **Telephone Number:** (509)782-2561

Associated Call Signs

Waivers/Conditions:

NONE

Location Details - ICICLE RIDGE

General | Details | Antenna | Contact | Rules | Alerts | Repeaters

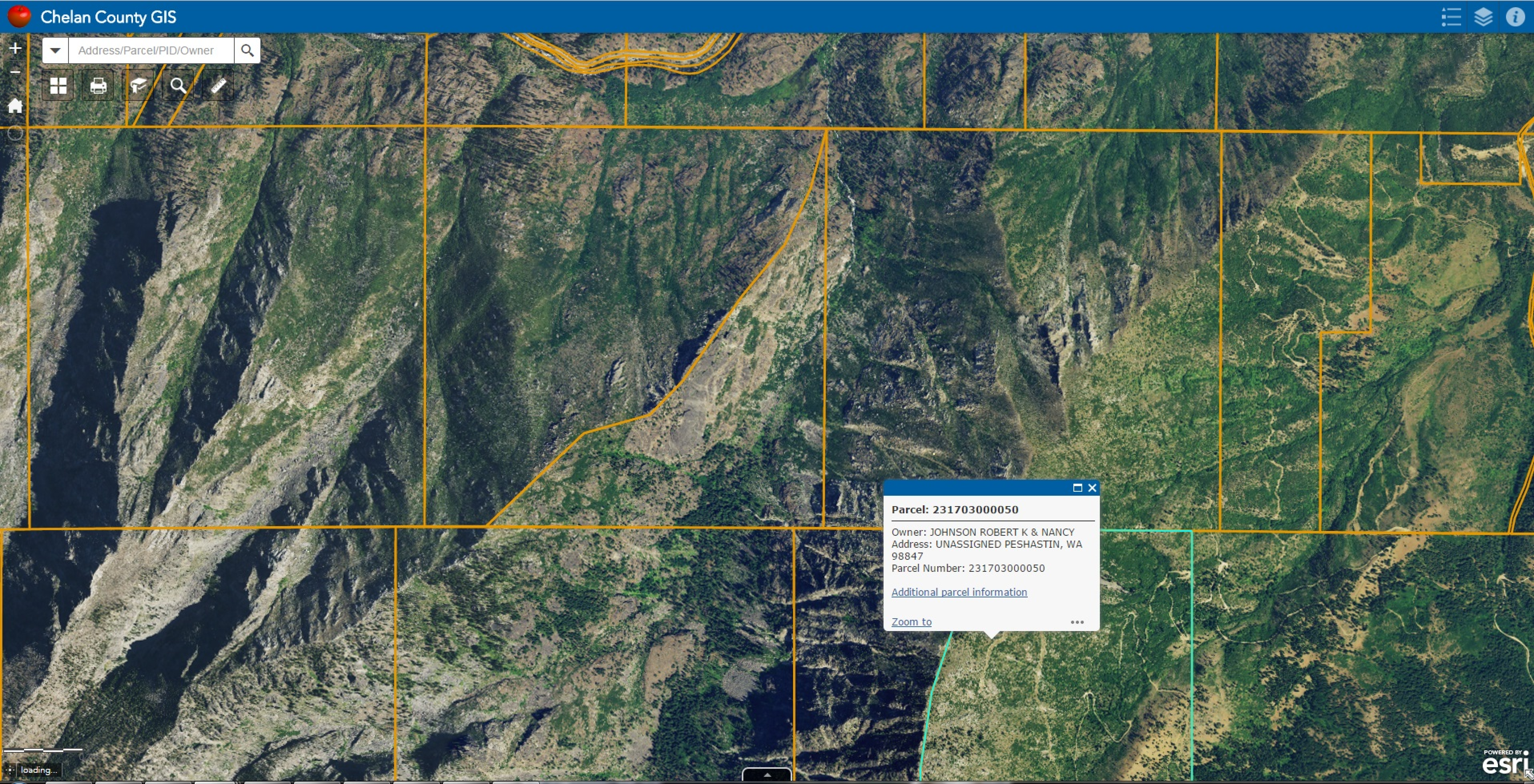
Health Status:	Auto (rules) ▼
ID:	ICICLERIDGE
Name:	ICICLE RIDGE
ESN:	
MGRS:	10TFT6856772797
Lat / Lon:	47.586667 / -120.758056
Elevation (m):	2079
Forest:	Okanogan-Wenatchee National Forest ▼


About
Dashboard
Admin
Help
Fourth of July Creek
Location Summary - ICICLE RIDGE
General
Data
Repeaters
Status: UNMONITORED
Updated: 4/8/2014, 6:15:43 AM
Reasons:
Lat/Lon: 47.5866670, -120.758056
MGRS: 10TFT6856772797
Region: R6-Pacific Northwest
Forest:
Okanogan-Wenatchee National Forest
Zoom to
Show Coverage
Location Details
Bridge Creek
Leavenworth
Leavenworth Golf Club
Repeaters
Layers
Legend
Tools
Placemarks
Coverage
POWERED BY esri

Location Details - ICICLE RIDGE

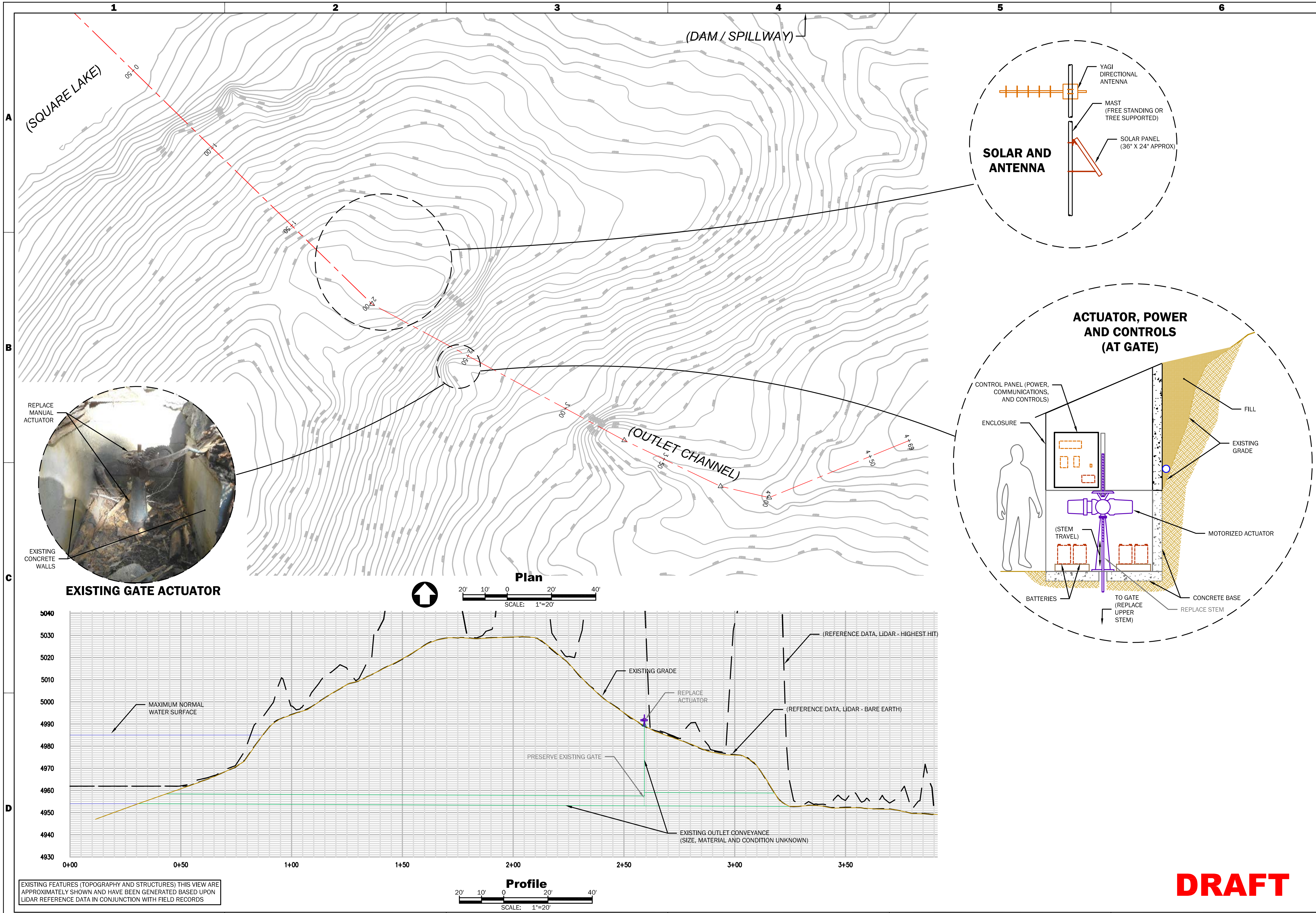
General | Details | Antenna | Contact | Rules | Alerts | Repeaters

Tx Antenna:	Collinear
Dbi:	6
Antenna Height Meters:	6
Antenna Azth:	ND
Txpo Watts:	50


Chelan County GIS
Address/Parcel/PID/Owner
Parcel: 231703000050
Owner: JOHNSON ROBERT K & NANCY
Address: UNASSIGNED PESHASTIN, WA 98847
Parcel Number: 231703000050
Additional parcel information
Zoom to
loading...
POWERED BY esri

APPENDIX D

Conceptual Engineering Drawings



Conceptual Improvements Square Lake

Alpine Lakes Automation Feasibility

Leavenworth, Washington

Aspect CONSULTING

DATE:	REVISION:	PROJECT NUMBER:	DESIGNED BY:	DRAWN BY:	REVISED BY:
FEB 2017	-	000000	-	SCC	-

REV.	DESCRIPTION	DATE	APPR.
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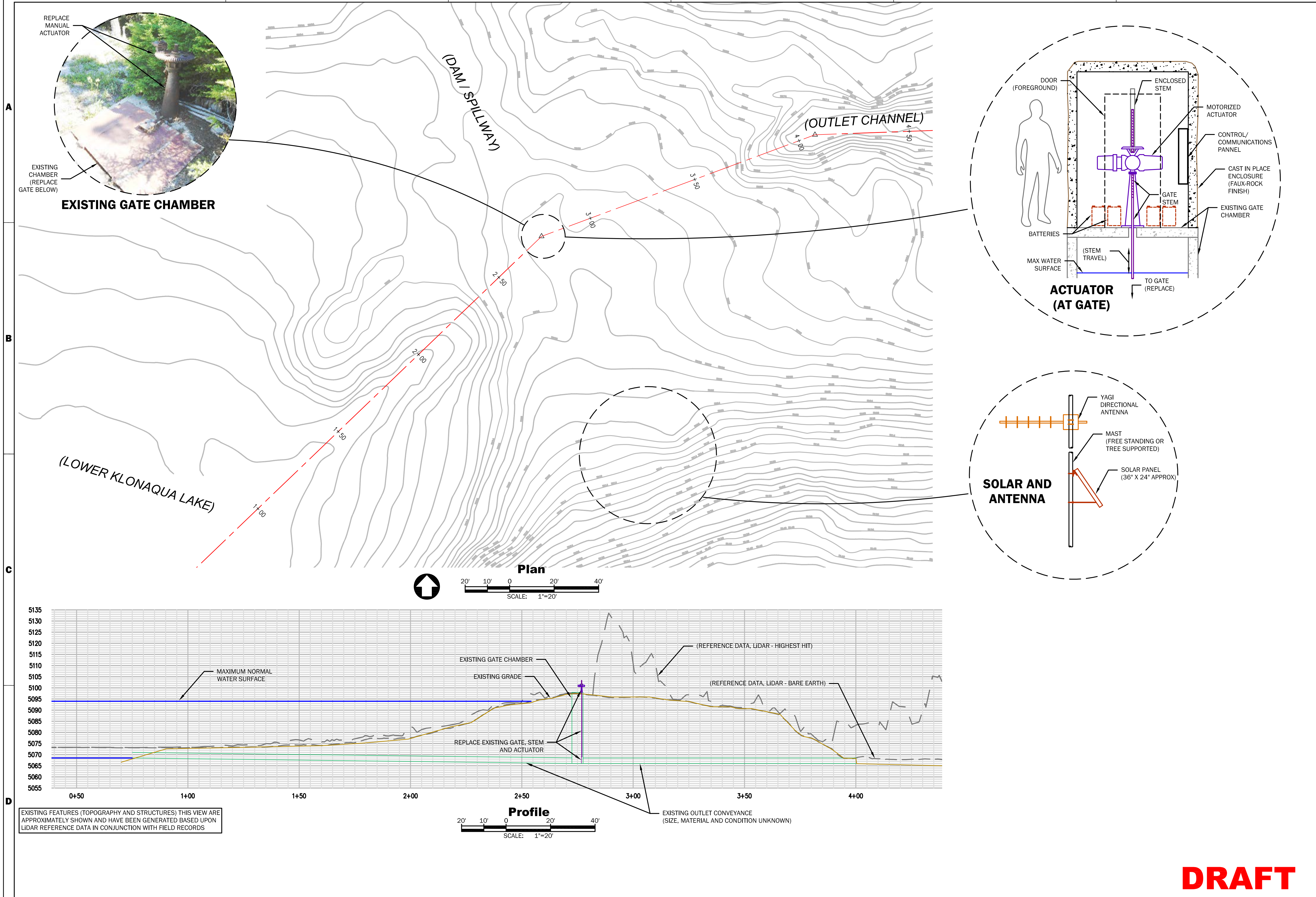
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

SHEET REFERENCE NUMBER: **C01**

SHEET 1 OF 3

CAD Path: K:\Projects\Chelan County Natural Resources-120045\Alpine Lakes\Feasibility Design\CAD\Square\square-p-civ01.dwg Square Plan || Date Saved: May 12, 2017 8:40am || User: rbrownlee



DRAFT

Conceptual Improvements
Klonaqua Lake

Alpine Lakes Automation Feasibility

Leavenworth, Washington

Aspect CONSULTING

DATE:	REVISION:	PROJECT NUMBER:	DESIGNED BY:	DRAWN BY:	REVISED BY:
FEB 2017	-	000000	-	SCC	-

REV.	DESCRIPTION	DATE	APPR.
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-	-	-	-

SHEET REFERENCE NUMBER:

C02

SHEET 2 OF 3

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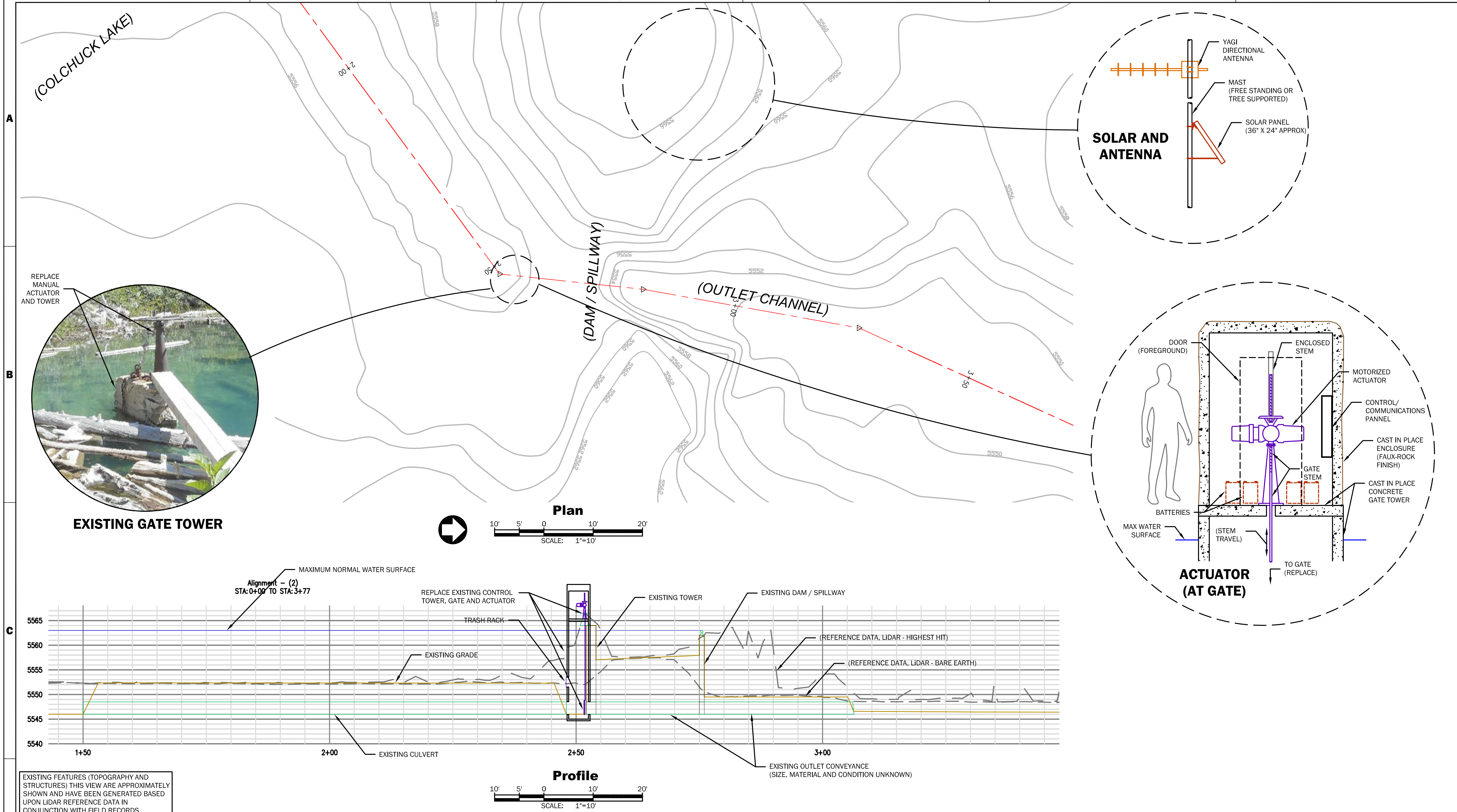

DRAFT

Conceptual Improvements
Colchuck Lake

Alpine Lakes Automation Feasibility
Leavenworth, Washington

Aspect CONSULTING

DATE:	REVISION:	PROJECT NUMBER:	DESIGNED BY:	DRAWN BY:	REVISED BY:
FEB 2017	-	000000	-	SCC	-

REV.	DESCRIPTION	DATE	APPR.
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SHEET REFERENCE NUMBER:
C03
SHEET 3 OF 3

CAD Path: K:\Projects\Chelan County Natural Resources-120045\Alpine Lakes\Feasibility Design\CAD\Colchuck\Colchuck-p-civ01.dwg Colchuck Plan || Date Saved: May 12, 2017 8:36am || User: rbrownlee

APPENDIX E

Preliminary Equipment Selection, Vendor Data

rotork®
Controls

IQ range DC actuators

Motor data for IQ range DC actuators

Publication number E130E_DC0807
Date of issue 08/07

Electric Motor Performance Data for IQD New Generation Actuators - DC Power Supplies

Publication number E130E_DC0807
Date of issue 08/07

Introduction
This guide provides IQD motor data for standard class F, 15 minute rated actuators at the following DC supply voltages:

24V 48V 110V

Actuator performance is limited by supply voltage due to current switching limitations. Refer to motor data tables.
The IQD actuator range is generally described in publication E110E. For IQD control and monitoring refer to publication E120E

Glossary
- Rated Torque – Corresponds to 100% torque switch setting
- Locked rotor – motor starting and stalled condition
- Rated Amps – current at 100% torque switch setting
- Average (nominal) load – Corresponds to 33% of rated torque.
- Efficiency – electrical efficiency of the actuator motor.

Design criteria
Motors designed for operation of valve actuators require special consideration. As continuous running is not a requirement with isolating and "inching" or regulating duty valves, motors need only be short duty time rated. Valve load can vary dramatically across stroke and from stroke to stroke as process and valve conditions change. Varying from light running to rated torque with a facility to exceed rated in unseating "sticky" valves, actual motor loading has no constant. To apply traditional motor protection to actuator motors is therefore flawed, leading to spurious tripping or no protection at all. Rotork recognise the special nature of actuator motors and have therefore designed the IQD motor and control package with this unique duty at the forefront.

IQD Motor Design
IQD motors are of a low inertia, permanent magnet design. In its standard form they are class F insulated, rated 15 minutes at average load. The motor torque/speed characteristic has been designed to fulfill the following requirements:
- High locked rotor torque in comparison with that required to operate and seat the valve. Rotork are able to guarantee actuator performance at +/-10% of nominal voltage, however in common with all DC motors of this type, speed will vary with load and voltage.
- Low inertia, high starting torque motor combined with the lost motion drive, allows the motor to reach full speed with maximum available torque before the drive is applied to the valve, ensuring unseating for all except jammed valves.
- Maintenance free for the life of the actuator.

IQD motor protection
The primary protection for the motor is torque switch protection. By measuring the actuator output torque and comparing it to the open and close torque switch setting, the motor will be de-energised when the set torque is reached. This method provides the only comprehensive means of motor *and* valve protection.

IQD motors also incorporate over temperature protection using thermostats that will de-energise the motor if the duty cycle exceeds actuator rating. Testing has shown that using motor mounted thermostats offer better protection than traditional thermal overload relays as they respond directly to motor temperature and therefore are more closely linked to the motor thermal characteristic.

IQD control protection will prevent motor stall in the event of valve jamming *.

*If "torque switch bypass" or "Boost" open torque has been set the actuator will develop torque in excess of rated and can stall in attempting to unseat a jammed valve. If the actuator stalls, jammed valve protection will trip the motor within 4 seconds.

Power supply cable sizing

As a minimum requirement, cables must be sized to ensure volt drop does not exceed 10% of nominal supply voltage at locked rotor current.

Fuse selection

Due to the unique nature of the motor duty and taking in to account the comprehensive control protection of the IQD, sizing of fuses or trip devices should be based on protecting the power cable connected to the actuator. If required, sizing trip devices to disconnect after 5 seconds at locked rotor current may enhance protection. This will reduce the risk of severe motor heating under stall conditions while preventing spurious trips under normal operation. It should be noted that sizing trip devices in this manner may not be possible while meeting other criteria and is purely designed to meet extreme fault conditions such as jammed contactor when standard control protection cannot de-energise the motor. All other operating conditions will be catered for by the standard IQD control protection.

DC power systems

Rotork can supply failsafe charger/battery and solar powered backup systems for use with IQD and IQT-24V DC range actuators. Please apply.

Motor Options

IQD motors are available with extended duty cycles. Please apply.

24VDC

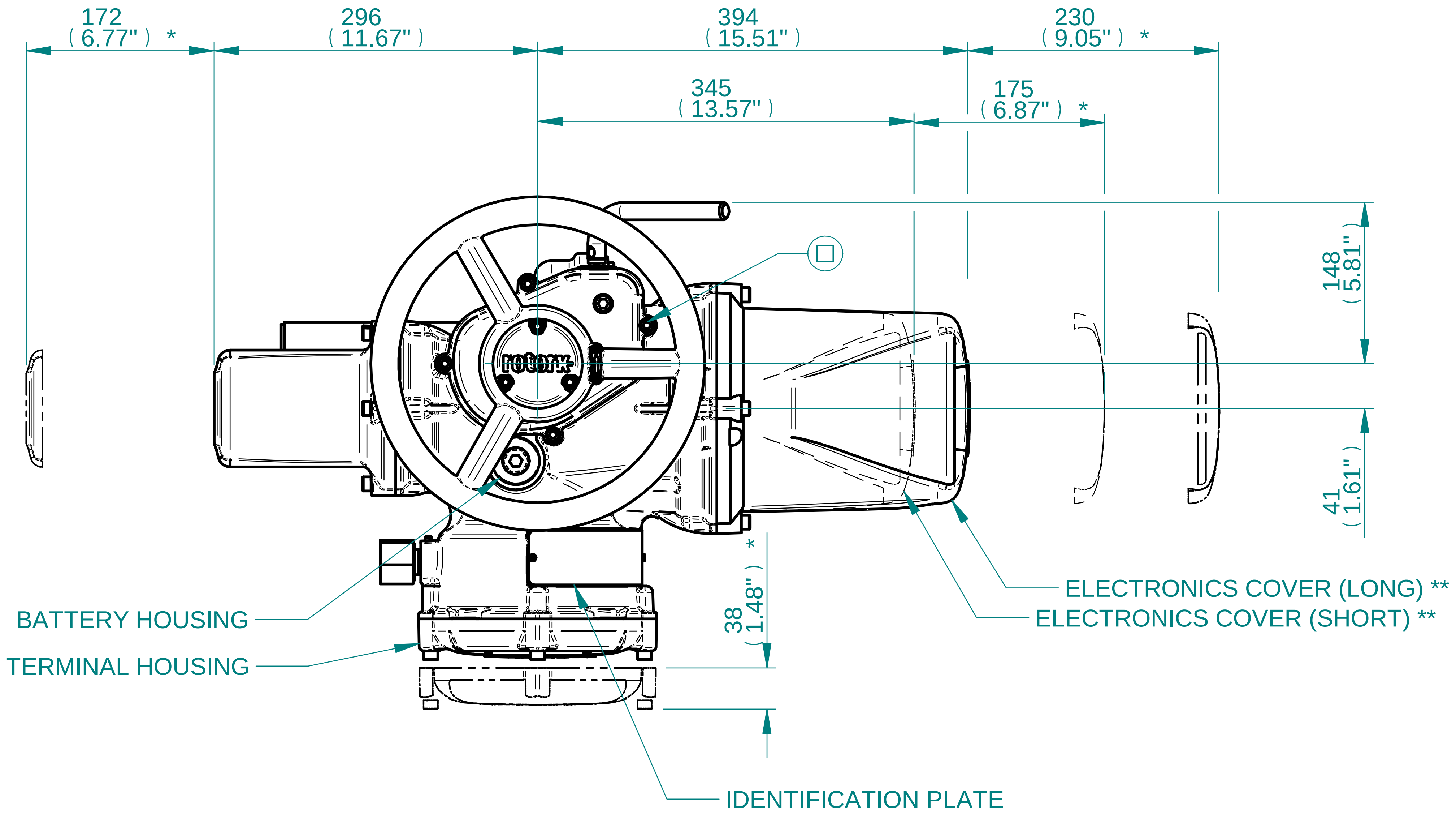
Size	Actuator	Rated Torque		Stall Current (A)	Rated Torque	Motor Average Load	
	rpm	Nm	Ft lbf	Cold Motor	Amps	Amps	KW
IQD10	18	34	25	50.5	19.2	7	0.21
	24	34	25	50.5	19.2	7	0.21
	36	31	23	50.5	19.2	7	0.21
	48	27	20	50.5	19.2	7	0.21

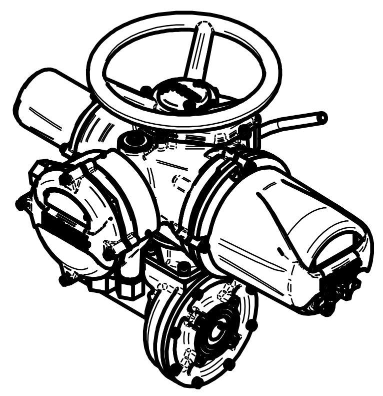
48VDC

Size	Actuator	Rated Torque		Stall Current (A)	Rated Torque	Motor Average Load	
	rpm	Nm	Ft lbf	Cold Motor	Amps	Amps	KW
IQD10	18	34	25	11	5.4	1.8	0.08
	24	34	25	11	5.4	1.8	0.08
	36	31	23	11	5.4	1.8	0.08
	48	27	20	11	5.4	1.8	0.08
IQD12	18	68	50	22.4	7.5	5.1	0.2
	24	68	50	22.4	7.5	5.1	0.2
	36	61	45	22.4	7.5	5.1	0.2
	48	54	40	22.4	7.5	5.1	0.2
IQD18	24	108	80	51	29.6	10.5	0.51

110VDC

Size	Actuator	Rated Torque		Stall Current (A)	Rated Torque	Motor Average Load	
	rpm	Nm	Ft lbf	Cold Motor	Amps	Amps	KW
IQD10	18	34	25	4.7	2.1	0.9	0.08
	24	34	25	4.7	2.1	0.9	0.08
	36	31	23	4.7	2.1	0.9	0.08
	48	27	20	4.7	2.1	0.9	0.08
IQD12	18	68	50	10.9	4.7	2.3	0.2
	24	68	50	10.9	4.7	2.3	0.2
	36	61	45	10.9	4.7	2.3	0.2
	48	54	40	10.9	4.7	2.3	0.2
IQD18	24	108	80	24	12.8	4.5	0.51
IQD20	18	163	120	19	6.3	4.9	0.34
	24	163	120	19	6.3	4.9	0.34
	36	136	100	19	6.3	4.9	0.34
	48	108	80	19	6.3	4.9	0.34
IQD25	18	305	225	31.9	10.2	7	0.61
	24	305	225	31.9	10.2	7	0.61
	36	257	190	31.9	10.2	7	0.61
	48	203	150	31.9	10.2	7	0.61

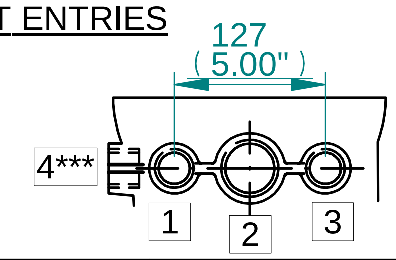




ISOMETRIC VIEW
(SCALE 1:12)

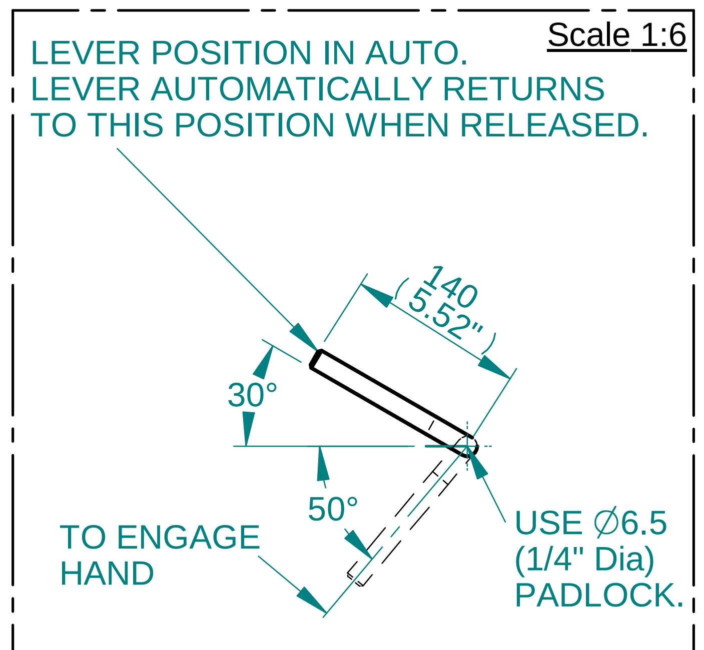
NOTES:
:DIMENSIONS WITH '*' INDICATE COVER REMOVAL ALLOWANCE
:ELECTRONICS COVER OPTION "**" WILL VARY DEPENDING ON CONFIGURATION
:NETT WEIGHT = 47kg/103lbs
: ▢ = OIL FILLER/DRAIN PLUG
:THE INTERFACE PROVIDED FOR MOUNTING THE ACTUATOR OR SECOND STAGE GEARBOX ONTO THE VALVE SHOULD CONFORM TO GOOD ENGINEERING PRACTICES, ENSURING ADEQUATELY TOLERANCED LIMITS FOR PARALLELISM, PERPENDICULARITY AND CONCENTRICITY.
:ROTORK CANNOT BE HELD LIABLE FOR DAMAGE TO OUR EQUIPMENT CAUSED BY EXCESSIVE LOADING FROM COVER TUBES. (SEE ALSO E156E)

CONDUIT ENTRIES

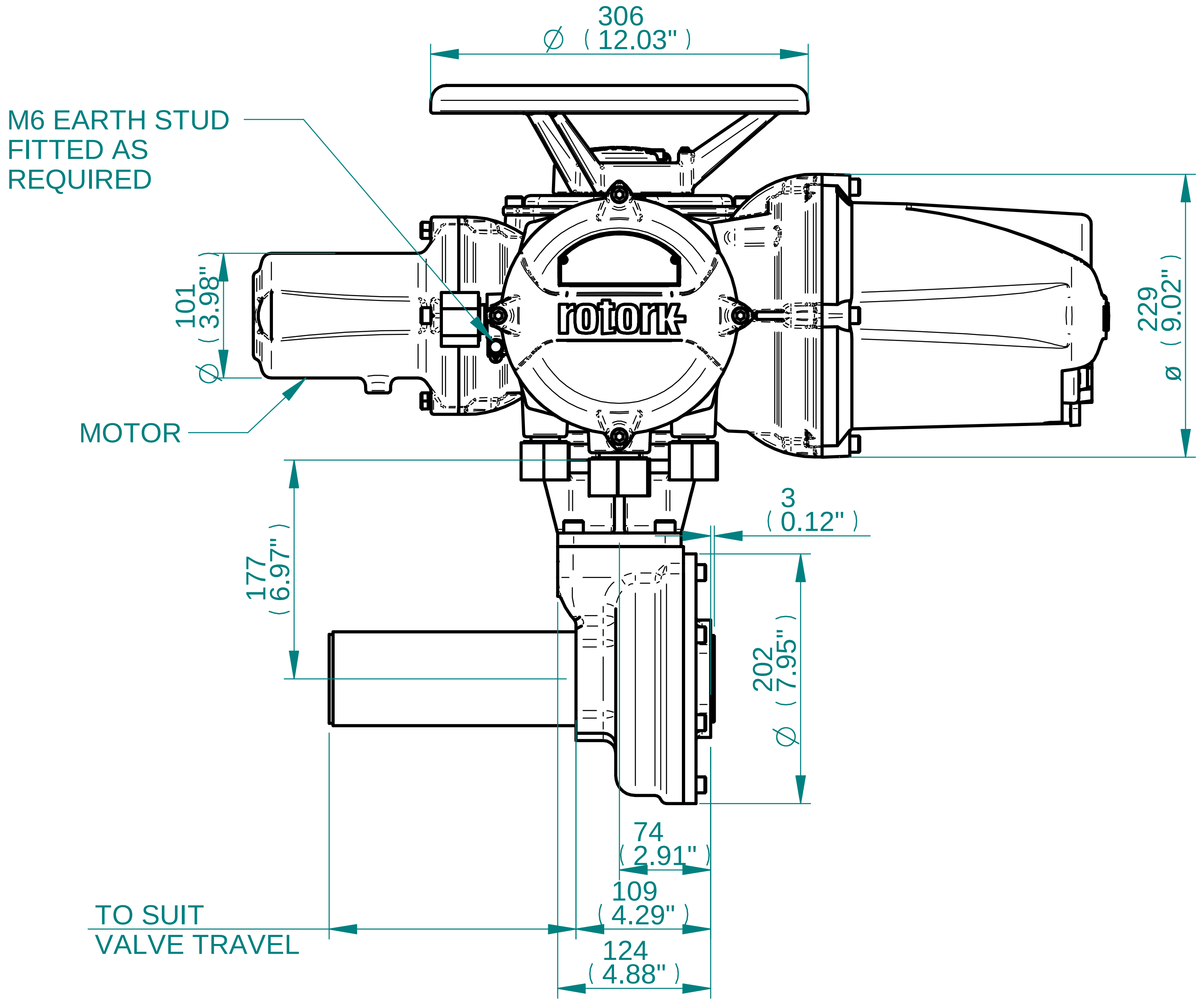


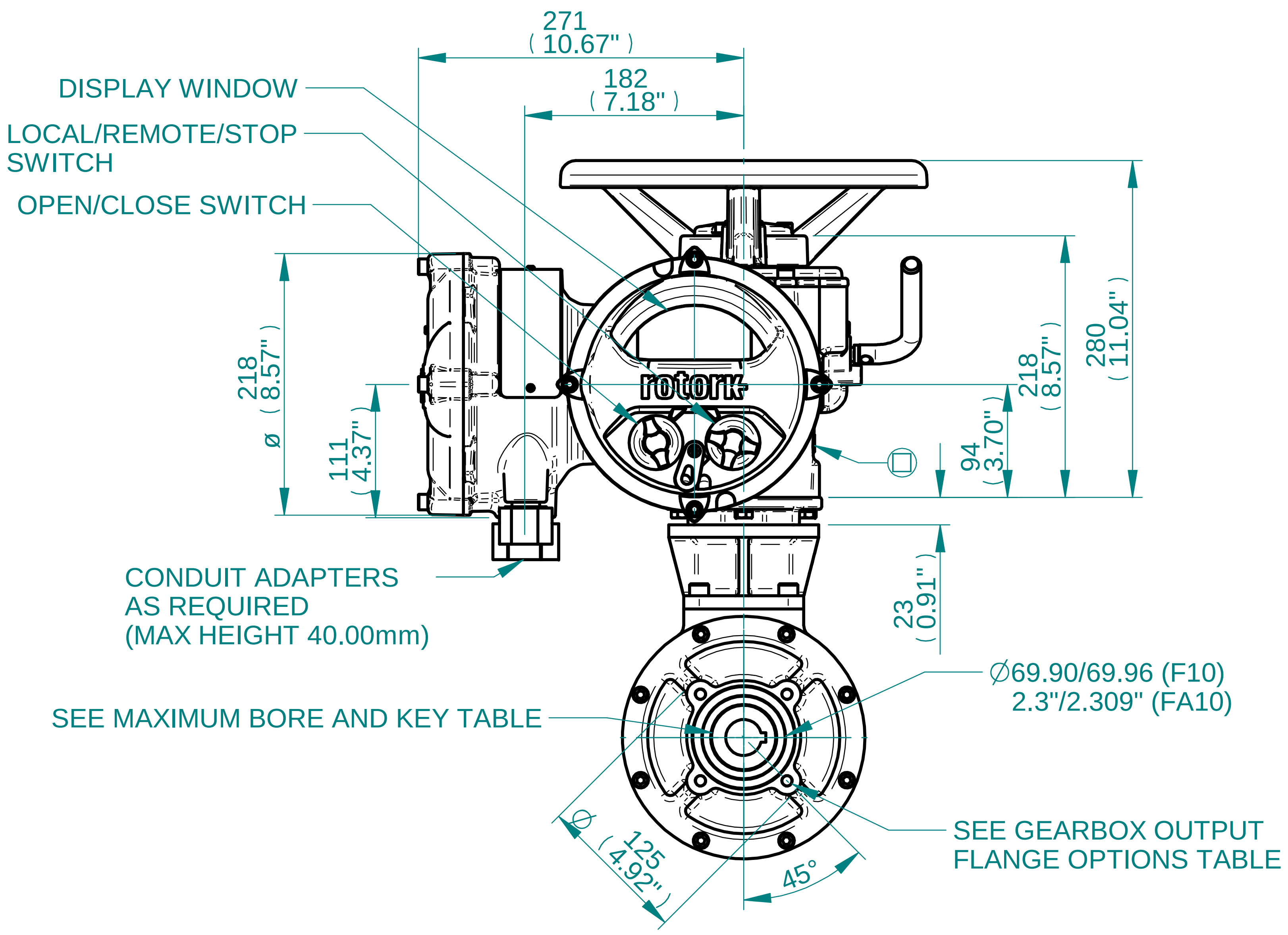
	Hole 1	Hole 2	Hole 3	Hole 4***
Size	As Required	As Required	As Required	As Required
Plugged	As Required	As Required	As Required	As Required
Gland	As Required	As Required	As Required	As Required

***HOLE 4 IS OPTIONAL



PADLOCKABLE HAND-AUTO LEVER





Gearbox output flange options

Designation	F10	-	-	-	FA10	-	-	-
No. Holes	4	-	-	-	4	-	-	-
Hole size	M10	-	-	-	3/8" UNC	-	-	-
PCD	102	-	-	-	4"	-	-	-

Maximum Bore & Key

Key form	Ø Bore	Key size
Rectangle (BS4235)	40	12 X 8
Rectangle (ANSI B17.1)	1-5/8"	3/8 X 1/4"
Square (ANSI B17.1)	1-1/2"	3/8"

rotork
www.rotork.com
Rotork Controls Limited
Bath, BA1 3JQ, England.
Telephone 01225-733200

Actuator Size: IQ10/12/18, IB4, F10/FA10

Title IQ10/12/18, TOP HANDWHEEL, IB4, F10/FA10, Ratios 2:1,3:1,4:1 & 6:1 Installation Details

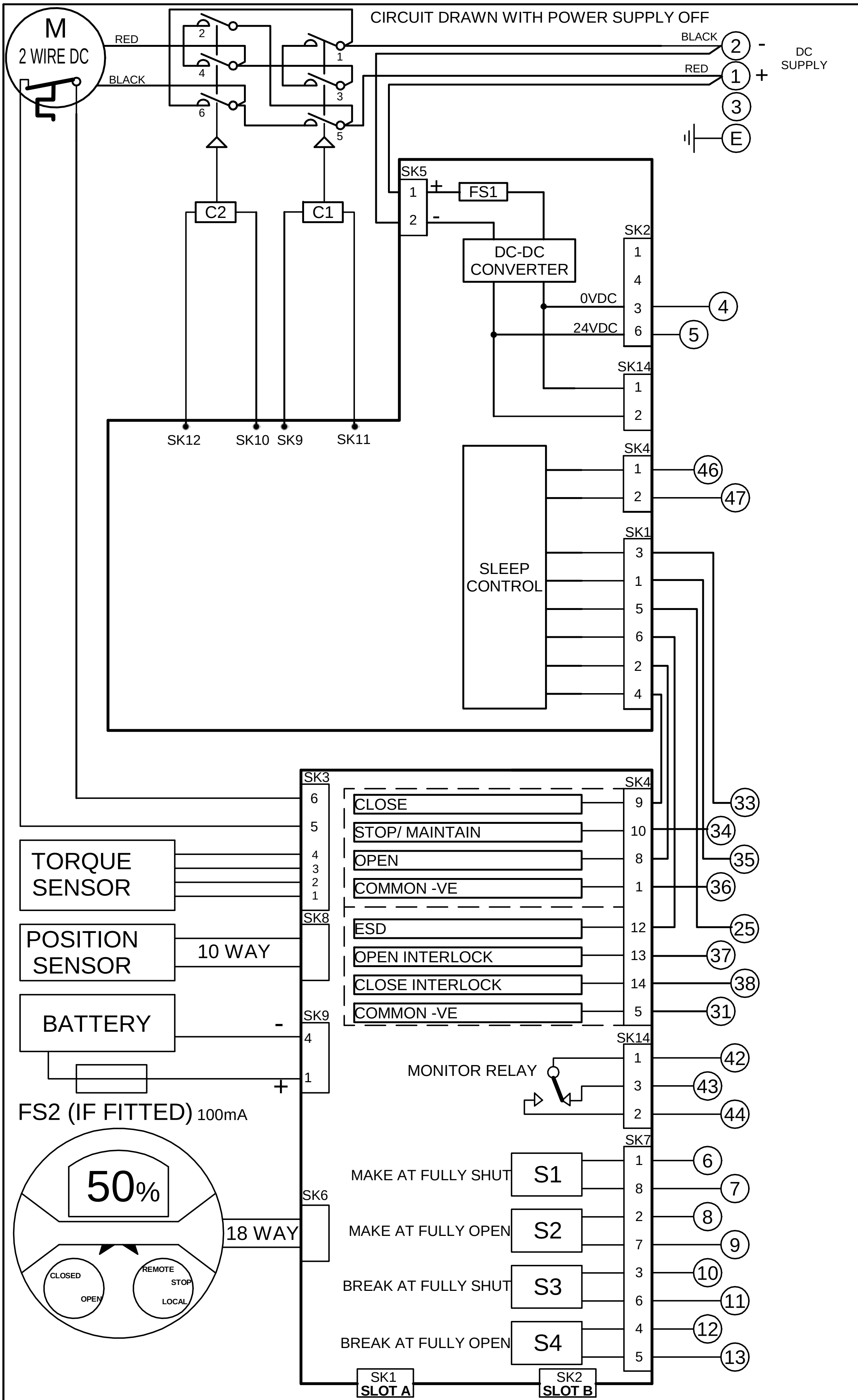
Drawn JLF Checked NJC Date 11-MAR-15

Ref SALES Project Ref QUOTATION

Issue	Description
1	First Issue

Scale: 1:5 THIRD ANGLE PROJECTION

A2 Drawing Number II1THWIB4STD Issue No 1 Sheet No 1 of 1



FOR TYPICAL REMOTE CONTROL DETAILS, SEE DOCUMENT
RWS100

VOLTAGE OPTIONS	
VOLTAGE	SIZE
110VDC	10,12,18,20,25
48VDC	10,12,18
24VDC	10

REFER TO SHEET 2 FOR NOTES & OPTION PCB'S IF FITTED

Iss	Date	Chkd	Revision Details
1	240413	PJW	FIRST ISSUE
2	240614	MR	SHEET 2, NOTE 1 UPDATED

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ROTORK CONTROLS LTD
BATH, BA1 3JQ
ENGLAND
Tel:01225-733200

ROTORK CONTROLS INC
ROCHESTER
NY 14624, USA
Tel:585-247-2304

IQ DC SOLAR BASIC DIAGRAM

Drawn by: JC1
Date : 240413
Base WD: 150B0000
Job No : - -
MI No : - -

Circuit Diagram Number
150B0000
B1 C1 B2 C2

Issue No 2

Sheet 1 of 2

IQ3

CIRCUIT DRAWN WITH POWER SUPPLY OFF

NO OPTIONS FITTED

NOTES

1.FUSES:
-FS1 - 6A anti-surge
-Actuator rated voltage specified on nameplate. Voltage tolerance +/-10%, applies for rated torque performance; duty cycle and speed is not guaranteed.

2.REMOTE CONTROL:
-For typical remote control circuits refer to:
 -RWS indicated or PUB002-041.
-For DC and AC control, connect –ve/0V to terminal 36.
-(For negative switch / positive common, refer to RWS indicated).
-Control signal threshold voltages:
 -DC: “on” ≥16Vdc / “off” ≤8Vdc, max 60Vdc.
 -AC: “on” ≥60Vac / “off” ≤40Vac, max 120Vac.
-Control signal duration to be 300ms minimum.
-Maximum current drawn from remote control signals is:
 -8mA at 24Vdc or 12mA at 120Vac.
-Supply provided on terminals 4 & 5:
 -Intended for remote control.
 -Max external load 5W at 24Vdc / 5VA at 120Vac

5.DC:
-Default for sleep mode is ENABLE.
-To disable sleep mode connect 5 to 46 & 4 to 47.
-Sleep mode can also be disabled by moving link LK1 from SOLAR to NORM.
-Actuator will remain powered up at all times while supply is present.
-24VDC will be lost when in sleep mode.
-If customer supply is needed to wake actuator link LK3 must be moved to CUST for maintained customer supply.

3.INDICATION:
-For typical position, status and alarm indication see PUB002-041.
-“S” contacts are user configurable and are shown in their default setting.
-Refer to PUB002-040 for functions and configuration instructions.
-Monitor Relay indicates actuator availability for remote control (shown “unavailable”). It can be configured to exclude local/remote selection.
-Refer to PUB002-040 for monitored functions and configuration instructions.
-Voltage applied to indication contacts must not exceed 150Vac
-Individual Switch current must not exceed 3.5A inductive, 5A resistive and no more than 8A in total for all 4 contacts.

4.BATTERY:
-Battery maintains local and remote “S” contact indication only.
-Refer to installation manual for approved replacement battery types.

See Sheet 1 for all Revision details/information

Circuit Diagram Number	Issue No	Sheet
150B0000	2	2 of 2

rotork®

Sizing Guide Search

Seating Torque
93.55 Nm 69 lbsft

Seating Thrust
26.33 kN 5919 lbsf

Rising Stem Diameter (RS)
mm ins

OR

Non Rising Stem Diameter (NRS)
mm ins

Number of Turns
0 Turns

Stroke Time
0 Secs

Stroke Time Tolerance
50 %+ 50 %-

Power Supply
DC 24V

Options
- [ ] Hazardous Area
- [ ] Watertight
- [ ] Failsafe

Output Flange
Any

Range
- [ ] ALL
- [x] IQD3
- [ ] IQ3
- [ ] IQS3

Reset Search

Output Performance

Combination	Rated Torque		Rated Thrust		Resultant Thrust		Stroke Time
	Nm	lbsft	kN	lbsf	kN	lbsf	Secs (60 Hz)
IQD10/IB4	138	102	53.00	12000	11812.27	8750	0.0

Available Output Flanges	Available Enclosures		Weight	
(ISO5210 "F" & MSS SP-102 "FA")	Hazardous	Watertight	Kg	Lbs
F10/FA10	Yes	Yes	52.66	116

Stem Acceptance	Max Bore		Min Bore		Fail Safe
	mm	in	mm	in	
Rising Stem	45	1.75	-	-	No
Non Rising Stem	40	1.63	-	-	

Actuator Performance

Size	Rated Torque		Output RPM	Rating
	Nm	lbsft	RPM (60Hz)	Starts / Hour
IQD10	27	20	48	60

Available for power supply			Available Enclosures		Weight	
1-Phase AC	3-Phase AC	DC	Hazardous	Watertight	Kg	Lbs
No	No	DC 24V DC 48V DC 110V	Yes	Yes	36.32	80

Handwheel	Type	Ratio	Turns	Rimpull	
		(:1)	(per stroke)	N	Lbsf
Standard	Direct	1.0	-	122	28
Option 1	Geared	5.0	-	87	20

Sales/Technical Information: IQD - Direct Current (DC)

Gearbox Performance

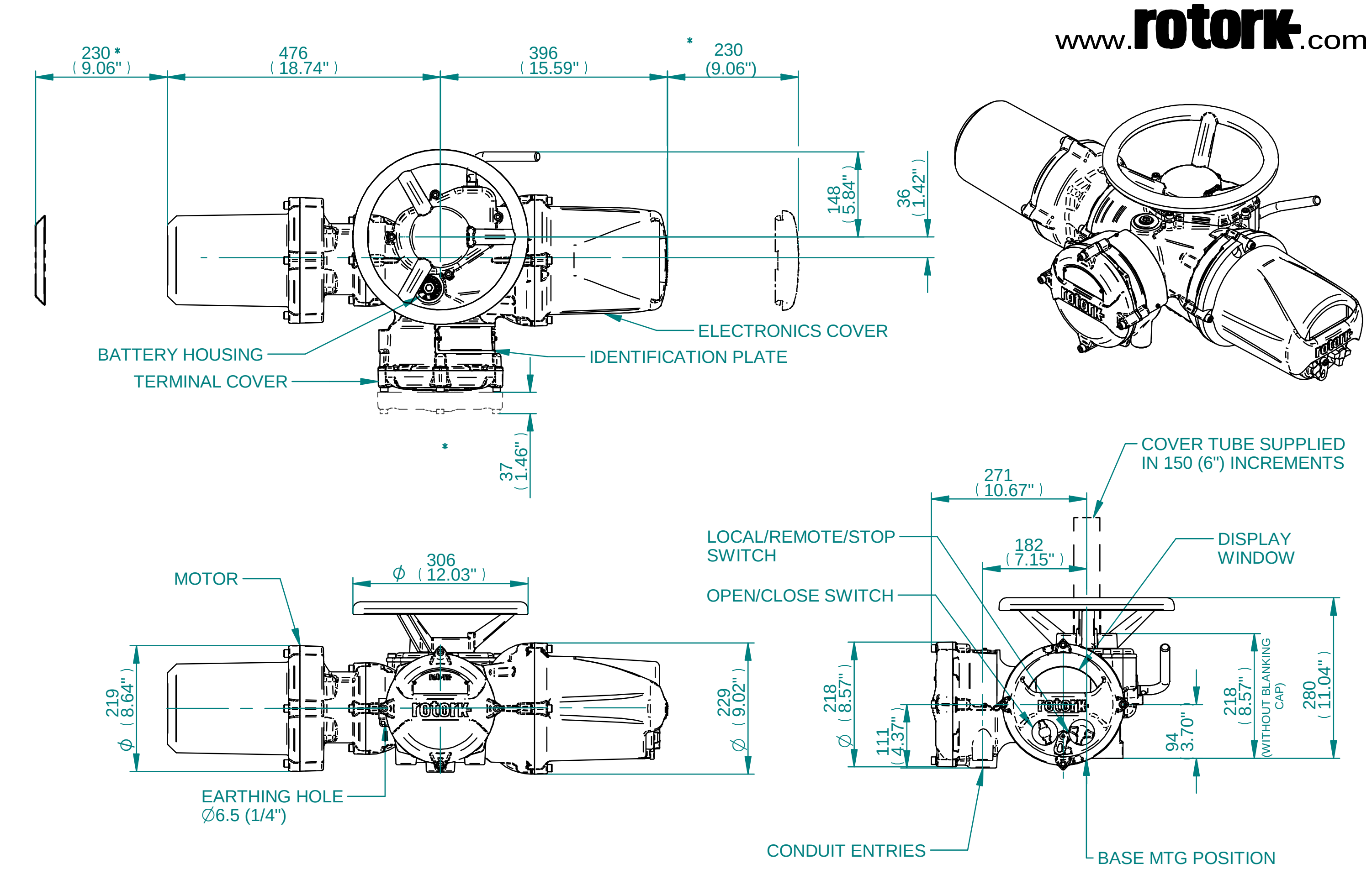
Size	Rated Torque		Ratio	MA	Weight	
	Nm	Lbsft	(:1)		Kg	Lbs
IB4	542	400	6	5.1	16.34	36

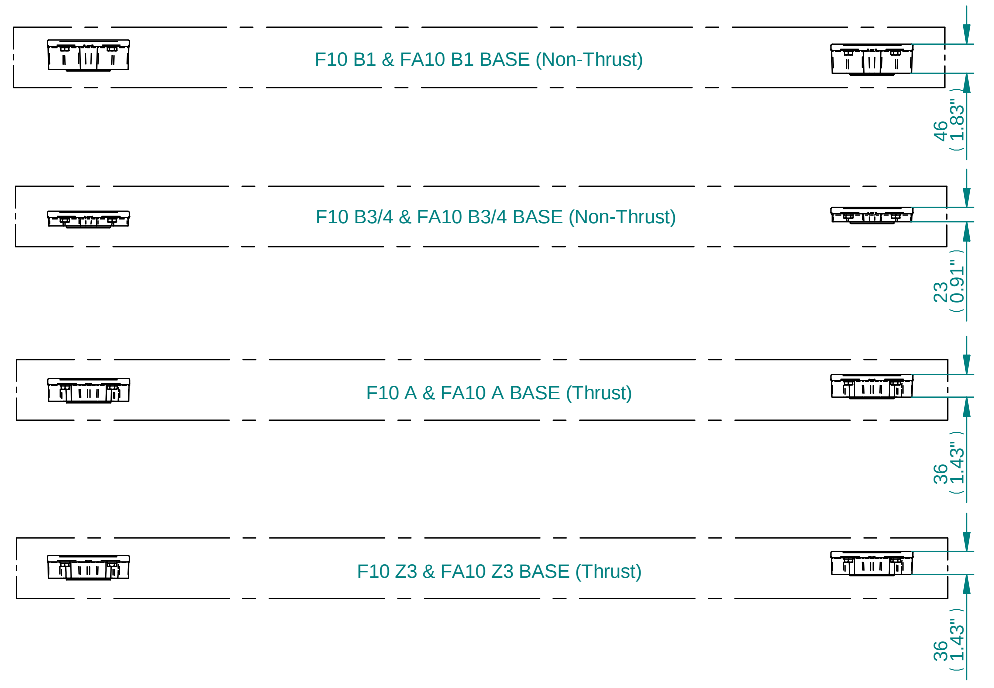
Sales/Technical Information: IB Motorised

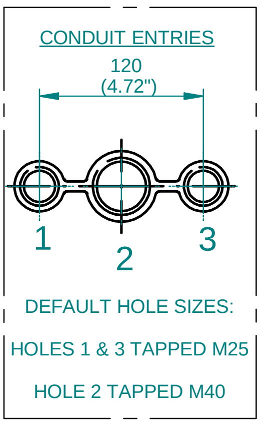
Enter your specific requirements and click 'Add to enquiry'

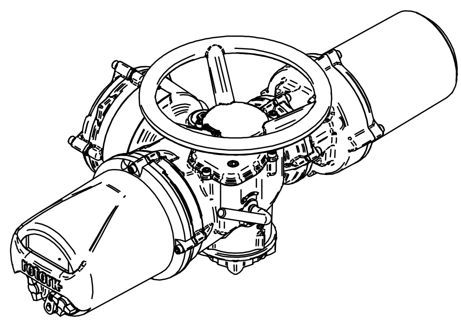
Fields marked with an * are required.

« Go Back



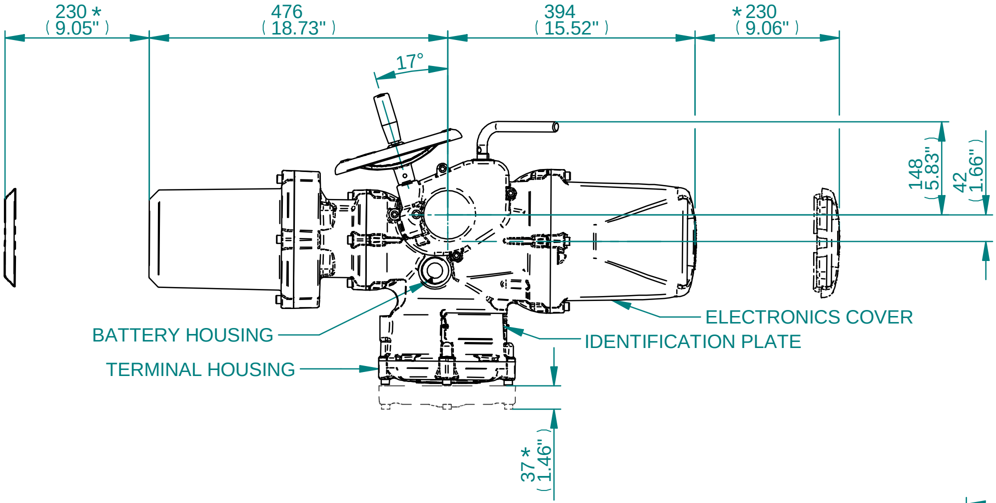


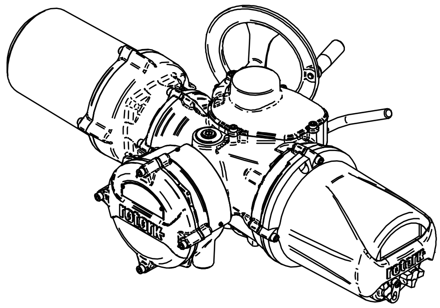


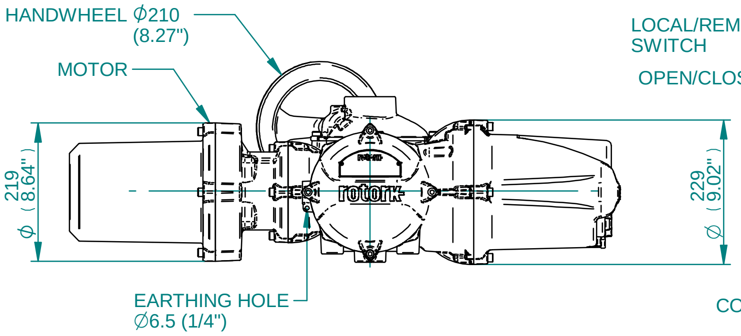


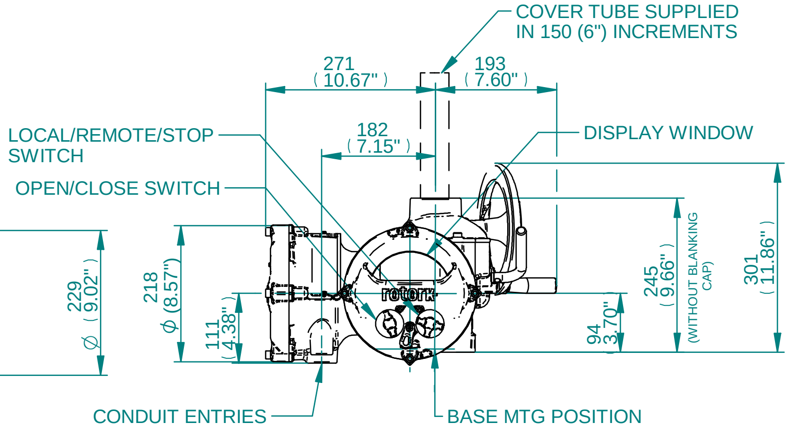
NOTES
1. FOUR BASE OPTIONS ARE DETAILED TO SUIT THE RELEVANT COUPLING ARRANGEMENT.
2. THE REQUIRED BASE FOR THE SIDE & END VIEWS SHOULD BE LOADED TO MTG POSITION INDICATED.
3. '*' REMOVAL ALLOWANCE REQUIRED.

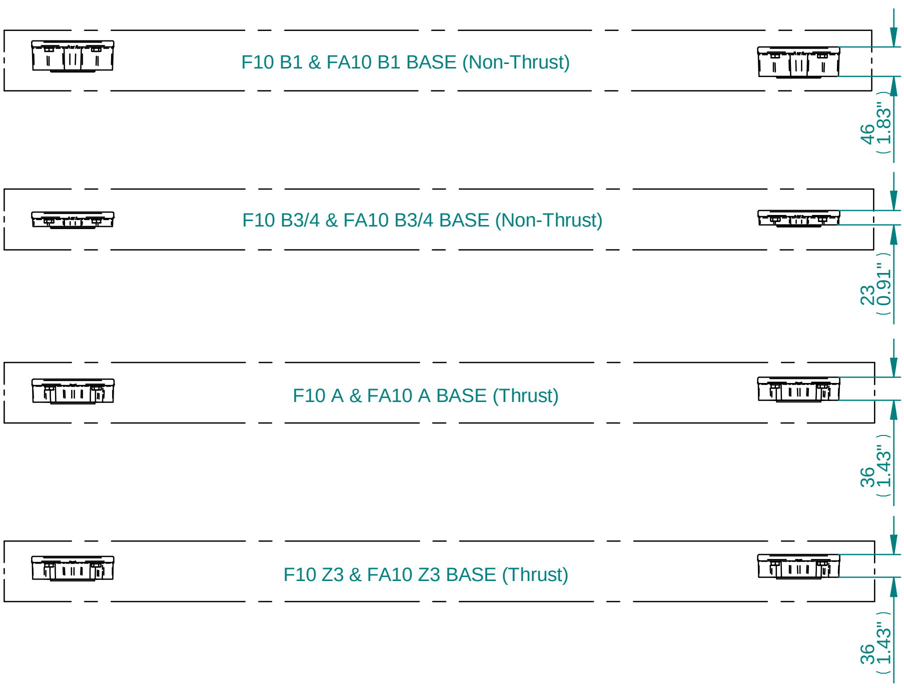
Title	Date	A4 Doc Number	Ver No	Scale	Sheet No
DIMENSIONAL DATA SHEET FOR IQD3 (Sizes 10-18) WITH TOP HANDWHEEL	030215	IQD3-1SP-BC	1	1:12	1 of 4



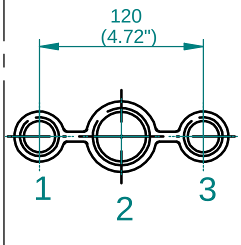








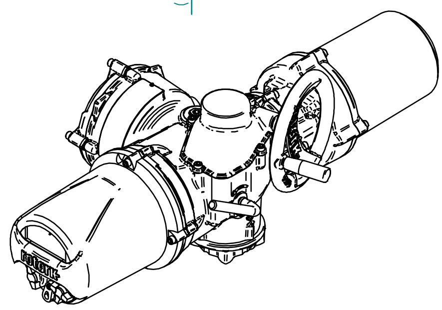
CONDUIT ENTRIES



DEFAULT HOLE SIZES:

HOLES 1 & 3 TAPPED M25

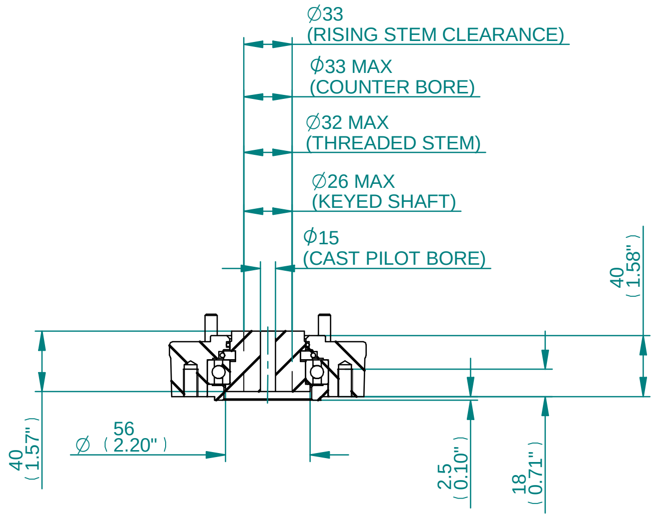
HOLE 2 TAPPED M40



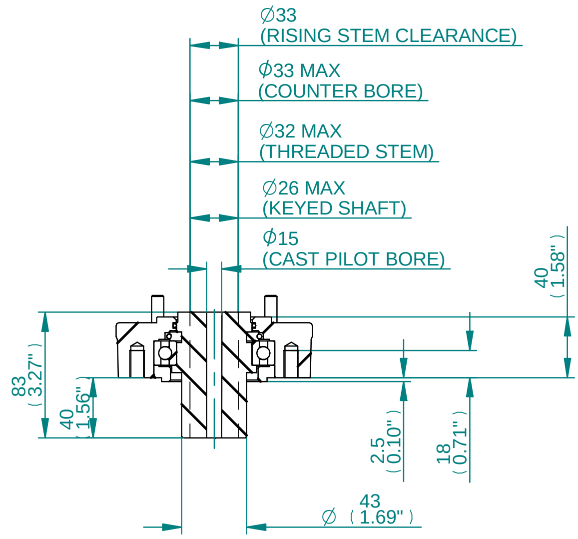
NOTES

1. FOUR BASE OPTIONS ARE DETAILED TO SUIT THE RELEVANT COUPLING ARRANGEMENT.
2. THE REQUIRED BASE FOR THE SIDE & END VIEWS SHOULD BE LOADED TO MTG POSITION INDICATED.
3. '*' REMOVAL ALLOWANCE REQUIRED.

Title	Date	A4 Doc Number	Ver No	Scale	Sheet No
DIMENSIONAL DATA SHEET FOR IQD3 (Sizes 10-18) WITH OPTIONAL SIDE HANDWHEEL	030215	IQD3-1SP-BC	1	1:12	2 of 4

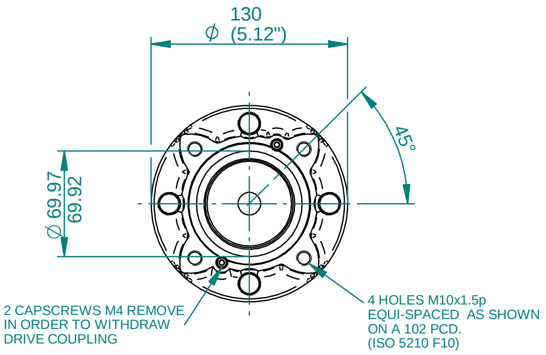


TYPE 'A' COUPLING DETAILS

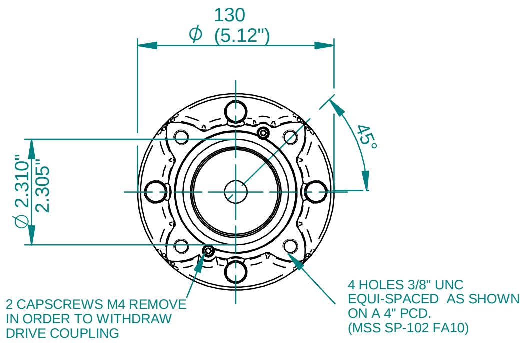


TYPE 'Z3' COUPLING DETIALS

NOTE : COUPLINGS WITHOUT PILOT BORE AVAILABLE IF SPECIFIED WITH ORDER.



F10 BASE DETAILS
FOR 'A' & 'Z3' COUPLINGS



FA10 BASE DETAILS
FOR 'A' & 'Z3' COUPLINGS

IQ3 SIZE 10-18 THRUST BASES

Title	Date	A4 Doc Number	Ver No	Scale	Sheet No
DIMENSIONAL DATA SHEET FOR F10/FA10 BASE & COUPLING OPTIONS	030215	IQD3-1SP-BC	1	1:5	3 of 4

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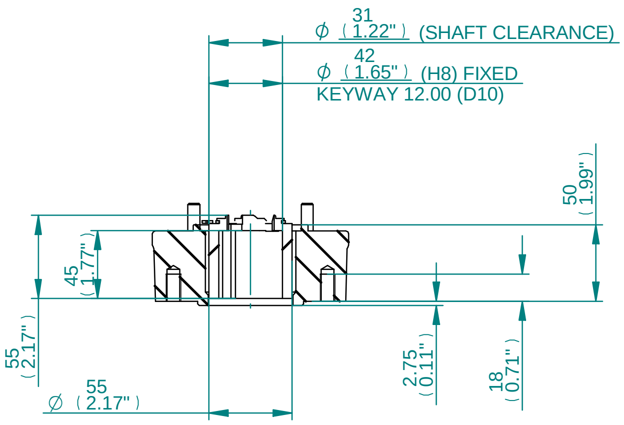
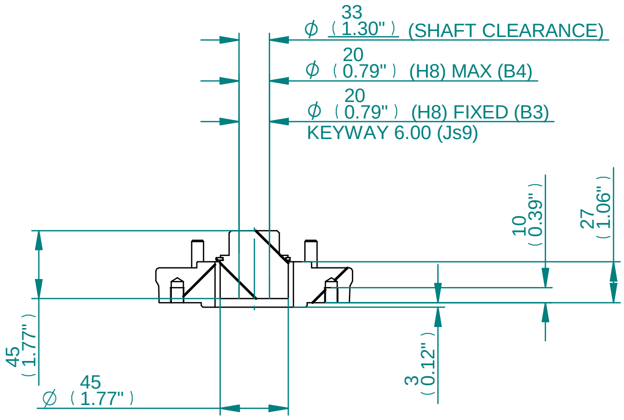
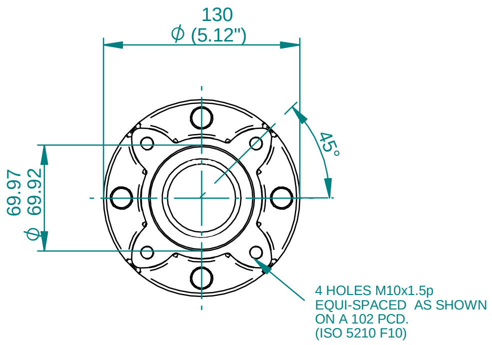


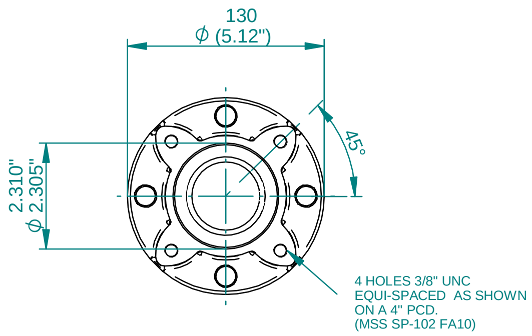
TYPE 'B1'
COUPLING DETAILS



TYPE 'B3/B4'
COUPLING DETAILS



F10 BASE DETAILS
FOR 'B1' & 'B3/B4' COUPLINGS



FA10 BASE DETAILS
FOR 'B1' & 'B3/B4' COUPLINGS

IQ3 SIZE 10-18
NON-THRUST BASES

Title	Date	A4 Doc Number	Ver No	Scale	Sheet No
DIMENSIONAL DATA SHEET FOR F10/FA10 BASE & COUPLING OPTIONS	030215	IQD3-1SP-BC	1	1:5	4 of 4

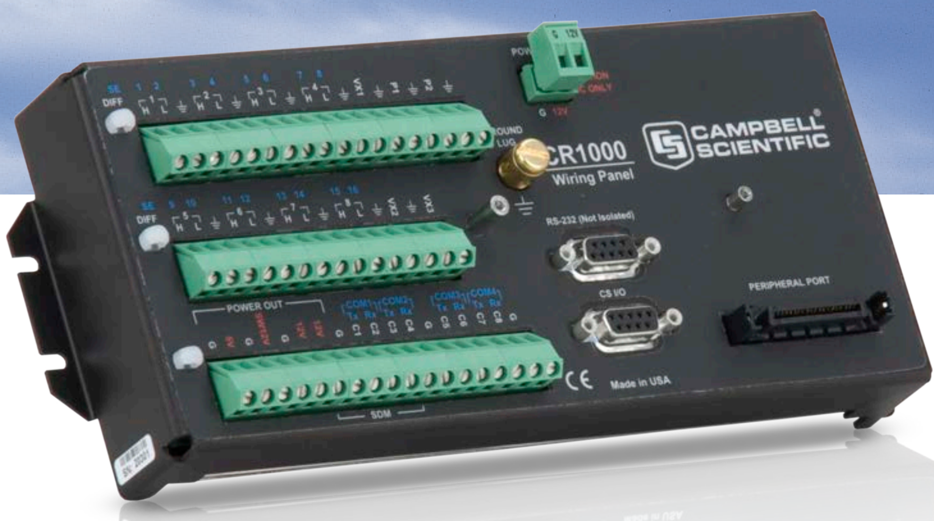
CAMPBELL SCIENTIFIC®
WHEN MEASUREMENTS MATTER

COMPONENT

CR1000

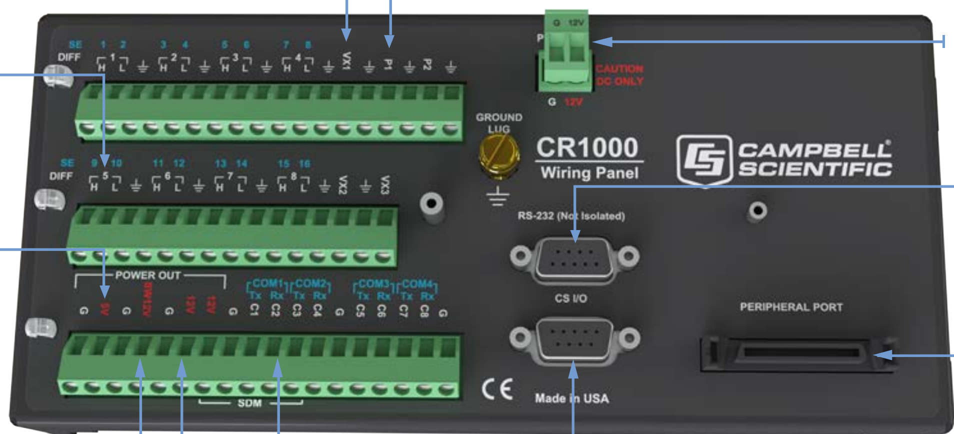
Measurement and Control Datalogger

Rugged, Reliable, and Ready for any Application



CR1000 Measurement and Control Datalogger

The CR1000 provides precision measurement capabilities in a rugged, battery-operated package. It consists of a measurement and control module and a wiring panel. Standard operating range is -25° to +50°C; an optional extended range of -55° to +85°C is available.



Benefits and Features

- 4 MB memory*
- Program execution rate of up to 100 Hz
- CS I/O and RS-232 serial ports
- 13-bit analog to digital conversions
- 16-bit H8S Renesas Microcontroller with 32-bit internal CPU architecture
- Temperature compensated real-time clock
- Background system calibration for accurate measurements over time and temperature changes
- Single DAC used for excitation and measurements to give ratio metric measurements
- Gas Discharge Tube (GDT) protected inputs
- Battery-backed SRAM memory and clock ensuring data, programs, and accurate time are maintained while the CR1000 is disconnected from its main power source
- Serial communications with serial sensors and devices supported via I/O port pairs
- PakBus®, Modbus, DNP3, TCP/IP, FTP, and SMTP protocols supported

Measurement and Control Module

The module measures sensors, drives direct communications and telecommunications, reduces data, controls external devices, and stores data and programs in on-board, non-volatile storage. The electronics are RF shielded and glitch protected by the sealed, stainless steel canister. A battery-backed clock assures accurate timekeeping. The module can simultaneously provide measurement and communication functions. The on-board, BASIC-like programming language supports data processing and analysis routines.

Wiring Panel

The CR1000WP is a black, anodized aluminum wiring panel that is compatible with all CR1000 modules. The wiring panel includes switchable 12 V, redistributed analog grounds (dispersed among analog channels rather than grouped), unpluggable terminal block for 12 V connections, gas-tube spark gaps, and 12 V supply on pin 8 to power our COM-series phone modems and other peripherals. The control module easily disconnects from the wiring panel allowing field replacement without rewiring the sensors. A description of the wiring panel's input/output channels follows.

**Originally, the standard CR1000 had 2 MB of data/program storage, and an optional version, the CR1000-4M, had 4 MB of memory. In September 2007, the standard CR1000 started having 4 MB of memory, making the CR1000-4M obsolete. Dataloggers that have a module with a serial number greater than or equal to 11832 will have a 4 MB memory. The 4 MB dataloggers will also have a sticker on the canister stating "4M Memory".*

Analog Inputs
Eight differential (16 single-ended) channels measure voltage levels. Resolution on the most sensitive range is 0.67 µV.

Pulse Counters
Two pulse channels can count pulses from high level (5 V square wave), switch closure, or low level AC signals.

Switched Voltage Excitations
Three outputs provide precision excitation voltages for resistive bridge measurements.

Digital I/O Ports
Eight ports are provided for frequency measurements, digital control, and triggering. Three of these ports can also be used to measure SDM devices. The I/O ports can be paired as transmit and receive. Each pair has 0 to 5 V UART hardware that allows serial communications with serial sensors and devices. An RS-232-to-logic level converter may be required in some cases.

CS I/O Port
AC-powered PCs and many communication peripherals connect with the CR1000 via this port. Connection to an AC-powered PC requires either an SC32B or SC-USB interface. These interfaces isolate the PC's electrical system from the datalogger, thereby protecting against ground loops, normal static discharge, and noise.

RS-232 Port
This non-isolated port is for connecting a battery-powered laptop, serial sensor, or RS-232 modem. Because of ground loop potential on some measurements (e.g., low level single-ended measurements), AC-powered PCs should use the CS I/O port instead of the RS-232 port (see above).

Peripheral Port
One 40-pin port interfaces with the NL116 Ethernet Interface and CompactFlash Module, the NL121 Ethernet Interface, or the CFM100 CompactFlash® Module.

Switched 12 Volt
This terminal provides unregulated 12 V that can be switched on and off under program control.

Storage Capacity

The CR1000 has 2 MB of flash memory for the Operating System, and 4 MB of battery-backed SRAM for CPU usage, program storage, and data storage. Data is stored in a table format. The storage capacity of the CR1000 can be increased by using a CompactFlash card.

Enclosure/Stack Bracket

A CR1000 housed in a weather-resistant enclosure can collect data under extremely harsh conditions. The 31551 and 31143 stack brackets allow a peripheral to be placed under the mounting bracket, thus conserving space. The 31143 is hinged, allowing easy access to the lower component during wiring or during maintenance.

Communication Protocols

The CR1000 supports the PakBus, Modbus, DNP3, TCP/IP, FTP, and SMTP communication protocols. With the PakBus protocol, networks have the distributed routing intelligence to continually evaluate links. Continually evaluating links optimizes delivery times and, in the case of delivery failure, allows automatic switch over to a configured backup route.

The Modbus RTU protocol supports both floating point and long formats. The datalogger can act as a slave and/or master.

The DNP3 protocol supports only long data formats. The dataloggers are level 2 slave compliant, with some of the operations found in a level 3 implementation.

The TCP/IP, FTP, and SMTP protocols provide TCP/IP functionality when the CR1000 is used in conjunction with an NL240, NL201, NL116, or NL121. Refer to the CR1000 manual for more information.

Power Supplies

Typically, the CR1000 is powered with a PS200, PS150, or BPALK. The PS200 and PS150 provide a 7 Ah sealed rechargeable battery that should be connected to a charging source (either a power converter or solar panel). The BPALK consists of eight non-rechargeable D-cell alkaline batteries with a 7.5 Ah rating at 20°C.

Also available are the BP7, BP12, and BP24 battery, which provide nominal ratings of 7, 12, and 24 Ah, respectively. The BP7 is typically used instead of the PS150 or PS200 when the battery needs to be mounted under the 31143 Hinged Stack Bracket. The BP12 and BP24 batteries are for powering systems that have higher current drain equipment such as satellite transmitters. The BP7, BP12, and BP24 should be connected to a regulated charging source (e.g., a CH200 or CH150 connected to a unregulated solar panel or power converter).

The PS200 (above) and CH200 can monitor charge input voltage, battery voltage, on-board temperature, battery current, and load current.

Communication Options

To determine the best option for an application, consider the accessibility of the site, availability of services (e.g., cellular phone or satellite coverage), quantity of data to collect, and desired time between data-collection sessions. Some communication options can be combined—increasing the flexibility, convenience, and reliability of the communications.

Keyboard Display
The CR1000KD can be used to program the CR1000, manually initiate data transfer, and display data. The CR1000KD displays 8 lines by 21 characters (64 by 128 pixels) and has a 16-character keyboard. Custom menus are supported allowing customers to set up choices within the datalogger program that can be initiated by a simple toggle or pick list. One CR1000KD can be carried station to station in a CR1000 network.

Mountable Displays
The CD100 and CD295 can be mounted in an enclosure lid. The CD100 has the same functionality and operation as the CD1000KD, allowing both data entry and display without opening the enclosure. The CD295 displays real-time data only.

The CD100 has a vacuum flourescent display for responsive use through a very wide operating temperature range.

iOS Devices and Android Devices
An iOS device or Android device can communicate with the datalogger or connect to the LoggerNet network using Apps available, at no charge, from the Apple Store or Google Play.

Direct Links
AC-powered PCs connect with the datalogger's CS I/O port using an SC32B or SC-USB interface. These interfaces provide optical isolation. A battery-powered laptop can be attached to the CR1000's RS-232 port via an RS-232 cable—no interface required.

External Data Storage Devices
A CFM100 or NL116 module can store the CR1000's data on an industrial-grade CompactFlash (CF) card. The CR1000 can also store data on an SC115 2 GB Flash Memory Drive.

Short Haul Modems
The SRM-5A RAD Short Haul Modem supports communications between the CR1000 and a PC using a four-wire unconditioned line (two twisted pairs).

Multidrop Interface
The MD485 intelligent RS-485 interface permits a PC to address and communicate with one or more dataloggers over the CABLE2TP two-twisted pair cable. Distances up to 4000 feet are supported.

Internet and IP Networks
Campbell Scientific offers several interfaces that enable the CR1000 to communicate with a PC using TCP/IP.

Radios
Radio frequency (RF) communications are supported using narrowband UHF, narrowband VHF, spread spectrum, or meteor burst radios. Line-of-sight is required for all of our RF options.

Satellite Transmitters
The CR1000 can transmit data using the Argos, Iridium, Inmarsat BGAN, GOES, or Meteosat satellite systems. Satellite telemetry offers an alternative for remote locations where phone lines or RF systems are impractical.

Telephone Networks
The CR1000 can communicate with a PC using landlines or cellular transceivers. A voice synthesized modem enables anyone to call the CR1000 via phone and receive a verbal report of real-time site conditions.

In Virginia, our RF500M Narrowband Radio Modem provides time- and event-driven ALERT data transmission.

Channel Expansion

4-Channel Low Level AC Module

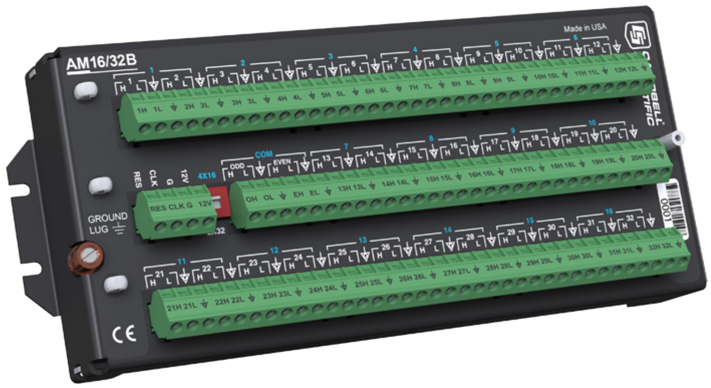
The LLAC4 is a small peripheral device that allows customers to increase the number of available low-level ac inputs by using control ports. This module is often used to measure up to four anemometers, and is especially useful for wind profiling applications.

Synchronous Devices for Measurement (SDMs)

SDMs are addressable peripherals that expand the datalogger's measurement and control capabilities. For example, SDMs are available to add control ports, analog outputs, pulse count channels, interval timers, or even a CANbus interface to the system. Multiple SDMs, in any combination, can be connected to one datalogger.

Multiplexers

Multiplexers increase the number of sensors that can be measured by a CR1000 by sequentially connecting each sensor to the datalogger. Several multiplexers can be controlled by a single CR1000.



The CR1000 is compatible with the AM16/32B (shown above) and AM25T multiplexers.

Software

Starter Software

Our easy-to-use starter software is intended for first time users or applications that don't require sophisticated communications or datalogger program editing. SCWin Short Cut generates straight-forward datalogger programs in four easy steps. PC200W allows customers to transfer a program to, or retrieve data from a CR1000 via a direct communications link.

At www.campbellsci.com/downloads, the starter software can be downloaded at no charge. Our Resource DVD also provides this software as well as PDF versions of our brochures and manuals.

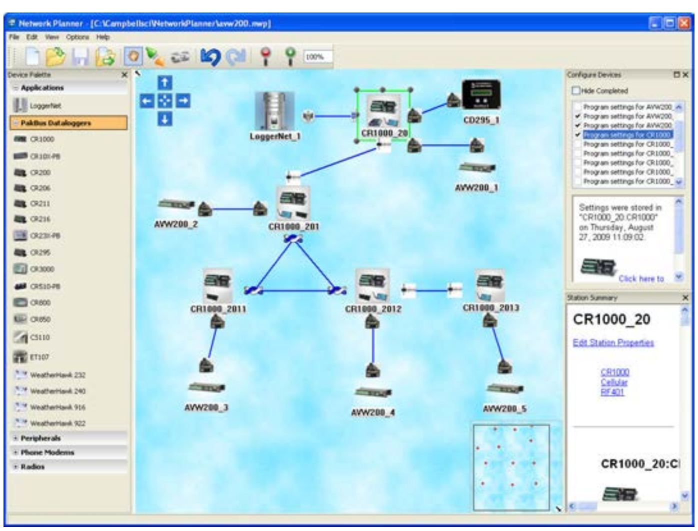
Datalogger Support Software

Our datalogger support software packages provide more capabilities than our starter software. These software packages contains program editing, communications, and display tools that can support an entire datalogger network.

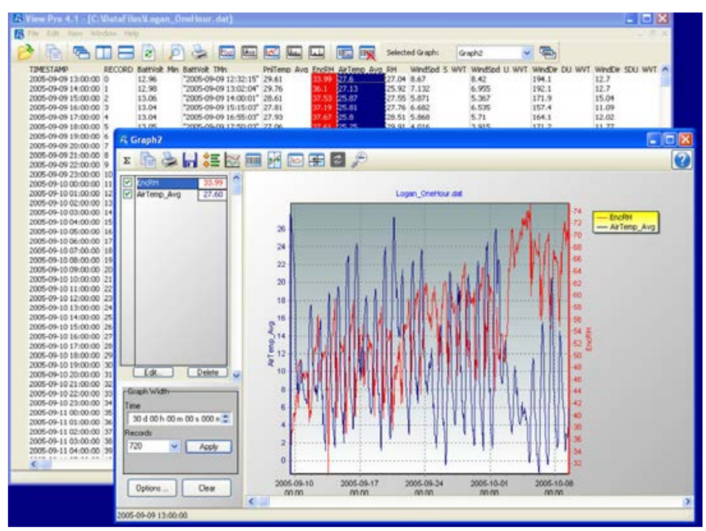
PC400, our mid-level software, supports a variety of telemetry options, manual data collection, and data display. For programming, it includes both Short Cut and the CRBasic program editor. PC400 does not support combined communication options (e.g., phone-to-RF), PakBus® routing, and scheduled data collection.

RTDAQ is an ideal solution for industrial and real-time users desiring to use reliable data collection software over a single telecommunications medium, and who do not rely on scheduled data collection. RTDAQ's strength lies in its ability to handle the display of high speed data.

LoggerNet is Campbell Scientific's full-featured datalogger support software. It is referred to as "full-featured" because it provides a way to accomplish almost all the tasks you'll need to complete when using a datalogger. LoggerNet supports combined communication options (e.g., phone-to-RF) and scheduled data collection.



The Network Planner, included in LoggerNet 4 or higher, generates device settings and configures the LoggerNet network map for PakBus networks.



Both LoggerNet and RTDAQ use View Pro to display historical data in a tabular or graphical format.

Applications

The measurement precision, flexibility, long-term reliability, and economical price of the CR1000 make it ideal for scientific, commercial, and industrial applications.

Meteorology

The CR1000 is used in long-term climatological monitoring, meteorological research, and routine weather measurement applications.

Our rugged, reliable weather station measures meteorological conditions at St. Mary's Lake, Glacier National Park, MT.

Sensors the CR1000 can measure include:

- cup, propeller, and sonic anemometers
- tipping bucket rain gages
- wind vanes
- pyranometers
- ultrasonic ranging sensor
- thermistors, RTDs, and thermocouples
- barometers
- RH probes
- Cooled mirror hygrometers

Agriculture and Agricultural Research

The versatility of the CR1000 allows measurement of agricultural processes and equipment in applications such as:

- plant water research
- canopy energy balance
- plant pathology
- machinery performance
- frost prediction
- crop management decisions
- food processing/storage
- integrated pest management
- irrigation scheduling

This vitaculture site in Australia integrates meteorological, soil, and crop measurements.

Wind Profiling

Our data acquisition systems can monitor conditions at wind assessment sites, at producing wind farms, and along transmission lines. The CR1000 makes and records measurements, controls electrical devices, and can function as PLCs or RTUs. Because the datalogger has its own power supply (batteries, solar panels), it can continue to measure and store data and perform control during power outages. Typical sensors for wind assessment applications include, but are not limited to:

- cup, propeller, and sonic anemometers (up to 10 anemometers can be measured by using two LLAC4 peripherals)
- wind vanes
- thermistors, RTDs, and thermocouples
- barometers
- pyranometers

For turbine performance applications, the CR1000 monitors electrical current, voltage, wattage, stress, and torque.

A Campbell Scientific system monitors an offshore wind farm in North Wales.

Photo courtesy npower renewables

Soil Moisture

The CR1000 are compatible with the following soil moisture measurement technologies:

- **Soil moisture blocks** are inexpensive sensors that estimate soil water potential.
- **Matric water potential sensors** also estimate soil water potential but are more durable than soil moisture blocks.
- **Time-Domain Reflectometry Systems (TDR)** use a reflectometer controlled by the datalogger to accurately measure soil water content. Multiplexers allow sequential measurement of a large number of probes by one reflectometer.
- **Self-contained water content reflectometers** are sensors that emit and measure a TDR pulse.
- **Tensiometers** measure the soil pore pressure of irrigated soils and calculate soil moisture.

Air Quality

The CR1000 can monitor and control gas analyzers, particle samplers, and visibility sensors. The datalogger can also automatically control calibration sequences and compute conditional averages that exclude invalid data (e.g., data recorded during power failures or calibration intervals).

Road Weather/RWIS

Our fully NTCIP-compliant Environmental Sensor Stations (ESS) are robust, reliable weather stations used for road weather/RWIS applications. A typical ESS includes a tower, CR1000, two road sensors, remote communication hardware, and sensors that measure wind speed and direction, air temperature, humidity, barometric pressure, solar radiation, and precipitation.

Water Resources/Aquaculture

Our CR1000 is well-suited to remote, unattended monitoring of hydrologic conditions. Most hydrologic sensors, including SDI-12 probes, interface directly to the CR1000.

Typical hydrologic measurements:

- **Water level** is monitored with incremental shaft encoders, double bubblers, ultrasonic ranging sensors, resistance tapes, strain gage pressure transducers, or vibrating wire pressure transducers. Vibrating wire transducers require an CDM-VW300-series, AVW200-series or another vibrating wire interface.
- **Well draw-down tests** use a pressure transducer measured at logarithmic intervals or at a rate based on incremental changes in water level.
- **Ionic conductivity measurements** use one of the switched excitation ports from the datalogger.
- **Samplers** are controlled by the CR1000 as a function of time, water quality, or water level.
- **Alarm and pump actuation** are controlled through digital I/O ports that operate external relay drivers

A turbidity sensor was installed in a tributary of the Cedar River watershed to monitor water quality conditions for Seattle, Washington.

Vehicle Testing

This versatile, rugged datalogger is ideally suited for testing cold and hot temperature, high altitude, off-highway, and cross-country performance. The CR1000 is compatible with our SDM-CAN interface and GPS16X-HVS receiver.

Vehicle monitoring includes not only passenger cars, but airplanes, locomotives, helicopters, tractors, buses, heavy trucks, drilling rigs, race cars, and motorcycles.

The CR1000 can measure:

- **Suspension**—strut pressure, spring force, travel, mounting point stress, deflection, ride.
- **Fuel system**—line and tank pressure, flow, temperature, injection timing.
- **Comfort control**—ambient and supply air temperature, solar radiation, fan speed, ac on and off, refrigerant pressures, time-to-comfort, blower current.
- **Brakes**—line pressure, pedal pressure and travel, ABS, line and pad temperature.
- **Engine**—pressure, temperature, crank position, RPM, time-to-start, oil pump cavitation.
- **General vehicle**—chassis monitoring, road noise, vehicle position and speed, steering, air bag, hot/cold soaks, wind tunnels, traction, CANbus, wiper speed and current, vehicle electrical loads.

Other Applications

- Eddy covariance systems
- Wireless sensor/datalogger networks
- Fire weather
- Geotechnical
- Mesonet systems
- Avalanche forecasting, snow science, polar, high altitude
- Historic preservation

CR1000 Specifications

Electrical specifications are valid over a -25° to +50°C, non-condensing environment, unless otherwise specified. Recalibration recommended every three years. Critical specifications and system configuration should be confirmed with Campbell Scientific before purchase.

PROGRAM EXECUTION RATE
10 ms to one day @ 10 ms increments

ANALOG INPUTS (SE1-SE16 or DIFF1-DIFF8)
8 differential (DF) or 16 single-ended (SE) individually configuredinput channels. Channel expansion provided by optional analog multiplexers.

RANGES and RESOLUTION: Basic resolution (Basic Res) is the A/D resolution of a single A/D conversion. A DIFF measurement with input reversal has better (finer) resolution by twice than Basic Res.

Range (mV)[1]	DF Res (µV)[2]	Basic Res (µV)
±5000	667	1333
±2500	333	667
±250	33.3	66.7
±25	3.33	6.7
±7.5	1.0	2.0
±2.5	0.33	0.67

[1]Range overhead of ~9% on all ranges guarantees that full-scale values will not cause over range.
[2]Resolution of DF measurements with input reversal.

ACCURACY[3]:
±(0.06% of reading + offset), 0° to 40°C
±(0.12% of reading + offset), -25° to 50°C
±(0.18% of reading + offset), -55° to 85°C (-XT only)

[3]Accuracy does not include the sensor and measurement noise. Offsets are defined as:
Offset for DF w/input reversal = 1.5•Basic Res + 1.0 µV
Offset for DF w/o input reversal = 3•Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 3.0 µV

ANALOG MEASUREMENT SPEED:

Integration Type/Code	Integration Time	Settling Time	Total Time[4] SE w/ No Rev	Total Time[4] DF w/ Input Rev
250	250 µs	450 µs	~1 ms	~12 ms
60 Hz[5]	16.67 ms	3 ms	~20 ms	~40 ms
50 Hz[5]	20.00 ms	3 ms	~25 ms	~50 ms

[4]Includes 250 µs for conversion to engineering units.
[5]AC line noise filter.

INPUT NOISE VOLTAGE: For DF measurements with input reversal on ±2.5 mV input range (digital resolution dominates for higher ranges).
250 µs Integration: 0.34 µV RMS
50/60 Hz Integration: 0.19 µV RMS

INPUT LIMITS: ±5 Vdc

DC COMMON MODE REJECTION: >100 dB

NORMAL MODE REJECTION: 70 dB @ 60 Hz when using 60 Hz rejection

INPUT VOLTAGE RANGE W/O MEASUREMENT CORRUPTION: ±8.6 Vdc max.

SUSTAINED INPUT VOLTAGE W/O DAMAGE: ±16 Vdc max.

INPUT CURRENT: ±1 nA typical, ±6 nA max. @ 50°C; ±90 nA @ 85°C

INPUT RESISTANCE: 20 GΩ typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION THERMISTOR (for thermocouple measurements):
±0.3°C, -25° to 50°C
±0.8°C, -55° to 85°C (-XT only)

ANALOG OUTPUTS (VX1-VX3)
3 switched voltage, sequentially active only during measurement.

RANGE AND RESOLUTION:

Channel	Range	Resolution	Current Source/Sink
(VX 1–3)	±2.5 Vdc	0.67 mV	±25 mA

ANALOG OUTPUT ACCURACY (VX):
±(0.06% of setting + 0.8 mV), 0° to 40°C
±(0.12% of setting + 0.8 mV), -25° to 50°C
±(0.18% of setting + 0.8 mV), -55° to 85°C (-XT only)

VX FREQUENCY SWEEP FUNCTION: Switched outputs provide a programmable swept frequency, 0 to 2500 mv square waves for exciting vibrating wire transducers.

PERIOD AVERAGE
Any of the 16 SE analog inputs can be used for period averaging. Accuracy is ±(0.01% of reading + resolution), where resolution is 136 ns divided by the specified number of cycles to be measured.

INPUT AMPLITUDE AND FREQUENCY:

Voltage Gain	Input Range (±mV)	Signal (peak to peak) Min. (mV)[6]	Signal (peak to peak) Max (V)[7]	Min Pulse Width (µV)	Max[8] Freq (kHz)
1	250	500	10	2.5	200
10	25	10	2	10	50
33	7.5	5	2	62	8
100	2.5	2	2	100	5

[6]Signal centered around Threshold (see PeriodAvg() instruction).
[7]With signal centered at the datalogger ground.
[8]The maximum frequency = 1/(twice minimum pulse width) for 50% of duty cycle signals.

RATIOMETRIC MEASUREMENTS
MEASUREMENT TYPES: Provides ratiometric resistance measurements using voltage excitation. 3 switched voltage excitation outputs are available for measurement of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. Optional excitation polarity reversal minimizes dc errors.

RATIOMETRIC MEASUREMENT ACCURACY:[9,10, 11]
±(0.04% of Voltage Measurement + Offset)

[9]Accuracy specification assumes excitation reversal for excitation voltages < 1000 mV. Assumption does not include bridge resistor errors and sensor and measurement noise.
[10]Estimated accuracy, ΔX (where X is value returned from the measurement with Multiplier = 1, Offset = 0):
BrHalf() instruction: $\Delta X = \Delta V_1/V_X$
BrFull() instruction $\Delta X = 1000 \cdot \Delta V_1/V_X$, expressed as $mV \cdot V^{-1}$.
ΔV^{-1} is calculated from the ratiometric measurement accuracy. See Resistance Measurements Section in the manual for more information.
[11]Offsets are defined as:
Offset for DIFF w/input reversal = 1.5•Basic Res + 1.0 µV
Offset for DIFF w/o input reversal = 3•Basic Res + 2.0 µV
Offset for SE = 3•Basic Res + 3.0 µV
Excitation reversal reduces offsets by a factor of two.

PULSE COUNTERS (P1-P2)
2 inputs individually selectable for switch closure, high frequency pulse, or low-level ac. Independent 24-bit counters for each input.

MAXIMUM COUNTS PER SCAN: 16.7×10^6

SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Max. Bounce Time: 1 ms open w/o being counted

HIGH-FREQUENCY PULSE MODE:
Maximum Input Frequency: 250 kHz
Maximum Input Voltage: ±20 V
Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 µs time constant.

LOW-LEVEL AC MODE: Internal ac coupling removes ac offsets up to ±0.5 Vdc.
Input Hysteresis: 12 mV RMS @ 1 Hz
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage:

Sine Wave (mV RMS)	Range(Hz)
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

DIGITAL I/O PORTS (C1-C8)
8 ports software selectable, as binary inputs or control outputs. Provide on/off, pulse width modulation, edge timing, subroutine interrupts / wake up, switch closure pulse counting, high frequency pulse counting, asynchronous communications (UARTs), and SDI-12 communications. SDM communications are also supported.

LOW FREQUENCY MODE MAX: <1 kHz

HIGH-FREQUENCY MODE MAX: 400 kHz

SWITCH-CLOSURE FREQUENCY MAX: 150 Hz

EDGE TIMING RESOLUTION: 540 ns

OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low <0.1

OUTPUT RESISTANCE: 330 Ω

INPUT STATE: high 3.8 to 16 V; low -8.0 to 1.2 V

INPUT HYSTERESIS: 1.4 V

INPUT RESISTANCE: 100 kΩ with inputs <6.2 Vdc
220 Ω with inputs ≥6.2 Vdc

SERIAL DEVICE/RS-232 SUPPORT: 0 TO 5 Vdc UART

SWITCHED 12 VDC (SW-12)
1 independent 12 Vdc unregulated source is switched on and off under program control. Thermal fuse hold current = 900 mA at 20°C, 650 mA at 50°C, 360 mA at 85°C.

EU DECLARATION OF COMPLIANCE
https://s.campbellsci.com/documents/us/compliance/eudoc_cr1000-series.pdf
https://s.campbellsci.com/documents/us/compliance/eudoc_cr1000kd.pdf

COMMUNICATIONS
RS-232 PORTS:
DCE 9-pin: (not electrically isolated) for computer connection or connection of modems not manufactured by Campbell Scientific.
COM1 to COM4: 4 independent Tx/Rx pairs on control ports (non-isolated); 0 to 5 Vdc UART
Baud Rates: selectable from 300 bps to 115.2 kbps.
Default Format: 8 data bits; 1 stop bits; no parity
Optional Formats: 7 data bits; 2 stop bits; odd, even parity

CS I/O PORT: Interface with telecommunications peripherals manufactured by Campbell Scientific.

SDI-12: Digital control ports C1, C3, C5, and C7 are individually configured and meet SDI-12 Standard v 1.3 for datalogger mode. Up to 10 SDI-12 sensors are supported per port.

PERIPHERAL PORT: 40-pin interface for attaching CompactFlash or Ethernet peripherals

PROTOCOLS SUPPORTED: PakBus, AES-128 Encrypted PakBus, Modbus, DNP3, FTP, HTTP, XML, HTML, POP3, SMTP, Telnet, NTCIP, NTP, Web API, SDI-12, SDM.

SYSTEM
PROCESSOR: Renesas H8S 2322 (16-bit CPU with 32-bit internal core running at 7.3 MHz)

MEMORY: 2 MB of flash for operating system; 4 MB of battery-backed SRAM for CPU usage and final data storage; 512 kB flash disk (CPU) for program files.

REAL-TIME CLOCK ACCURACY: ±3 min. per year. Correction via GPS optional.

REAL-TIME CLOCK RESOLUTION: 10 ms

SYSTEM POWER REQUIREMENTS
VOLTAGE: 9.6 to 16 Vdc

INTERNAL BATTERIES: 1200 mAh lithium battery for clock and SRAM backup that typically provides three years of backup

EXTERNAL BATTERIES: Optional 12 Vdc nominal alkaline and rechargeable available. Power connection is reverse polarity protected.

TYPICAL CURRENT DRAIN at 12 Vdc:
Sleep Mode: < 1 mA
1 Hz Sample Rate (1 fast SE meas.): 1 mA
100 Hz Sample Rate (1 fast SE meas.): 6 mA
100 Hz Sample Rate (1 fast SE meas. w/RS-232 communication): 20 mA
Active external keyboard display adds 7 mA (100 mA with backlight on).

PHYSICAL
DIMENSIONS: 23.9 x 10.2 x 6.1 cm (9.4 x 4 x 2.4 in); additional clearance required for cables and leads.

MASS/WEIGHT: 1 kg / 2.1 lb

WARRANTY
3 years against defects in materials and workmanship.

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MAXIMUM COUNTS PER SCAN: 16.7×10^6

SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Max. Bounce Time: 1 ms open w/o being counted

HIGH-FREQUENCY PULSE MODE:
Maximum Input Frequency: 250 kHz
Maximum Input Voltage: ±20 V
Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 µs time constant.

LOW-LEVEL AC MODE: Internal ac coupling removes ac offsets up to ±0.5 Vdc.
Input Hysteresis: 12 mV RMS @ 1 Hz
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage:

Sine Wave (mV RMS)	*Range(Hz)*
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

DIGITAL I/O PORTS (C1-C8)
8 ports software selectable, as binary inputs or control outputs. Provide on/off, pulse width modulation, edge timing, subroutine interrupts / wake up, switch closure pulse counting, high frequency pulse counting, asynchronous communications (UARTs), and SDI-12 communications. SDM communications are also supported.

LOW FREQUENCY MODE MAX: <1 kHz

HIGH-FREQUENCY MODE MAX: 400 kHz

SWITCH-CLOSURE FREQUENCY MAX: 150 Hz

EDGE TIMING RESOLUTION: 540 ns

OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low <0.1

OUTPUT RESISTANCE: 330 Ω

INPUT STATE: high 3.8 to 16 V; low -8.0 to 1.2 V

INPUT HYSTERESIS: 1.4 V

INPUT RESISTANCE: 100 kΩ with inputs <6.2 Vdc
220 Ω with inputs ≥6.2 Vdc

SERIAL DEVICE/RS-232 SUPPORT: 0 TO 5 Vdc UART

SWITCHED 12 VDC (SW-12)
1 independent 12 Vdc unregulated source is switched on and off under program control. Thermal fuse hold current = 900 mA at 20°C, 650 mA at 50°C, 360 mA at 85°C.

EU DECLARATION OF COMPLIANCE
https://s.campbellsci.com/documents/us/compliance/eudoc_cr1000-series.pdf
https://s.campbellsci.com/documents/us/compliance/eudoc_cr1000kd.pdf

COMMUNICATIONS
RS-232 PORTS:
DCE 9-pin: (not electrically isolated) for computer connection or connection of modems not manufactured by Campbell Scientific.
COM1 to COM4: 4 independent Tx/Rx pairs on control ports (non-isolated); 0 to 5 Vdc UART
Baud Rates: selectable from 300 bps to 115.2 kbps.
Default Format: 8 data bits; 1 stop bits; no parity
Optional Formats: 7 data bits; 2 stop bits; odd, even parity

CS I/O PORT: Interface with telecommunications peripherals manufactured by Campbell Scientific.

SDI-12: Digital control ports C1, C3, C5, and C7 are individually configured and meet SDI-12 Standard v 1.3 for datalogger mode. Up to 10 SDI-12 sensors are supported per port.

PERIPHERAL PORT: 40-pin interface for attaching CompactFlash or Ethernet peripherals

PROTOCOLS SUPPORTED: PakBus, AES-128 Encrypted PakBus, Modbus, DNP3, FTP, HTTP, XML, HTML, POP3, SMTP, Telnet, NTCIP, NTP, Web API, SDI-12, SDM.

SYSTEM
PROCESSOR: Renesas H8S 2322 (16-bit CPU with 32-bit internal core running at 7.3 MHz)

MEMORY: 2 MB of flash for operating system; 4 MB of battery-backed SRAM for CPU usage and final data storage; 512 kB flash disk (CPU) for program files.

REAL-TIME CLOCK ACCURACY: ±3 min. per year. Correction via GPS optional.

REAL-TIME CLOCK RESOLUTION: 10 ms

SYSTEM POWER REQUIREMENTS
VOLTAGE: 9.6 to 16 Vdc

INTERNAL BATTERIES: 1200 mAh lithium battery for clock and SRAM backup that typically provides three years of backup

EXTERNAL BATTERIES: Optional 12 Vdc nominal alkaline and rechargeable available. Power connection is reverse polarity protected.

TYPICAL CURRENT DRAIN at 12 Vdc:
Sleep Mode: < 1 mA
1 Hz Sample Rate (1 fast SE meas.): 1 mA
100 Hz Sample Rate (1 fast SE meas.): 6 mA
100 Hz Sample Rate (1 fast SE meas. w/RS-232 communication): 20 mA
Active external keyboard display adds 7 mA (100 mA with backlight on).

PHYSICAL
DIMENSIONS: 23.9 x 10.2 x 6.1 cm (9.4 x 4 x 2.4 in); additional clearance required for cables and leads.

MASS/WEIGHT: 1 kg / 2.1 lb

WARRANTY
3 years against defects in materials and workmanship.

13855

Quick Links

Overview

The 13855 push-to-talk switch allows a customer an easy method for keying up a radio. The 13855 attaches to a square 10-position connector on the radio-to-modem cable that is supplied with the radio (for example, pn 29201). Pressing the button grounds the radio push-to-talk (PTT) line, which causes the radio to transmit the carrier frequency. This process is useful during radio maintenance and for troubleshooting. For example, it allows a user to sustain a transmission while measuring the forward and reflected radio transmit power with a watt meter.

Images

Specifications

Connector	Square, 10-pin (2x5), 0.100 inch pitch, male
Button	Metal dome button with overlay

Compatibility

The 13855 is compatible with the 29201, 13547, and 12160 cables.

Listed Under

Other Accessories for the following products:

- RF304 - UHF Radio Transceiver
- RF302 - UHF Radio Transceiver
- RF300 - VHF Radio Transceiver
- RF301 - VHF Radio Transceiver
- RF303 - UHF Radio Transceiver
- RF310 - VHF Radio Transceiver
- RF312 - UHF Radio Transceiver
- RF313 - UHF Radio Transceiver
- RF323 - UHF Radio Transceiver
- RF321 - UHF Radio Transceiver
- RF320 - VHF Radio Transceiver
- RF322 - UHF Radio Transceiver

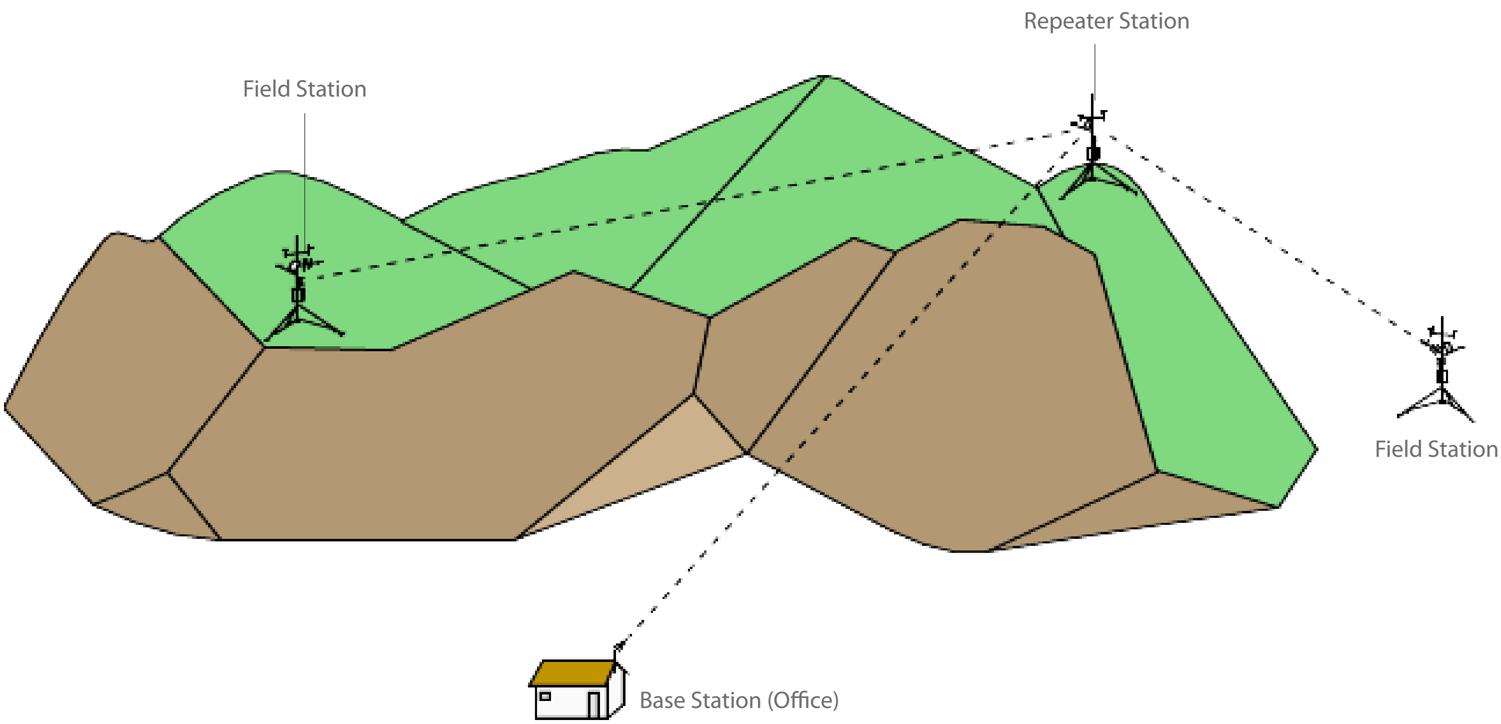
CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

Narrowband RF Networks

for remote wireless communications

Stable, long-range,wireless communication

Using narrowband, licensed, UHF/VHF radios



Overview

Campbell Scientific's radiotelemetry (RF) systems support data retrieval from moving vehicles or remote areas where communication via cables is impractical.

Data from field stations are retrieved at a computer base station. The base station can communicate with up to 254 remote stations over a single frequency. A phone modem can also access an RF network.

Field stations and repeater stations can be located to allow communication over long distances and rough terrain. The maximum distance between any two communicating stations is approximately 25 miles and must be line-of-sight (unobstructed by mountains, large buildings, etc.). Longer distances and rough terrain may require intermediate repeater station(s).

RF data transmission hardware includes radios, antennas, and radio modems. Power at the field and repeater stations is provided by sealed rechargeable batteries trickle-charged by solar or ac power.

Benefits and Features

- Measurement sites can be located in areas without phone lines or cellular coverage
- Eliminates cables and cable costs
- Supports local and remote data retrieval
- Allows remote control of datalogger functions

Before ordering radios and antennas, you must submit an application to the Federal Communications Commission (FCC) to acquire an FCC license and be assigned a frequency range. To file for an FCC license on-line, go to http://wireless.fcc.gov/uls and register. Canadian DOC approval is available for radios in the 138 to 174 MHz and 403 to 470 MHz frequency bands only.

Field Station Components

Field stations are located at the measurement site. They can also act as a repeater to extend the range of the network.

1 Datalogger

2 Power supply (5 Ah minimum)

3 RF500M Radio Modem

4 Radio transceiver such as the RF320, RF321, RF322, or RF323

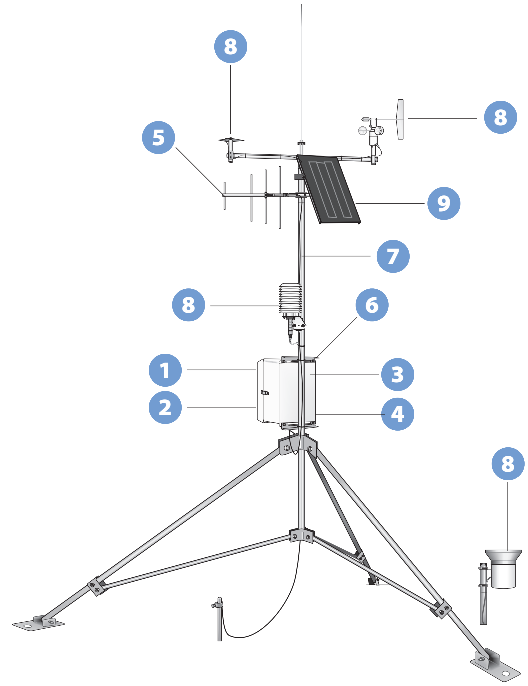
5 Antenna (Yagi directional antenna shown) and antenna cable

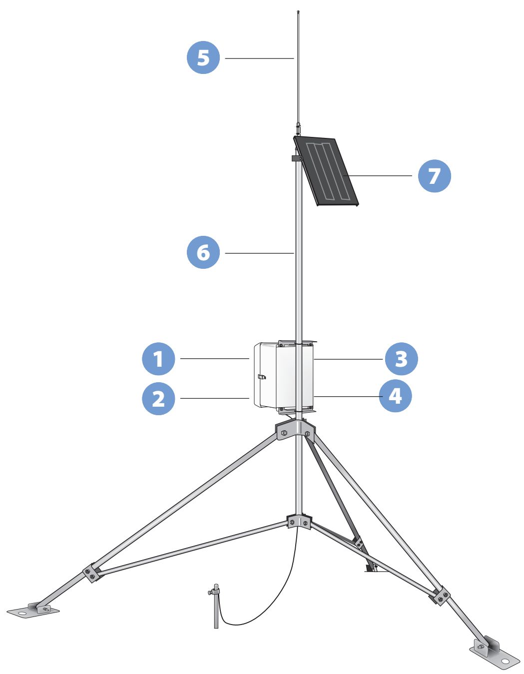
6 Environmental enclosure

7 Tripod or tower

8 Sensors and sensor mounts

9 Solar Panel (optional)





Repeater Station Components

Repeater stations act as communication relays between stations that cannot communicate directly due to distance or obstacles.

1 RF500M Radio Modem

2 Radio transceiver such as the RF320, RF321, RF322, or RF323

3 Power supply with charging regulator and null modem ports such as an A100 adapter connected to a CH150 regulator and a user-supplied rechargeable battery

4 Environmental enclosure

5 Omnidirectional antenna and antenna cable

6 Tripod or tower

7 Solar Panel

Computer Base Station Components

Base stations support attended and unattended retrieval of the field station's data and provide communication error checking and data processing. AC power is required. Base stations should contain:

- RF500B Base Station or the RF500M modem and power supply
- Radio transceiver such as the RF320, RF321, RF322, or RF323
- PC running LoggerNet Datalogger Support Software
- Antenna (directional or omnidirectional) and antenna cable

Power Considerations

The location of your site, number of calls, and length of calls affect the power requirements of your system. Information on analyzing your system's power requirements is provided in our Power Supply Overview brochure and the Power Supply application note. You can also contact an applications engineer who will help you determine an appropriate power supply for your system.

CAMPBELL SCIENTIFIC

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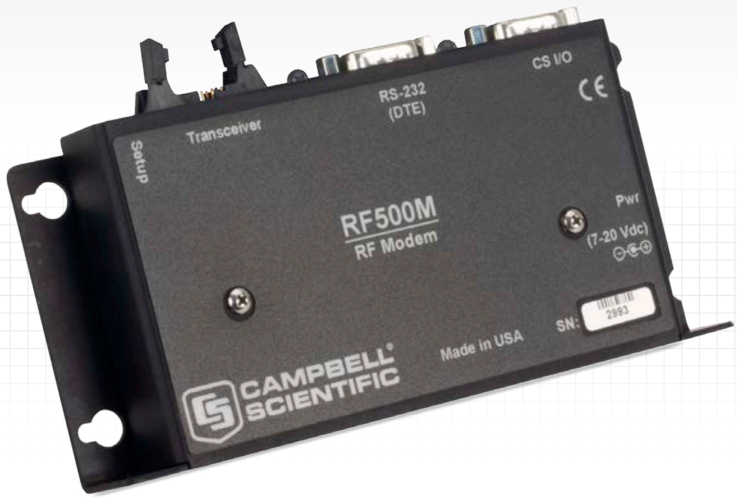
WHEN MEASUREMENTS MATTER

RF500M
Radio Modem



Versatile radio modem

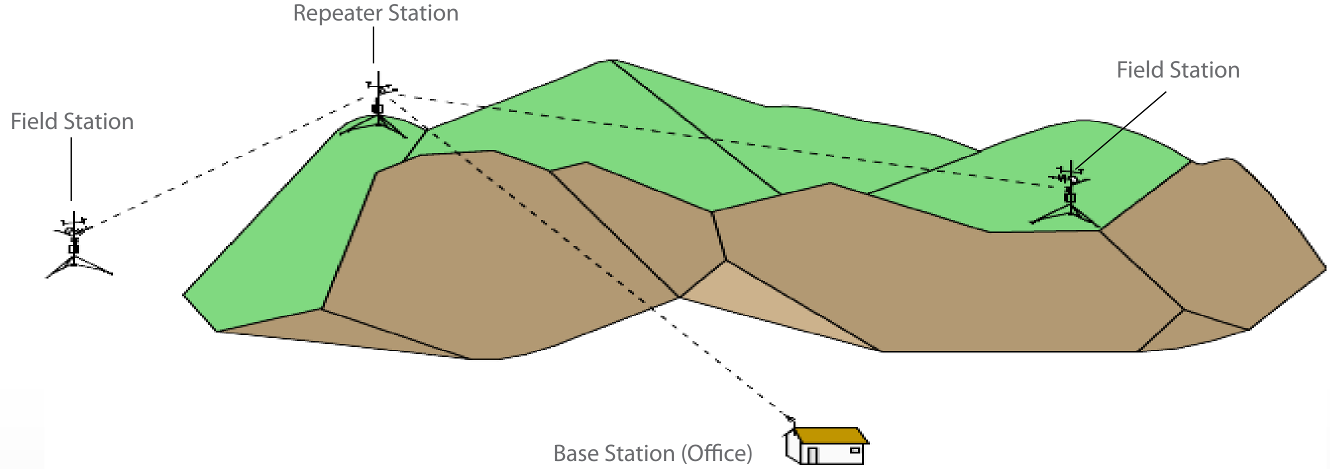
For networks with narrowband, UHF/VHF, licensed radios

Overview

The RF500M serves as a field, repeater, or base station communication interface, generally for our licensed radio applications. It provides an interface between a datalogger or computer and a radio and can be a stand-alone repeater when onsite logging is not required. The RF500M is powered from the CS I/O port or from an external power connection. This modem is software configurable, and has been designed to interface with data telemetry radios such as our RF320-, RF310-, and RF300-series VHF/UHF radios.

Benefits and Features

- Supports multiple radio configurations including our RF320-series, our RF310-series, our RF300-series, and the DataRadio DL-3400 radio
- Uses software instead of hardware modifications to upgrade the operating system (OS) and change RF ID or other settings
- Provides an RS-232 port (DTE) for modem configuration or attachment of an RS-232 radio
- Avoids all collisions within a network, thus increasing polling speeds and reducing overall current drain



Our RF networks require line-of-sight transmission. The mountain in this drawing obstructs line-of-sight with the base station. Use of the repeater station allows the base station to receive data from the field stations.

Ordering Information

Radio Modem

Must choose an OS option and a radio jumper setting option (see below).

RF500M Radio Modem.

OS Options (see discussion at right)

-PB	PakBus OS.
-AL	ALERT Dual Mode OS.
-DA	Dial OS.

Radio Jumper Setting Options

-MJ	Jumper for RF320-series or RF310-series radios.
-RJ	Jumper for RF300-series radios.
-UJ	Jumper for radios purchased directly from DRL.

Temperature Range Options

-ST	Standard -25° to +50°C (default).
-XT	Extended -55° to +85°C.

Warranty Length Options

-SW	Standard one year warranty (default).
-XW	Four year warranty extension.

Accessories

10873	9-pin female to 9-pin male serial data cable (6 ft); cable is required to connect RS-232 digital radios.
15966	Wall Charger 12 Vdc, 800 mA Output, 100 to 240 Vac, 50 to 60 Hz with Barrel Plug, 6 ft Cable.
14291	Field Power Cable 12 Vdc Plug to Pigtail (2 ft) connects with a 12 Vdc power supply.
14020	Field Power Cable CS I/O to 12 Vdc Barrel Plug (2 ft) connects with datalogger.

Operating System (OS) Options Descriptions

PakBus OS

Considered the standard for the RF500M, the -PB OS uses TDRF polling to quickly and efficiently move data through a network. Each station can be individually dialed by LoggerNet. This OS is compatible with -TD, -PB, and our current generation of PakBus dataloggers.

ALERT Dual Mode OS

The ALERT (Automated Local Evaluation in Real Time) OS allows for transmission, repeating, and reception of binary ALERT formatted data. It is a derivative of the -PB OS, and therefore supports both ALERT and TDRF communications (allowing true two-way communication with a station). This OS is compatible with the CR200(X)-series, CR800-series, CR1000, and CR3000 dataloggers.

Dial OS

The dial OS works with both mixed-array and PakBus/table-based dataloggers. Each station can be dialed by LoggerNet for downloading data, sending programs, and performing other tasks. Additionally, this OS allows stations to create point-to-point networks for sharing of measurement and control tasks.

Specifications

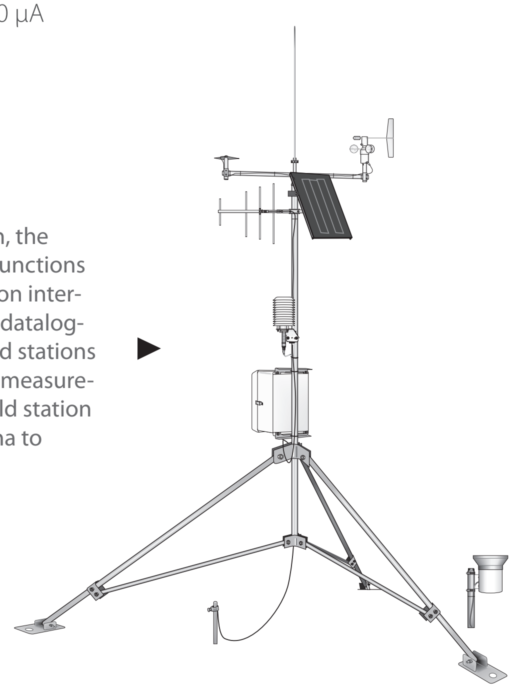
- Voltage: 7 to 20 Vdc
- Dimension: 160 x 95 x 22 mm (6.31 x 3.69 x 0.88 in.)
- Weight: 0.18 kg (0.4 lb)

Current Drain

- Active: <15 mA
- Quiescent: <350 µA

The RF500M can be used as a stand-alone repeater. Repeater stations provide a communication relay between stations that cannot communicate directly due to distance or obstacles. Repeater stations use omnidirectional antennas.

At the field station, the RF500M modem functions as a communication interface between the datalogger and radio. Field stations are located at the measurement site. This field station uses a Yagi antenna to transmit the data.



RF320

UHF / VHF Radios / RF320

Rugged, Long Range

Long-distance option for communication

Quick Links

Overview

The RF320 is a 136 to 174 MHz radio. Campbell Scientific's RF320-series narrowband UHF/VHF radio transceivers provide a long-distance telemetry option for communicating with remote measurement stations. Each radio includes a configured Ritron DTX-L radio, a mounting bracket, and a cable for connecting the radio to a radio modem. The different models vary by the frequency ranges they support.

Read More

Images



Similar Products


RF321 UHF Radio Transceiver


RF322 UHF Radio Transceiver


RF323 UHF Radio Transceiver

Detailed Description

The RF320 is programmed by Campbell Scientific to the frequency that was assigned by the Federal Communications Commission (FCC). This frequency must be specified at time of order so that it can be programmed into the radio.

A user-supplied antenna is required for each radio; contact Campbell Scientific for more information about selecting the antenna and cable. Each radio must also be connected to an RF500M or RF310M radio modem.

Specifications

Ritron Module	DTX-445
FCC ID	AIERIT17-445
Industry Canada ID	1084A-RIT17145
FCC Rule Parts	90
Industry Canada Rule Parts	RSS-119
Frequency Range	136 to 174 MHz
RF Channels	8 independent Tx/Rx frequencies
Synthesizer Step	2.5 kHz
Channel Spacing	12.5 kHz
Frequency Stability	±2.5 PPM (-30° to +60°C)
Input Voltage	9 to 17 Vdc
Antenna Connector	BNC female
Dimensions	14.5 x 7.6 x 3.5 cm (5.7 x 3 x 1.375 in.)
Weight	0.2 kg (7.3 oz)

Current Drain @ 12.5 Vdc

Receive Standby	25 mA
Transmitter	› < 0.9 A (2 W output) › < 1.2 A (5 W output)

Receiver

Receiver Type	12.5 kHz narrowband
Sensitivity	0.25 µV (12 dB SINAD)
Adjacent Channel	-60 dB
Receiver Attack Time	< 10 ms (Tx to Rx)
Noise Squelch Sensitivity	PC adjustable (factory set for -121 dBm)

Transmitter

RF Power Output	2.0 W or 5.0 W (@ 12.5 Vdc)
Duty Cycle	50% (< 13.5 V, 5 W output, 25°C)
Voice Emissions Designator	10K0F3E
Data Emissions Designator	9K8F1D, 11K0F2D, 11K0F3D
Transmitter Attack Time	< 10 ms

Compatibility

Radio Modems

RF500M	RF310M	RF95A	RF95	RF95T	RF315M
✓	✓				

Radio Base Stations

RF500B	RF310B	RF232A	RF232	RF232T
✓	✓			

Radios

The RF320 is compatible with the RF310 radio.

Datalogger Considerations

Compatible Contemporary Dataloggers

CR200(X) Series	CR800/CR850	CR1000	CR3000	CR9000X
*	✓	✓	✓	

Compatible Retired Dataloggers

CR500	CR510	CR10	CR10X	21X	CR23X	CR9000	CR5000	CR7
✓	✓	✓	✓	✓	✓			✓

Note: The CR200(X)-series dataloggers are only compatible if the RF500 radio modem is used.

Documents

Brochures

- RF320-Series Narrowband UHF/VHF Radios
- Narrowband RF Networks
- Data Storage and Retrieval Peripherals

Manuals

- RF320-Series Ritron VHF/UHF Radios

Technical Papers

- Line of Sight Obstruction
- The Link Budget and Fade Margin

Frequently Asked Questions

Number of FAQs related to RF320: 2

1. Can an RF500M work with a GPS device for vehicle tracking systems?
   No. The RF500M cannot be directly interfaced with a GPS receiver. However, most Campbell Scientific dataloggers can be interfaced with the output from a GPS receiver and programmed to extract the positional information. This information can then be accessed via an RF500M/RF320 RF link.

2. Can more than one antenna be connected to a single radio?
   It is possible to connect two antennas to a single radio via a properly specified (operating frequency and power handling capability) two-way, 50 ohm RF power divider. One example of this type of power divider is offered by Pasternack. Note that using a device like this will induce additional losses into the system (3 to 4 dB, typically).

1
100V
7A
+2
OUTPUT
CRYDOM
SOLID-STATE RELAY
ASSEMBLED
IN MEXICO
D1D07
INPUT
4
3.5-32V
+3

COMPONENT

PS150 and CH150

Power Supply and Charge Controller

Optimized Power Performance

Manages voltage and amperage to protect battery

Overview

The PS150 and CH150 are smart charge controllers that manage amperage and voltage for safe, optimized battery charging from a solar-panel or ac power source. The PS150 includes a 12 Vdc, 7 Ah valve-regulated lead-acid (VRLA) battery, while the CH150 is for use with a separate larger battery such as our BP12, BP24, or a user-supplied battery.

Benefits and Features

- Protects against high-amperage and high-voltage damage to power supply
- Battery reversal protection
- Allows simultaneous connection of two charging sources (e.g., solar panel, ac wall charger)
- ETL listed Class 2 power supply

Technical Description

The PS150 and CH150 are micro-controller-based smart chargers with temperature compensation that optimize battery charging and increase the battery's life. Two input terminals enable simultaneous connection of two charging sources. They also incorporate a maximum power point tracking algorithm for solar inputs that maximize available solar charging resources.

The PS150 and CH150 have several safety features intended to protect the charging source, battery, charger, and load devices. Both the SOLAR – G and CHARGE – CHARGE input terminals incorporate hardware current limits and polarity-reversal protection. A 5 A fuse protects the CHARGE – CHARGE inputs in the event of a catastrophic AC/AC or AC/DC charging source failure. A 4.65 A solid-state circuit breaker protects the 12 V output terminals of the charger in the event of an output load fault. The PS150 and CH150 also have battery-reversal protection, and include ESD and surge protection on all of its inputs and outputs.

Ordering Information

Power Supplies

CH150 12 V Charging Regulator. Choose a warranty option (see below).

PS150 12 V Power Supply with Charging Regulator and 7 Ah Sealed Rechargeable Battery. Choose a warranty option (see below).

Warranty Options (choose one)

-SW Standard 1 Year Warranty. See manual for full warranty policy.

-XW 4 Year Warranty Extension (available only at the time of original product purchase).

12 Vdc Battery Packs for CH150

BP12 12 Ah Sealed Rechargeable Battery with Mounts

BP24 24 Ah Sealed Rechargeable Battery with Mounts

External Battery Cable

6186 Battery Cable for connecting an external 12 Vdc flooded battery such as a deep-cycle marine or RV battery.

Wall Chargers

29796 Wall Charger 24 Vdc 1.67 A Output, 100 to 240 Vac, 1A Input, 5 ft Cable. Must choose a power plug option (see below).

22110 Wall Charger 24 Vdc 1.67 A Output, 100 to 240 Vac, 1 A Input for prewired enclosure. Must choose a power plug option (see below).

Power Plug Options (choose one)

-US US/Canada Plug

-IP 7 International Plugs

Unregulated Solar Panels

Regulated solar panels such as the SP10R are not recommended. Must choose a cable termination option and a mounting option.

SP10 10 W Solar Panel with 15 ft cable

SP20 20 W Solar Panel with 15 ft cable

SP50-L 50 W Solar Panel with user-specified cable length (used with the CH150 only). Enter length, in feet, after the -L. A 20 ft length is typical; maximum length is 50 ft.

Cable Termination Options (choose one)

-PT Cable terminates in stripped and tinned leads for direct connection to the CH150 or PS150.

-PW Cable terminates in a connector that attaches to a prewired enclosure.

-C Cable terminates in a connector that attaches to an ET station or the CS110 Electric Field Meter (only available for the SP10).

Mounting Option (choose one)

-SM Standard Mounting Kit

-EM Extended Mounting Kit

Adapters

Only one adapter can be used at a time.

A100 Null Modem Adapter for powering peripherals and external devices at non-datalogger sites such as repeater stations.

A105 12 V Terminal Expansion Adapter that increases the number of 12 V and ground terminals available on the PS150 or CH150.

Specifications

- EU Declaration of Conformity: https://s.campbellsci.com/documents/us/compliance/eudoc_ch150-ps150.pdf
- Operational Temperature Range*: –40° to +60°C
- Dimensions:

	Height	Length	Width
PS150	10.6 cm (4.2 in)	19.3 cm (7.5 in)	7.6 cm (3 in)
CH150	10 cm (3.9 in)	7.5 cm (3 in)	3.7 cm (1.5 in)

Battery Charging

- FLOAT Charging: $V_{batt}(T) = 13.65 - (24\text{ mV}) \times (T - 25) + (0.24\text{ mV}) \times (T - 25)^2$
- Accuracy: ±1% accuracy on charging voltage over -40° to +60°C

CHARGE – CHARGE Terminals (AC or DC Source)

- AC: 18 to 24 V RMS internally limited to 1.2 A RMS
- DC: 16 to 40 Vdc internally limited to 0.85 A dc

SOLAR Terminals (Solar Panel or Other DC Source)

- Input Voltage Range: 15 to 40 Vdc
- Maximum Charging Current: 4.0 A dc typical; 3.1 A dc to 4.8 A dc depending on individual charger

Quiescent Current

- No Charge Source Present: 160 µA at 13.7 Vdc
- No Battery Connected: 930 µA at 30 V input voltage (ac or dc)

Power Out (+12 terminals)

- Voltage: Unregulated 12 V from battery
- 4.65 A solid state circuit breaker
- ETL Listed Class 2 power supply

**VRLA battery manufacturers state that "heat kills batteries" and recommend operating batteries ≤50°C.*

14221

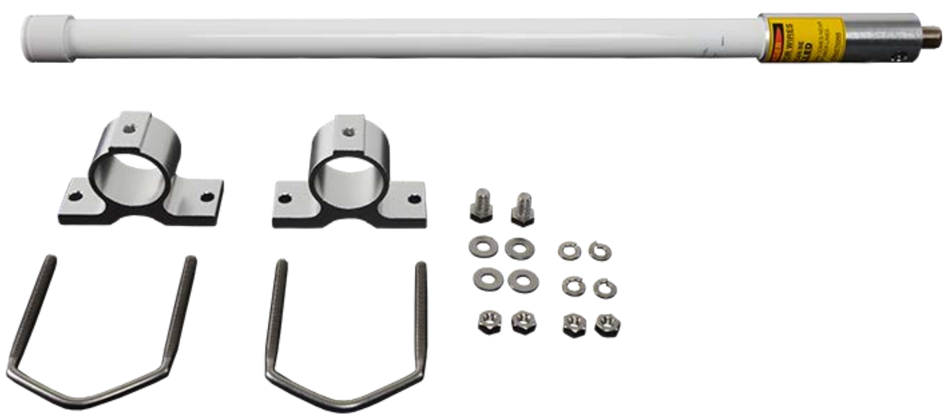
Quick Links

Overview

The 14221 is a 3 dBd omnidirectional antenna for use with many of our spread-spectrum products. The 14221 is suitable for base station use where you need to communicate with multiple stations located in different directions. It is also preferred in mobile applications and in other applications in which the best radio path is not constant, including close-up applications without clear line-of-sight.

Read More ›

Images



14221 antenna with mounting hardware, disassembled

Similar Products

14205 900 MHz 6 dBd Yagi Antenna with Mounting Hardware

14201 900 MHz 9 dBd Yagi Antenna with Mounting Hardware

14203 900 MHz 3 dBd Omnidirectional Antenna without Mounting Hardware

17548 900 MHz 0 dBd Omnidirectional Antenna without Mounting Hardware

14204 900 MHz 0 dBd 1/2 Wave Omnidirectional Antenna with RPSMA Connector

15731 900 MHz 0 dBd 1/4 Wave Omnidirectional Antenna with RPSMA Connector

15730 900 MHz 0 dBd 1/4 Wave Omnidirectional Antenna with RPSMA Connector

15970 900 MHz 1 dBd Omnidirectional Dipole Antenna with Adhesive Mount

Detailed Description

The 14221 is the highest gain, omnidirectional antenna available for our 900 MHz spread spectrum radios that Campbell Scientific offers. This outdoor antenna is ideal for a base station or repeater station where you need to communicate with multiple stations located in different directions. The 14221 is also preferred in mobile applications and in applications where the best radio path is not constant, including close-up applications without clear line-of-sight.

The 14221 requires an antenna cable to connect it to the spread-spectrum radio. (See the Compatibility information for options.)

Specifications

Gain	3 dBd
Frequency Band Supported	902 to 928 MHz
Connector	Type N female
Antenna Type	Omnidirectional, outdoor antenna with mounting hardware
Manufacturer's Model Name	ANTENEX FG9023
Mounting	Mounts to pipes with outer diameters from 3.18 to 6.35 cm (1.25 to 2.5 in.).
Diameter	3.175 cm (1.25 in.) at base
Length	63.5 cm (25 in.)
Weight	383 g (13.5 oz)

Compatibility

Antenna Cables

The following cables can be used:

- COAXNTN-L—connects the antenna to the radio, datalogger, or interface via a surge protector.
- COAXRPSMA-L—connects the antenna to spread-spectrum radios other than the RF450 when surge protection is not required.
- COAXSMA-L—connects the antenna to an RF450 when surge protection is not required.

Mounting Hardware

The antenna includes a rugged FM2 antenna mounting bracket. The mounting bracket will accommodate a pipe with up to 6.5 cm (2.5 in.) outer diameter. A similar antenna, the 14203, does not have mounting hardware and is intended for customers who want to construct an antenna mounting bracket that fits their specific application.

Contemporary Devices

The 14221 is compatible with these current products:

Spread-Spectrum Radios

- RF451
- RF401A
- RF411A
- RF407
- RF412

Dataloggers

- CR206X
- CR211X
- CR6-RF451
- CR6-RF407
- CR6-RF412
- CRVW3-RF451
- CRVW3-RF407
- CRVW3-RF412
- CR300-RF407
- CR300-RF412
- CR310-RF407
- CR310-RF412

Vibrating-Wire Peripherals

- AVW206
- AVW211

Retired Devices

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

SP50-L

50 W Solar Panel

Powers Remote Systems

Useful at sites far from ac sources

The SP50 50 W solar panel is a photovoltaic power source capable of recharging batteries. It is used for our CS110 Electric Field Meter or other systems that require 50 W solar panels. The SP50 allows unattended operation of systems in remote locations, far from ac electrical sources.

This solar panel needs to be used with either a 18529 Morningstar SunSaver, CH200, or CH150 regulator. One SP50 can be connected to any of the regulators to provide a peak charge of 50 W. Two SP50 solar panels can be wired in parallel to the charge inputs of the SunSaver 18529 regulator to provide a peak charge of 100 W.

Regulators

CH150/CH200 Charge Controller
The CH150 and CH200 limit charging current to approximately 3.6 A and can precisely charge these battery families: EnerSys Genesis NP Series (BP12, BP24), EnerSys Cyclone Series, Concorde Sun Xtender Series (BP84, PS84), or a custom battery.

18529 MorningStar SunSaver
The 18529 Morning Star SunSaver limits charging current to approximately 10 A and can charge flooded batteries or sealed rechargable batteries such as our BP12, BP2, BP24, and BP84.

Mounting Hardware

The SP50 includes the 31107 Extended Mounting Kit for attaching the solar panel to a Campbell Scientific tripod or tower. The 31107 positions the solar panel approximately 25 cm (10 in) from the tripod or tower, which reduces shadows from other components and guy wires. The zenith angle indicator and the slotted supports simplify installation. The 31107 began shipping with the solar panel in October 2014. This kit may be purchased separately to retrofit existing solar panels.

Ordering Information

Solar Panel

SP50-L 50 W Solar Panel with user-specified cable length. Enter length, in feet, after the -L. A 20 ft length is typical; maximum length is 50 ft. Must choose a cable termination option (see below).

Cable Termination Option (choose one)

-PT Cable terminates in stripped and tinned leads for connection to the CH200 Smart Charge Controller or 18529 regulator.

-PW Cable terminates in a connector that attaches to a prewired enclosure.

Regulators

CH200	12 Vdc Charging Regulator
18529	Morning Star SunSaver-10 10A 12V Regulator with 15 ft Battery Cable
CH150	12 Vdc Charging Regulator

18529 Morning Star SunSaver

CH200

Above shows two regulators available for use with the SP50. Regulators must be housed in an environmental enclosure.

Specifications[a]

- Maximum Power: 50 W (100 W peak power when two SP50s are connected to one 18529 regulator)
- Voltage at Peak: 17.5 V
- Current at Peak: 2.9 A
- Dimensions: 83.9 x 53.7 x 5 cm (33 x 21.1 x 2.0 in)
- Weight: 6 kg (13 lb)
- Maximum Wind Speed Rating[b]: 58 m s^{-1} (130 mph)
- Cable Description: 16 AWG, 1-twisted pair

[a]Solar panel characteristics assume 1 kW m^{-2} illumination and 25°C solar panel temperature. Individual panels may vary up to 10%. The output panel voltage increases as the panel temperature decreases.

[b]Assumes the 31107 Extended Mounting Kit is used to mount the SP50 to an adequately anchored tripod or tower.

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14201

Quick Links

Overview

The 14201 is a high-gain (9 dBd), directional (Yagi) antenna. It is useful for making RF links over longer distances in one direction. This antenna is typically used with sub-315 mW radios such as the RF401A. The 14201 requires an antenna cable to connect it to the spread-spectrum transceiver. (See the Compatibility information for cable options.)

Read More

Images

Similar Products

14205 900 MHz 6 dBd Yagi Antenna with Mounting Hardware

14221 900 MHz 3 dBd Omnidirectional Antenna with Mounting Hardware

14204 900 MHz 0 dBd 1/2 Wave Omnidirectional Antenna with RPSMA Connector

15731 900 MHz 0 dBd 1/4 Wave Omnidirectional Antenna with RPSMA Connector

15730 900 MHz 0 dBd 1/4 Wave Omnidirectional Antenna with RPSMA Connector

15970 900 MHz 1 dBd Omnidirectional Dipole Antenna with Adhesive Mount

Detailed Description

The 14201 is a high-gain, Yagi antenna used with our 900 MHz spread spectrum transceivers. This outdoor antenna has a narrow beam width that requires precise aiming. It should be used to communicate with one distant station. The 14201 requires an antenna cable to connect it to the spread spectrum transceiver. (See the Compatibility information for cable options.)

Note: Because the FCC limits the EIRP of 900 MHz spread-spectrum radios to 36 dBm, using this antenna with an RF450- or RF451-based system requires the user to reduce the radio's transmit power to a setting of 5 or less.

Specifications

Gain	9 dBd
Frequency Band Supported	900 MHz
Connector	Type N female
Antenna Type	Yagi (directional) with mounting hardware
Manufacturer's Model Name	MAXRAD BMOY8905

Mounting	Mounts to pipes with outer diameters from 3.18 to 6.35 cm (1.25 to 2.5 in.)
Bracket Dimensions	11.5 x 9 x 0.6 cm (4.5 x 3.5 x 0.25 in.)
Overall Length	56.5 cm (22.3 in.)
Longest Element Length	16 cm (6.3 in.)
Weight	0.73 kg (1.6 lb)

Compatibility

Spread-Spectrum Transceivers

Note: Because the FCC limits the EIRP of 900 MHz spread-spectrum radios to 36 dBm, using this antenna with an RF450- or RF451-based system requires the user to reduce the radio's transmit power to a setting of 5 or less.

Antenna Cables

The following cables can be used:

- COAXNTN-L—connects the antenna to the radio, datalogger, or interface via a surge protector.
- COAXRPSMA-L—connects the antenna to spread-spectrum radios other than the RF450 when surge protection is not required.
- COAXSMA-L—connects the antenna to an RF450 when surge protection is not required.

Mounting Hardware

The antenna includes mounting hardware that accommodates a pipe of up to 3.18 to 6.35 cm (1.25 to 2.5 in.) outer diameter.

Contemporary Devices

The 14201 is compatible with these current products:

Spread-Spectrum Radios

- RF451
- RF401A
- RF411A
- RF407
- RF412
- RF422

Dataloggers

- CR206X
- CR211X
- CR6-RF451
- CR6-RF407
- CR6-RF412
- CRVW3-RF451
- CRVW3-RF407
- CRVW3-RF412

Vibrating-Wire Peripherals

- AVW206
- AVW211

Retired Devices

The 14201 is compatible with these retired products:

Spread-Spectrum Radios

- RF400
- RF401
- RF430
- RF410
- RF411
- RF431
- RF450
- FGR-115RE and RC

Dataloggers

- CR205
- CR206
- CR210
- CR211

Listed Under

Replacement Parts for the following products:

- RF400 - 900 MHz Spread Spectrum Radio/Modem
- RF410 - 922 MHz Spread Spectrum Radio/Modem

Common Accessories for the following products:

- AVW211 - 922 MHz Wireless 2-Channel Vibrating-Wire Analyzer Module
- AVW206 - 900 MHz Wireless 2-Channel Vibrating-Wire Analyzer Module
- RF401A - 900 MHz Spread-Spectrum Radio
- RF412 - 922 MHz Spread-Spectrum Radio
- RF407 - 900 MHz Spread-Spectrum Radio
- RF411A - 922 MHz Spread-Spectrum Radio
- CWB100A - 922 MHz Wireless Sensor Base for Australia
- CWB100 - 900 MHz Wireless-Sensor Base
- CR206X - Datalogger with 900 MHz Spread-Spectrum Radio
- CR211X - Datalogger with 922 MHz Spread-Spectrum Radio
- CR310 - Datalogger with Ethernet
- CR300 - Datalogger

Other Accessories for the following products:

- FGR-115RC - Freewave 900 MHz Spread Spectrum Radio
- FGR-115RE - FREEWAVE 900 MHz, 1 W Spread Spectrum Radio with Ethernet
- RF401 - 900 MHz Spread-Spectrum Radio
- RF411 - 922-MHz Spread-Spectrum Radio
- CR206 - Datalogger with 900 MHz Spread-Spectrum Radio
- RF431 - 922-MHz Spread-Spectrum Radio
- RF430 - 900-MHz Spread-Spectrum Radio

COMPONENTS

CAMPBELL SCIENTIFIC

WHEN MEASUREMENTS MATTER

LoggerNet 4 Series

Datalogger Support Software

loggerNet

Datalogger Support Software

questions & quotes: **435.227.9120**

campbellsci.com/loggernet-packages

LoggerNet 4 Series

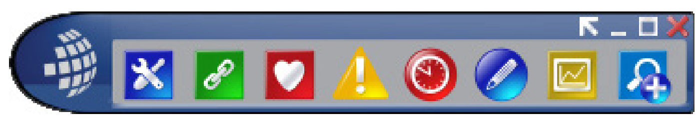
The LoggerNet family of datalogger support software

LoggerNet version 4 is Campbell Scientific's latest offering in its suite of datalogger support software packages. LoggerNet 4 is still built on a solid client/server architecture that allows data to be served to multiple LoggerNet clients simultaneously, while featuring a newly designed user-interface and new or updated clients. While the LoggerNet server does the work of communicating with the datalogger network, the client applications are used to manage the network. This includes network setup, configuration, monitoring, and backup; datalogger programming, maintenance, and data collection; and real-time or historical data display.

Toolbar and Navigation

LoggerNet's Toolbar starts the LoggerNet server and is used to navigate to all the client applications. It has been redesigned to offer quick access to all LoggerNet clients. A new Favorites category has been added to the Toolbar. With the click of a button the Toolbar can be restored down to Favorites view, allowing easy access to those clients most important to your application.

The Toolbar's Full view is shown on top right. The Favorites view reduces the size of the toolbar and provides access to your most-used applications. ▶



LoggerNet Packages

LoggerNet offers a complementary suite of client applications for datalogger programming, data collection, network monitoring and troubleshooting, and data display. This standard package is recommended for those who have datalogger networks that do not require the more advanced features offered in LoggerNet Admin. LoggerNet 30-day Trial version is available for download.

LoggerNet Admin includes tools that are useful for those with large datalogger networks. It provides all the capabilities of LoggerNet, plus it adds network security, network management from a remote PC, LoggerNet service, data export to third party applications, and the ability to launch multiple instances of the same client (for instance, two Connect windows).

LoggerNet Remote is the full suite of LoggerNet Admin client applications that lets you manage an existing datalogger network from a remote PC. LoggerNet Remote does not include the LoggerNet server or the service.

LoggerNet for Linux provides a solution for those who want to run the LoggerNet server in a Linux environment. The package includes a Linux version of the LoggerNet server. At least one copy of LoggerNet Remote must be purchased to use LoggerNet for Linux. LoggerNet Remote's Windows-based clients are used to manage the LoggerNet Linux server and the datalogger network. LoggerNet Linux includes a Debian distribution and two RPM distributions—Red Hat and SUSE.

Setup and Network Configuration

Setup

Setup and EZSetup have been combined into one application, providing you with a choice in setting up the datalogger network. EZSetup walks you through the process for each station step-by-step, while Setup allows you more flexibility and access to more advanced features. You can toggle between the two by pressing a button. When in Setup mode, you can choose to view all devices in the network or the datalogger stations only, to make finding a particular station easy.

New features for Setup include the ability to configure a scheduled datalogger network backup, the File Retrieval tab for scheduling retrieval of image or other files from a datalogger, the Notes tab for creating custom notes for a station, and the ability to cut and paste single devices or a branch of the network to another location in the network map. New file output options include support for CSIXML and incrementing file names with each data collection from a datalogger.

Task Master

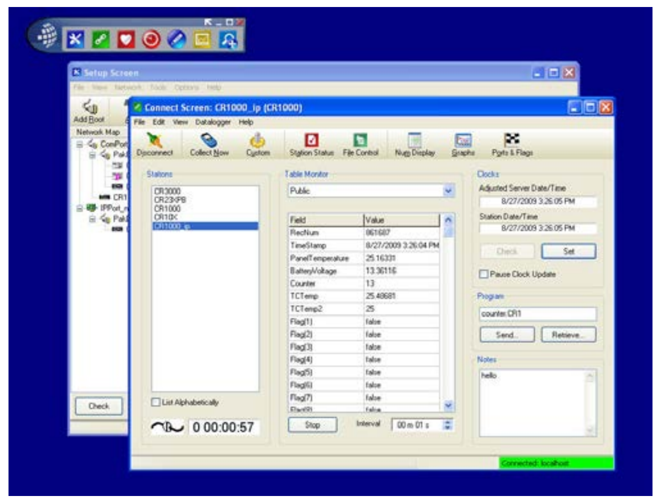
The Task Master allows you to set up events (e.g., running a batch file) that occur on a schedule (interval or calendar) or based on some trigger event such as a successful or failed data collection attempt to a datalogger. LoggerNet 4 Task Master now supports sending files via FTP/SFTP and the new "After File Closed" and "After File Retrieved" trigger events.

Network Planner

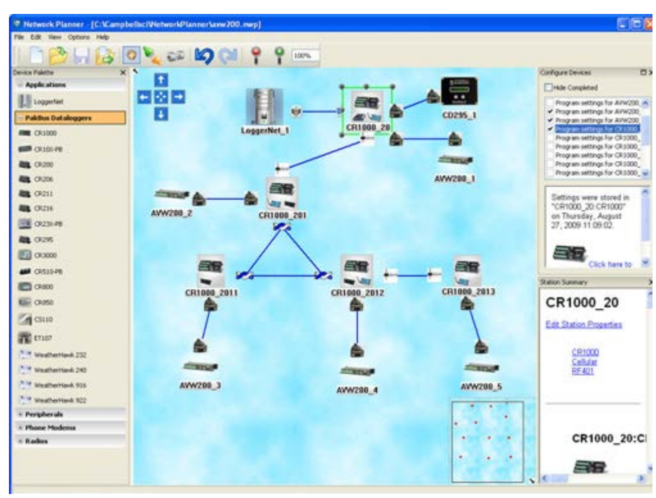
LoggerNet 4 includes the Network Planner, a new tool for designing your PakBus datalogger network. First, PakBus devices are selected from a list and placed on the network design palette. You then use a link tool to draw lines indicating the physical communication links between devices, and an activity tool to indicate activities that will take place between devices (scheduled data collection, call-back, one-way data messages, or get/set variable transactions between dataloggers).

The Network Planner calculates the optimum settings for each device in the network and then allows you to send these settings to the device, or save them for later download via the Network Planner or the Device Configuration Utility. If any change is made to a device in the network, that change is propagated to any other devices in the network that are affected. The configuration can then be imported into LoggerNet's network map, providing a start-to-finish solution for PakBus network setup.

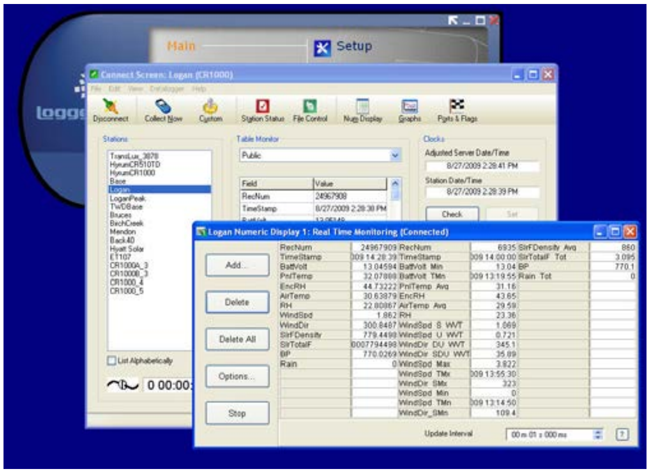
Select the EZSetup to walk through datalogger setup step-by-step.



The standard Setup screen along with the Connect screen are shown above.   Notes entered in the Setup screen are displayed in the Connect screen (lower right corner).



The Network Planner generates device settings and configures the LoggerNet network map for PakBus networks.



The Connect window's numerical monitor displays real-time and historical data.

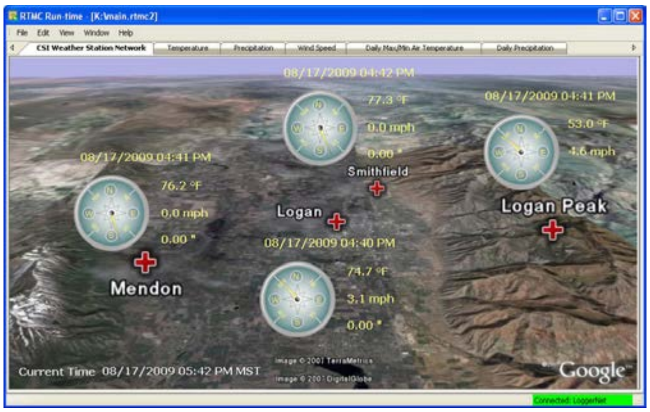
Connect and Datalogger Status

Connect

Connect allows you to perform maintenance on a station (including sending a program and setting the clock) while also viewing important datalogger status information, managing program and other files on a datalogger's CPU, and displaying numerical and graphical data. A new Table Monitor has been designed within the Connect window so that a table can be quickly selected from a drop-down list, and all values from that table displayed. The numerical and graphical displays are fully configurable and now allow saving a configuration that can then be reloaded for the original station or a different station. Any notes that have been added for a station during Setup will be displayed at the bottom right of the Connect window.

Status Monitor

The Status monitor is used to view the communication and data collection status of the overall datalogger network.



RTMC simultaneously displays data from any number of dataloggers on one display.

Advanced Data Display and File Viewing

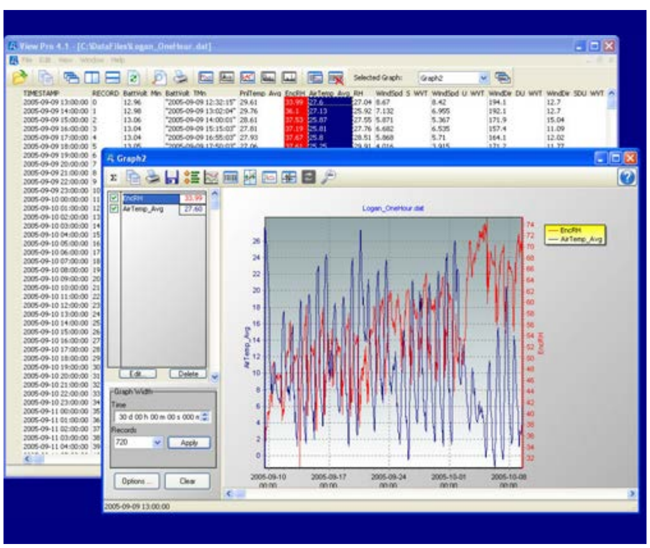
RTMC Development, RTMC Run-Time

RTMC is used to create custom displays of real-time data, flags, and ports. It provides digital, tabular, graphical, and Boolean data display objects, as well as alarms. You can combine data from multiple dataloggers on one display. Complex displays can be organized on multi-tabbed windows.

View Pro

View Pro is our newly designed data file viewer. Beginning with LoggerNet 4.1, View Pro can also be used to view data from a LoggerNet database table. Data can be viewed in numeric format or in one of several graphical layouts, including a line graph, X/Y plot, histogram, rainflow, and 2D/3D FFTs. Multiple data files can be opened at once, allowing side-by-side comparison of the data. There is no limit to the number of traces that can be displayed on a graph.

The Zoom feature offers a closer look at important data, and the Statistical window provides the average, standard deviation, minimum, and maximum for all points displayed on a graph. Graphs can be saved to a file (BMP, JPG, WMF, EMF, or PCX). View Pro supports all Campbell Scientific data file types (including the new CSIXML format).



View Pro displays historical data in a tabular or graphical format.

Programming

Full-featured Programming Tools

LoggerNet offers two full-featured programming tools—the CRBasic Editor and Edlog. The CRBasic Editor uses syntax similar to BASIC programming language to provide sophisticated programming capabilities for our CR6, CR300, CR200-series, CR800/CR850, CR1000, CR3000, CR5000, and CR9000(X) dataloggers. The CRBasic Editor in LoggerNet 4 includes new functionality to support encrypting a file prior to sending it to the datalogger and support for user-defined functions. Edlog provides programming capabilities for our CR500, CR510, CR10(X), 21X, CR23X, and CR7 dataloggers.

Simple Program Generator

For those who prefer a simpler means of programming their dataloggers, LoggerNet 4 includes Short Cut for Windows (SCWin). SCWin provides a wizard-like interface for generating programs for all Campbell Scientific dataloggers and supports all of the popular sensors we offer, as well as user-created custom sensor files (using an existing sensor file as the starting point). You can use a program as generated by SCWin, or open it in the CRBasic Editor for further editing (for CR6, CR300, CR200-series, CR800, CR850, CR1000, CR3000, CR5000, and CR9000(X) dataloggers).

Troubleshooting

Troubleshooter

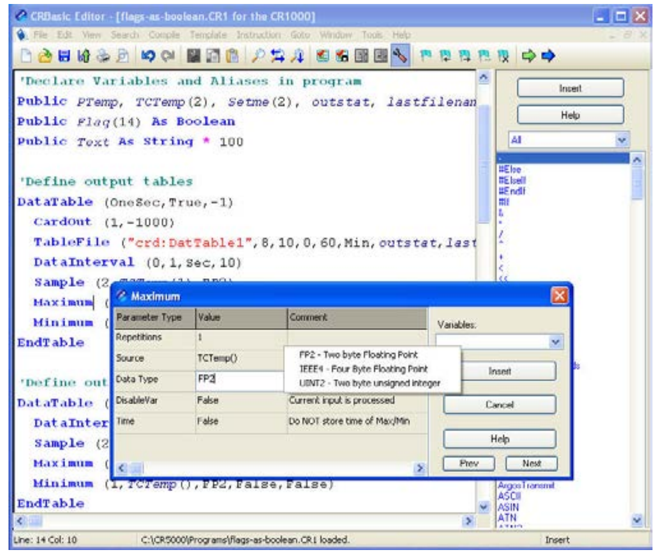
Troubleshooter helps you discover the cause of communication problems. Troubleshooter can be customized to display only the warnings of interest. In addition, you can click on any highlighted warning to bring up a menu that allows you to go to the Setup Screen or Status Monitor to fix the problem, bring up help describing the problem, or, in some cases, fix the problem directly.

PakBus Graph

PakBus Graph provides a graphical display of a PakBus network as known by the LoggerNet server, and quick access to the PakBus settings in LoggerNet and other PakBus devices.

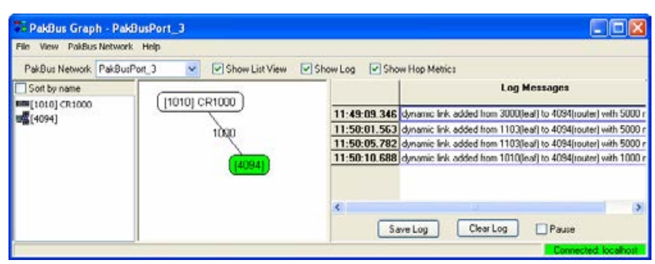
LogTool

The LogTool application is available to view operational log messages for the server as well as the low-level communication between the datalogger and the server.



CRBasic Editor offers keyword and other syntax highlighting and a parameter dialog box with drop-down lists for CRBasic programming.

Short Cut provides a wizard-like interface for generating datalogger programs.



Troubleshooter, PakBus Graph (shown above), and Log Tool are tools available for monitoring the status of a datalogger network and troubleshooting communication problems within that network.

DevConfig is used to configure dataloggers, communication devices, and programmable sensors.

The RWIS Administrator supports communication with RWIS weather stations such as the one shown above.

Other Applications

Device Configuration Utility (DevConfig)

DevConfig allows you to send new operating systems to dataloggers and other devices with flash memory, configure various PakBus® settings in dataloggers, and edit settings for communication peripherals such as the MD485 and RF401A. DevConfig can now be launched from within LoggerNet, without conflict with the remainder of the datalogger network. The latest DevConfig can be downloaded from our website.

RWIS Administrator

New in LoggerNet 4 is the RWIS Administrator. With the RWIS Administrator, LoggerNet is able to communicate with any station that implements the NTCIP (National Transportation Communications for ITS Protocol) Environmental Sensor Station interface.

Card Convert

CardConvert is used to convert and save binary data from a microSD card, CompactFlash® (CF) card, or PC Card. It can also perform other conversions. MicroSD cards are compatible with the CR6 datalogger. CF cards are compatible with our CR1000, CR3000, CR5000, and CR9000X dataloggers. PC Cards are compatible with our CR5000 and CR9000X dataloggers.

Split

Split is used to post-process data files and create printed reports. It sorts and combines data based on time or conditions, performs calculations on data values, converts between mixed-array "day of year" calendar dates and more traditional date/time stamps, and generates simple HTML-formatted reports.

Transformer

The Transformer tool converts Edlog programs to CRBasic programs. Specifically, it can convert a CR510 or CR10X program to a CR1000, CR800, or CR850 program, or a CR23X program to a CR3000 program.

Data Filer (LoggerNet Admin and LoggerNet Remote only)

Data Filer is an application used to retrieve data from the LoggerNet server's data cache and save that data to a file. It provides a way to manually retrieve data from a remote LoggerNet server and store the data on the local computer.

Data Export (LoggerNet Admin and LoggerNet Remote only)

Data Export is an application used to export data from the LoggerNet server's data cache to a third party computer program. Data Export "listens" for a request from another application and sends the requested data via a socket connection.

Service Manager (LoggerNet Admin only)

Service Manager is used to install LoggerNet as a service, and to manage the service on the PC. When run as a service, after a power failure, LoggerNet will resume data collection and scheduled task activities when power is restored to the computer—regardless of whether or not a user logs on to the computer.

Security Manager (LoggerNet Admin and LoggerNet Remote only)

Security Manager is used to set up security within the LoggerNet application to restrict access to certain functions. Individual user accounts are set up and assigned one of five levels of security, with different user privileges assigned to each level.

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LoggerNet Server Monitor (LoggerNet Admin and LoggerNet Remote only)

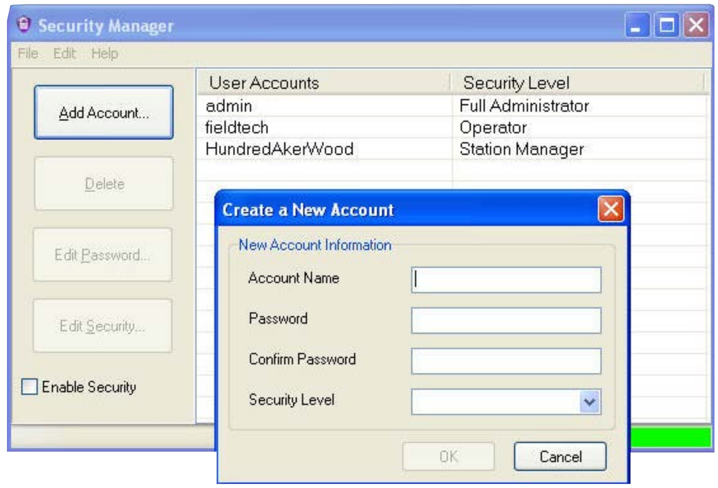
The LoggerNet Server Monitor is a utility that runs minimized with an icon in the Windows Status Area. It monitors the status of a LoggerNet server when it is being run as a service or being run on a remote computer. Multiple instances of the LoggerNet Server Monitor can be launched to monitor more than one server running on remote computers.

Hole Monitor (LoggerNet Admin and LoggerNet Remote only)

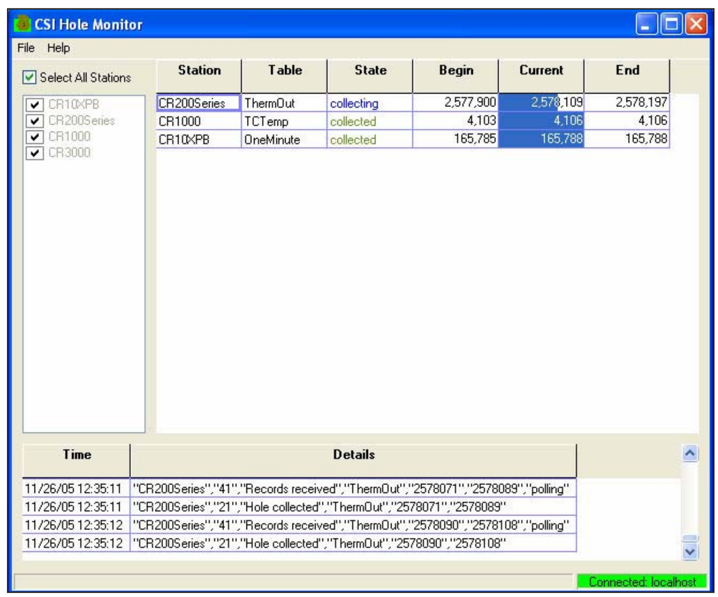
The Hole Monitor is used to monitor the hole collection activity for the dataloggers in a LoggerNet network. Holes are most often encountered with data collected from table-based dataloggers via data advise (data advise is used for data collection in large table-data RF networks). A hole occurs when there are missing records of data in the LoggerNet server's data cache for a datalogger.

CoraScript

CoraScript is a command line scripting tool, which can be used to configure the datalogger network from a command prompt.



Security Manager lets you set up multiple security accounts for access to the datalogger network.



The Hole Monitor lists datalogger stations and collection status for missing records in LoggerNet's data cache.

Requirements and Certificates

- PC Operating System: Windows 10, 8, 7, Vista, or XP (both 32- and 64-bit versions supported)
- Military Certificate of Networthiness (CoN):
  - LoggerNet 4.0 is certified as Cert #201004872
  - LoggerNet 4.x is certified as an upgrade to 4.0 and has ASC CoN ID 12274
  - Expires 1/13/2017

Related Products

Upgrades

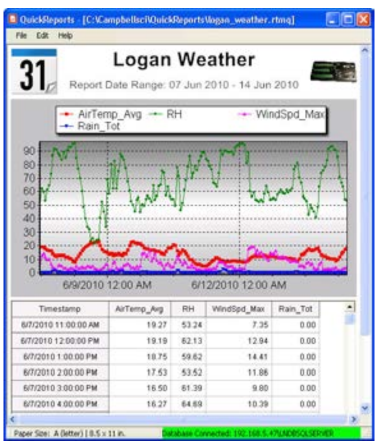
Upgrade pricing is available for current licenses of any version of LoggerNet. Contact Campbell Scientific for details.

Software Developers Kits

LoggerNet-SDK and LoggerNet Server-SDK allow software developers to create custom applications that communicate with the LoggerNet server and through the server to one or more dataloggers. Refer to the Software Development Kit product brochure for more information.

Separately Purchased Clients

Several clients may be purchased to add functionality to our LoggerNet and LoggerNetAdmin software packages. To use the clients, a licensed copy of the datalogger support software needs to be running on a PC. Functions supported by these clients include distributing data to remote files, OPC interface, PC displays, and web browsers. For more information, refer to: www.campbellsci.com/loggernet-clients



LNDB is one of the client application available for use with LoggerNet.

License for Use

LoggerNet is protected by United States copyright law and international copyright treaty provisions. Installation of LoggerNet (including the trial version) constitutes an agreement to abide by the provisions of its licensing agreement. The agreement grants the user a non-exclusive license to use the software in accordance with the following:

(1) The purchase of this software allows you to install and use a single instance of the software on one physical computer or one virtual machine only.

(2) This software cannot be loaded on a network server for the purposes of distribution or for access to the software by multiple operators. If the software can be used from any computer other than the computer on which it is installed, you must license a copy of the software for each additional computer from which the software may be accessed.

(3) If this copy of the software is an upgrade from a previous version, you must possess a valid license for the earlier version of software. You may continue to use the earlier copy of software only if the upgrade copy and earlier version are installed and used on the same computer. The earlier version of software may not be installed and used on a separate computer or transferred to another party.

(4) This software package is licensed as a single product. Its component parts may not be separated for use on more than one computer.

(5) You may make one (1) backup copy of this software onto media similar to the original distribution, to protect your investment in the software in case of damage or loss. This backup copy can be used only to replace an unusable copy of the original installation media.

LoggerNet software or its trial may not be sold, included, or redistributed in any other software or altered in any way without prior written permission from Campbell Scientific.

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

ENC24/30, ENC24/30S

Large Steel Enclosures

Rugged, Versatile

Campbell components mount easily and securely

Overview

The ENC24/30 and ENC24/30S are large steel enclosures that provide additional wiring room. They include a prepunched back-plate with one-inch-on-center holes suitable for attaching the datalogger, power supply, communication device, and measurement and control peripherals. The enclosures can be mounted to a building, tower, or other structures, but the users must provide their own mounting. The ENC24/30 is a painted mild-steel version, and the ENC24/30S is a stainless-steel version.

Benefits and Features

- Weather resistant to protect instruments
- Backplate designed so that Campbell Scientific components mount easily and securely

Cable-Entry Options

The ENC24/30 and ENC24/30S can be ordered with one to four 1.5-in. conduit openings or 12 individual cable-entry seals.

Conduit(s)

Multiple cables can be routed through one conduit. A plug included in the 7363 enclosure supply kit can reduce the conduit's internal diameter to 0.5 in. (1.3 cm). The enclosure supply kit also contains the putty used to seal each conduit.

Entry Seals

Entry seals have a more water-tight seal than the conduits. Each entry seal is compressed around one cable. A small vent is included to equalize pressure with the atmosphere. Theses enclosures are fitted with four large, four medium, and four small cable entry seals.

The acceptable cable diameters are:

- Large—0.236 to 0.512 in. (6 to 13 mm)
- Medium—0.231 to 0.394 in. (5.8 to 10 mm)
- Small—0.187 to 0.312 in. (4.75 to 8 mm)

Enclosure Supply Kit

The enclosure supply kit is included with our enclosures, but can be purchased separately. The assembled equipment aids in mounting your equipment inside the enclosure as well as monitoring relative humidity and sealing the enclosure. It includes desiccant packs, humidity indicator card, cable ties, putty, screws, grommets, and a Phillips-head screwdriver.

Ordering Information

Steel Enclosures

ENC24/30	Weather-Proof 24 x 30 Mild Steel Enclosure
ENC24/30S	Weather-Proof 24 x 30 Stainless-Steel Enclosure

Enclosure Hole Options

-SC	One Conduit for cable entry.
-DC	Two Conduits for cable entry.
-TC	Three Conduits for cable entry.
-QC	Four Conduits for cable entry.
-ES	12 individual-Cable Entry Seals for cable entry.

Accessories

27814	CD100 Mountable Display with Keypad Installed in Enclosure Lid. The CD100 provides the same operation and functionality as the CR1000KD keyboard display.
31551	Enclosure Leg Stack Mounting Kit
31143	Hinged Stack Bracket Kit
10525	Two-pack desiccant holder that mounts to the inside of the enclosure lid.
CS210	Enclosure Humidity Sensor.
6714	Desiccant Four-Unit Bag (Qty 20).

Antenna Cable/Bulkhead Installations

These accessories are offered for enclosures that will house a cellular phone, satellite transmitter, or radio. They allow an antenna to be connected to the outside of the enclosure.

31327	Compatible with the type N-to-type N antenna cable used with the GOES satellite transmitters.
31312	Compatible with the type N-to-RPSMA antenna cable used with the RF401-series spread spectrum radios, CR200(X)-series dataloggers, AVW200-series Interfaces, or CWB100-series wireless bases..
31315	Compatible with the type N-to-SMA antenna cable used with the RF450 radio, LS300G cellular modem, RavenXT-series cellular modems, or Iridium9522 satellite modem.
31330	Compatible with the type N-to-BNC antenna cable used with the ST-21 Argos Satellite Transmitter, RF320-series radios, RF310-series radios, or RF300-series radios.
31321	Compatible with the type N-to-TNC antenna cable used with the HUGHES9502 Inmarsat-BGAN transmitter.
31324	Compatible with the type SMA-to-SMA antenna cable used with the GPS device included with our GOES satellite transmitters, AL200 ALERT transmitter, and Iridium9522B satellite modem.

Specifications

- Dimensions: 61 x 76 x 20 cm (24 x 30 x 8 in)
- Weight: 21 kg (46 lb)

ENC24/30

- Construction: painted, 14-gauge, mild steel with door gasket and stainless steel hinges
- Enclosure Classification: NEMA Type 3R, 4, and 12 (before being modified for cable entry

ENC24/30S

- Construction: formed, 14-gauge, 304 stainless steel with door gasket and stainless steel hinges
- Enclosure Classification: NEMA Type 3R, 4, 12, and 13 (before being modified for cable entry)

MODEL 114 APPLICATION MEASUREMENTS:

Usable dimensions at incremental heights. Diameter is for circular shaped objects at listed heights. The length and width measurements are for rectangular shaped objects at listed heights. When choosing a rock enclosure for an application, note the shape of the rock as well as the application measurements. Measurements are listed in inches.

Height at	Length (max)	Width (max)	Diameter (max)	Notes
4	58	42.5	44	
4	72	4	44	Diagonal measurement; more width available at middle
8	58	41.5	43	
8	71	4	43	Diagonal measurement; more width available at middle
12	57	39.5	42	
12	70	4	42	Diagonal measurement; more width available at middle
16	57	38.5	41	
16	68	4	41	
20	56	37.5	41	
20	67	4	41	Diagonal measurement; more width available at middle
24	53	37.7	40	
24	66	4	40	Diagonal measurement; more width available at middle
28	52	36	39	
28	64	4	39	Diagonal measurement; more width available at middle
32	48	36	38	
32	57	4	38	Diagonal measurement; more width available at middle
36	46	35	38	
36	56	4	38	Diagonal measurement; more width available at middle
40	42	33	36	
40	53	4	36	Diagonal measurement; more width available at middle
44	42	32	35	
44	52	4	35	Diagonal measurement; more width available at middle
48	40	32	34	
48	50	4	34	Diagonal measurement; more width available at middle
52	38	31	34	
52	48	4	34	Diagonal measurement; more width available at middle
56	38	28	28	
56	45	4	28	Diagonal measurement; more width available at middle
58	39	28	28	
58	40	4	28	Diagonal measurement; more width available at middle

OUTDOOR CONCRETE STYLES

OLD WORLD PALETTE

Distressed finishes, stone surfaces and warm, masculine colors evoke the Old World style. Concrete gives you the ability to imitate the timeworn appeal of the pathways and patios of Tuscan and Mediterranean-style homes, while conveying a sense of New World permanence.

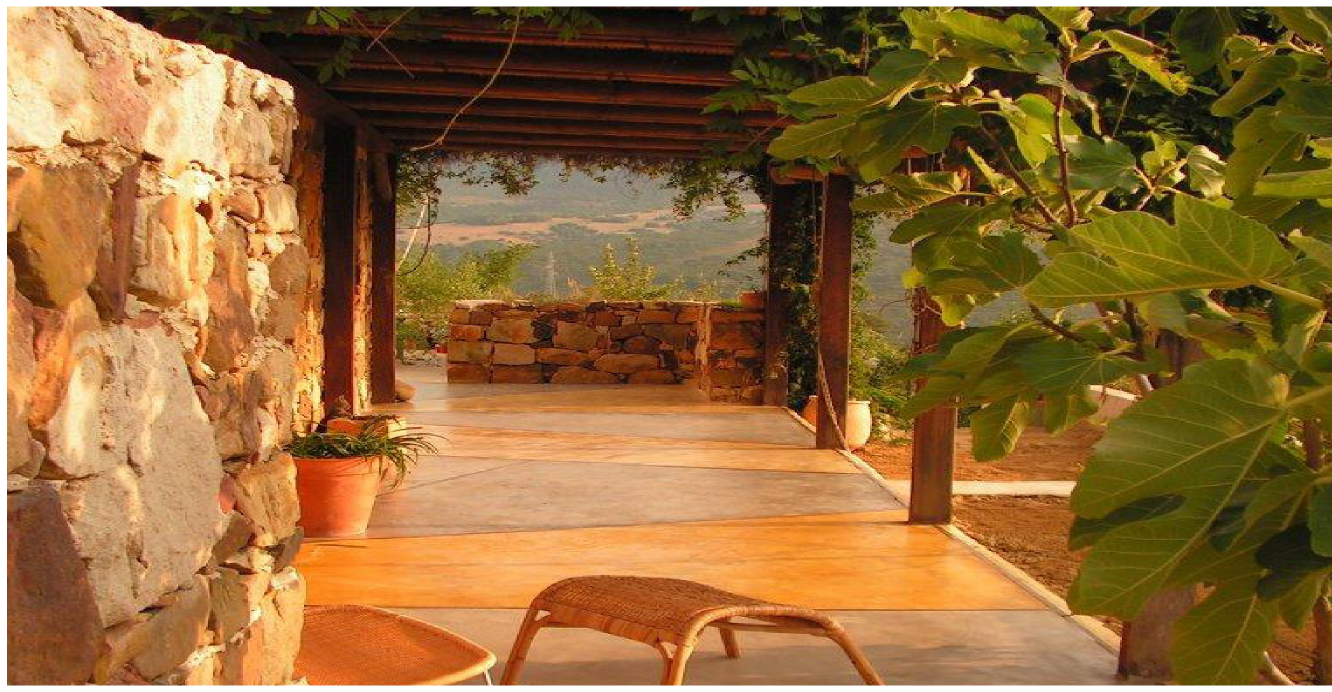
COLORS + FINISHES

Marsh Brown

Spicy Mustard

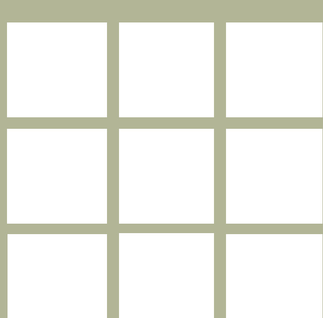
Urban Nature

Baked Terra Cotta

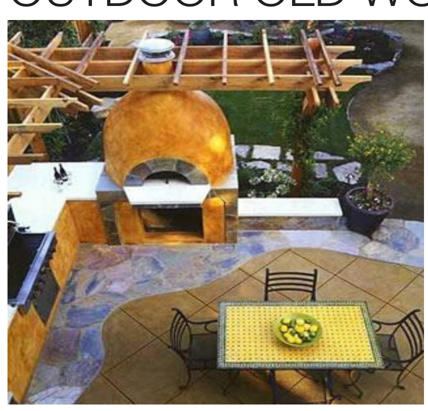


SHAPES & PATTERNS

You can achieve an Old Word style using concrete by incorporating small tiles or stone-like patterns for hardscape surfaces.

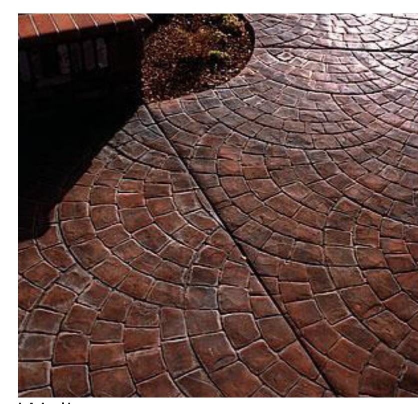


OUTDOOR OLD WORLD ELEMENTS



Patios

Driveways



Walkways

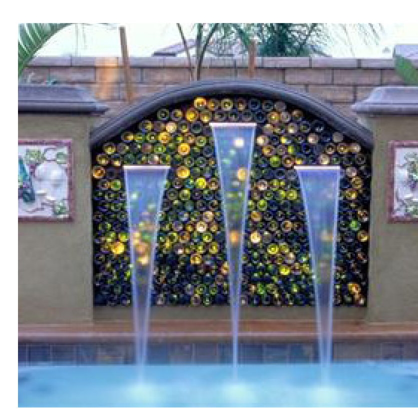
Walls

Outdoor kitchens

Fire pits

Steps

Fireplaces



Fountains

TEXTURES

Fractured Earth Seamless Stamp

European Fan Paver

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ConcreteNetwork.com

PHOTO: www.estudioarque.com; COLORS: www.benjaminmoore.com; ELEMENTS: www.tomralstonconcrete.com, www.gkrete.com, www.brickform.com, California Decorative Concrete, www.tomralstonconcrete.com, www.greenscenelandscape.com, www.ozarkpatternedconcrete.com, www.greenscenelandscape.com, www.greenscrenelandscape.com; TEXTURES: www.scofield.com

OUTDOOR CONCRETE STYLES

RANCH/RUSTIC PALETTE

Concrete in rich earth-tone colors and rough stonelike textures contributes to the rustic charm of ranch, farmhouse and country home styles. Using stains and dyes, it's also possible to "antique" existing concrete and give it an aged, weathered look.

COLORS + FINISHES

Rio Rancho Clay

Van Buren Brown

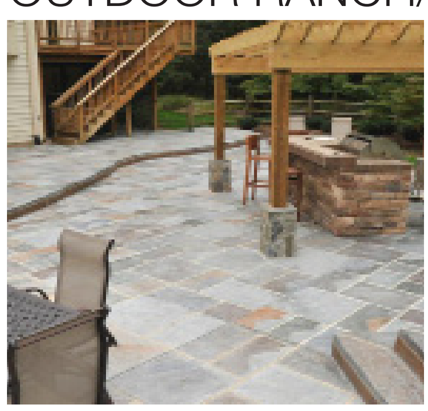
Glacial Till

Morning Light

SHAPES & PATTERNS

You can achieve a ranch or rustic style using concrete by incorporating irregular stone-like patterns or large organic spaces for hardscape surfaces.

OUTDOOR RANCH/RUSTIC ELEMENTS


Patios


Driveways


Walkways


Walls


Outdoor kitchens


Fire pits


Steps


Fireplaces


Water features

TEXTURES


Ashlar Stone


Vermont Slate

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OUTDOOR CONCRETE STYLES

TRADITIONAL PALETTE

Formal brick-lined and stone pathways often grace the exteriors of traditional homes. This same classic, unfussy style can be replicated in concrete by incorporating formal details such as scalloped edges, brick-patterned borders and symmetrical lines.

COLORS + FINISHES

Brick Red

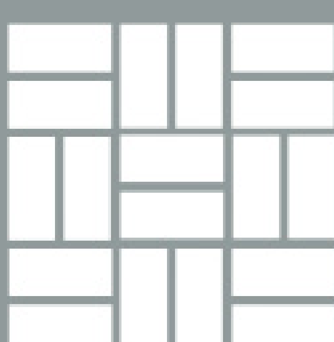
Midnight Oil

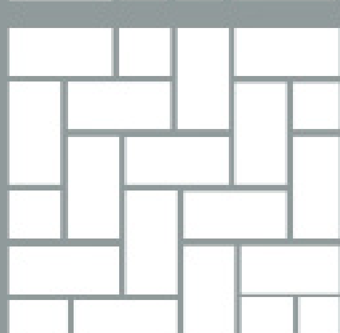
Gibraltar Cliffs

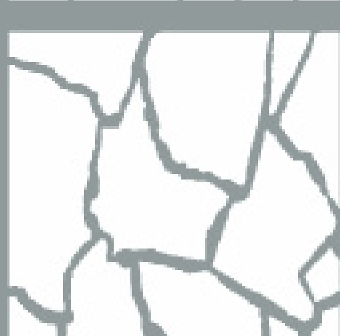
Gray Lake

SHAPES & PATTERNS

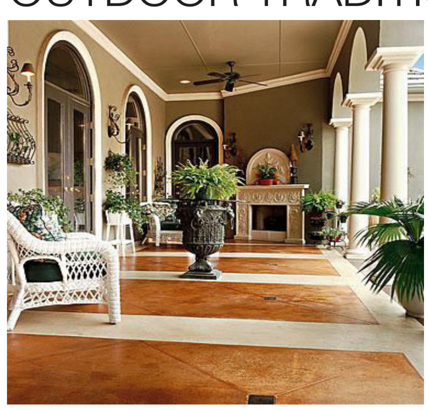
You can achieve a traditional style using concrete by incorporating repeating brick and natural cut patterns for hardscape surfaces.







OUTDOOR TRADITIONAL ELEMENTS

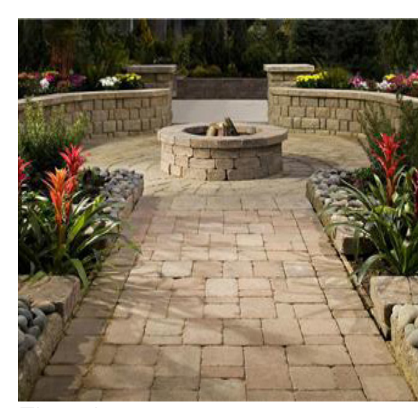

Patios


Driveways


Walkways

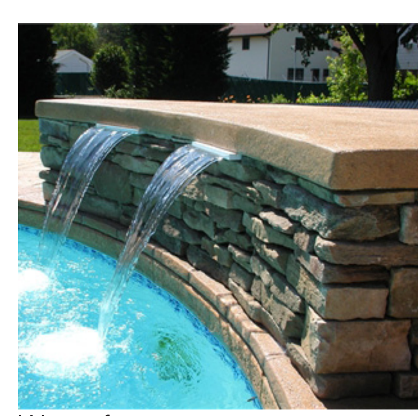

Walls


Outdoor kitchens


Fire pits


Steps


Fireplaces


Water features

TEXTURES


English Yorkstone


London Slate

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ConcreteNetwork.com

PHOTO: www.actionconcreteservices.com; COLORS: www.benjaminmoore.com; ELEMENTS: www.bomanite.com, www.ozarkpatternedconcrete.com, www.actionconcreteservices.com, www.flex-c-ment.com, www.nehardscapes.com, www.belmanpaversandconcrete.com, www.ozarkpatternedconcrete.com, www.greenscenelandscape.com, www.uniqueconcretenj.com; TEXTURES: www.scofield.com

OUTDOOR CONCRETE STYLES

TROPICAL PALETTE

Concrete is a natural fit for the beachy sand-and-sea vibe of an oceanside home. Colored in natural browns and sandy hues, concrete complements the vibrant turquoise blues and palm-tree greens of a tropical setting.

COLORS + FINISHES

Green Thumb

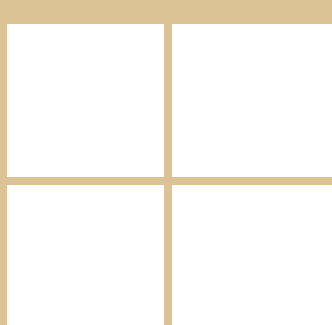
Tropical Oasis

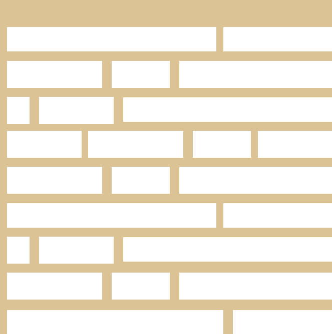
Shortbread

Gotham

SHAPES & PATTERNS

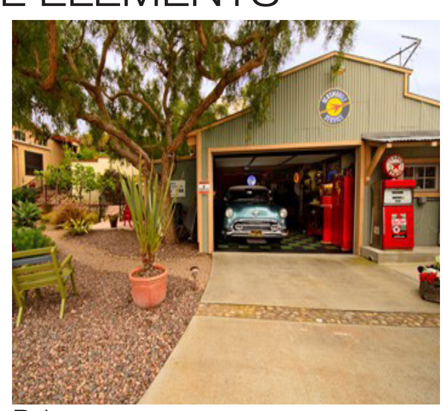
You can achieve a tropical style using concrete by incorporating subtle geometric-shaped or random stone patterns for hardscape surfaces.



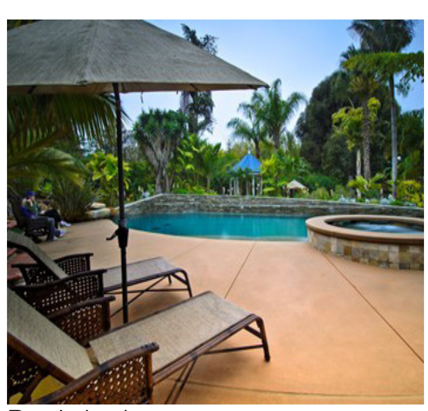


OUTDOOR TROPICAL ELEMENTS

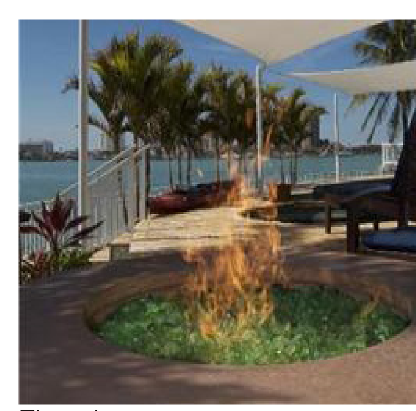

Patios


Driveways


Walkways

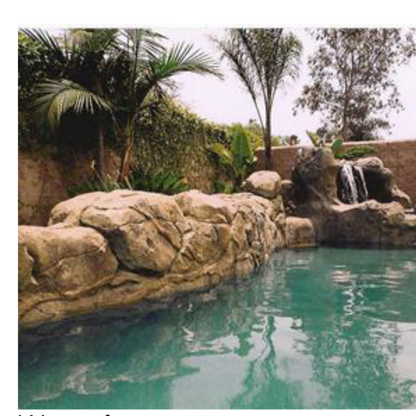

Pool decks


Outdoor kitchens


Fire pits


Steps


Fireplaces


Water features

TEXTURES


Pine Interlocking


Canyon Stone

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APPENDIX F

Equipment Sizing Calculations

Table G-1 - Alpine Lakes Power Consumption

Project No. 120045, Alpine Lakes, Chelan County, WA

System	Communication interval (days)	Gate adjustment interval (days)	Daily power drawdown (Ahr)	Summer Battery size (Ahr)	Summer Solar Size (W)	All Year Battery Size (Ahr)	All Year Solar Size (W)	Radio Repeater daily drawdown (Ahr)	Summer Battery size (Ahr)	Summer Solar Size (W)	All Year Battery Size (Ahr)	All Year Solar Size (W)
VHF Telemetry	1	1	1.654	28.95	13	206.76	52	1.812	31.72	13	226.54	52
Hughes Immarsat	1	1	0.871	15.25	6	108.92	25					
Iridium Satellite	1	1	0.788	13.80	6	98.55	23					
VHF Telemetry	2	2	1.237	21.65	9	154.62	35	1.218	21.32	9	152.25	35
Hughes Immarsat	2	2	0.468	8.20	4	58.55	14					
Iridium Satellite	2	2	0.424	7.42	3	53.03	12					
VHF Telemetry	7	7	0.939	16.43	7	117.38	27	0.793	13.88	6	99.14	23
Hughes Immarsat	7	7	0.181	3.16	2	22.57	6					
Iridium Satellite	7	7	0.164	2.87	2	20.51	5					

Notes

For this latitude Campbell Scientific recommends 336 hr battery reserve, this is used for Summer sizing

all year sizing assumes solar panel is burried in the snow for 100 consecutive days

All estimates are for 24Vdc systems except repeater, which is 12Vdc

ROTORK CONTROL SLUICE GATE SIZING CALCULATIONS

Customer Aspect Consulting - Taylor Dayton

Gate Location Wenatchee 24" C-10 Canal Gate

Required Data | Computed Data

1 CALCULATE TOTAL LIFTING FORCE F (THRUST)

F = 62.4 * A * P * f + W

f = Coefficient of Friction (0.6 for sluice gates)

H=	21.25	in.	Length of gate in inches
W =	21.25	in.	Width of gate in inches
A =	3.14	sq ft.	Area of gate in square feet
P =	30.00	ft	Efective head of water in feet
W =	300	lb	Total weight of gate and stem in pounds
Thrust	3,822	lbs	

2 CALCULATE TORQUE REFER TO ROTORK PUB. NO.AE 2/0.2 8/93

TORQUE = STEM FACTOR X F (THRUST)

Stem Type	Rising=R Non-Rising=NR	R
Rotating Stem	Y=Yes N=No	N
Stem Diameter -- in.		1.50
Stem -- TPI		4
Number of Starts		1
Lead		1/4
Stem Factor		0.012

TORQUE = 45 ftlb

3 DATA FOR ROTORK SIZING CD

TORQUE	45	ftlb	
THRUST	3,822	lb	
STEM DIA	1.50	in	
STROKE	300	sec	12 inches/minute
TURNS	85		
TOLERANCE	50	?+ / - stroke time %	

ROTORK CONTROL SLUICE GATE SIZING CALCULATIONS

Customer Aspect Consulting - Taylor Dayton

Gate Location Wenatchee 30" C-10 Canal Gate

Required Data | Computed Data

1 CALCULATE TOTAL LIFTING FORCE F (THRUST)

F = 62.4 * A * P * f + W

f = Coefficient of Friction (0.6 for sluice gates)

H=	26.60	in.	Length of gate in inches
W =	26.60	in.	Width of gate in inches
A =	4.91	sq ft.	Area of gate in square feet
P =	30.00	ft	Efective head of water in feet
W =	400	lb	Total weight of gate and stem in pounds

Thrust 5,919 lbs

2 CALCULATE TORQUE REFER TO ROTORK PUB. NO.AE 2/0.2 8/93

TORQUE = STEM FACTOR X F (THRUST)

Stem Type	Rising=R Non-Rising=NR	R
Rotating Stem	Y=Yes N=No	N
Stem Diameter -- in.		1.50
Stem -- TPI		4
Number of Starts		1
Lead		1/4
Stem Factor		0.012

TORQUE = 69 ftlb

3 DATA FOR ROTORK SIZING CD

TORQUE	69	ftlb	
THRUST	5,919	lb	
STEM DIA	1.50	in	
STROKE	300	sec	12 inches/minute
TURNS	106		
TOLERANCE	50	?+ / - stroke time %	

APPENDIX G

Opinions of Probable Cost

Table H-1 - Opinion of Probable Costs

Project No. 120045, Alpine Lakes, Chelan County, WA

			SQUARE LAKE		KLONOQUA LAKES		EIGHTMILE LAKE		COLCHUCK LAKE		SNOW LAKES	
ITEM	**UNIT**	**UNIT COST**	**QUANTITY**	**COST**	**QUANTITY**	**COST**	**QUANTITY**	**COST**	**QUANTITY**	**COST**	**QUANTITY**	**COST**
Install Monitoring Equipment												
Install Staff Gage / Lake Level Monitoring	EA	$5,000	1	$5,000	1	$5,000	1	$5,000	1	$5,000	0	$0
Install Staff Gage / Discharge Monitoring and Develop Rating	EA	$6,500	1	$6,500	1	$6,500	1	$6,500	1	$6,500	0	$0
Subtotal - Install Monitoring Equipment				**$11,500**		**$11,500**		**$11,500**		**$11,500**		**$0**
Gate Modifications												
Remove Existing Gate	LS	(Varies)	0	$0	1	$5,000	0	$0	1	$2,500	0	$0
Modify Existing Gate Appurtenances	LS	(Varies)	1	$3,500	0	$0	0	$0	0	$0	0	$0
Gate Tower	LS	(Varies)	0	$0	0	$0	0	$0	1	$24,000	0	$0
Install 30-inch Diameter Slide Gate	EA	$25,000	0	$0	1	$25,000	0	$0	1	$25,000	0	$0
Subtotal - Existing Control Gate Modifications				**$3,500**		**$30,000**		**$0**		**$51,500**		**$0**
Automate Gates/Valves to Optimize Releases												
Motorized Valve or Gate Actuator	EA	$20,000	1	$20,000	1	$20,000	0	$0	1	$20,000	1	$20,000
Power, Controls and Communications	EA	$25,000	1	$25,000	1	$25,000	0	$0	1	$25,000	1	$25,000
Controls Enclosure	LS	(Varies)	1	$11,000	1	$11,000	0	$0	1	$11,000	0	$0
Repeater Station	EA	$20,600	0.25	$5,150	0.25	$5,150	0.25	$5,150	0.25	$5,150	1	$20,600
Base Station	EA	$18,400	0.25	$4,600	0.25	$4,600	0.25	$4,600	0.25	$4,600	1	$18,400
Subtotal - Automate Gate to Optimize Releases				**$65,750**		**$65,750**		**$9,750**		**$65,750**		**$84,000**
		`										
Subtotal - All Work				**$80,750**		**$107,250**		**$21,250**		**$128,750**		**$84,000**
Mobilization Costs (Assumes Use of Helicopter)				**$31,056**		**$33,044**		**$26,594**		**$34,656**		**$11,300**
Miscellaneous Mobilization/Demobilization	7.5%			$6,056		$8,044		$1,594		$9,656		$6,300
Helicopter Mobilization/Demoblization/Rental				$25,000		$25,000		$25,000		$25,000		$5,000
Construction Subtotal				**$111,806**		**$140,294**		**$47,844**		**$163,406**		**$95,300**
Contingency	25.0%			$27,952		$35,073		$11,961		$40,852		$23,825
Engineering, Permitting and Administration	20.0%			$22,361		$28,059		$9,569		$32,681		$19,060
Sales Tax	8.2%			$13,294		$16,681		$5,689		$19,429		$11,331
Total Project Cost				**$175,413**		**$220,107**		**$75,062**		**$256,368**		**$149,516**

Table H-2 - Operations and Maintenance Cost Estimate

Project No 120045, Alpine Lakes, Chelan County, WA

O&M Element	Unit Cost	Unit	Qty	Total Cost	Notes
Actuators				**$7,700**	
Preventative Maintenance				**$1,700**	
Labor	$7,500	year	0.20	$1,500	100 hours labor @ $75 / hr, Once every 5-years
Equipment	$100	year	1.00	$100	nominal hand toolls and equipment / year
Materials	$500	year	0.20	$100	$500 materials, Once every 5-years
Operations				**$2,000**	
Labor	$50	hr	40.00	$2,000	40 hours of operational labor (system), yearly
Repair / Replacement (Labor, Equipment, Materials)				**$4,000**	
Actuators	$100,000	year	0.04	$4,000	Replacement cost of actuator, 25-year estimated life
Electrical Equipment (Controls and Communications)				**$20,450**	
Preventative Maintenance				**$2,200**	
Labor	$10,000	year	0.20	$2,000	100 hours labor @ $100 / hr, Once every 5-years
Equipment	$100	year	1.00	$100	nominal hand toolls and equipment / year
Materials	$500	year	0.20	$100	$500 materials, Once every 5-years
Operations				**$1,000**	
Labor	$50	hr	20.00	$1,000	40 hours of operational labor (controls troubleshooting), yearly
Repair / Replacement (Labor, Equipment, Materials)				**$17,250**	
Controls and Communications Equipment	$125,000	year	0.10	$13,000	Replacement cost of equipment, 10-year estimated life
Solar Panel Replacement	$2,500	year	0.10	$250	Replacement solar panel, 10-year estimated life
Batteries	$20,000	year	0.20	$4,000	Replacement battery banks, 5-year estimated life
Monitoring Equipment				**$1,550**	
Preventative Maintenance				**$1,000**	
Labor	$5,000	year	0.20	$1,000	40 hours labor @ $125 / hr, Once every 5-years
Repair / Replacement (Labor, Equipment, Materials)				**$550**	
Transducer Replacement	$5,000	year	0.10	$500	Transducer replacement, every 10-years
Staff Gage Replacement	$1,000	year	0.05	$50	Repair / Replace Staff Gage, Every 20-years
Miscellaneous				**$6,000**	
Operations and Maintenance				**$6,000**	
Labor (Misc System Operation)	$50	hr	40.00	$2,000	40 hours misc labor @$50, yearly
Equipment (Helicopter Support)	$15,000	year	0.20	$3,000	3-days misc. helicopter support, every 5-years
Materials and Equipment (Misc.)	$1,000	year	1.00	$1,000	$1,000 materials and equipment, yearly
Total				**$35,700**	

APPENDIX D

WDFW Priority Species and Preferred Habitats that Occur in Chelan County and the Alpine Lakes Area

Table 6
WDFW Priority Species and Preferred Habitats that Occur in Chelan County and the Alpine Lakes Area

Common Name (Scientific Name)	State Status[1]	Priority Area[1]	PHS Habitat Description[2]	Chelan County[1]	Alpine Lakes Area[3]
Birds					
American white pelican (*Pelecanus erthrhynchos*)	Endangered	Breeding areas, regular concentrations	Rivers, lakes, reservoirs, estuaries, bays, and open marshes, sometimes inshore marine habitats.	**X**	
Bald eagle (*Haliaeetus leucocephalus*)	Sensitive	Breeding areas, communal roosts, regular concentrations	Roost, nest habitat and forage areas near lakes, reservoirs, rivers, and uneven-aged coniferous forest stands with readily available food source (fish and carrion).	**X**	
Black-backed woodpecker (*Picoides arcticus*)	Candidate	Breeding areas, regular occurrences	Associated with boreal and montane coniferous forests, especially in areas with standing dead trees such as burns, bogs, and windfalls.	**X**	
Black-crowned night-heron (*Nycticorax nycticorax*)	Priority	Breeding areas	Marshes, swamps, wooded streams, mangroves, shores of lakes, ponds, lagoons; salt water, brackish, and freshwater situations.	**X**	
Burrowing owl (*Athene cunicularia*)	Candidate	Breeding areas, foraging areas, regular concentrations	Open grasslands, especially prairie, plains, and savanna, sometimes other open areas such as vacant lots near human habitation or airports. Spends much time on the ground or on low perches such as fence posts or dirt mounds.	**X**	
Cavity-nesting ducks: wood duck (*Aix sponsa*), Barrow's goldeneye (*Bucephala islandica*), common goldeneye (*Bucephala clangula*), bufflehead (*Bucephala albeola*), hooded merganser (*Lophodytes cucullatu* s)	Priority	Breeding areas	Nest primarily in late successional forests and riparian areas adjacent to low gradient rivers, sloughs, lakes, and beaver ponds. Nest almost exclusively in tree cavities, which offer protection from weather and predators. Snags and cavity trees near shallow wetlands are ideal for brood.	**X**	
Common loon (*Gavia immer*)	Sensitive	Breeding sites, migratory stopovers, regular concentrations	Breeding habitat includes usually clear lakes containing both shallow and deep water areas. Nest sites are found on small islands, quiet backwaters, mainland shores, marshy portions of lakes. In winter and during migration, use inland lakes and rivers and marine and estuarine coastal waters.	**X**	
Dusky grouse (*Dendragapus obscurus*)	Priority	Breedings areas, regular concentrations	Coniferous forest, especially fir, mostly in open situations with a mixture of deciduous trees and shrubs	**X**	
Eastern Washington breeding concentrations of: Phalaropes (*Scolopacidae*), stilts (*Recurvirostridae*), avocets (*Recurvirostridae*)	Priority	Breeding areas	None provided.	**X**	
Eastern Washington nonbreeding concentrations of: grebes (*Podicipedidae*), cormorants (*Phalacrocoracidae*)	Priority	Breeding areas	None provided.	**X**	
Flammulated owl (*Otus flammeolus*)	Candidate	Breeding sites, regular concentrations	Montane forest, usually open conifer forests containing pine, with some brush or saplings (typical of the physiognomy of pre-European settlement ponderosa pine forests).	**X**	
Golden eagle (*Aquila chrysaetos*)	Candidate	Breeding areas, foraging areas	Open, arid plateaus deeply cut by streams and canyons, western shrub-steppe and grassland communities and transition zones between shrub, grassland, and forested habitat. Sometimes found in mature and old-growth forests near the edges of clearcuts in western Washington. Nests generally are located on cliffs and are occasionally located in trees.	**X**	**X**
Great blue heron (*Ardea herodias*)	Priority	Breeding areas	Nesting habitat typically consists of mature forest. Breeding herons feed in wetland complexes, large rivers and creeks, and small lakes. Fall/Winter often prey on small mammals in fallow, freshly plowed, or mowed fields and in grasslands habitats.	**X**	
Harlequin duck (*Histrionicus histrionicus*)	Priority	Breeding areas, regular concentrations in salt water	Require fast-flowing water with loafing sites nearby. Streams usually have substrate that ranges from cobble to boulder, with adjacent vegetated banks. They have been found more often at distances >50 meter (164 feet) from roads or trails, and in stream reaches with mature and old-growth forest cover. Stream alterations that would cause greater surface runoff, changing water levels, or lower macroinvertebrate levels should be avoided.	**X**	

Table 6
WDFW Priority Species and Preferred Habitats that Occur in Chelan County and the Alpine Lakes Area

Common Name (Scientific Name)	State Status[1]	Priority Area[1]	PHS Habitat Description[2]	Chelan County[1]	Alpine Lakes Area[3]
Lewis' woodpecker (*Melanerpes lewis*)	Candidate	Breeding areas, regular occurrences	Open forest and woodland, often logged or burned, including oak, coniferous forest (primarily ponderosa pine, riparian woodland and orchards, less commonly in pinyon-juniper.	X	
Loggerhead shrike (*Lanius ludovicianus*)	Candidate	Regular concentrations, regular occurrences in breeding areas	Open country with scattered trees and shrubs, savanna, and, occasionally, open woodland; often perches on poles, wires, or fenceposts.	X	
Mountain quail (*Oreortyx pictus*)	Priority	Any occurrence	Mixed evergreen-deciduous forests, regenerating clearcuts, forest and meadow edges, chaparral slopes, shrub-steppe, and mixed forest/shrub areas. Seek brush, hardwood, and conifer communities for nesting, brooding in cool, moist bottoms of draws and canyons.	X	
Northern goshawk (*Accipiter gentilis*)	Candidate	Breeding areas. Including alternate nest sites, post-fledging foraging areas	All forested regions with >50% closed canopy with multiple layers.	X	
Prairie falcon (*Falco mexicanus*)	Priority	Breeding areas	Primarily open situations, especially in mountainous areas, steppe, plains, or prairies.	X	
Peregrine falcon (*Falco peregrinus*)	Sensitive	Breeding areas, regular occurrences	Nest on cliffs, typically 45 meters (150 feet) or more in height. Nest on off-shore islands and ledges on vegetated slopes. Wetlands, especially intertidal mudflats, estuaries, and coastal marshes, are key feeding areas in winter; maintain large trees and snags in these areas.	X	
Pileated woodpecker (*Dryocopus pileatus*)	Candidate	Breeding areas	Old-Growth and Mature Forest	X	
Sage sparrow (*Amphispiza belli*)	Priority	Breedings areas, regular occurrences in suitable habitat during breeding season	Found from sea level to alpine; strongly associated with sagebrush for breeding.	X	
Sage thrasher (*Oreoscoptes montanus*)	Candidate	Breedings areas, regular occurrences in suitable habitat during breeding season	Sagebrush plains, primarily in arid or semi-arid situations, rarely around towns.	X	
Sooty grouse (*Dendragapus fuliginosus*)	Priority	Breedings areas, regular concentrations	During breeding season, can be found in forested habitats from sea level to thousands of feet in elevation. Lowland forest in the preferrred habitat for this species. In winter, found almost entirely in coniferous forests.	X	
Vaux's swift (*Chaetura vauxi*)	Candidate	Breeding areas, communal roosts	Strongly associated with old-growth and mature forests. They require hollow chambers in large snags or live trees with broken tops for nesting and night roosting.	X	
Waterfowl concentrations (*Anatidae,* excluding Canada geese in urban areas)	Priority	Significant breeding areas, regular concentrations in winter	None provided.	X	
Western grebe (*Aechmophorus occidentalis*)	Candidate	Breeding areas, regular concentrations, migratory stopovers, regular occurrences in winter	Marshes, lakes, and bays; in migration and winter also sheltered seacoasts or rivers. Nests anchored to living vegetation on large inland bodies of water very close to deep water to allow bird to swim submerged.	X	
White-headed woodpecker (*Picoides albolarvatus*)	Candidate	Breeding sites, regular occurrences	Montane coniferous forest, primarily pine and fir.	X	
Terrestrial Mammals					
Bighorn sheep (*Ovis canadensis*)	Priority	Breeding areas, regular concentrations	Occur in mesic to xeric, alpine to desert grasslands or shrub-steppe in mountains, foothills, or river canyons.	X	
Black-tailed jackrabbit (*Lepus californicus*)	Candidate	Regular concentrations	Inhabits open plains, fields, and deserts; open country with scattered thickets or patches of shrubs.	X	
Cascade red fox (*Vulpes vulpes cascadensis*)	Candidate	Any occurrence	None provided.	X	

Table 6
WDFW Priority Species and Preferred Habitats that Occur in Chelan County and the Alpine Lakes Area

Common Name (Scientific Name)	State Status[1]	Priority Area[1]	PHS Habitat Description[2]	Chelan County[1]	Alpine Lakes Area[3]
Elk (*Cervus elaphus*)	Priority	Calving areas, migration corridors, regular concentrations in winter and in foraging areas along coastal waters	Forested areas in winter; summer can be moderate-sized patches of forage openings and cover areas.	X	
Fisher (*Martes pennanti*)	Endangered	Any occurrence	Mature, uneven stands of coniferous and mixed coniferous/deciduous with extensive continuous canopy where 50% to 90% of overstory is evergreen that is optimal winter habitat.	X	
Marten (*Martes americana*)	Priority	Regular occurrence	Mixed age forests of a variety of species composition.	X	X
Mountain goat (*Oreamnos americanus*)	Priority	Breeding areas, regular concentrations	Alpine and subalpine habitat; steep grassy talus slopes, grassy ledges of cliffs, or alpine meadows, usually at timberline or above. May seek shelter and food in stands of spruce or hemlock in winter.	X	
Northwest white-tailed deer (*Odocoileus virginianus ochrorus*)	Priority	Regular concentrations in winter, migration corridors	Occupy many types of habitats in mountains and lowlands, including various forests and woodlands, forest edges, shrublands, grasslands with shrubs, and residential areas.	X	
Preble's shrew (*Sorex preblei*)	Candidate	Any occurrence	Habitats include arid and semiarid shrub-grass associations and openings in montane coniferous forests dominated by sagebrush.	X	
Rocky mountain mule deer (*Odocoileus hemionus hemionus*)	Priority	Breeding areas, migration corridors, regular concentrations in winter	Occupy many types of habitats in mountains and lowlands, including various forests and woodlands, forest edges, shrublands, grasslands with shrubs, and residential areas.	X	
Western gray squirrel (*Sciurus griseus*)	Threatened	Any occurrence	Pine and oak typical. Transitional, conifer-dominated areas that merge with open patches of oak and other deciduous trees. Mature and large seeded mast-producing trees provide abundant food and sites for nest construction.	X	
White-tailed jackrabbit (*Lepus townsendii*)	Candidate	Regular concentrations	Open grasslands and sagebrush plains. At higher elevations found in open areas adjacent to pine forests and in alpine tundra.	X	
Amphibians					
Columbia spotted frog (*Rana luteiventris*)	Candidate	Any occurrence	Highly aquatic; rarely found far from permanent quiet water; usually occurs at the grassy/sedgy margins of streams, lakes, ponds, springs, and marshes. May disperse into forest, grassland, and brushland during wet weather, and may traverse uplands to reach wintering sites.	X	
Western toad (*Anaxyrus boreas*)	Candidate	Any occurrence	Occur in a wide variety of habitats ranging from desert springs to mountain wetlands, and various upland habitats around ponds, lakes, reservoirs, and slow-moving rivers and streams. For shelter, they dig burrows in loose soil or seclude themselves under logs or rocks. Egg laying sites include shallow areas of ponds, lakes, or reservoirs, or pools of slow-moving streams.	X	
Reptiles					
Sagebrush lizard (*Sceloporus graciosus*)	Candidate	Any occurrence	Sagebrush and other types of shrublands, also pinyon-juniper woodland and openly wooded areas of ponderosa pine or Douglas-fir; occupied areas have open ground and some low bushes	X	
Sharptail snake (*Contia tenuis*)	Candidate	Any occurrence	Moist situations in pastures, meadows, oak woodlands, broken chaparral, and the edges of coniferous or hardwood forests.	X	
Bivalves					
California floater (*Anodonta californiensis*)	Candidate	Any occurrence	Freshwater	X	

Table 6
WDFW Priority Species and Preferred Habitats that Occur in Chelan County and the Alpine Lakes Area

Common Name (Scientific Name)	State Status[1]	Priority Area[1]	PHS Habitat Description[2]	Chelan County[1]	Alpine Lakes Area[3]
Bats					
Roosting concentrations of: Big-brown bat (*Eptesicus fuscus*), Myotis bats (*Myotis* spp.), Pallid bat (*Antrozous pallidus*)	Priority	Regular concentrations in naturally occurring breeding areas and other communal roosts	None provided.	**X**	
Townsend's big-eared bat (*Corynorhinus townsendii*)	Candidate	Any occurrence	This species uses caves, mines, hollow trees, and built structures for roosting. Westside lowland conifer-hardwood forest, ponderosa pine forest and woodlands, mixed highland conifer forest, eastside mixed conifer forest, shrub-steppe, and both eastside and westside riparian wetlands.	**X**	

Notes:

1. Washington Department of Fish and Wildlife. 2008. Priority Habitat and Species List. Olympia, Washington. 177 pp.
2. NatureServe: An Online Encyclopedia of Life. Available from: http://explorer.natureserve.org/servlet/NatureServe?init=Species. Accessed on: October 20, 2016.
3. Washington Department of Fish and Wildlife, 2016. WDFW PHS online. Cited: July 7, 2016. Available from: http://wdfw.wa.gov/mapping/phs/.

PHS: Priority Habitats and Species

WDFW: Washington Department of Fish and Wildlife

APPENDIX E

Easement Agreements and Deeds

Icicle Irrig. Exchange
(Alpine Lakes)

DIRECTORS
LYMAN B. BARDIN
RONALD K. PFLUGRATH
KENT A. CHRISTENSEN

MONROE WASHBURN, SECRETARY, MANAGER
JANET ROGERS, DEPUTY SECRETARY

ICICLE IRRIGATION DISTRICT

CHELAN COUNTY
308 SOUTH DIVISION STREET – 509/782-2561
CASHMERE, WASHINGTON 98815

WENATCHEE N.F.
FEB 2 '87

SUP	DEP
AO	LMP
AS	ELM ACT
BUD	LDS
FISC	~~LMIN~~
I&E	FIRE
IP	REC
PER	ARCH
DR	RWWS
EC	TBR
RDS	FSL

DIST. RESPONDED

January 29, 1987

Wenatchee National Forest
Donald H. Smith, Forest Supervisor
Post Office 811
Wenatchee, Washington 98801

RE: Decision Notice of Categorical Exclusion Leavenworth Ranger District
Wenatchee National Forest Enchantment Core Management
Wenatchee World, Friday, January 16, 1987

Dear Mr. Smith:

This letter is being written to inform you that the Icicle Irrigation District and the Peshastin Irrigation District have entered into a land exchange agreement with the Forest Service, Department of Agriculture relative to Colchuck Lake, Eight Mile Lake and Klonaqua Lake and the Snow Lakes Trailhead. Within this agreement, the Forest Service acknowledges that there is reserved to the Districts a nonexclusive, perpetual easement across, through, along and upon the property for the purpose of maintenance, repair, operation, modification, upgrading and replacement of all facilities presently located in and upon the property, together with a nonexclusive right of ingress to and egress from all such facilities for all such purposes.

The Districts 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. These rights include the right to regulate water level to all facilities located upon the property. In performing maintenance, repair operation, modification, upgrading and replacement of facilities located in or upon the property, the District will not without the prior written consent of the Forest Service, which consent shall not be unreasonably be withheld, materially increase the size or scope of the facilities.

The easements reserved by the District and granted by the United States of America, Forest Service, herein shall be perpetual unless the Districts, their assigns or heirs, abandon such faciliteis for a period of five successive years. The United States of America, Forest Service, acknowledges that the interests in real property, improvements to real property and water rights are used by the Districts on an "as-needed" basis to supplement the water supply of the Districts. No abandonment shall be deemed to take place unless the Districts have ceased to use the interest in real property, the water rights and the improvements to real property on an "as-needed" basis, for five successive years.

The United States shall charge no fee for the exercise of the rights reserved or granted hereunder, nor shall it require any further permission for the Districts to exercise the rights granted or reserved herein.

Because the Districts reserve the aforementioned rights, it is this writer's hopes that mandatory permits with a limited number issued and the fee charge on reservation permits will not pertain to the Icicle or Peshastin Irrigation Districts. During the period after May 1 of each year and running through November 31 of each year, the Districts need to make random inspections of the facilities for the purpose of water regulation, water storage and facility maintenance. Some of these trips are on the spur of the moment due to numerous circumstances and the thought of having to obtain a mandatory permit or not being able to enter the area at all on a particular day, would pose a hardship on the Districts' overall function of delivering irrigation water in an efficient manner. It is the desire of the Districts that some acknowledgement of exemption from the practice of mandatory permits on a first-come, first-serve basis and the fee charge on reservation permits, be made by the United States Forest Service for the Districts.

The Districts would appreciate a response to the above concerns at your earliest convenience.

Sincerely,

ICICLE IRRIGATION DISTRICT
PESHASTIN IRRIGATION DISTRICT

Monroe Mashburn Secretary/Manager

Monroe Mashburn, Secretary/Manager

C.C. Leavenworth Ranger Station
Attention: Steve Morton
600 Sherbourne
Leavenworth, Washington 98826

MM/jr

RIGHTS PREVIOUSLY CONVEYED OR PERMITTED BY THE UNITED STATES

1. Existing Contracts/Agreements/Memorandums of Understanding - NONE

2. Existing public roads - NONE.

3. Special Use Permits -

   a. SU Permit dated 3/21/32 for a right of way for a power transmission line granted to Puget Sound Power and Light Company (now Chelan County P.U.D.), over and across the SW1/4SW1/4 sec. 15, T.24N., R.18E., W.M.

   b. SU Permit dated 6/30/23 for a right of way for an irrigation canal, flume and tunnel granted to Icicle Irrigation District over and across the E1/2SE1/4 sec. 28, and lots 2 to 4 inclusive, sec. 26, T. 24 N., R. 17 E., W.M.

   c. SU Permit dated 9/14/12 for a right of way for a water pipeline granted to the City of Leavenworth over and across the SE1/4 sec. 28, T. 24 N., R. 17 E., W.M.

4. Grazing Permits - NONE.

5. Mining Claims - NONE.

6. Oil & Gas Leases - NONE.

7. Cost-Share Agreement Areas - NONE.

8. Power Site Classification Withdrawal - #224 dated 5/13/29 - (Affects lots 3 & 4, sec. 26, and SE1/4 sec. 28, T. 24 N., R. 17 E., W.M.) Will be revoked before documents are conveyed to Icicle Irrigation District.

9. Other Outstanding Rights:

   a. Certificate of Water Rights in Icicle Creek and Snow Creek, a tributary to Icicle Creek, for 83.33 second feet issued to Icicle Irrigation District on 9/18/34, and recorded in Volume F, Page 2 of Water Right Certificates at Olympia, Washington. Intakes are located in SW1/4SW1/4 sec. 27 and NE1/4SE1/4 sec. 28, T. 24 N., R. 17 E., W.M.

   b. The interests, rights and privileges of both the United States of America and Joseph L. Hughes and the Pacific National Bank of Seattle, as set forth in that certain easement dated 10/17/67 and recorded in Volume 602, Page 451, Chelan County, Washington.

Certified &
Prepared By: /s/ Dorylee M. Engle
Dorylee M. Engle, Land Law Examiner
Title Examiner for the Washington Forests

Date 6/27/89

Icicle Irrigation District Land Exchange
Wenatchee #139 - OR 44205(W)

tchee National Forest - Chelan County, Washington

T. 23 N., R. 19 E., W.M.
sec. 7, NE1/4SE1/4. 40.00 acres

WEEKS LAW STATUS - Acquired through donation from Chelan County #146, under the Clarke-McNary Act of June 7, 1924. Received Title Approval from the Office of General Counsel on 9/27/39. Surface rights use and management in U.S.A. Will be conveyed to Icicle Irrigation District by USDA Exchange Deed.

T. 24 N., R. 17 E., W.M.
sec. 26, lots 2 to 4 inclusive; 125.25 acres
sec. 28, SE1/4. 160.00 acres

RESERVED PUBLIC DOMAIN STATUS - Became NF System Lands by Proclamation dated 3/2/1907. Determination of surface rights under Serial No. OR 04264 on 5/7/1962 - use and management in U.S.A. Will be conveyed to Icicle Irrigation District by Patent.

Power Site Classification #224 - lots 3 & 4, sec. 26, and SE1/4 sec. 28.

T. 24 N., R. 18 E., W.M.

Changed and sent District 11/28/89

sec. 15, W1/2~~S~~W1/2SW1/4SW1/4, SE1/4SW1/4SW1/4SW1/4, done
and S1/2SE1/4SW1/4SW1/4. 17.50 acres

RESERVED PUBLIC DOMAIN STATUS - Acquired through land exchange from Peshastin Lumber & Box Company under General Exchange Act of 3/20/1922; Serial No. 018679, received Final Title Approval on 5/17/1941. Surface rights use and management in U.S.A. Will be conveyed to Icicle Irrigation District by Patent.

SUBJECT TO:

1. Easement for transmission and power lines to Puget Sound Power & Light Company dated 8/20/1930.

2. Rights of way of the Icicle Irrigation District for irrigation canals.

sec. 34, W1/2SE1/4. 80.00 acres

WEEKS LAW STATUS - Acquired through donation from Chelan County #D58, under the Clarke-McNary Act of June 7, 1924. Received Title Approval from the Office of General Counsel on 9/27/34. Surface rights use and management in U.S.A. Will be conveyed to Icicle Irrigation District by USDA Exchange Deed.

TERRENCE M. MCCAULEY
LAW OFFICES
100 NORTH DIVISION STREET
POST OFFICE BOX 836
CASHMERE, WASHINGTON 98815

AREA CODE 509
782-1023

December 6, 1989

Ms. Dorylee M. Engle
Land Law Examiner
United States Department of Agriculture
Forest Service
1022 First Avenue
Seattle, WA 98104-1008

Dear Dorylee:

Re: Forest Service - Icicle Land Exchange

I will be unable to review the land exchange files and proceed for two weeks because of a Supreme Court brief which I am obligated to write and file in the very near future. I do enclose for you a revised easement termination agreement adding a signature line for the third director, Mr. Ralph Kimmerly.

To save time, you could have this original agreement signed by Mr. Jackson on behalf of the Department of Agriculture and you could return the signed original to me. I could then obtain the signatures of the directors and take care of recording that agreement at the appropriate time.

Please call if you have any questions.

Very truly yours,

Terrence M. McCauley

TMM:ljt
Enclosure
cc: Mr. Monroe Mashburn
icla9

EASEMENT TERMINATION AGREEMENT

This agreement, made and entered into on the date last shown below, by and between the ICICLE IRRIGATION DISTRICT, a municipal corporation organized under the laws of the State of Washington, hereinafter referred to as "DISTRICT", and the UNITED STATES OF AMERICA acting by and through the U. S. Department of Agriculture, hereinafter referred to as "UNITED STATES",

WITNESSETH:

WHEREAS, DISTRICT and UNITED STATES have executed a certain land exchange agreement dated April 1, 1986 which is incorporated herein by this reference (hereinafter referred to as "Agreement" and,

WHEREAS, DISTRICT pursuant to the Agreement as conveyed by warranty deed certain real property in Chelan County, Washington to the UNITED STATES in which deed DISTRICT reserved certain easements and,

WHEREAS, DISTRICT and the UNITED STATES desire to set forth the terms and conditions on the basis of which the reserved easements shall terminate, now therefore,

In consideration of the agreement between DISTRICT and UNITED STATES and in consideration of the land exchange pursuant thereto and for valuable consideration, DISTRICT and the UNITED STATES agree as follows:

The easements reserved by DISTRICT in that certain warranty deed in which the DISTRICT conveyed certain real property in Chelan County, Washington to the UNITED STATES pursuant to the agreement shall be perpetual unless the DISTRICT, its successors and assigns, abandons DISTRICT facilities. <u>NO ABANDONMENT</u> for purposes of this agreement shall be deemed to have taken place unless the DISTRICT has ceased to use the interests in real property and easements, the water rights and the improvements to real property on an "as - needed" basis for five (5) consecutive years. In the event of such

TERRENCE M. MCCAULEY
LAW OFFICES
100 NORTH DIVISION STREET
POST OFFICE BOX 836
CASHMERE, WASHINGTON 98815
509/782-1023

COPY

abandonment for five (5) consecutive years, the easements shall terminate.

Dated this ______ day of ______________, 1989.

ICICLE IRRIGATION DISTRICT

By:

____
LYMAN B. BARDIN - Director

____
KENT CHRISTENSEN - Director

____
RALPH F. KIMMERLY

Attest:

____
MONROE MASHBURN - Secretary/Manager

THE UNITED STATES OF AMERICA

By:________________________________
Carlin B. Jackson
Director of Lands,
Pacific Northwest Region Forest Service
U.S. Department of Agriculture

TERRENCE M. MCCAULEY
LAW OFFICES
100 NORTH DIVISION STREET
POST OFFICE BOX 836
CASHMERE, WASHINGTON 98815
509/782-1023

State of Washington)
) ss.
County of Chelan)

I certify that I know or have satisfactory evidence that LYMAN B. BARDIN, KENT CHRISTENSEN, RALPH F. KIMMERLY and MONROE MASHBURN are the persons who appeared before me, and said persons acknowledged that they signed this instrument, on oath stated that they were authorized to execute the instrument and acknowledged it as the Directors and Secretary/Manager respectively of ICICLE IRRIGATION DISTRICT to be the free and voluntary act of such party for the uses and purposes mentioned in the instrument.

Dated this _______ day of ___________________, 1989.

____
NOTARY PUBLIC for the State of Washington

My Appointment Expires __________________

State of Washington)
) ss.
County of __________)

I certify that I know or have satisfactory evidence that CARLIN B. JACKSON is the person who appeared before me, and said person acknowledged that he signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the Director of Lands, Pacific Northwest Region Forest Service, U.S. Department of Agriculture, to be the free and voluntary act of such party for the uses and purposes mentioned in the instrument.

Dated this _______ day of ___________________, 1989.

____
NOTARY PUBLIC for the State of Washington

My Appointment Expires __________________

TERRENCE M. MCCAULEY
LAW OFFICES
100 NORTH DIVISION STREET
POST OFFICE BOX 836
CASHMERE, WASHINGTON 98815
509 782-1023

FEE 8.00
FILED FOR RECORD
PIONEER TITLE COMPANY
'90 MAY 22 AM 10 51
BOOK 929 PAGE 496-97 Deed
KENNETH C. HOUSDEN
CHELAN COUNTY AUDITOR
WENATCHEE, WASH.

OR 44205(W)
Wenatchee #139

9005220028

EXCHANGE DEED

THIS DEED, made this 27th day of December, 1989, between the UNITED STATES OF AMERICA, Grantor, acting herein by and through the Forest Service, United States Department of Agriculture, and ICICLE IRRIGATION DISTRICT, a municipal corporation organized and existing under the laws of the State of Washington and fully authorized to do business in the State of Washington, Grantee.

WITNESSETH: That the Grantor, hereunto authorized by the Weeks Law Act approved March 1, 1911, (16 U.S.C. 516), the provisions of which have been complied with, for, and in consideration of the conveyance to it by the Grantee of lands in the County of Chelan, State of Washington, as stated in the deed to the United States, the receipt of which is hereby acknowledged, does hereby remise, release, quitclaim and convey unto the Grantee all its rights, title, and interest in and to the real property situated in the County of Chelan, State of Washington, described as follows:

T. 23 N., R. 19 E., W.M.
sec. 7, NE1/4SE1/4.

T. 24 N., R. 18 E., W.M.
sec. 34, W1/2SE1/4.

Containing 120 acres, more or less.

TO HAVE AND TO HOLD the above-described real property unto Icicle Irrigation District and its successors and assigns forever, together with all hereditaments and appurtenances thereunto belonging.

IN WITNESS WHEREOF, the Grantor, by its duly authorized representative, has executed this deed pursuant to the delegation of authority promulgated in Title 7 CFR 2.60 and 49 FR 34283, August 29, 1984, on the day and year first above written.

Certified correct as to consideration, description and conditions.
5/17/90 [signature]
Realty Forester

UNITED STATES OF AMERICA

By Carlin B. Jackson
CARLIN B. JACKSON
Director of Lands
Pacific Northwest Region
Forest Service
U.S. Department of Agriculture

REAL ESTATE EXCISE TAX
EXEMPT
Chelan County Treasurer
Robert H. May
By SE
Deputy

OR 44205(W)

ACKNOWLEDGMENT

State of OREGON)
) ss.
County of MULTNOMAH)

On this 27th day of December, 1989, before me a Notary Public within and for said State, personally appeared CARLIN B. JACKSON, Director of Lands, Pacific Northwest Region, Forest Service, Department of Agriculture, and the same person who executed the within and foregoing instrument, who, being by me duly sworn according to law, did say that said instrument was signed in behalf of the United States of America by its authority duly given and by him delivered as and for its act and deed. And he did further acknowledge that he executed said instrument as the free act and deed of the United States of America, for the purposes and consideration herein mentioned and set forth, and I do hereby so certify.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year above written.

Theresa A. Bowar
Notary Public for the State of Oregon
Residing at Portland Oregon
My Commission expires 8/3/91

THERESA A. BOWAR NOTARY PUBLIC STATE OF OREGON

Form 1860-9
(November 1984)

The United States of America

To all to whom these presents shall come, Greeting:

FEE
FILED FOR RECORD
'90 MAY 22 AM 10
KENNETH C. HOUSDEN
COUNTY AUDITOR
WENATCHEE, WASH.

FEE 9.00
FILED FOR RECORD
PIONEER TITLE COMPANY
'90 MAY 22 AM 10 50
Patent
BOOK 929 PAGE 493-95
KENNETH C. HOUSDEN
CHELAN COUNTY AUDITOR
WENATCHEE, WASH.

OR 44205(W)

9005220027

WHEREAS,

ICICLE IRRIGATION DISTRICT

being the owner of certain tracts of land situated and included within the limits of to the Wenatchee National Forest, Washington has under provisions of the General Exchange Act of March 20, 1922, as amended (16 U.S.C. 485, 486); Alpine Lakes Area Management Act of July 12, 1976, (16 U.S.C. 1132); Federal Land Policy and Management Act of October 21, 1976, as amended (43 U.S.C. 1715, 1716, 1717); and the Weeks Law Act of March 1, 1911, as amended (16 U.S.C. 516), reconveyed and relinquished the said tracts to the United States of America and has, under provisions of the said Acts, selected in lieu thereof the following tracts of land:

Willamette Meridian, Chelan County, Washington

T. 24 N., R. 17 E.,
sec. 26, lots 2, 3 and 4 inclusive;
sec. 28, SE1/4.

The area described contains 285.25 acres according to the official plats of the survey of the said land, on file in the Bureau of Land Management;

NOW KNOW YE, that there is, therefore, granted by the UNITED STATES OF AMERICA unto ICICLE IRRIGATION DISTRICT, the lands above described, together with all minerals; TO HAVE AND TO HOLD the said lands with all the rights, privileges, immunities, and appurtenances, of whatsoever nature thereunto belonging, unto the said ICICLE IRRIGATION DISTRICT, its successors and assigns, forever;

EXCEPTING AND RESERVING TO THE UNITED STATES from the lands so granted:

1. A right-of-way thereon for ditches or canals constructed by the authority of the United States (Act of August 30, 1890, 43 U.S.C. 945).

2. A right-of-way for all right, title and interest in the existing Icicle Creek Road No. 2451 over and across the E1/2SE1/4 of sec. 28, T. 24 N., R. 17 E., the easement being 80 feet in width, lying 40 feet on each side of the centerline. The centerline of the existing road is more particularly described as follows:

Patent Number **46-90-0006**

OR 44205(W)

Beginning at a point on the east line of said sec. 28, from which point the southeast section corner bears south, 2,020 feet more or less; thence in a southwesterly direction to a point on the west line of the E1/2SE1/4 of said sec. 28, from which point the southeast section corner bears N. 46° W., 1,848 feet more or less.

IT IS AGREED that Icicle Irrigation District and assigns shall have the right to use the road for all proper and lawful purposes as provided for in 36 CFR 212.8(c) subject to compliance with traffic control regulations as provided in 36 CFR 212.7(a)(1) and (2). The exercise of the rights herein granted shall be subordinate to any easement on said road subsequently granted by the United States to a public road agency for operation as a public highway.

Provided, that if at any time the Regional Forester determines that the road or any segment thereof, is no longer needed, the easement traversed thereby shall terminate. In the event of such determination, the Regional Forester shall furnish to Icicle Irrigation District, its successors or assigns, a statement in recordable form evidencing termination.

3. The interests, rights and privileges of both the United States and Joseph L. Hughes and the Pacific National Bank of Seattle as set forth in that certain easement for Icicle Creek Road No. 2451, dated October 17, 1967, and recorded as Auditor's File No. 688811 in Volume 602, Page 451, Chelan County, Washington, records, which interests, rights and privileges together with the right to construct, reconstruct, and maintain the road over and across NW1/4SE1/4 and SW1/4SE1/4 sec. 28, T. 24 N., R. 17 E., W.M., are herein reserved, except the United States does not reserve in this patent, the title to any timber within the road easement, but only the right to cut and deck for use of the landowner such timber as may be necessary to accommodate the construction and maintenance of the road on the reserved right-of-way. This reservation is made subject to the following terms, provisions, and conditions:

   Joseph L. Hughes and The Pacific National Bank of Seattle and its assigns shall have the right to use for all useful purposes the road described above, subject to traffic control regulations as provided in 36 CFR 212.7(a) (1) and (2) and the bearing of road maintenance costs proportionate to use as provided in 36 CFR 212.7(d).

Patent Number 46-90-0006

Form 1860-10
(April 1988)

OR 44205(W)

Provided, that if at any time the Regional Forester determines that the road or any segment thereof, is no longer needed, the easement traversed thereby shall terminate. In the event of such determination, the Regional Forester shall furnish to Icicle Irrigation District, its successors or assigns, a statement in recordable form evidencing termination.

SUBJECT TO a Certificate of Water Rights in Icicle Creek and Snow Creek, a tributary to Icicle Creek, for B3.33 second feet issued to Icicle Irrigation District on September 18, 1934, and recorded in Volume F, page 2 of Water Right Certificates at Olympia, Washington. (Also affects intakes located in the NE1/4SE1/4, sec. 28, T. 24 N., R. 17 E., W.M.)

[SEAL]

IN TESTIMONY WHEREOF, the undersigned authorized officer of the Bureau of Land Management, in accordance with the provisions of the Act of June 17, 1948 (62 Stat. 476), has, in the name of the United States, caused these letters to be made Patent, and the Seal of the Bureau to be hereunto affixed.

GIVEN under my hand, in Portland, Oregon the Twentyseventh day of April in the year of our Lord one thousand nine hundred and Ninety and of the Independence of the United States the two hundred and fourteenth

By Robert E. Mallohan
Chief, Branch of Lands and Minerals Operations

Patent Number 46-90-0006

BOOK 929 PAGE 495

FEE 9.00
FILED FOR RECORD
PIONEER TITLE COMPANY
'90 MAY 9 AM 10 21
BOOK 928 PAGE 612-14
KENNETH C. HOUSDEN
CHELAN COUNTY AUDITOR
WENATCHEE, WASH.

Agmt

9005090031

EASEMENT TERMINATION AGREEMENT

This agreement, made and entered into on the date last shown below, by and between the ICICLE IRRIGATION DISTRICT, a municipal corporation organized under the laws of the State of Washington, hereinafter referred to as "DISTRICT", and the UNITED STATES OF AMERICA acting by and through the U. S. Department of Agriculture, hereinafter referred to as "UNITED STATES",

WITNESSETH:

WHEREAS, DISTRICT and UNITED STATES have executed a certain land exchange agreement dated April 1, 1986 which is incorporated herein by this reference (hereinafter referred to as "Agreement" and,

WHEREAS, DISTRICT pursuant to the Agreement as conveyed by warranty deed certain real property in Chelan County, Washington to the UNITED STATES in which deed DISTRICT reserved certain easements and,

WHEREAS, DISTRICT and the UNITED STATES desire to set forth the terms and conditions on the basis of which the reserved easements shall terminate, now therefore,

In consideration of the agreement between DISTRICT and UNITED STATES and in consideration of the land exchange pursuant thereto and for valuable consideration, DISTRICT and the UNITED STATES agree as follows:

The easements reserved by DISTRICT in that certain warranty deed in which the DISTRICT conveyed certain real property in Chelan County, Washington to the UNITED STATES pursuant to the agreement shall be perpetual unless the DISTRICT, its successors and assigns, abandons DISTRICT facilities. NO ABANDONMENT for purposes of this agreement shall be deemed to have taken place unless the DISTRICT has ceased to use the interests in real property and easements, the water rights and the improvements to real property on an "as - needed" basis for five (5) consecutive years. In the event of such

BOOK 928 PAGE 612

TERRENCE M. McCAULEY
LAW OFFICES
100 NORTH DIVISION STREET
POST OFFICE BOX 636
CASHMERE, WASHINGTON 98815
509-782-1023

State of Washington)
) ss.
County of Chelan)

I certify that I know or have satisfactory evidence that LYMAN B. BARDIN, KENT CHRISTENSEN, RALPH F. KIMMERLY and MONROE MASHBURN are the persons who appeared before me, and said persons acknowledged that they signed this instrument, on oath stated that they were authorized to execute the instrument and acknowledged it as the Directors and Secretary/Manager respectively of ICICLE IRRIGATION DISTRICT to be the free and voluntary act of such party for the uses and purposes mentioned in the instrument.

Dated this 3d day of April, 19~~89~~90.

Terrence M. McCauley
NOTARY PUBLIC for the State of Washington

My Appointment Expires May 1, 1991

State of ~~Washington~~ Oregon)
) ss.
County of Multnomah)

I certify that I know or have satisfactory evidence that CARLIN B. JACKSON is the person who appeared before me, and said person acknowledged that he signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the Director of Lands, Pacific Northwest Region Forest Service, U.S. Department of Agriculture, to be the free and voluntary act of such party for the uses and purposes mentioned in the instrument.

Dated this 27th day of December, 1989.

Theresa A. Bowar
NOTARY PUBLIC for the State of ~~Washington~~ Oregon

My Appointment Expires 8/3/91

BOOK 928 PAGE 614

Easement termination agreement -3-
icju2 - 12/6/89

TERRENCE M. MCCAULEY
LAW OFFICES
100 NORTH DIVISION STREET
POST OFFICE BOX 836
CASHMERE, WASHINGTON 98815
509 782 1023

abandonment for five (5) consecutive years, the easements shall terminate.

Dated this 3rd day of April, 19~~89~~90.

ICICLE IRRIGATION DISTRICT

By:

LYMAN B. BARDIN - Director

KENT CHRISTENSEN - Director

RALPH F. KIMMERLY - Director

Attest:

MONROE MASHBURN - Secretary/Manager

THE UNITED STATES OF AMERICA

By:
Carlin B. Jackson
Director of Lands,
Pacific Northwest Region Forest Service
U.S. Department of Agriculture

TERRENCE M. MCCAULEY
LAW OFFICES
100 NORTH DIVISION STREET
POST OFFICE BOX 836
CASHMERE, WASHINGTON 98815
509 782 1023

Form 1860-9
(November 1984)

The United States of America

To all to whom these presents shall come, Greeting:

FEE 9.00
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PIONEER TITLE COMPANY
'90 MAY 22 AM 10 50
BOOK 929 PAGE 493
KENNETH C. HOUSDEN
CHELAN COUNTY AUDITOR
WENATCHEE, WASH.

OR 44205(W)

WHEREAS,

ICICLE IRRIGATION DISTRICT

being the owner of certain tracts of land situated and included within the limits of to the Wenatchee National Forest, Washington, has under provisions of the General Exchange Act of March 20, 1922, as amended (16 U.S.C. 485, 486); Alpine Lakes Area Management Act of July 12, 1976, (16 U.S.C. 1132); Federal Land Policy and Management Act of October 21, 1976, as amended (43 U.S.C. 1715, 1716, 1717); and the Weeks Law Act of March 1, 1911, as amended (16 U.S.C. 516), reconveyed and relinquished the said tracts to the United States of America and has, under provisions of the said Acts, selected in lieu thereof the following tracts of land:

9005220027

Willamette Meridian, Chelan County, Washington

T. 24 N., R. 17 E.,
sec. 26, lots 2, 3 and 4 inclusive;
sec. 28, SE1/4.

The area described contains 285.25 acres according to the official plats of the survey of the said land, on file in the Bureau of Land Management;

NOW KNOW YE, that there is, therefore, granted by the UNITED STATES OF AMERICA unto ICICLE IRRIGATION DISTRICT, the lands above described, together with all minerals; TO HAVE AND TO HOLD the said lands with all the rights, privileges, immunities, and appurtenances, of whatsoever nature thereunto belonging, unto the said ICICLE IRRIGATION DISTRICT, its successors and assigns, forever;

EXCEPTING AND RESERVING TO THE UNITED STATES from the lands so granted:

1. A right-of-way thereon for ditches or canals constructed by the authority of the United States (Act of August 30, 1890, 43 U.S.C. 945).

2. A right-of-way for all right, title and interest in the existing Icicle Creek Road No. 2451 over and across the E1/2SE1/4 of sec. 28, T. 24 N., R. 17 E., the easement being 80 feet in width, lying 40 feet on each side of the centerline. The centerline of the existing road is more particularly described as follows:

BOOK 929 PAGE 493

Patent Number 46-90-0006

OR 44205(W)

Beginning at a point on the east line of said sec. 28, from which point the southeast section corner bears south, 2,020 feet more or less; thence in a southwesterly direction to a point on the west line of the E1/2SE1/4 of said sec. 28, from which point the southeast section corner bears N. 46° W., 1,848 feet more or less.

IT IS AGREED that Icicle Irrigation District and assigns shall have the right to use the road for all proper and lawful purposes as provided for in 36 CFR 212.8(c) subject to compliance with traffic control regulations as provided in 36 CFR 212.7(a)(1) and (2). The exercise of the rights herein granted shall be subordinate to any easement on said road subsequently granted by the United States to a public road agency for operation as a public highway.

Provided, that if at any time the Regional Forester determines that the road or any segment thereof, is no longer needed, the easement traversed thereby shall terminate. In the event of such determination, the Regional Forester shall furnish to Icicle Irrigation District, its successors or assigns, a statement in recordable form evidencing termination.

3. The interests, rights and privileges of both the United States and Joseph L. Hughes and the Pacific National Bank of Seattle as set forth in that certain easement for Icicle Creek Road No. 2451, dated October 17, 1967, and recorded as Auditor's File No. 688811 in Volume 602, Page 451, Chelan County, Washington, records, which interests, rights and privileges together with the right to construct, reconstruct, and maintain the road over and across NW1/4SE1/4 and SW1/4SE1/4 sec. 28, T. 24 N., R. 17 E., W.M., are herein reserved, except the United States does not reserve in this patent, the title to any timber within the road easement, but only the right to cut and deck for use of the landowner such timber as may be necessary to accommodate the construction and maintenance of the road on the reserved right-of-way. This reservation is made subject to the following terms, provisions, and conditions:

Joseph L. Hughes and The Pacific National Bank of Seattle and its assigns shall have the right to use for all useful purposes the road described above, subject to traffic control regulations as provided in 36 CFR 212.7(a) (1) and (2) and the bearing of road maintenance costs proportionate to use as provided in 36 CFR 212.7(d).

Patent Number 46-90-0006

Form 1860-10
(April 1988)

OR 44205(W)

Provided, that if at any time the Regional Forester determines that the road or any segment thereof, is no longer needed, the easement traversed thereby shall terminate. In the event of such determination, the Regional Forester shall furnish to Icicle Irrigation District, its successors or assigns, a statement in recordable form evidencing termination.

SUBJECT TO a Certificate of Water Rights in Icicle Creek and Snow Creek, a tributary to Icicle Creek, for 83.33 second feet issued to Icicle Irrigation District on September 18, 1934, and recorded in Volume F, page 2 of Water Right Certificates at Olympia, Washington. (Also affects intakes located in the NE1/4SE1/4, sec. 28, T. 24 N., R. 17 E., W.M.)

[SEAL]

IN TESTIMONY WHEREOF, the undersigned authorized officer of the Bureau of Land Management, in accordance with the provisions of the Act of June 17, 1948 (62 Stat. 476), has, in the name of the United States, caused these letters to be made Patent, and the Seal of the Bureau to be hereunto affixed.

GIVEN under my hand, in Portland, Oregon the Twentyseventh day of April in the year of our Lord one thousand nine hundred and Ninety and of the Independence of the United States the two hundred and fourteenth

By Robert E. Mallopa
Chief, Branch of Lands and Minerals Operations

Patent Number 46-90-0006

BOOK 929 PAGE 495

FEE 8.00
FILED FOR RECORD
PIONEER TITLE COMPANY
'90 MAY 22 AM 10 51
Deed
BOOK 929 PAGE 496-97
KENNETH C. HOUSDEN
CHELAN COUNTY AUDITOR
WENATCHEE, WASH.

OR 44205(W)
Wenatchee #139

9005220028

EXCHANGE DEED

THIS DEED, made this 27th day of December, 1989, between the UNITED STATES OF AMERICA, Grantor, acting herein by and through the Forest Service, United States Department of Agriculture, and ICICLE IRRIGATION DISTRICT, a municipal corporation organized and existing under the laws of the State of Washington and fully authorized to do business in the State of Washington, Grantee.

WITNESSETH: That the Grantor, hereunto authorized by the Weeks Law Act approved March 1, 1911, (16 U.S.C. 516), the provisions of which have been complied with, for, and in consideration of the conveyance to it by the Grantee of lands in the County of Chelan, State of Washington, as stated in the deed to the United States, the receipt of which is hereby acknowledged, does hereby remise, release, quitclaim and convey unto the Grantee all its rights, title, and interest in and to the real property situated in the County of Chelan, State of Washington, described as follows:

T. 23 N., R. 19 E., W.M.
sec. 7, NE1/4SE1/4.

T. 24 N., R. 18 E., W.M.
sec. 34, W1/2SE1/4.

Containing 120 acres, more or less.

Certified correct as to consideration, description and conditions.
5/17/90 Date
D. M. Olson Examiner

TO HAVE AND TO HOLD the above-described real property unto Icicle Irrigation District and its successors and assigns forever, together with all hereditaments and appurtenances thereunto belonging.

IN WITNESS WHEREOF, the Grantor, by its duly authorized representative, has executed this deed pursuant to the delegation of authority promulgated in Title 7 CFR 2.60 and 49 FR 34283, August 29, 1984, on the day and year first above written.

UNITED STATES OF AMERICA

By Carlin B. Jackson
CARLIN B. JACKSON
Director of Lands
Pacific Northwest Region
Forest Service
U.S. Department of Agriculture

REAL ESTATE EXCISE TAX
EXEMPT
Chelan County Treasurer
Robert H. May
By SE
Deputy

ACKNOWLEDGMENT

State of OREGON)
) ss.
County of MULTNOMAH)

On this 27th day of December, 1989, before me a Notary Public within and for said State, personally appeared CARLIN B. JACKSON, Director of Lands, Pacific Northwest Region, Forest Service, Department of Agriculture, and the same person who executed the within and foregoing instrument, who, being by me duly sworn according to law, did say that said instrument was signed in behalf of the United States of America by its authority duly given and by him delivered as and for its act and deed. And he did further acknowledge that he executed said instrument as the free act and deed of the United States of America, for the purposes and consideration herein mentioned and set forth, and I do hereby so certify.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year above written.

Theresa A. Bower
Notary Public for the State of Oregon
Residing at Portland Oregon
My Commission expires 8/3/91

NOTARY PUBLIC STATE OF OREGON

OR 44205 (W)
Wenatchee #139

64267
REAL ESTATE EXCISE TAX
EXEMPT
Chelan County Treasurer
Robert H. May
By [signature]
Deputy

9005170061

SPECIAL WARRANTY DEED

ICICLE IRRIGATION DISTRICT, a municipal corporation organized and existing under the laws of the State of Washington and fully authorized to do business in the State of Washington, hereinafter called Grantor, for and in consideration of National Forest System land under the provisions of the General Exchange Act of March 20, 1922 (42 Stat. 465, as amended; 16 U.S.C. 485, 486); the Alpine Lakes Area Management Act of July 12, 1976 (90 Stat. 906; 16 U.S.C. 1132), the Federal Land Policy and Management Act of October 21, 1976 (90 Stat. 2755; 43 U.S.C. 1715, 1716, 1717); and the Weeks Law Act of March 1, 1911 (36 Stat., 961, as amended; 16 U.S.C. 516), which is of equal value to the land herein conveyed, the receipt of which is hereby acknowledged, hereby grants, bargains, sells, conveys and confirms to the UNITED STATES OF AMERICA, Grantee, and its assigns, all interest in the following described real property, including minerals, in the County of Chelan, State of Washington, except for those encumbrances specifically set forth:

Willamette Meridian, Chelan County, Washington

T. 23 N., R. 16 E.,
sec. 5, lots 1 and 2;
sec. 15, lots 1 and 2.

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PIONEER TITLE COMPANY
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Deed
BOOK 929 PAGE 085-91
KENNETH C. HOUSDEN
CHELAN COUNTY AUDITOR
WENATCHEE, WASH.

T. 24 N., R. 14 E.,
sec. 3, lots 17 thru 25, inclusive.

T. 24 N., R. 16 E.,
sec. 33, lot 1.

T. 24 N., R. 17 E.,
sec. 27, Part of the NW1/4SW1/4 described as follows:
BEGINNING at an aluminum monument, set on the southerly edge of the Icicle River Road right-of-way as recorded under Auditor's No. 692951 and 617768, and common with point "A" as described in the City of Leavenworth deed, recorded under Auditor's No. 698355, from said POINT OF BEGINNING the west 1/4 corner of said section 27 bears N. 37° 18' 55" W., 718.59 feet.
THENCE S. 54° 01' 45" E., 292.95 feet along line A-E of said City of Leavenworth property to a rebar with aluminum cap;
THENCE S. 29° 00' 59" E., 108.50 feet to an "X" on a boulder 2 feet x 4 feet x 3 feet lying on the north bank of the Icicle River;
THENCE S. 16° 26' 32" W., 40.00 feet to the center of the Icicle River;
THENCE N. 73° 33' 28" W., 400.00 feet along the north bank of the Icicle River;

THENCE N. 16° 26' 32" E., 40.00 feet to a rebar with aluminum cap located on the north bank of said Icicle River;
THENCE N. 28° 07' 10" W., 199.96 feet to a rebar with aluminum cap located on the southerly edge of said Icicle River Road right-of-way;
THENCE S. 82° 28' 37" E., 137.81 feet along the southerly edge of said right-of-way;
THENCE along the southerly edge of said right-of-way following a curve to the left having a radius length of 613.00 feet along an arc length of 51.77 feet to the POINT OF BEGINNING, as shown in that certain record of survey recorded on January 11, 1983, as Auditor's File No. 8301120006 in Book 14 of Surveys, at Page 80.

Containing 362.83 acres, more or less.

EXCEPTING AND RESERVING to the Grantor, its successors and assigns, 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 the 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 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 the prior written consent of the Forest Service, which consent shall not unreasonably be withheld, materially increase the size or scope of the facilities.

The United States of America shall charge no fee for the exercise of the rights reserved or granted hereunder, nor shall it require any further permission for the Grantor to exercise the rights granted or reserved herein.

Said easements shall be perpetual unless the Grantor, its successors and assigns, abandons such facilities. The United States of America acknowledges that the interests in real property, improvements to real property and water rights referred to in this Warranty Deed are used by the Grantor on an "as-needed" basis to supplement the water supply of the Grantor.

Termination of this easement will be according to terms and conditions set out in the "Easement Termination Agreement" dated December 27, 1989 and recorded on May 9, 1990, as Auditor's File No. 9005090031 in records of Chelan County, Washington. (Affects all parcels.)

OR 44205(W)

FURTHER EXCEPTING AND RESERVING to the Grantor, its successors and assigns, the right to overflow and inundate the bed and shore of Colchuck, Eight Mile and Klonaqua Lakes and further excepting and reserving to the Grantor all other water rights in favor of the Icicle Irrigation District, in accordance with the Rules and Regulations of the Secretary of Agriculture, 36 CFR 251.19, attached hereto and made a part hereof, including, but not limited to, the following:

1. Rights granted by Commissioners of Public Lands, under that certain Application No. 12855 dated October 26, 1927, and recorded April 14, 1928, in volume 172 of Deeds, page 131 in the records of Chelan County, Washington, as Auditor's File No. 165072. (Affects secs. 5 and 15, T.23 N., R.16 E.; sec. 3, T.24 N., R.14 E., and sec. 33, T.24 N., R.16 E., W.M.).

2. Water rights granted under Certificate of Water Right to use the waters of Klonaqua Lake for the purposes of irrigation under Appropriation Permit No. 827, entered of record in Volume 3, at Page 1227, on August 21, 1939.

3. Water rights granted under Certificate of Water Right to use the waters of Eight Mile Lake for the purposes of irrigation under Appropriation Permit No. 828, entered of record in Volume 3, at Page 1228, on August 21, 1939.

4. Water rights granted under Certificate of Water Right to use the waters of Colchuck Lake for the purposes of irrigation under Appropriation Permit No. 829, entered of record in Volume 3, at Page 1229, on August 21, 1939.

5. Water rights granted in Icicle Creek and Snow Creek, a tributary of Icicle Creek, as noted in that certain Certificate of Water Rights for 83.33 second feet issued to Icicle Irrigation District on September 18, 1934, and recorded in Volume F, Page 2 of Water Right Certificates at Olympia, Washington. (Also affects intakes located in the SW1/4SW1/4 sec. 27, T. 24 N., R. 17 E., W.M.)

SUBJECT TO:

1. Easements for water pipeline and use incidental thereto over and across the eastern portion of NW1/4SW1/4 sec. 27, T. 24 N., R. 17 E., W.M., granted to the City of Leavenworth, a municipal corporation. Recorded February 25, 1964, under Auditor's No. 617729 in volume 657, page 54, and March 19, 1970, under Auditor's No. 698355 in volume 697, page 603, Chelan County.

2. Shifting or change in the course of the ICICLE RIVER and rights of the State of Washington in and to that portion of said premises, if any, lying in the bed or former bed of the Icicle River, if it is navigable. Affects NW1/4SW1/4 sec. 27, T. 24 N., R. 17 E., W.M.

OR 44205(W)

The acquiring agency is the Forest Service, U.S. Department of Agriculture.

The Grantor for itself and for its successors in interest does by these presents expressly limit the covenants of the deed to those herein expressed, and excludes all covenants arising or to arise by statutory or other implication, and does hereby covenant that against all persons whomsoever lawfully claiming or to claim by, through or under said Grantor and not otherwise, Grantor will forever warrant and defend the said described real estate.

Dated this 17th day of May, 1990.

ICICLE IRRIGATION DISTRICT

By Lyman B. Bardin
Lyman B. Bardin
President, Board of Directors

ATTEST:

By Kent A. Christensen
Kent A. Christensen, Director

By Monroe Mashburn
Monroe Mashburn
Title Secretary/Manager

By Ralph F. Kimmerly
Ralph F. Kimmerly, Director

ACKNOWLEDGMENT

STATE OF Washington)
)ss
County of)

On this 17th day of May, 1990, before me the undersigned, a Notary Public in and for said State, personally appeared Lyman B. Bardin, Kent Christensen, Ralph F. Kimmerly, and Monroe Mashburn, known to me to be the Directors and Secretary/Manager, respectively, of the ICICLE IRRIGATION DISTRICT, the municipal corporation that executed the within and foregoing instrument, and acknowledged to me that such corporation executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year first above written.

TERENCE M. McCAULEY NOTARY PUBLIC STATE OF WASHINGTON (SEAL)

Terence M. McCauley
Notary Public for the State of Washington
Residing at Leavenworth
My Commission Expires May 1, 1991

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

RULES AND REGULATIONS OF THE SECRETARY OF AGRICULTURE GOVERNING THE GRANTOR'S RIGHT TO OCCUPY AND USE LANDS CONVEYED TO THE UNITED STATES

Code of Federal Regulations - Title 36 - Chapter II - Section 251.17

Except as otherwise provided in paragraph (h) of this section, in conveyances of lands to the United States under authorized programs of the Forest Service, where owners reserve the right to occupy and use the land for the purposes of residence, agriculture, industry, or commerce, said reservations shall be subject to the following conditions, rules and regulations which shall be expressed in and made a part of the deed of conveyance to the United States and such reservations shall be exercised thereunder and in obedience thereto:

(a) Except when provided otherwise by statute, the reservation so created shall not be assigned, used, or occupied by anyone other than the grantor without the consent of the United States.

(b) All reasonable precautions shall be taken by the grantor and all persons acting for or claiming under him to prevent and suppress forest fires upon or threatening the premises or other adjacent lands of the United States, and any persons failing to comply with this requirement shall be responsible for any damages sustained by the United States by reason thereof.

(c) The premises shall not be used or permitted to be used without the written consent of the United States, for any purpose or purposes other than those specified in the instrument creating the reservation.

(d) The grantor and all persons acting for or claiming under him shall maintain the premises and all buildings and structures thereon in proper repair and sanitation and shall comply with the National Forest laws and regulations and the laws and lawful orders of the State in which the premises are located.

(e) Except when provided otherwise by statute, the reservation shall terminate (1) upon the expiration of the period named in the deed; (2) upon failure for a period of more than one calendar year to use and occupy the premises for the purposes named in the deed; (3) by use and occupancy for unlawful purposes or for purposes other than those specified in the deed; and (4) by voluntary written relinquishment by the owner.

(f) Upon the termination of the reservation the owners of personal property remaining on the premises shall remove same within a period of three months, and all such property not so removed shall become the property of the United States except that when such removal is prevented by conditions beyond the control of the owners the period shall be extended in writing by the Forest Service to allow a reasonable time for said removal, but in no event longer than one year.

(g) The said reservation shall be subject to rights-of-way for the use of the United States or its permittees, upon, across, or through the said land, as may hereafter be required for the erection, construction, maintenance, and operation of public utility systems over all or parts thereof, or for the construction and maintenance of any improvements necessary for the good administration and protection of the National Forests, and shall be subject to the right of officials or employees of the Forest Service to inspect the premises, or any part thereof, at all reasonable times and as often as deemed necessary in the performance of official duties in respect to the premises.

(h) The conditions, rules and regulations set forth in paragraphs (a) through (g) of this section shall not apply to reservations contained in conveyances of lands to the United States under the act of March 3, 1925, as amended (43 Stat. 1133, 64 Stat. 82; 16 U.S.C. 555).

All regulations heretofore issued by the Secretary of Agriculture to govern the exercise of occupancy and use rights reserved in conveyances of lands to the United States under authorized programs of the Forest Service shall continue to be effective in the cases to which they are applicable, but are hereby superseded as to occupancy and use rights hereafter reserved in conveyances under such programs.

(36 Stat. 961, as amended, 16 U.S.C. 513–518, 42 Stat. 465, as amended, 16 U.S.C. 485, 486, and 50 Stat. 525, as amended, 7 U.S.C. 1011, and 70 Stat. 1034, 7 U.S.C. 428a, 78 Stat. 890, 16 U.S.C. 1131–1136; 79 Stat. 843, 16 U.S.C. 460p—460p-5; 79 Stat. 1295, 16 U.S.C. 460q—460q-9; 80 Stat. 190, 16 U.S.C. 460r—460r-5; 82 Stat. 904, 16 U.S.C. 460v—460v-8; 82 Stat. 919, 16 U.S.C. 1241–1249 and 82 Stat. 906, 16 U.S.C. 1271–1287)

Done at Washington, D.C., this 30th day of December 1970.

T. K. COWDEN,
Assistant Secretary of Agriculture.

(F.R. Doc. 71-132; Filed, Jan. 5, 1971; 8:48 a.m.)

GPO 909-221

8400-28 (9/68)

EXHIBIT 10J-1

United States Department of Agriculture
Forest Service

CONDITIONS, RULES AND REGULATIONS OF THE SECRETARY OF AGRICULTURE GOVERNING EXERCISE OF RIGHTS-OF-WAY RESERVED IN CONVEYANCES TO THE UNITED STATES OF AMERICA

Code of Federal Regulations - Title 36 - Chapter II - Section 251.18

This section governs the use, occupancy & operation of rights-of-way reserved by a grantor of lands to the U.S.

(a) Brush and refuse resulting from the exercise of the right-of-way reservation shall be disposed of to the satisfaction of the Forest Officer in in charge.

(b) Timber cut an destroyed in the exercise of the right-of-way reservation shall be paid for at the rates to be prescribed by the Forest Officer in charge, which rates shall be the usual stumpage prices charged in the locality in sales of National Forest timber of the same kind or species; for injury to timber, second growth, and reproduction, the amount of actual damage shall be ascertained by the Forest Supervisor according to the rules applicable in such cases.

(c) All improvements built or maintained upon the right-of-way shall be kept in an orderly, safe and sanitary condition. Failure to maintain such conditions shall be cause for the termination of the reservation after 30 days' notice in writing to the occupant or user that unsatisfactory conditions exist and that the Department intends to terminate all rights under the reservation unless such conditions are forthwith corrected to the satisfaction of the Regional Forester.

(d) Upon the abandonment of a reserved right-of-way, either by formal release, by termination, or by non-use for a period of 1 calendar year, all improvements thereon not the property of the United States shall be removed therefrom within 3 months from the date of the abandonment; otherwise, such improvements shall vest in and become the property of the United States.

(e) All reasonable precautions to prevent and suppress forest fires shall be taken by the grantor and all persons acting for or claiming under him; suitable crossings shall be constructed by grantor and/or said persons where the reserved right-of-way intersects existing roads and trails; borrow pits shall not be opened outside of the immediate graded section except under a special-use permit from the Forest Supervisor.

(f) Officers of the Forest Service shall have free ingress and egress on and over the reserved rights-of-way for all purposes necessary and incidental to the protection and administration of the National Forest.

(36 Stat. 962, as amended; 16 U.S.C. 518)

United States Department of Agriculture
Forest Service

CONDITIONS, RULES AND REGULATIONS OF THE SECRETARY OF AGRICULTURE GOVERNING EXERCISE OF WATER RIGHTS RESERVED BY THE GRANTOR OF LANDS CONVEYED TO THE UNITED STATES

Code of Federal Regulations - Title 36 - Chapter II - Section 251.19

This section governs the exercise of water and related rights reserved by the grantor of land conveyed to the United States under the provisions of the act of March 1, 1911 (36 Stat. 961).

(a) All reasonable precautions shall be taken by the grantor and all persons acting for or claiming under him to prevent and suppress forest fires upon or threatening the premises or other adjacent lands of the United States, and any person failing to comply with this requirement shall be responsible for any damages sustained by the United States by reason thereof.

(b) All slash and debris resulting from the cutting and removal of timber shall be disposed of as directed by the Forest Officer in charge.

(c) Flowage and reservoir areas shall be cleared of timber and debris, in a manner satisfactory to the Forest Supervisor, or in accordance with a special agreement approved by him. Timber cut and destroyed in the exercise of the reserved rights shall be paid for at rates to be prescribed by the Forest Officer in charge, which rate shall be the usual stumpage price charged in the locality.

(d) The water surface created shall be open to the Forest Service and its permittees when such use does not interfere with the original purpose of the development.

(e) The water surface shall be open to fishing by the public in accordance with State laws when such use does not interfere with the original purpose of the development.

(f) Plans for dams and supplemental structures, impounding or controlling more than 10 acre-feet of water or with a head in excess of 6 feet, shall be approved by the Regional Engineer of the Forest Service before construction shall begin.

(36 Stat. 962, as amended, 16 U.S.C. 518)

EXHIBIT 10J-5 (Rev. 7/26/88)

OR 44205 (W)
Wenatchee #139

64267
REAL ESTATE EXCISE TAX
EXEMPT
Chelan County Treasurer
Robert H. May
By [signature]
Deputy

SPECIAL WARRANTY DEED

ICICLE IRRIGATION DISTRICT, a municipal corporation organized and existing under the laws of the State of Washington and fully authorized to do business in the State of Washington, hereinafter called Grantor, for and in consideration of National Forest System land under the provisions of the General Exchange Act of March 20, 1922 (42 Stat. 465, as amended; 16 U.S.C. 485, 486); the Alpine Lakes Area Management Act of July 12, 1976 (90 Stat. 906; 16 U.S.C. 1132), the Federal Land Policy and Management Act of October 21, 1976 (90 Stat. 2755; 43 U.S.C. 1715, 1716, 1717); and the Weeks Law Act of March 1, 1911 (36 Stat., 961, as amended; 16 U.S.C. 516), which is of equal value to the land herein conveyed, the receipt of which is hereby acknowledged, hereby grants, bargains, sells, conveys and confirms to the UNITED STATES OF AMERICA, Grantee, and its assigns, all interest in the following described real property, including minerals, in the County of Chelan, State of Washington, except for those encumbrances specifically set forth:

9005170061

Willamette Meridian, Chelan County, Washington

T. 23 N., R. 16 E.,
sec. 5, lots 1 and 2;
sec. 15, lots 1 and 2.

FEE 13.00
FILED FOR RECORD
PIONEER TITLE COMPANY
90 MAY 17 PM 2 55
Deed
BOOK 929 PAGE 085-91
KENNETH C. HOUSDEN
CHELAN COUNTY AUDITOR
WENATCHEE, WASH.

T. 24 N., R. 14 E.,
sec. 3, lots 17 thru 25, inclusive.

T. 24 N., R. 16 E.,
sec. 33, lot 1.

T. 24 N., R. 17 E.,
sec. 27, Part of the NW1/4SW1/4 described as follows:
BEGINNING at an aluminum monument, set on the southerly edge of the Icicle River Road right-of-way as recorded under Auditor's No. 692951 and 617768, and common with point "A" as described in the City of Leavenworth deed, recorded under Auditor's No. 698355, from said POINT OF BEGINNING the west 1/4 corner of said section 27 bears N. 37° 18' 55" W., 718.59 feet.
THENCE S. 54° 01' 45" E., 292.95 feet along line A-E of said City of Leavenworth property to a rebar with aluminum cap;
THENCE S. 29° 00' 59" E., 108.50 feet to an "X" on a boulder 2 feet x 4 feet x 3 feet lying on the north bank of the Icicle River;
THENCE S. 16° 26' 32" W., 40.00 feet to the center of the Icicle River;
THENCE N. 73° 33' 28" W., 400.00 feet along the north bank of the Icicle River;

THENCE N. 16° 26' 32" E., 40.00 feet to a rebar with aluminum cap located on the north bank of said Icicle River;
THENCE N. 28° 07' 10" W., 199.96 feet to a rebar with aluminum cap located on the southerly edge of said Icicle River Road right-of-way;
THENCE S. 82° 28' 37" E., 137.81 feet along the southerly edge of said right-of-way;
THENCE along the southerly edge of said right-of-way following a curve to the left having a radius length of 613.00 feet along an arc length of 51.77 feet to the POINT OF BEGINNING, as shown in that certain record of survey recorded on January 11, 1983, as Auditor's File No. 8301120006 in Book 14 of Surveys, at Page 80.

Containing 362.83 acres, more or less.

EXCEPTING AND RESERVING to the Grantor, its successors and assigns, 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 the 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 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 the prior written consent of the Forest Service, which consent shall not unreasonably be withheld, materially increase the size or scope of the facilities.

The United States of America shall charge no fee for the exercise of the rights reserved or granted hereunder, nor shall it require any further permission for the Grantor to exercise the rights granted or reserved herein.

Said easements shall be perpetual unless the Grantor, its successors and assigns, abandons such facilities. The United States of America acknowledges that the interests in real property, improvements to real property and water rights referred to in this Warranty Deed are used by the Grantor on an "as-needed" basis to supplement the water supply of the Grantor.

Termination of this easement will be according to terms and conditions set out in the "Easement Termination Agreement" dated December 27, 1989 and recorded on May 9 , 1990, as Auditor's File No. 9005090031 in records of Chelan County, Washington. (Affects all parcels.)

OR 44205(W)

FURTHER EXCEPTING AND RESERVING to the Grantor, its successors and assigns, the right to overflow and inundate the bed and shore of Colchuck, Eight Mile and Klonaqua Lakes and further excepting and reserving to the Grantor all other water rights in favor of the Icicle Irrigation District, in accordance with the Rules and Regulations of the Secretary of Agriculture, 36 CFR 251.19, attached hereto and made a part hereof, including, but not limited to, the following:

1. Rights granted by Commissioners of Public Lands, under that certain Application No. 12855 dated October 26, 1927, and recorded April 14, 1928, in volume 172 of Deeds, page 131 in the records of Chelan County, Washington, as Auditor's File No. 165072. (Affects secs. 5 and 15, T.23 N., R.16 E.; sec. 3, T.24 N., R.14 E., and sec. 33, T.24 N., R.16 E., W.M.).

2. Water rights granted under Certificate of Water Right to use the waters of Klonaqua Lake for the purposes of irrigation under Appropriation Permit No. 827, entered of record in Volume 3, at Page 1227, on August 21, 1939.

3. Water rights granted under Certificate of Water Right to use the waters of Eight Mile Lake for the purposes of irrigation under Appropriation Permit No. 828, entered of record in Volume 3, at Page 1228, on August 21, 1939.

4. Water rights granted under Certificate of Water Right to use the waters of Colchuck Lake for the purposes of irrigation under Appropriation Permit No. 829, entered of record in Volume 3, at Page 1229, on August 21, 1939.

5. Water rights granted in Icicle Creek and Snow Creek, a tributary of Icicle Creek, as noted in that certain Certificate of Water Rights for 83.33 second feet issued to Icicle Irrigation District on September 18, 1934, and recorded in Volume F, Page 2 of Water Right Certificates at Olympia, Washington. (Also affects intakes located in the SW1/4SW1/4 sec. 27, T. 24 N., R. 17 E., W.M.)

SUBJECT TO:

1. Easements for water pipeline and use incidental thereto over and across the eastern portion of NW1/4SW1/4 sec. 27, T. 24 N., R. 17 E., W.M., granted to the City of Leavenworth, a municipal corporation. Recorded February 25, 1964, under Auditor's No. 617729 in volume 657, page 54, and March 19, 1970, under Auditor's No. 698355 in volume 697, page 603, Chelan County.

2. Shifting or change in the course of the ICICLE RIVER and rights of the State of Washington in and to that portion of said premises, if any, lying in the bed or former bed of the Icicle River, if it is navigable. Affects NW1/4SW1/4 sec. 27, T. 24 N., R. 17 E., W.M.

OR 44205(W)

The acquiring agency is the Forest Service, U.S. Department of Agriculture.

The Grantor for itself and for its successors in interest does by these presents expressly limit the covenants of the deed to those herein expressed, and excludes all covenants arising or to arise by statutory or other implication, and does hereby covenant that against all persons whomsoever lawfully claiming or to claim by, through or under said Grantor and not otherwise, Grantor will forever warrant and defend the said described real estate.

Dated this 17th day of May, 1990.

ICICLE IRRIGATION DISTRICT

By Lyman B. Bardin
Lyman B. Bardin
President, Board of Directors

ATTEST:

By Kent A. Christensen
Kent A. Christensen, Director

By Monroe Mashburn
Monroe Mashburn
Title Secretary/Manager

By Ralph F. Kimmerly
Ralph F. Kimmerly, Director

ACKNOWLEDGMENT

STATE OF Washington)
)ss
County of)

On this 17th day of May, 1990, before me the undersigned, a Notary Public in and for said State, personally appeared Lyman B. Bardin, Kent Christensen, Ralph F. Kimmerly, and Monroe Mashburn, known to me to be the Directors and Secretary/Manager, respectively, of the ICICLE IRRIGATION DISTRICT, the municipal corporation that executed the within and foregoing instrument, and acknowledged to me that such corporation executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year first above written.

TERRENCE M. McCAULEY NOTARY PUBLIC STATE OF WASHINGTON COMMISSION EXPIRES 5-1-91 (SEAL)

Terence M. McCauley
Notary Public for the State of Washington
Residing at Leavenworth
My Commission Expires May 1, 1991

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

RULES AND REGULATIONS OF THE SECRETARY OF AGRICULTURE GOVERNING THE GRANTOR'S RIGHT TO OCCUPY AND USE LANDS CONVEYED TO THE UNITED STATES

Code of Federal Regulations - Title 36 - Chapter II - Section 251.17

Except as otherwise provided in paragraph (h) of this section, in conveyances of lands to the United States under authorized programs of the Forest Service, where owners reserve the right to occupy and use the land for the purposes of residence, agriculture, industry, or commerce, said reservations shall be subject to the following conditions, rules and regulations which shall be expressed in and made a part of the deed of conveyance to the United States and such reservations shall be exercised thereunder and in obedience thereto:

(a) Except when provided otherwise by statute, the reservation so created shall not be assigned, used, or occupied by anyone other than the grantor without the consent of the United States.

(b) All reasonable precautions shall be taken by the grantor and all persons acting for or claiming under him to prevent and suppress forest fires upon or threatening the premises or other adjacent lands of the United States, and any persons failing to comply with this requirement shall be responsible for any damages sustained by the United States by reason thereof.

(c) The premises shall not be used or permitted to be used without the written consent of the United States, for any purpose or purposes other than those specified in the instrument creating the reservation.

(d) The grantor and all persons acting for or claiming under him shall maintain the premises and all buildings and structures thereon in proper repair and sanitation and shall comply with the National Forest laws and regulations and the laws and lawful orders of the State in which the premises are located.

(e) Except when provided otherwise by statute, the reservation shall terminate (1) upon the expiration of the period named in the deed; (2) upon failure for a period of more than one calendar year to use and occupy the premises for the purposes named in the deed; (3) by use and occupancy for unlawful purposes or for purposes other than those specified in the deed; and (4) by voluntary written relinquishment by the owner.

(f) Upon the termination of the reservation the owners of personal property remaining on the premises shall remove same within a period of three months, and all such property not so removed shall become the property of the United States except that when such removal is prevented by conditions beyond the control of the owners the period shall be extended in writing by the Forest Service to allow a reasonable time for said removal, but in no event longer than one year.

(g) The said reservation shall be subject to rights-of-way for the use of the United States or its permittees, upon, across, or through the said land, as may hereafter be required for the erection, construction, maintenance, and operation of public utility systems over all or parts thereof, or for the construction and maintenance of any improvements necessary for the good administration and protection of the National Forests, and shall be subject to the right of officials or employees of the Forest Service to inspect the premises, or any part thereof, at all reasonable times and as often as deemed necessary in the performance of official duties in respect to the premises.

(h) The conditions, rules and regulations set forth in paragraphs (a) through (g) of this section shall not apply to reservations contained in conveyances of lands to the United States under the act of March 3, 1925, as amended (43 Stat. 1133, 44 Stat. 82; 16 U.S.C. 555).

All regulations heretofore issued by the Secretary of Agriculture to govern the exercise of occupancy and use rights reserved in conveyances of lands to the United States under authorized programs of the Forest Service shall continue to be effective in the cases to which they are applicable, but are hereby superseded as to occupancy and use rights hereafter reserved in conveyances under such programs.

(36 Stat. 961, as amended, 16 U.S.C. 513–518, 42 Stat. 465, as amended, 16 U.S.C. 485, 486, and 50 Stat. 525, as amended, 7 U.S.C. 1011, and 70 Stat. 1034, 7 U.S.C. 428a, 78 Stat. 890, 16 U.S.C. 1131–1136; 79 Stat. 843, 16 U.S.C. 460p—460p–5; 79 Stat. 1295, 16 U.S.C. 460q—460q–9; 80 Stat. 190, 16 U.S.C. 460r—460r–5; 82 Stat. 904, 16 U.S.C. 460v—460v–8; 82 Stat. 919, 16 U.S.C. 1241–1249 and 82 Stat. 906, 16 U.S.C. 1271–1287)

Done at Washington, D.C., this 30th day of December 1970.

T. K. COWDEN,
Assistant Secretary of Agriculture.

(F.R. Doc. 71-132; Filed, Jan. 5, 1971; 8:49 a.m.)

GPO 909-231

5400-38 (9/68)

EXHIBIT 10J-1

BOOK 929 PAGE 089

United States Department of Agriculture
Forest Service

CONDITIONS, RULES AND REGULATIONS OF THE SECRETARY OF AGRICULTURE GOVERNING EXERCISE OF RIGHTS-OF-WAY RESERVED IN CONVEYANCES TO THE UNITED STATES OF AMERICA

Code of Federal Regulations - Title 36 - Chapter II - Section 251.18

This section governs the use, occupancy & operation of rights-of-way reserved by a grantor of lands to the U.S.

(a) Brush and refuse resulting from the exercise of the right-of-way reservation shall be disposed of to the satisfaction of the Forest Officer in in charge.

(b) Timber cut an destroyed in the exercise of the right-of-way reservation shall be paid for at the rates to be prescribed by the Forest Officer in charge, which rates shall be the usual stumpage prices charged in the locality in sales of National Forest timber of the same kind or species; for injury to timber, second growth, and reproduction, the amount of actual damage shall be ascertained by the Forest Supervisor according to the rules applicable in such cases.

(c) All improvements built or maintained upon the right-of-way shall be kept in an orderly, safe and sanitary condition. Failure to maintain such conditions shall be cause for the termination of the reservation after 30 days' notice in writing to the occupant or user that unsatisfactory conditions exist and that the Department intends to terminate all rights under the reservation unless such conditions are forthwith corrected to the satisfaction of the Regional Forester.

(d) Upon the abandonment of a reserved right-of-way, either by formal release, by termination, or by non-use for a period of 1 calendar year, all improvements thereon not the property of the United States shall be removed therefrom within 3 months from the date of the abandonment; otherwise, such improvements shall vest in and become the property of the United States.

(e) All reasonable precautions to prevent and suppress forest fires shall be taken by the grantor and all persons acting for or claiming under him; suitable crossings shall be constructed by grantor and/or said persons where the reserved right-of-way intersects existing roads and trails; borrow pits shall not be opened outside of the immediate graded section except under a special-use permit from the Forest Supervisor.

(f) Officers of the Forest Service shall have free ingress and egress on and over the reserved rights-of-way for all purposes necessary and incidental to the protection and administration of the National Forest.

(36 Stat. 962, as amended; 16 U.S.C. 518)

United States Department of Agriculture
Forest Service

CONDITIONS, RULES AND REGULATIONS OF THE SECRETARY OF AGRICULTURE GOVERNING EXERCISE OF WATER RIGHTS RESERVED BY THE GRANTOR OF LANDS CONVEYED TO THE UNITED STATES

Code of Federal Regulations - Title 36 - Chapter II - Section 251.19

This section governs the exercise of water and related rights reserved by the grantor of land conveyed to the United States under the provisions of the act of March 1, 1911 (36 Stat. 961).

(a) All reasonable precautions shall be taken by the grantor and all persons acting for or claiming under him to prevent and suppress forest fires upon or threatening the premises or other adjacent lands of the United States, and any person failing to comply with this requirement shall be responsible for any damages sustained by the United States by reason thereof.

(b) All slash and debris resulting from the cutting and removal of timber shall be disposed of as directed by the Forest Officer in charge.

(c) Flowage and reservoir areas shall be cleared of timber and debris, in a manner satisfactory to the Forest Supervisor, or in accordance with a special agreement approved by him. Timber cut and destroyed in the exercise of the reserved rights shall be paid for at rates to be prescribed by the Forest Officer in charge, which rate shall be the usual stumpage price charged in the locality.

(d) The water surface created shall be open to the Forest Service and its permittees when such use does not interfere with the original purpose of the development.

(e) The water surface shall be open to fishing by the public in accordance with State laws when such use does not interfere with the original purpose of the development.

(f) Plans for dams and supplemental structures, impounding or controlling more than 10 acre-feet of water or with a head in excess of 6 feet, shall be approved by the Regional Engineer of the Forest Service before construction shall begin.

(36 Stat. 962, as amended, 16 U.S.C. 518)

EXHIBIT 10J-5 (Rev. 7/26/88)

DECISION MEMO

ISSUANCE OF A CONDITIONAL PERMANENT EASEMENT
FOR THE
ICICLE IRRIGATION DISTRICT

USDA FOREST SERVICE
Region 6
Wenatchee National Forest
Chelan County, Washington

The Forest Service has received an application from Icicle Irrigation District for the issuance of a conditional permanent easement for an agricultural irrigation and/or livestock watering system on National Forest System lands. This system is located within Sections 10 and 15, T. 23 N., R.16 E., Section 3, T. 24 N., R. 14 E., and Sections 22 and 27, T. 25 N., R. 13 E., and is used to divert, store and transport water for agricultural irrigation and/or livestock watering purposes from National Forest System land, to non Federal land owned by the applicant.

The Act of October 27, 1986 directs the Secretary of Agriculture (through the Forest Service) to issue conditional permanent easements to all who apply for and meet specific qualifying criteria in the Act. The Forest Service has reviewed the application submitted in this particular case, and has found that it meets the criteria identified in the Act. Therefore, pursuant to that Act, the applicant is entitled to the issuance of an easement.

The Forest Service has conducted an environmental analysis of the use and occupancy of National Forest System land included in this application. That analysis included a public notice and comment period, during which the agency disclosed to the public that the standard terms and conditions of the easement itself should be adequate to protect National Forest System lands and resources in a manner consistent with the standards and guidelines in the amended Wenatchee National Forest Land and Resource Management Plan.

It is my decision to respond to this application with the issuance of the Agricultural Irrigation and Livestock Watering System Easement (Form FS-2700-9a). The subject facilities use and occupy 12.30 acres of National Forest System lands, have been in place for more than 25 years, and have an existing water right. Operation and maintenance will be done in accordance with applicable Federal, State, and local laws and no extension or enlargement of the system is allowed.

Therefore, I have determined that, consistent with agency policy at Chapt. 31.2, category 7, of Forest Service Handbook 1909.15, this is an action which has been categorically excluded from documentation in an environmental assessment or environmental impact statement.

This decision is not subject to appeal pursuant to 36 CFR 215.8(a)(4). Implementation will occur upon completion of the easement documentation. For further information about this project, contact Steve Johnson at Wenatchee National Forest, Supervisor's Office, 215 Melody Lane, Wenatchee, WA 98801, (509) 664-2789.

Kimberly Evart Bown

KIMBERLY EVART/BOWN
Director of Recreation, Lands, Mineral Resources

1-6-2000
Date

FS-2700-9a (09/96)
OMB No. 0596-0082

U. S. DEPARTMENT OF AGRICULTURE Forest Service **AGRICULTURE IRRIGATION AND LIVESTOCK WATERING SYSTEM EASEMENT** Act of October 21, 1976, Act of October 27, 1986 (Pub. L. 99-545), 36 CFR 251, Subpart B	Holder No. 1 2 0 3-0 3	Issue Date 01-06-2000	Expir. Date 0 X/ /
	Type Site 9 1 6	Authority 6 7 6	Auth. Type 1 0
	Region/Forest/District 0 6/ 1 7/ 0 7		State/County 5 3/ 0 0 7
	Cong. Dist. 0 4	Latitude 4 7-3 8-2 6	Longitude 1 2 0-0 7-1 6

THIS EASEMENT, is issued this 6 day of January, ~~19~~ 2000, by the UNITED STATES OF AMERICA, acting by and through the Forest Service, Department of Agriculture, hereinafter called Grantor, to **ICICLE IRRIGATION DISTRICT**, of the State of Washington hereinafter called the Holder(s).

WHEREAS, the Holder has applied for an easement under Section 501 of the Federal Land Policy and Management Act of October 21, 1976, as amended by P. L. 99-545 (90 Stat. 2743; 43 U.S.C. 1761), for agricultural irrigation or livestock watering system facilities located on lands owned by the United States on the Wenatchee National Forest, in the County of Chelan, State of Washington.

WITNESSETH

WHEREAS, upon acceptance of this easement the Holder relinquishes all right, title, and interest in and to any easement issued for the same lands by the United States by any previous grant or permit.

NOW THEREFORE, the United States does hereby grant, subject to valid existing rights, an easement for occupancy with water conveyance system facilities of lands shown on the plat contained in Exhibit "A", attached hereto and incorporated herein, as provided by the Holder and hereby accepted by the Authorized Officer.

This easement is issued subject to the following terms, provisions, and conditions applicable to the Holder, its permittees, contractors, assignees, and successors in interest.

1. AUTHORIZED USE. This easement authorizes only the right-of-way and water conveyance system facilities as constructed and operated on October 21, 1976, as specified herein.

2. EXTENSIONS or ENLARGEMENTS. This easement does not authorize extensions or enlargements of the water conveyance system.

3. FEES. This easement is issued free of charge.

4. TRANSFERABILITY. This easement is fully transferable provided the water conveyance system facilities are used for agricultural irrigation or livestock watering. Holder shall notify Grantor within sixty (60) days of any address change or change in ownership.

5. TENURE. This easement shall continue for as long as the above described lands and water conveyance system facilities are used, operated, and maintained in accordance with the terms and conditions herein described.

6. OPERATION and MAINTENANCE.
   a. Holder agrees to operate and maintain the facilities and use the authorized easement in accordance with applicable Federal, State, and local laws, regulations, and standards.

   b. Holder shall notify, consult with, and obtain concurrence of the Grantor for operation and maintenance of the authorized facilities.

   c. Holder agrees to install and maintain an operable headgate at each diversion structure. Such headgate shall be capable of controlling the amount of water entering the system.

   d. Holder will not use fire or herbicides on the authorized right-of-way except as permitted in writing by the Grantor.

7. EMERGENCY REPAIRS.
   a. Except for emergency repairs required to protect the environment, property of the United States, or public health and safety, the Holder may not use materials on National Forest System lands outside the easement prior to obtaining written authorization and paying for the materials to be used. Holder's use of material within the easement is limited to maintenance of the water conveyance system facility.

   b. If the water conveyance system facilities authorized by this Easement are allowed to deteriorate to the point of threatening persons or property, and the Holder, after notification by the Grantor, refuses to perform the repairs and maintenance required to remove the threat to persons or property, Grantor shall have the right to undertake such repair and maintenance and to assess the Holder for the costs of such repair and maintenance, regardless of whether Grantor had required the Holder to furnish a bond or other security.

8. INDEMNIFICATION. Holder shall indemnify the United States against liability for any and all injury, loss, or damage, including fire suppression costs, that the United States may suffer as a result of claims, demands, losses, or judgements caused by the Holder's use or occupancy under this easement.

9. LIABILITY. Holder is liable for and agrees to repair damage to National Forest System lands caused by Holder's negligence, intentional acts, or of failure to comply with the terms and conditions of this easement or of any law or regulation applicable to the National Forests.

10. SITE RESTORATION. Holder shall, upon termination of this easement, stabilize the site as required by the Grantor. If Holder does not stabilize the site, the Holder agrees to pay the costs of such stabilization if undertaken by the Grantor.

11. SPECIAL PROVISIONS.

The foregoing notwithstanding, this easement is granted subject to the following reservations by Grantor, for itself, its permittees, contractors, and assigns.

A. NONEXCLUSIVE USE. The Grantor reserves the right to use or permit others to use the easement area, provided such use does not unreasonably interfere with the rights and privileges hereby authorized.

B. TERMINATION. This easement may be terminated with consent of Holder, or if Holder fails to exercise the rights and privileges authorized for any continuous period of five (5) years or more. This easement expires according to its terms if Holder uses the water conveyance system for any purpose other than agricultural irrigation or livestock watering. Grantor may take action to terminate this easement under 7 CFR 1.130 - 1.151, for noncompliance with applicable statutes and regulations, or the terms and conditions of this easement.

ACCEPTANCE On this 28th day of September, 1999 I, the undersigned Holder have read, understand, and accept the terms and conditions of this easement.

Holder

The following certificate shall be executed by the Vice President of the Corporation:

I, Ralph Kimmerly, certify that I am the Vice President of the Corporation that accepted the above easement; that Joel J. Teeley, who signed said easement on behalf of said Corporation was then Secretary/Manager of said Corporation; that I know his/her signature, and that his/her signature on said easement is genuine; and that said easement was duly signed, sealed, and attested to for and on behalf of said Corporation by authority of its governing body.

(CORPORATE SEAL)

Ralph Kimmerly
Vice President

IN WITNESS WHEREOF, the Secretary of Agriculture by the Director of Recreation, Lands, and Mineral Resources, Forest Service, has executed this easement pursuant to delegation of authority specified in 7 CFR 2.60 and 36 CFR 251.52 and the delegation of authority by the Regional Forester published June 23, 1997 (62 F.R. 33826) on the day and year first above written.

UNITED STATES OF AMERICA

Kimberly Evart Bown

Kimberly Evart Bown, Director, RLM
Recreation, Lands and Mineral Resources
Pacific Northwest Region
USDA Forest Service

ACKNOWLEDGMENT

STATE OF Oregon)
)ss.
County of Multnomah)

On this 6th day of January 19 2000, before me, the undersigned, a Notary Public in and for said State personally appeared Kimberly Evart Bowan ____________ Director of Recreation, Lands, and Mineral Resources, Pacific Northwest Region, Forest Service, Department of Agriculture, the same person who executed the within and foregoing instrument, who being by me duly sworn according to law, did say that he/she executed said instrument on behalf of the United States of America by its authority duly given and by him/her delivered as and for its act and deed. And he/she did further acknowledge that he/she executed said instrument as the free act and deed of the United States of America, for the purposes and consideration herein mentioned and set forth, and I do hereby so certify.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal the day and year first above written.

OFFICIAL SEAL
LOUISA HERRERA
NOTARY PUBLIC-OREGON
COMMISSION NO. 327916
MY COMMISSION EXPIRES OCT. 10, 2003

Louisa Herrera
Name (Printed) Louisa Herrera
Residing at Portland, OR.
My Commission Expires 10/10/2003

According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082.

This information is needed by the Forest Service to evaluate requests to use National Forest System lands and manage those lands to protect natural resources, administer the use, and ensure public health and safety. This information is required to obtain or retain a benefit. The authority for that requirement is provided by the Organic Act of 1897 and the Federal Land Policy and Management Act of 1976, which authorize the Secretary of Agriculture to promulgate rules and regulations for authorizing and managing National Forest System lands. These statutes, along with the Term Permit Act, National Forest Ski Area Permit Act, Granger-Thye Act, Mineral Leasing Act, Alaska Term Permit Act, Act of September 3, 1954, Wilderness Act, National Forest Roads and Trails Act, Act of November 16, 1973, Archeological Resources Protection Act, and Alaska National Interest Lands Conservation Act, authorize the Secretary of Agriculture to issue authorizations for the use and occupancy of National Forest System lands. The Secretary of Agriculture's regulations at 36 CFR Part 251, Subpart B, establish procedures for issuing those authorizations.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

Public reporting burden for this collection of information, if requested, is estimated to average 1 hour per response for annual financial information; average 1 hour per response to prepare or update operation and/or maintenance plan; average 1 hour per response for inspection reports; and an average of 1 hour for each request that may include such things as reports, logs, facility and user information, sublease information, and other similar miscellaneous information requests. This includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Agriculture, Clearance Officer, OIRM, AG Box 7630, Washington D.C. 20250; and to the Office of Management and Budget, Paperwork Reduction Project (OMB #0596-0082), Washington, D.C. 20503.

Certified correct as to consideration, conditions, and descriptions ____________

EASEMENT SURVEY
ICICLE IRRIGATION
A PORTION OF GOV. LOTS 6, 7, 8, 9, 10 AND 11, OF SECTION 10, T. 23 N. R. 16 E. W. M. CHELAN COUNTY, WASHINGTON

EXHIBIT 'A'

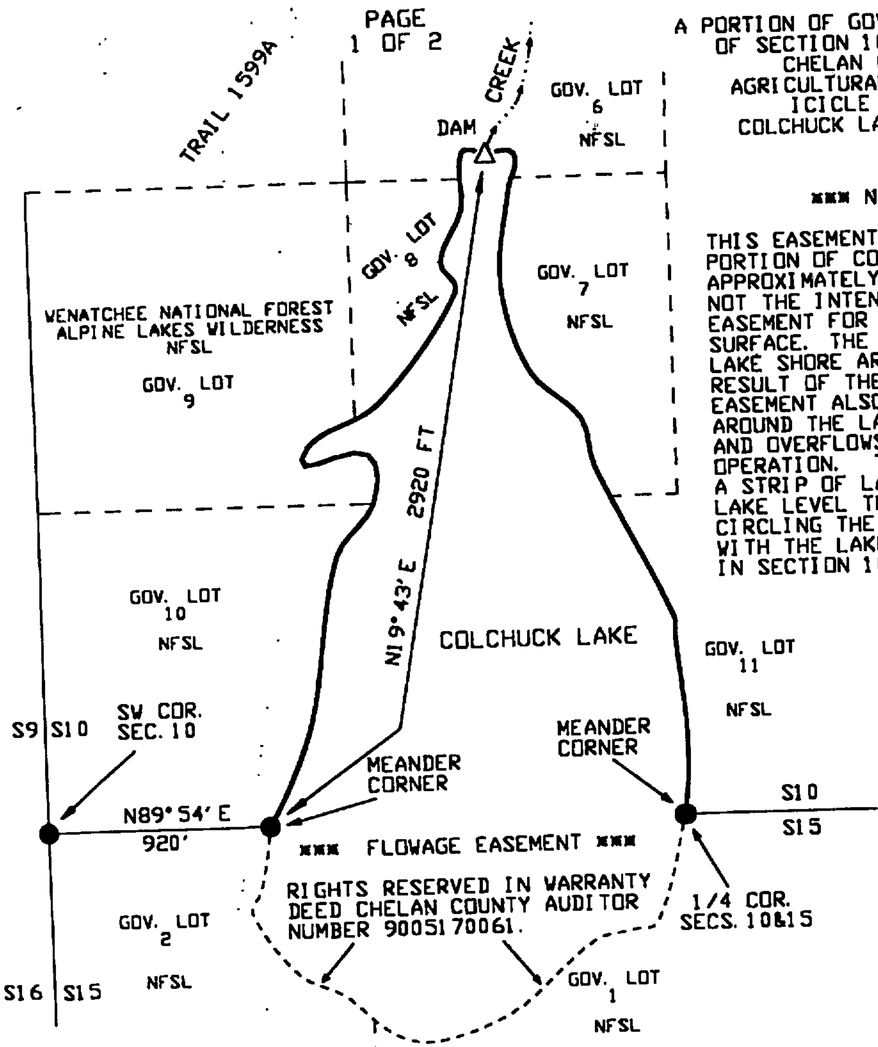

EXHIBIT A
2720 SPECIAL USES
USDA - FOREST SERVICE
PACIFIC NORTHWEST REGION
WENATCHEE NATIONAL FOREST

A PORTION OF GOV. LOTS 6, 7, 8, 9, 10 AND 11, OF SECTION 10, T. 23 N. R. 16 E. W. M.
CHELAN COUNTY, WASHINGTON
AGRICULTURAL EASEMENT - PL 99-545
ICICLE IRRIGATION SYSTEM
COLCHUCK LAKE CONTAINS 3.1 ACRES

*** NOTE ***

THIS EASEMENT FOR THE NORTHERN PORTION OF COLCHUCK LAKE IS APPROXIMATELY 3.1 ACRES. IT IS NOT THE INTENTION TO GRANT AN EASEMENT FOR THE ENTIRE LAKE SURFACE. THE EASEMENT IS FOR THE LAKE SHORE AREA FLOODED AS A RESULT OF THE DAMMING. THE EASEMENT ALSO COVERS THE AREA AROUND THE LAKE, DAM, SPILLWAYS AND OVERFLOWS FOR MAINTENANCE AND OPERATION. THE EASEMENT AREA IS A STRIP OF LAND ABOVE THE ORIGINAL LAKE LEVEL THAT IS 20 FT +/- WIDE CIRCLING THE LAKE IN SECTION 10, WITH THE LAKE HAVING A PERIMETER, IN SECTION 10, OF 6,650 FT.

*** SCALE ***
FEET
0 400 800

ACCESS FOR MAINTENANCE AND REPAIR

THE SYSTEM IS ACCESSED BY FOREST ROADS 7600 AND 7601 AND TRAILS 1599 AND 1599A. ALSO BY HELICOPTER AS DETERMINED BY PREVIOUS AGREEMENTS AND PERMITS.

CORNER TIES TO DIVERSION POINT

FROM THE MEANDER CORNER ON THE WEST SIDE OF COLCHUCK LAKE, THE DIVERSION POINT (DAM), BEARS N19°43'E 2920 FT..

*** NOTE ***

BASIS OF MEASUREMENTS, LOCATIONS AND TIES TO LANDLINE CORNERS IS GLO SURVEY RECORDS ALONG WITH GIS AND QUAD MAP DATA.

*** NOTE ***

THIS IS A LOCATION MAP OF COLCHUCK LAKE WHICH FEEDS THE ICICLE IRRIGATION SYSTEM. THE INFORMATION SHOWN ON THIS MAP IS PROVIDED AS LOCATIONAL INFORMATION AND IS NOT INTENDED TO BE A SURVEY OF COLCHUCK LAKE.

*** LEGEND ***

- NFSL — NATIONAL FOREST SYSTEM LAND
- △ — DAM AND DIVERSION PT
- ● — ORIGINAL GLO STONE MON. PER RECORD
- CREEK AND NATURAL DRAINAGE
- TRAIL
- SECTION SUBD. LINES
- SECTION LINES

SURVEYED BY 6/9/99

REVIEWED BY 6/9/99

Supervisor's Office, Wenatchee 2710

Charles F. Banko, District Ranger February 26, 1968

Special Uses

Attached is an application from the Icicle Irrigation District for a special use permit at Square Lake.

1. Cabin
2. Small dam and operating valves
3. Diversion tunnel

This is in response to your memo regarding the Regional Attorney's opinion of their existing occupancy under a State of Washington hydrology permit.

Three (3) plats are being sent under separate cover. Please have them printed. Return the originals plus three (3) copies of each.

C.BANKO:bd

since 1.08 / 1

cont next pa

District Ranger, Leavenworth

A. C. Wright, Forest Supervisor, By

Special-Use Permits (Icicle Irrigation District, Square Lake Dam)

In 1940 the State Public Lands Commissioner granted an easement to the Icicle Irrigation District which supposedly gave permission to construct a dam and overflow Square Lake. This easement was based on the premise that Square Lake was a navigable body of water and hence the shoreland belonged to the State.

In 1965 the Regional Attorney reviewed the case. Due to the size and location of the lake, and the fact that it is frozen over five to eight months of the year, it was his opinion that the lake would not be considered navigable and hence all lands used by the Irrigation District are National Forest owned and controlled.

The structures at Square Lake are in trespass unless covered by a special-use permit.

Please discuss a permit with the Irrigation District and furnish this office with a rough or penciled permit covering all facilities along with as built plans of existing improvements.

Next summer, after the permit is issued, you should schedule an inspection trip to the lake. At this time you could take representatives of the District along with you and work out an agreement for bringing the improvements up to standard.

If the Irrigation District refuses to accept a permit let us know. We will then recommend the navigability of the lake be decided in court.

Attached is a copy of Ed Sage's memorandum covering the facilities from an engineering standpoint. His comment on the cabin is applicable now since it is under special-use. The other items should be kept in mind and resolved when you make the joint visit to Square Lake.

Enclosure

cc: 7500 Square Lakes Dam

FRITZ M. MORRISON

FMorrison:zmc

since 1,00 / 1

con't next p

7500 Water Storage [illegible]
(2720) [illegible]

Dam Safety Inspection

Regional Forester, R-6

This is in answer to your letters of August 2, 1978, and January 30, 1980, relative to hazard ratings of permittee-owned dams in Class A and B categories.

We presently have nine dams in the A class, of which six are under the jurisdiction of the Bureau of Reclamation and one (Beehive Reservoir) under Corps of Engineers jurisdiction. The remaining two are presently rated as Moderate Hazard. Enclosed are classification narratives for the latter. Please note that Colchuck Dam is unchanged while Square Lake Dam is recommended for change, from Moderate to Low Hazard. Please let us know if you concur with this change.

We have one dam in the Moderate Hazard Class B category. Enclosed is our classification narrative retaining this structure in the Moderate Hazard class.

ALLEN THOMPSON
Engineering Staff Officer

Enclosures DS

CC:
Leavenworth R.D. w/enclosure Note: Suggest you place copy of classification write-up in appropriate permittee folder

Black notebook by Sage's desk w/enclosure

2720 Files
Icicle Irrigation District
  Colchuck
  Square Lake
H&H Reservoir

EASage:blg

Sudden failure of this 5 foot high, 132 foot long dam would release a surge of water (370 acre feet ±) into Prospect Creek, a tributary to Icicle Creek approximately 4.5 miles downstream. The streambed gradient of Prospect Creek is very steep at first, dropping 790 feet in the first 0.6 mile but then levels off for the remaining distance to its confluence with Icicle, dropping another 1,000 feet.

The major storage of this lake (1,850 - 370 = 1,480 acre feet ±) is controlled by a 30 inch concrete pipe and gate which exits through a 5 foot by 7 foot tunnel carved through solid rock. Because of this controlled outlet, large volumes of water are not involved if failure to the pipe/control gate occurs.

Public hazard is considered minor as the access trail to the lake is located well above the stream channel except at one bridge crossing. This crossing is located approximately 2.4 miles downstream from the lake. The dam itself serves as a bridge for access to a cabin and control works of the project. It is very unlikely that loss of life would occur if this dam were to fail. However, some damage to land and one trail bridge would most likely result. Overall damage should be considered minor, as project is located in undeveloped, remote area.

I recommend this Class "A" structure be placed in a Low Hazard Classification.

Signed: EDWARD A. SAGE
Forest Civil Engineer

Date : March 1980

Hazard Rating For Square Lake – Wenatchee N.F.

2720 - Special-Uses

2017-FS-R6-01590-F

SUBJECT: Reservoir & Cabin, Icicle Irrigation District, 9/12/68

TO: District Ranger, Leavenworth

REPLY DUE SEPTEMBER 30, 1969

Clause 20 of the above permit states that the permittee shall perform such maintenance on dam as necessary to bring it up to a standard acceptable to the Forest Officer-in-charge. This maintenance shall be completed by September, 1969.

Please advise by the above due date as to the status of the completion of the necessary work.

A. C. WRIGHT
Forest Supervisor

By E. W. GANO

GUpham:zmc

since 1.08 / 1

con't next page

Regional Forester

March [illegible]

A. C. Wright, Forest Supervisor, By

Special-Use Permits (Reservoir - Icicle Irrigation District)

Attached for your review and approval are an original and two copies of a special-use permit for the Icicle Irrigation District, including an existing dam, diversion tunnel, and maintenance cabin at Square Lake.

The reservoir and associated improvements have been in existence for many years. They were covered by two old permits dated April 13, 1940, and September 5, 1940.

When approved and signed by the permittee the new permit will give us current, complete, and accurate coverage of the reservoir and its related facilities.

Enclosures

OVanderlin:zmc

E. W. GANO

since 1.08/1

con't next pag

SPECIAL USE PERMIT			
Act of June 4, 1897, or February 15, 1901 This permit is revocable and nontransferable (Ref. FSM 2718)	70		
	d. District (7-8) 07	e. Use number (9-12) 2720	f. Kind of use (13-15) 049
	g. State (16-17) 46	h. County (18-20) 007	k. Card no. (21) 1

Permission is hereby granted to **Icicle Irrigation District**

of **Cashmere, Washington 98815**,
hereinafter called the permittee, to use subject to the conditions set out below, the following described lands or improvements:

A tract of land on the outlet of Square Lake in the SE¼ of Section 22, T. 25 N., R. 13 E., W. M., as shown on the plats attached hereto. Plats prepared by C. M. Zediker on July 20, 1939.

This permit covers **1** acres ~~and/or~~ ~~miles~~ and is issued for the purpose of:

Maintaining and using an existing dam, diversion tunnel, with operating valves, etc., and a small maintenance cabin for irrigation water storage and utilization.

1. Construction or occupancy and use under this permit shall begin within ---- months, and nstruction, if any, shall be completed within ---- months, from the date of the permit. This e shall be actually exercised at least **365** days each year, unless otherwise authorized writing.

2. In consideration for this use, the permittee shall pay to the Forest Service, U.S. Department of riculture, the sum of **No Charge, Reg. U-11** Dollars ($ ----) for the period n ---- 19 --, to ---- , 19 --, and thereafter ually on ----, ---- Dollars ($ ----): vided, however, Charges for this use may be made or readjusted whenever necessary to place the ges on a basis commensurate with the value of use authorized by this permit.

3. This permit is accepted subject to the conditions set forth herein, and to conditions **18** to ________ attached hereto and made a part of this permit.

ERMITTEE	NAME OF PERMITTEE Icicle Irrigation District	SIGNATURE OF AUTHORIZED OFFICER Lloyd L. Berry TITLE Manager	DATE Sept. 11, 1968
SUING FICER	NAME AND SIGNATURE A. C. WRIGHT	TITLE Forest Supervisor	DATE September 12, 1968

(CONTINUED ON REVERSE)

forest officer in charge has approved, and has marked or otherwise designated that which may be removed or destroyed. Timber cut or destroyed will be paid for by the permittee as follows: Merchantable timber at appraised value; young-growth timber below merchantable size at current damage appraisal value; *provided* that the Forest Service reserves the right to dispose of the merchantable timber to others than the permittee at no stumpage cost to the permittee. Trees, shrubs, and other plants may be planted in such manner and in such places about the premises as may be approved by the forest officer in charge.

5. The permittee shall maintain the improvements and premises to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the forest officer in charge.

6. This permit is subject to all valid claims.

7. The permittee, in exercising the privileges granted by this permit, shall comply with the regulations of the Department of Agriculture and all Federal, State, county, and municipal laws, ordinances, or regulations which are applicable to the area or operations covered by this permit.

8. The permittee shall take all reasonable precautions to prevent and suppress forest fires. No material shall be disposed of by burning in open fires during the closed season established by law or regulation without a written permit from the forest officer in charge or his authorized agent.

9. The permittee shall exercise diligence in protecting from damage the land and property of the United States covered by and used in connection with this permit, and shall pay the United States for any damage resulting from negligence or from the violation of the terms of this permit or of any law or regulation applicable to the national forests by the permittee, or by any agents or employees of the permittee acting within the scope of their agency or employment.

10. The permittee shall fully repair all damage, other than ordinary wear and tear, to national forest roads and trails caused by the permittee in the exercise of the privilege granted by this permit.

11. No Member of or Delegate to Congress or Resident Commissioner shall be admitted to any share or part of this agreement or to any benefit that may arise herefrom unless it is made with a corporation for its general benefit.

12. Upon abandonment, termination, revocation, or cancellation of this permit, the permittee shall remove within a reasonable time all structures and improvements except those owned by the United States, and shall restore the site, unless otherwise agreed upon in writing or in this permit. If the permittee fails to remove all such structures or improvements within a reasonable period, they shall become the property of the United States, but that will not relieve the permittee of liability for the cost of their removal and restoration of the site.

13. This permit is not transferable. If the permittee through voluntary sale or transfer, or through enforcement of contract, foreclosure, tax sale, or other valid legal proceeding shall cease to be the owner of the physical improvements other than those owned by the United States situated on the land described in this permit and is unable to furnish adequate proof of ability to redeem or otherwise reestablish title to said improvements, this permit shall be subject to cancellation. But if the person to whom title to said improvements shall have been transferred in either manner provided as qualified as a permittee and is willing that his future occupancy of the premises shall be subject to such new conditions and stipulations as existing or prospective circumstances may warrant, his continued occupancy of the premises may be authorized by permit to him if, in the opinion of the issuing officer or his successor, issuance of a permit is desirable and in the public interest.

14. In case of change of address, the permittee shall immediately notify the forest supervisor.

15. The temporary use and occupancy of the premises and improvements herein described may be sublet by the permittee to third parties only with the prior written approval of the forest supervisor but the permittee shall continue to be responsible for compliance with all conditions of this permit by persons to whom such premises may be sublet.

16. This permit may be terminated upon breach of any of the conditions herein or at the discretion of the regional forester or the Chief, Forest Service.

17. In the event of any conflict between any of the preceding printed clauses or any provisions thereof and any of the following clauses or any provisions thereof, the following printed clauses will control.

18. This permit confers no right upon the permittee to the use of the water involved.

19. The Forest Service reserves the right to issue additional permits to increase the storage capacity of this site if such action proves feasible. No permit will be granted for additional facilities that will jeopardize the privileges granted by this permit. Any additional permits authorizing larger facilities will provide for payment of costs including the cost of construction of the original project works, on a cost-benefit ratio mutually agreeable to the permittee and the new applicant. If the permittee and applicant cannot agree on division of costs, the Regional Forester shall decide on an equitable division between the old and new works.

20. Permittee shall perform such maintenance on dam as necessary to bring it up to a standard acceptable to the Forest Officer in charge. This maintenence shall be completed by September 15, 1969.

21. The maintenance cabin shall be removed when no longer servicable. Decision as to serviceability and methods of removal is reserved to the Forest Supervisor.

22. This permit supersedes those certain permits issued by Walter H. Lund on April 13, 1940, and September 5, 1940; one for the purpose of construction of diversion tunnel into Square Lake, the other for the purpose of constructing and maintaining a cabin to be used in connection with the reclamation project.

Supervisor's Office, Wenatchee

2710

Charles F. Banko, District Ranger

February 26, 1968

Special Uses

Attached is an application from the Icicle Irrigation District for a special use permit at Square Lake.

1. Cabin
2. Small dam and operating valves
3. Diversion tunnel

This is in response to your memo regarding the Regional Attorney's opinion of their existing occupancy under a State of Washington hydrology permit.

Three (3) plats are being sent under separate cover. Please have them printed. Return the originals plus three (3) copies of each.

C.BANKO:bd

since 1.08 / 1

con't next pg

District Ranger, Leavenworth

A. C. Wright, Forest Supervisor, By

Special-Use Permits (Icicle Irrigation District, Square Lake Dam)

In 1940 the State Public Lands Commissioner granted an easement to the Icicle Irrigation District which supposedly gave permission to construct a dam and overflow Square Lake. This easement was based on the premise that Square Lake was a navigable body of water and hence the shoreland belonged to the State.

In 1965 the Regional Attorney reviewed the case. Due to the size and location of the lake, and the fact that it is frozen over five to eight months of the year, it was his opinion that the lake would not be considered navigable and hence all lands used by the Irrigation District are National Forest owned and controlled.

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Next summer, after the permit is issued, you should schedule an inspection trip to the lake. At this time you could take representatives of the District along with you and work out an agreement for bringing the improvements up to standard.

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Attached is a copy of Ed Sage's memorandum covering the facilities from an engineering standpoint. His comment on the cabin is applicable now since it is under special-use. The other items should be kept in mind and resolved when you make the joint visit to Square Lake.

Enclosure

cc: 7500 Square Lakes Dam

FRITZ M. MORRISON

FMorrison:zmc

since 1.08/1

con't next p

7500 Water Storage and Transmission
(2720)

Dam Safety Inspection

Regional Forester, R-6

This is in answer to your letters of August 2, 1978, and January 30, 1980, relative to hazard ratings of permittee-owned dams in Class A and B categories.

We presently have nine dams in the A class, of which six are under the jurisdiction of the Bureau of Reclamation and one (Beehive Reservoir) under Corps of Engineers jurisdiction. The remaining two are presently rated as Moderate Hazard. Enclosed are classification narratives for the latter. Please note that Colchuck Dam is unchanged while Square Lake Dam is recommended for change, from Moderate to Low Hazard. Please let us know if you concur with this change.

We have one dam in the Moderate Hazard Class B category. Enclosed is our classification narrative retaining this structure in the Moderate Hazard class.

ALLEN THOMPSON
Engineering Staff Officer

Enclosures DS

CC:
Leavenworth R.D. w/enclosure   Note: Suggest you place copy of classification write-up in appropriate permittee folder

Black notebook by Sage's desk w/enclosure

2720 Files
Icicle Irrigation District
Colchuck
Square Lake
H&H Reservoir

EASage:blg

SUPR	DR
DEP	TCD
P & AO	
AO	
PS	

Sudden failure of this 5 foot high, 132 foot long dam would release a surge of water (370 acre feet ±) into Prospect Creek, a tributary to Icicle Creek approximately 4.5 miles downstream. The streambed gradient of Prospect Creek is very steep at first, dropping 790 feet in the first 0.6 mile but then levels off for the remaining distance to its confluence with Icicle, dropping another 1,000 feet.

The major storage of this lake (1,850 - 370 = 1,480 acre feet ±) is controlled by a 30 inch concrete pipe and gate which exits through a 5 foot by 7 foot tunnel carved through solid rock. Because of this controlled outlet, large volumes of water are not involved if failure to the pipe/control gate occurs.

Public hazard is considered minor as the access trail to the lake is located well above the stream channel except at one bridge crossing. This crossing is located approximately 2.4 miles downstream from the lake. The dam itself serves as a bridge for access to a cabin and control works of the project. It is very unlikely that loss of life would occur if this dam were to fail. However, some damage to land and one trail bridge would most likely result. Overall damage should be considered minor, as project is located in undeveloped, remote area.

I recommend this Class "A" structure be placed in a Low Hazard Classification.

Signed: EDWARD A. SAGE
Forest Civil Engineer

Date : March 1980

Hazard Rating For Square Lake - Wenatchee N.F.

2017-FS-R6-01590-F

2720 – Special-Uses

SUBJECT: Reservoir & Cabin, Icicle Irrigation District, 9/12/68

TO: District Ranger, Leavenworth

REPLY DUE SEPTEMBER 30, 1969

Clause 20 of the above permit states that the permittee shall perform such maintenance on dam as necessary to bring it up to a standard acceptable to the Forest Officer-in-charge. This maintenance shall be completed by September, 1969.

Please advise by the above due date as to the status of the completion of the necessary work.

A. C. WRIGHT
Forest Supervisor

By E. W. GANO

GUpham:zmc

since 1,00 / 1

con't next pag

Regional Forester

March [illegible]

A. C. Wright, Forest Supervisor, By

Special-Use Permits (Reservoir - Icicle Irrigation District)

Attached for your review and approval are an original and two copies of a special-use permit for the Icicle Irrigation District, including an existing dam, diversion tunnel, and maintenance cabin at Square Lake.

The reservoir and associated improvements have been in existence for many years. They were covered by two old permits dated April 13, 1940, and September 5, 1940.

When approved and signed by the permittee the new permit will give us current, complete, and accurate coverage of the reservoir and its related facilities.

Enclosures

OVanderlin:mmc

E. W. GANO

since 1.08 / 1

con't next pag

UNITED STATES GOVERNMENT

Memorandum

TO : Supervisor's Office, Wenatchee

File No. 2710

FROM : Charles F. Banko, District Ranger

Date: February 26, 1968

SUBJECT: Special Uses

Your reference:

Attached is an application from the Icicle Irrigation District for a special use permit at Square Lake.

1. Cabin
2. Small dam and operating valves
3. Diversion tunnel

This is in response to your memo regarding the Regional Attorney's opinion of their existing occupancy under a State of Washington hydrology permit.

Three (3) plats are being sent under separate cover. Please have them printed. Return the originals plus three (3) copies of each.

Charles F. Banko.

sma 1.08 / 1

con't next pag

UNITED STATES GOVERNMENT

Memorandum

P. O. BOX 3623
PORTLAND, OREGON 97208

TO : Forest Supervisor, Wenatchee N. F. File No. 2720

FROM : Philip L. Heaton, Assistant Regional Forester Date: August 9, 1968
Recreation, by

SUBJECT: Special Use Permits (Icicle Irrigation District, Square Lake Dam 4/13/40, 9/5/40) Your reference: 3/20, 5/31

Your Multiple Use Survey Report has been reviewed, and it is a satisfactory record of the analysis of resource values involved in this application.

It is agreed that this permit can be granted within the proposed Wilderness because it was an existing use predating the Wilderness Act.

Some maintenance is needed on the dam. This work should be done before the Wilderness classification is completed.

You should determine what disposition will be made of the cabin. We recommend that it be permitted for use until it is no longer serviceable or worth rebuilding. A clause to this effect is needed, and it should carefully reserve the decision for continued use or removal, to the Forest Supervisor.

Copies of the Multiple Use Survey Report were mailed to the Fish and Wildlife Service and the Washington State Department of Game for wildlife coordination. A copy of a reply from the Washington Department of Game is attached.

Your draft of the permit is approved with our marginal notes. You may issue it with the recommended changes. Please send us a copy of the permit as issued to complete the case file in this office.

Richard M. Love

Enclosure

cc: WS

since 1.08 / 1

con't next pg.

Regional Forester July 2, 1968

A. C. Wright, Forest Supervisor, By Your Ref: 6/21/68

Special Use Permits (Reservoir)--Icicle Irrigation District
Multiple Use Survey Reports

There seem to be a few questions remaining about this permit.

First--is the cabin needed? The answer is--not any longer. Its principal use any more is to provide shelter for working, hiking, or riding in the area. The cabin could be removed now or left until such time as it is no longer serviceable and/or safe.

Second--some maintenance is necessary on the dam itself. It is intended this work will be done this field season. The maintenance consists of grouting to check a leak in the dam.

Third--is the proposal likely to be controversial. The answer is no. We do not forsee any problems along this line.

Again, if you have any further questions, or need more information, please let us know.

OVanderlin:zmc

E. W. GANO

since 1,08/1

con't next pg

UNITED STATES GOVERNMENT

Memorandum

Department of

P. O. Box 3623
Portland, Oregon 97208

TO : Forest Supervisor, Wenatchee National Forest

File No. 2720
2140 (2500)

FROM : T. B. Glazebrook, Assistant Regional Forester
Watershed Management, By

Date: June 21, 1968

SUBJECT: Special Use Permits (Reservoir)--Icicle Irrigation District
Multiple Use Survey Reports

Your reference:

Several questions have been raised about this case that were not covered by your Multiple Use Survey Reports. They are discussed in the attached correspondence. Would you please consider these points and respond to us at an early date?

Thank you.

Enclosures

since 1.08 / 1

con't next pag

UNITED STATES GOVERNMENT

Memorandum

P. O. Box 3623
Portland, Oregon 97208

TO : T. B. Glazebrook, Assistant Regional Forester, Watershed Management
File No. 2140(2500)

FROM : Philip L. Heaton, Assistant Regional Forester, Recreation
Date: June 20, 1968

SUBJECT: Surveys (Multiple Use Survey Reports - Reservoir - Icicle Irrigation District)
Your reference: 6/4

We have reviewed the above multiple use survey report on the Wenatchee National Forest.

This project is within the Alpine Lakes Area which has been proposed for Wilderness, and we are directed to manage it as though it were classified. If this was a new project, we could not approve it. However, it is something that was in existence at the time the Wilderness Act was passed. The proposal is not to change the project itself in any way, but rather to change the permit. So long as the new permit does not authorize anything not already approved in existing permits, we see nothing wrong.

Existing special use permits cover the diversion tunnel and cabin. The only question we have is on the dam and overflow. This is not under special use permit, but is covered by an easement from the State of Washington. Our Regional Attorney has given the opinion that the easement is not valid because the lake is not a navigable body of water. The land involved is entirely National Forest so a special use permit would be the proper document.

Our feeling is that, while the dam was not previously covered by a special use permit, it was covered by an easement which was believed, at the time, to be the proper document. As far as intent was concerned it was approved and, as has been stated, the dam and overflow were in existence when the Wilderness Act was passed.

It is not clear as to whether or not the cabin is needed. If it is not needed, the permit should specify that it be removed now or that it be eliminated when it requires heavy maintenance or reconstruction. With this understanding, we approve the issuance of a new special use permit as recommended.

Philip L. Heaton

since 1.08 / 1

con't next pag

This is a revised special use for a reservoir and related facilities.

The applicant is the Icicle Irrigation District of Cashmere, Washington.

The area involved is within the State of Washington, Chelan County, on the Leavenworth Ranger District of the Wenatchee National Forest.

It is located at the head of the Prospect Creek drainage. This drainage becomes part of the Icicle Creek system.

The specific area in the permit is located in the SE$\frac{1}{4}$ of Section 22, T. 25 N., R. 13 E., W.M. (Square Lake)

This special use is for the maintenance and use of an existing dam, diversion tunnel with operating valves, etc., and a small maintenance cabin for irrigation water storage and utilization.

The facilities involved are limited to the minimum necessary to store and control release of the water. They are of native materials and blend well with the area. Attached are photos of the dam, storage area, tunnel entrance, and operating valves.

The area is completely in National Forest ownership. This permit replaces two older permits dated April 13, 1940, and September 5, 1940. These permits covered the diversion tunnel and cabin, respectively. In addition, the irrigation district also has an easement from the State of Washington for a dam and overflow. Our Regional Attorney, however, has given the opinion that this easement is not valid because the lake is not a navigable body of water. Hence, the land involved is entirely National Forest owned and controlled.

The purpose of this permit is to combine the two older permits and cover that area which was in the easement from the State of Washington.

This project is located in an area typical of the high Cascades. The elevation is from 5000' to 6700' with slopes averaging close to 70%. Area above the dam is about 1000 acres. Ground cover is about 50% rock and bare ground and 50% brush and small trees. Because the lake is within a mile of the Cascade crest, flood potential is very low.

Other than water storage, the area receives little use. Access is by trail only, and back-country hikers and riders are about the only visitors.

since 1.08 / 1

con't next pg

June 30, 1923.

Mr. A. H. Sylvester, Forest Supervisor,
Wenatchee, Wash.

Uses-Wenatchee, Canal & Flu
Icicle Canal Co. 5/6/10

Answered

Dear Sir:-

I am in receipt of your favor of the 26th inst. I am asking Mr. B
ger to prepare as soon as he can conveniently do so a plat or data concerni
the alignment of the Icicle system and furnish you with the same for prepar
of application for permit as outlined in your letter.

I have been under the impression that the site of the tunnels ws
privately owned land, although I will admit that formal right of way has no
been secured.

Yours truly,

[illegible signature]

17, 1910. It is pro... the Icicle ditch and ... should ha
Company ceased to operate the Icicle District, the Icicle District issued to
over by the Icicle District, the permit should have been issued to
~~been~~ advised that a new permit should to the Icicle Canal Company contains
as the permit issued to the Icicle Canal Company contains
clause saying that it is not transferable.

The permit to the Icicle Canal Company, moreove
specified that it was for the purpose of constructing and
a canal and flume, nothing being said about a tunnel, the
i do not think the building of a tunnel is a serious infr
ment on the terms of the permit. However, I believe it w
be best for the Icicle District to make application for
permit issued in its own name which shall permit not only
flume and ditch but a tunnel. ~~with making~~ this applicatio
should like to receive a plat or other satisfactory info
showing the location of the tunnel or tunnels. I will b
to prepare and issue a new permit upon receipt of the ap
and this information. If the course of the canal or flu
been changed from the original location the new permit sho
cover such change so that information on this point sho
furnished. This applies only, of course, to the locatio
canal within the National Forest.

Very sincerely yours,

A H Sylvester

Forest Supervisor.

SEE BACK FOR INSTRUCTIONS

June 26, 1922

L
Uses-Wenatchee
Canal & Flume
Icicle Canal Company.
6/6/10

Mr. Hubert Remley, Secretary,
Icicle Canal District,
Dryden, Washington.

Dear Mr. Remley;

The Special Use permit which authorized the use of National Forest lands for the construction and maintenance of the Icicle ditch was issued to the Icicle Canal Company June 17, 1910. It is probably my fault that when the Icicle Canal Company ceased to operate the Icicle ditch and it was taken over by the Icicle District, the Icicle District ~~should have been~~ advised that a new permit should have been issued to it as the permit issued to the Icicle Canal Company contains a clause saying that it is not transferable.

The permit to the Icicle Canal Company, moreover specified that it was for the purpose of constructing and a canal and flume, nothing being said about a tunnel, though I do not think the building of a tunnel is a serious infringement on the terms of the permit. However, I believe it would be best for the Icicle District to make application for a permit issued in its own name which shall permit not only a flume and ditch but a tunnel. ~~with making~~ this application I should like to receive a plat or other satisfactory information showing the location of the tunnel or tunnels. I will be glad to prepare and issue a new permit upon receipt of the application and this information. If the course of the canal or flume has been changed from the original location the new permit should cover such change so that information on this point should be furnished. This applies only, of course, to the location of the canal within the National Forest.

Very sincerely yours,

AHSg

Forest Supervisor.

(PREPARE IN TRIPLICATE--1 EACH FOR RANGER, SUPERVISOR, AND REGIONAL OFFICE)
(REQUIRED ONCE ONLY FOR ALL PROJECTS ON OR PARTLY ON NATIONAL FOREST LANDS--
SUBMIT REVISION AFTER ANY MAJOR CHANGE IN PROJECT WORKS)

GENERAL INFORMATION

NAME OF PROJECT: Square Lake FOREST: Wenatchee

OWNER: Icicle Irrigation District DISTRICT: Leavenworth

AUTHORITY: Division of Hydraulics STREAM: Prospect Creek

PRIMARY PURPOSE: Reservoir Control YEAR CONSTRUCTED: 1939
(If Power Give HP Capacity)

LOCATION: Section 22; Township 25N; Range 13E; Meridian Willamette

DRAINAGE AREA: Total 1.3 Sq.Mi.; National Forest 1.3 Sq. Mi.

FULL POOL AREA: Total 74 Acres; National Forest 74 Acres

PERCENT OF DAM ON N.F. (OR L.U.) LAND: 100; GROSS STORAGE CAPACITY 1850 Ac. Ft.

ADMINISTRATIVE CLASSIFICATION, (FSM 5670.21); A X B (B) C

HAZARD CLASSIFICATION, (FSM 5670.22); High Moderate X Low LOW

FSM 7500.1 7500.2

DAM STRUCTURE DATA

LENGTH: ~~370~~ 100 Feet; TOP WIDTH: ~~10~~ 3 Feet; HEIGHT: ~~72~~ 10 Feet

SIDE SLOPE: UPSTREAM ½ : 1; DOWNSTREAM ½ : 1

MATERIAL: Earth X (no) Masonry X (yes grav.) Concrete Wood Other

CORE WALL: Clay Masonry Concrete Metal None X

OUTLET DATA

TYPE: Tunnel; SIZE: 5' x 7'; CAPACITY: 310 cfs

TYPE OF OUTLET CONTROL Gate

EMERGENCY SPILLWAY DATA

DESIGN DISCHARGE: None cfs.; cfs/sq.mi.

WIDTH (AT CREST): BOTTOM Ft. In.; TOP Ft. In.

DEPTH OF DESIGN FLOW IN SPILLWAY: Ft., In.; FREEBOARD: Ft. In.

MATERIAL: Concrete Wood Rock Masonry Earth Gravel Other

DATA COLLECTED BY: Ed Sage (Name), High. Engr. (Title), August 3, 1959 (Date)

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Wenatchee National Forest
Supervisor's Office

REPLY TO: 5540 - Land Transfers
(2740)

July 19, 1972

SUBJECT: Memorandum of Understanding, Bureau of Fisheries and Wildlife
(Your ltr. 7/21/71 -- Our ltr. 4/14/72)

TO:

Regional Forester

Please advise us as to the status of the Memorandum of Understanding with the Bureau of Sport Fisheries and Wildlife. We have enclosed a copy of your July 21, 1971, letter and extra copy of the agreement.

A. C. WRIGHT
Forest Supervisor

P. B. Int-Hoad
By

Enclosures

ZChappelle:zmc

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Wenatchee National Forest
Supervisor's Office

REPLY TO: 5540 - Land Transfers

April 14, 1972

SUBJECT: Memorandum of Understanding, Bureau of Fisheries and Wildlife

TO: Regional Forester

Please advise us as to the status of the Memorandum of Understanding with the Bureau of Sport Fisheries and Wildlife. We have enclosed a copy of your July 27, 1971, letter and extra copy of the agreement.

A. C. WRIGHT
Forest Supervisor

E. W. GANO
By

Enclosures

cc:
District Ranger, Leavenworth

ZChappelle:zmc

9e7

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Wenatchee National Forest
P.O. Box 811, Wenatchee, Washington

REPLY TO: 5540 Land Transfers

January 4, 1972

SUBJECT: Memorandum of Understanding, Bureau of Fisheries and Wildlife

TO: Regional Forester

We would like to explore other means of obtaining a necessary document to permit the Forest Service to manage the trails and the portions of the lake shore that are heavily used by the public on the Bureau's land. Hopefully we could obtain a cooperative agreement or memorandum of understanding such as many other governmental agencies use that occupy National Forest land. Reference is made to the memorandums of understanding and coop agreements between Bonneville Power Administration and the Forest Service that permits the B.P.A. to construct facilities on National Forest land.

As a last resort we may have to consider an easement on those lands that require expenditure of National Forest funds to accommodate the public on trails and associated use areas. We hope this last method is not a necessity. Any advice and counsel would be appreciated.

A. C. WRIGHT
Forest Supervisor

E. W. GANO

By

cc: D.R., Leavenworth w/attachments

PBInt-Hout:rs

PBD

To: Wenatchee

WENATCHEE N. F. RECD DEC 22 1971

Supr. O. Eng. Fire Rec.

COPIES R&U.... WS.... B&F Res. A.S. P.M.... I&E.... Rgr.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6
P. O. BOX 3623, PORTLAND, OREGON 97208

REPLY TO: 5540 Land Transfers

August 27, 1971

SUBJECT: Memorandum of Understanding, Bureau of Fisheries and Wildlife

JB

TO: Lands

KS

RAM

We have reviewed the proposed Memorandum of Understanding between the Bureau of Sport Fisheries and Wildlife and the United States Forest Service transmitted with your memorandum of July 21.

We cannot agree to the conditions proposed. We have no authority to spend monies appropriated to the Forest Service for the care, protection and development of land under the jurisdiction of another Federal agency. Presumably the Bureau of Sport Fisheries and Wildlife is funded for the necessary care and protection of lands in their custody.

A similar arrangement which we have been advised exists in Region 1 has been reviewed with their Fiscal Agent. The agreement in Region 1 was never referred to the Division of Fiscal Control for review and they were unaware of its existence. However, they advised that the agreement is improper and would not have been approved if submitted for review. They are presently taking the necessary action to close out any improper arrangements.

Unless the Bureau of Sport Fisheries is able to transfer the land to the Forest Service, there is nothing we can do toward using appropriated funds for development of any improvements or care and maintenance of their land. If we have a trail or road crossing the land and have obtained the necessary easement or right-of-way, it will be satisfactory to continue operation and maintenance of existing facilities or to construct new facilities.

If we can be of any further assistance, please let us know.

Omer E Riehl

OMER E. RIEHL
Acting Regional Fiscal Agent

cc: ✓ Wenatchee w/replies to 7/21 memo
Chief (for info.)
(R-6 L&M, 12/20/71, ks)

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

REGION 6
P. O. BOX 3623, PORTLAND, OREGON 97208

REPLY TO: 5540 Land Transfers

July 27, 1971

SUBJECT: Memorandum of Understanding, Bureau of Sport Fisheries and Wildlife

TO: Lands and Minerals

The May 14, 1971 proposed Memorandum of Understanding between the Bureau of Sport Fisheries and Wildlife and the Forest Service, which will permit the Forest Service to manage certain parcels of land, meets the needs of fish and wildlife. It has our approval.

for WILLIAM E. PINT
Acting Assistant Regional Forester
Range and Wildlife Management

Enclosure

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6
P. O. BOX 3623, PORTLAND, OREGON 97208

REPLY TO: 5540 Land Transfers

July 26, 1971

SUBJECT: Memorandum of Understanding, Bureau of Fisheries and Wildlife

TO: Division of Lands and Minerals

We have reviewed the proposed Memorandum of Understanding with the Bureau of Sport Fisheries and Wildlife and concur that it will do the job.

You may wish to consider preparing the agreement for signature by the Regional Forester although this may depend upon how closely the Forest Supervisor has worked with the Bureau (FSH 2741.12).

ROBERT E. CAREY
Assistant Regional Forester
Operation

Enclosure

Wenatchee N. F.
P. O. Box 811, Wenatchee, Washington 98801

5540 Land Transfers
(2150)

February 20, 1973

Bureau of Sport Fisheries and Wildlife

Forest Supervisor
Snoqualmie National Forest
Attention: Dick Buscher

As you are aware, there are 657.33 acres in and around Snow Lakes in your wilderness proposals belonging to the Bureau of Sport Fisheries and Wildlife.

We tried four years ago to have this land transferred to the Forest Service. We were informed that this was impossible, in that the Bureau acquired these lands, "to carry out the National Bird Management Program." Note correspondence attached.

They may be hampered by regulations on transferring these lands, but there should be nothing to prevent the same Act of Congress that establishes the Wilderness, also, to transfer these lands to the National Forest.

We believe that it would be advisable to propose this transfer. We would then be legal in whatever administrative use that would be required.

A. C. WRIGHT
Forest Supervisor

P. B. Int-Hoal

By

Enclosure

cc: Jack Wright

JCFeigal:jd

WENATCHEE N. F. RECD
Supr. NOV 16 1972 B&F Res. P.M. I&E Rgr.
Fire R&R Tbr. COPIES R&U WS

2017-FS-R6-01590-F

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Region 6
P.O.Box 3623, Portland, Oregon 97208

REPLY TO: 5540 Land Transfer
(2740)

November 13, 1972

cc LEAV 2-5-73 JEF.

SUBJECT: Memorandum of Understanding, Bureau of Sports Fisheries and Wildlife

TO: Forest Supervisor, Wenatchee

Reference is made to the past correspondence on the proposed transfer of certain Bureau of Sports Fisheries and Wildlife lands to the Forest Service.

We have again gone the complete gamut of possibilities to resolve this problem with Fiscal Control and the Regional Attorney's Office. We find no relief.

We therefore suggest you obtain rights-of-way for the trails in the area built on the Sports Fisheries' lands as well as a right-of-way for a strip of land 200 ft. deep and a half-mile long or whatever length you need on the shore of Snow Lake for public use of the lake.

We have discussed this with the Bureau of Sports Fisheries and they say their representative in charge of the hatchery can grant you such an easement.

J. H. Brillhart

J. H. BRILLHART
Branch Chief, Land Adjustments
L&M

Suggest we plug it into the wilderness act for transfer to the Forest Service. Jef.

WENATCHEE NF

2017-FS-R6-01590-F

OCT 2 '81

United States Department of Agriculture

Forest Service

LEAVENWORTH R.D.

Supr	✓	Dep	✓
LMP		Eng	
		Fin	
AS		Lds	
Fire		Min	
Flt		LA	
I&E		RWWS	
IP		Soil	
Per		WS	
Rec			
Tbr		DR	
		TC	
		Rts	

Reply to: 5400 - Landownership

Date: September 30, 1981

Subject: USDI - Fish and Wildlife Service Lands (Snow and Nada Lakes)

To: Forest Supervisor, Wenatchee N.F.

I recently met with Ralph Malsam, Manager of the Leavenworth National Fish Hatchery. One of the discussion topics was the management of FWS lands surrounding Snow and Nada Lakes. My desire is to see those lands transferred to the National Forest for continuity of administration, site rehabilitation and enforcement of regulations. To my surprise, Ralph thought the lands were already under N.F. jurisdiction. His position is that the FWS neither wants to administer them nor are they able to do it.

The lands and waters are located in Sections 9, 17, 18, 19, and 20, T.23N., R.17E., and total about 700 acres more or less. Mr. Malsam vaguely remembers some type of past written agreement on administration of the area, as did Orville Vanderlin. Apparently it had been searched for, about fifteen years ago, but was not found in files of the District, S.O. or R.O.

The only concern of the FWS is that they be able to retain flexibility to draw down the lakes if necessary during low water years. Mr. Malsam indicated he would look again for a copy of any existing agreement and I indicated we would do the same. If nothing can be found (and we cannot find one here), I suggest we start a proposal back through the proper procedure. This is consistent with the Alpine Lakes Act which states in Section 4 (a):

> "Notwithstanding any other provision of law, any Federal property located within the management unit may, with the concurrence of the agency having custody thereof, be transferred without consideration to the administrative jurisdiction of the Secretary for use by him in carrying out the purposes of this Act."

Now that this matter has been reopened, we would like to pursue it. A similar case I am familiar with in Missoula resulted in an Executive Order being issued transferring jurisdiction from the Dept. of Defense to the Dept. of Agriculture.

Please check the records again for any existing agreements and advise us as to what the next steps should be to affect the transfer.

Stephen L. Morton

STEPHEN L. MORTON
District Ranger

2017-FS-R6-01590-F

Wenatchee
National
Forest

301 Yakima Street
P.O. Box 811
Wenatchee, WA 98801

5540 Land Transfers

October 9, 1981

USDI - Fish and Wildlife Service Lands within Alpine Lakes Wilderness (Snow and Nada Lakes)

District Ranger, Leavenworth RD

This letter is in response to your proposal of September 30. I concur with your proposal to transfer the Fish and Wildlife Service lands to the National Forest Service.

The first step should be a letter from the F&WS documenting their willingness to make the transfer. You can probably do this best working through Ralph Malsom.

A land transfer report as outlined in FSM 5541.22 (Amend. #5, 3/73) will be needed. We can rough this out in this office and coordinate it with both you and the Regional Office.

We will also need to know what method the F&WS used to acquire the land. There may have been management constraints in the title. If so, we need to know what they are. Again, you can best initiate this through Ralph.

We have made a search of our records for a copy of the 1968 memorandum of understanding. No copy was found. We made a similar search in 1979 with the same results. At that time, we also consulted with the Regional Office and the USF&WS offices in Portland and Seattle. No signed copy of the memorandum of understanding was found. (A copy of a 1979 note from Kelly Huff, Land Status Specialist in the R.O., is enclosed.)

If a memorandum of understanding is needed, I suggest we make a final check with the Region and the F&WS. If we do not turn up a copy, a new memorandum of understanding would seem to be in order.

Please let me have your thoughts on how you wish to proceed.

DONALD H. SMITH
Forest Supervisor

Enclosure BS

DVandeslin: jc:blg

Supr
LMP
AO
AS
Fisc
Flt
I&E
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Per
Rec
Tbr

U S DEPARTMENT OF AGRICULTURE **SPEED-MEMO**

PART NUMBER 1

DATE May 7, 1979

2017-FS-R6-01590-F

TO
WENATCHEE NF
Orv Vanderlin

Sent out 8/3/79 KK

SUBJECT
5540 Transfers
Memorandum of Understanding
Bureau of Fisheries and Wildlife
(Snow Lakes)

FROM
RO - Lands and Minerals

MESSAGE *(WRITE CONCISE MESSAGE. SIGN AND FORWARD PARTS 1 AND 2 TO ADDRESSEE. RETAIN PART 3)*

This is to confirm our telephone conversation on this date. I have been unable to locate a signed copy ofthe proposed memorandum of understanding (see above).

I have searched the 2740 files in this office as well as talked to Walt Bennett about this file.

As a further search, I have contacted RO Fish and Wildlife, Watershed Management, and Range Management (since Range and Wildlife were once one unit). In addition, I called the U. S. Fish and Wildlife office in Portland. They do not have a signed copy. They contacted their field office and were unable to locate a signed copy.

If you have any further suggestions of people I might be able to contact I will be glad to make further search, but am at a complete loss now.

WENATCHEE NF
MAY 10 '79

SUPR	DR
DEP	TCD
P & AO	
AO	ENG
	FIRE
PS	LD & M'N
CONT	VS
FISC	WS
I & E	R & WL
PER	REC
PROG	TBR
	SOILS
LU PLN	
TBR INV	

SIGNATURE
Kelly Huff

REPLY *(USE THIS SPACE FOR REPLY, SIGN AND DATE, RETURN PART 2 TO SENDER, RETAIN PART 1)*

SIGNATURE

DATE

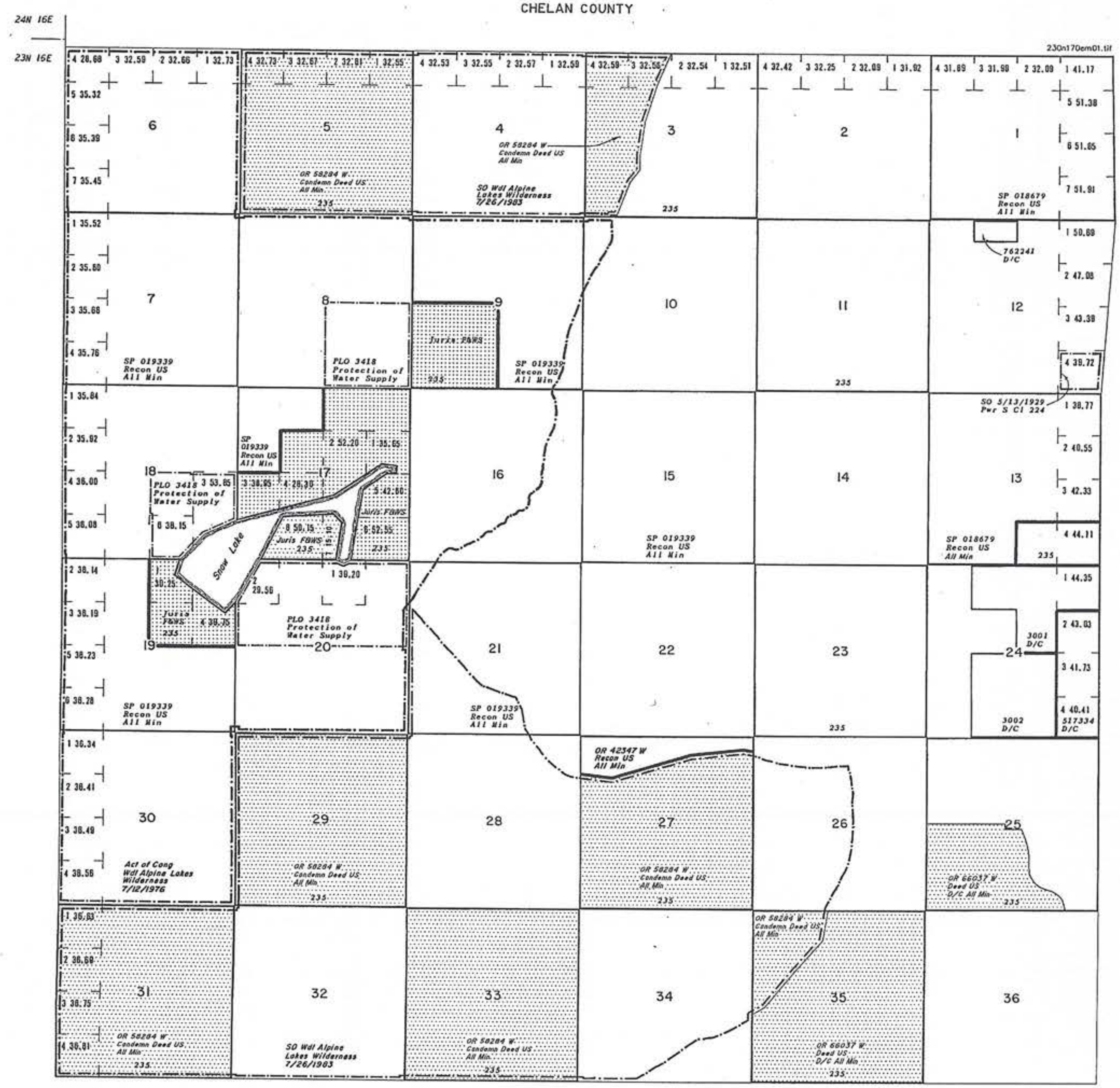
FORM AD-311 (REV. 5-68)

2017-FS-R6-01590-F

TOWNSHIP 23 NORTH RANGE 17 EAST OF THE WILLAMETTE MERIDIAN, WASHINGTON

SPOKANE DISTRICT - WENATCHEE RA

CHELAN COUNTY



SCALE in Chains

SCALE in Feet

WARNING STATEMENT

This plat is the Bureau's Record of Title, and should be used only as a graphic display of the township survey data. Records herein do not reflect title changes which may have been effected by lateral movements of rivers or other bodies of water. Refer to the cadastral surveys for official survey information.

STATUS OF PUBLIC DOMAIN LAND AND MINERAL TITLES AND ACQUIRED LANDS

MT PLAT

INDEX TO SEGREGATED TRACTS				
RESURVEY	ORIGINAL SURVEY			
TRACT NO	T	R	SEC	SUBDIVISION

FOR ORDERS AFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS WITHDRAWN FOR CLASSIFICATION, MINERAL, WATER AND/OR OTHER PUBLIC PURPOSES, REFER TO INDEX OF MISCELLANEOUS DOCUMENTS.

Refer to HI for PL 167, R/W, Esmt, 44LD513, on all lands, see MTP and HI for US rights on private land

All Tp included in Wdl Wenatchee NF

FILE REF: 230n170em01.tif	ACAD Map2000/GTX RasterCAD 6.0
CONVERT JPEG: 06/29/2000	BY: H. GISCH
LAST UPDATE: 08/06/2009	BY: D. LEAVENWORTH
POSTED TO PUBLIC RECORDS: 09/08/2009	

SURVEYED TOWNSHIP
SURVEYED COORDINATE SOURCE:
GCDB NAD 83 CURRENT TO: N/A
IMAGE SOURCE: SCANNED ORIGINAL NTP
PROJECTION: N/A
COORDINATE ELEVATION: N/A
SOURCE FOR METES & BOUNDS: N/A

NOTES:

USE PLAT:

T. 23 N.
R. 17 E.

FOREST SERVICE

Region 6
P. O. Box 3623, Portland, Oregon 97208

REPLY TO: 5540 Land Transfers

July 21, 1971

SUBJECT: Memorandum of Understanding, Bureau of Fisheries and Wildlife

TO: Operation, Fiscal Control, and Range & Wildlife

Since 1969 the Wenatchee National Forest has been working with the Bureau of Sports Fisheries & Wildlife on the possibility of transfer of certain BF&W lands to the jurisdiction of the Forest Service (see copy of Banko's memo - 7/1/69).

It has been determined by the Regional Attorney that the Fish & Wildlife Coordination Act of March 10, 1934, can not be used to transfer such lands to the Forest Service. As an alternative, it has been determined a Memorandum of Understanding could be used which would permit the Forest Service to manage the Bureau's land under the "multiple-use concept including recreation use and development."

Such a Memorandum has been drawn up by the Wenatchee National Forest. A copy is attached for your review and comments.

If this Memorandum of Understanding meets with your approval, we will initiate action to have it signed by the Regional Director and Regional Forester. Please return the attached copy of the Memorandum with your reply.

LLOYD H. WARNER

J. H. BRILLHART
Branch Chief, Land Adjustments
Lands and Minerals

Enclosure

cc: Wenatchee

JHBrillhart:pah

U ED STATES DEPARTMENT OF AGR   TURE
FOREST SERVICE

REGION 6
P. O. BOX 3623, PORTLAND, OREGON 97208

WENATCHEE N. F. RECD
JUL 22 1971
A.O.
Eng.
Fire
Rec.
Tbr.
COPIES
R&U.
WS.
B&F.
Res.
A.S.
P.M.
I&E.
Rgr

2740

REPLY TO: 5540 Land Transfers

July 21, 1971

Jim

SUBJECT: Memorandum of Understanding, Bureau of Fisheries and Wildlife

TO: Operation, Fiscal Control, and Range & Wildlife

cc Leov. 7-26-71

Since 1969 the Wenatchee National Forest has been working with the Bureau of Sports Fisheries & Wildlife on the possibility of transfer of certain BF&W lands to the jurisdiction of the Forest Service (see copy of Banko's memo - 7/1/69).

It has been determined by the Regional Attorney that the Fish & Wildlife Coordination Act of March 10, 1934, can not be used to transfer such lands to the Forest Service. As an alternative, it has been determined a Memorandum of Understanding could be used which would permit the Forest Service to manage the Bureau's land under the "multiple-use concept including recreation use and development."

Such a Memorandum has been drawn up by the Wenatchee National Forest. A copy is attached for your review and comments.

If this Memorandum of Understanding meets with your approval, we will initiate action to have it signed by the Regional Director and Regional Forester. Please return the attached copy of the Memorandum with your reply.

LLOYD H. WARNER

For J. H. BRILLHART
Branch Chief, Land Adjustments
Lands and Minerals

Enclosure

cc: Wenatchee

MEMORANDUM OF UNDERSTANDING

between

BUREAU OF SPORT FISHERIES AND WILDLIFE

AND

UNITED STATES FOREST SERVICE

THIS AGREEMENT, made and entered into this ______ day of ________________, 1971, between the Bureau of Sport Fisheries and Wildlife, Department of the Interior, hereinafter referred to as the Bureau, and the Forest Service, United States Department of Agriculture, hereinafter referred to as the Service,.

WITNESSETH that,

WHEREAS THE BUREAU has sole jurisdiction and control of the following described land:

T. 23 N., R. 17 E., Willamette Meridian
Section 9, $SW\frac{1}{4}$
Section 17, Government Lots 1, 2, 3, 4, 5, 6, 7 and 8, $N\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$
Section 19, Government Lots 1 and 4, $SE\frac{1}{4}NE\frac{1}{4}$

WHEREAS THE SERVICE is desirous of obtaining use of the subject tract;

NOW, THEREFORE, it is mutually understood and agreed by and between the parties hereto that the Bureau's prime interest in the tract is for watershed, water quality control and carry out the National Bird Management Program.

That the Service will be permitted to manage the land under the multiple use concept including recreational use and development.

In consideration of the use privileges contained herein the Service agrees to the following terms and conditions:

1. All use and development will be consistent with the Bureau's use and objectives and subject to the Bureau's concurrence.

2. Water use requirements of the Service will be subject to the Bureau's approval.

3. Care and protection of the land surface from all causes will be the responsibility of the Service.

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5/14/71

4. Neither party shall assume herein any obligation without legal authority. Nothing contained herein shall require either agency to expend funds in excess of appropriations.

5. No cutting or clearing will be done without written approval of the Bureau.

6. This Memorandum of Understanding may be amended at any time by mutual consent and can be terminated in 90 days upon delivery of a written notice of intent to terminate.

IN WITNESS WHEREOF the Bureau and the Service have through their respective officials hereinafter affixed their signatures.

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF SPORT FISHERIES AND WILDLIFE

Date: ____________________ By ______________________________
Regional Director

UNITED STATES DEPARTMENT OF AGRICULTURE

WENATCHEE NATIONAL FOREST

Date: ____________________ By ______________________________
Forest Supervisor

JMD
5/14/71

APPENDIX F

Changing Streamflow in Icicle, Peshastin, and Mission Creeks

and

Flow Charts of Instream Flow Benefit per Alternative Based on Climate Change Modeling

Changing Streamflow in Icicle, Peshastin, and Mission Creeks

Eightmile Lake, Chelan County, Washington

Prepared by

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May 12th, 2017

Contents

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Cover photo source: http://blog.theclymb.com/passions/places-and-adventure-travel/6-great-hikes-to-alpine-lakes-in-the-pacific-northwest/

1 Purpose of this project

As part of the Icicle Work Group (IWG), a diverse set of stakeholders have been working to identify collaborative solutions to water management in Icicle Creek. Water management decisions that are made today will have implications for decades to come. Given the large changes in climate and hydrology anticipated in the coming decades, such plans will need to account for the effects of climate change if they are going to be robust.

The purpose of this project is to leverage existing hydrologic change datasets to estimate future changes in streamflow in Icicle, Peshastin, and Mission Creeks as well as seven regulated alpine lakes (Figure 1). These will be used to evaluate proposed alternatives for managing water in Icicle Creek.

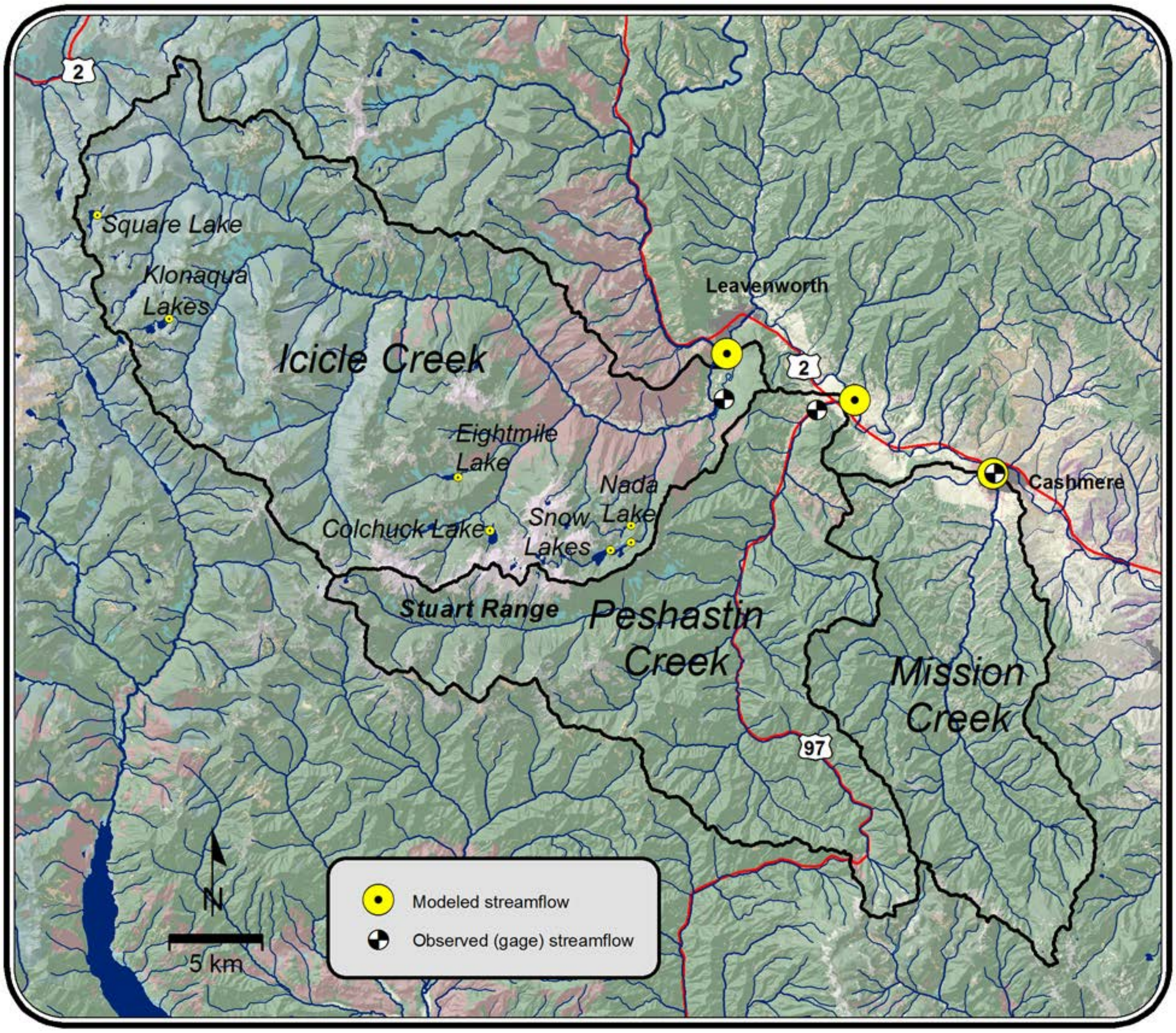

Figure 1. Map of the study locations, including the three watersheds – Icicle, Peshastin, and Mission Creeks, along with the locations of the seven Alpine lakes for which flows are regulated in summer.

2 Streamflow Change Datasets

Hydrologic projections are derived by transforming coarse-scale global climate model results, via downscaling, to fine-scale climate projections, which are then used to drive a hydrologic model (Figure 2; More information on climate scenarios can be found in Chapter 3 of Snover et al. 2013).

The datasets used in this project differ at each of the first three steps in Figure 2: they are based on different greenhouse gas scenarios, different global climate models, and different downscaling approaches. The hydrologic model is the same throughout, although slightly different versions of the model were used for each dataset.

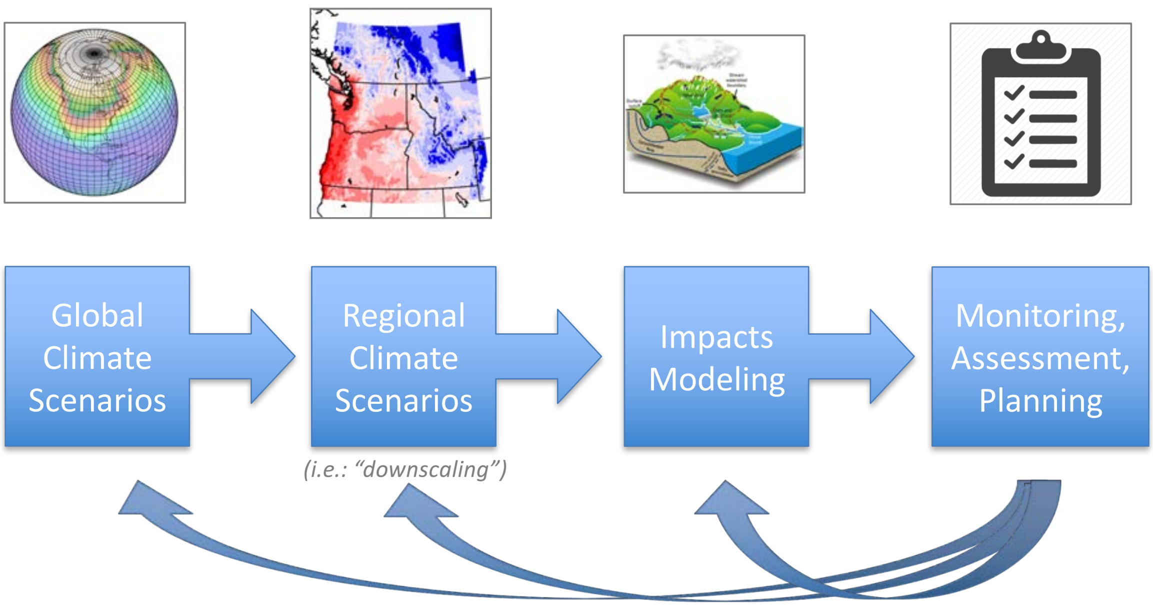

Figure 2. Modeling chain from global climate scenarios to impacts. This section describes the first three steps in the chain.

2.1 Greenhouse gas scenarios

Greenhouse gas scenarios are plausible scenarios of future greenhouse gas emissions that are used to drive global climate models. High scenarios assume continued increases in greenhouse gas emissions throughout the century, with concentrations more than quadrupling by 2100, relative to pre-industrial conditions. Low scenarios assume that multiple factors conspire to reduce the rate of emissions over time, ultimately resulting in about a doubling of greenhouse gas concentrations by 2100. Differences among greenhouse scenarios do not have a big effect on climate projections until after 2050.

The newest set of scenarios was developed for use in the latest Intergovernmental Panel on Climate Change report (IPCC, 2013). These are called Representative Concentration Pathways (RCPs, Van Vuuren et al. 2011). Scenarios used in the current study include both a low and a high greenhouse gas scenario (RCPs 4.5 and 8.5, respectively; Table 1). An older set of scenarios, used in the previous IPCC report, stem from the Special Report on Emissions Scenarios (SRES, Nakicenovic et al. 2000). Two of the datasets in this study are based on the SRES A1B scenario, a moderate greenhouse gas scenario in which emissions stabilize towards the end of the century.

Table 1. Greenhouse gas scenarios used in this report.

Scenario	***Scenario characteristics***	***Description***	***Citation***
RCP 4.5	A low scenario in which greenhouse gas emissions stabilize by mid-century and fall sharply thereafter.	"Low"	*Van Vuuren et al. 2011*
A1B	A medium scenario in which greenhouse gas emissions increase gradually until stabilizing in the final decades of the 21^{st} century	"Moderate"	*Nakicenovic et al. 2000*
RCP 8.5	A high scenario that assumes continued increases in greenhouse gas emissions until the end of the 21^{st} century	"High"	*Van Vuuren et al. 2011*

2.2 Global Climate Models

Greenhouse gas scenarios are used to drive global climate models, or GCMs, which simulate processes in the atmosphere, ocean, and land surface, along with the interactions between each. Coordinated experiments are regularly conducted in which international modeling groups agree to produce climate simulations using the same sets of conditions. This allows for intercomparisons among models and more robust estimates of future changes in climate. These experiments are called Climate Modeling Intercomparison Projects (CMIP).

The datasets used in this study stem from two CMIP generations: Phase 3 (CMIP3, Meehl et al. 2007) and Phase 5 (CMIP5, Taylor et al. 2012). The CMIP3 experiments use the older SRES greenhouse gas scenarios (in our case, the moderate A1B scenario), while the CMIP5 experiments make use of the newer RCPs (for this study, RCPs 4.5 and 8.5). Although the models in the more recent CMIP5 dataset include new features and improvements, they show the same sensitivity to greenhouse gas emissions as the older CMIP3 projections (i.e., they model the same amount of warming per unit of emissions).

2.3 Downscaling

Since GCMs are coarse in spatial scale, these must often be "downscaled" in order to produce climate projections at a scale that is compatible with the impacts that are to be assessed (labeled "regional climate scenarios" in Figure 2). All of the datasets used in this study were downscaled to a spatial resolution of 0.0625-degree (about 2.9 x 4.3 mi, or 12.6 sq. mi.).

Downscaling approaches generally fall into two categories: statistical downscaling and dynamical downscaling. Statistical approaches use empirical relationships derived by relating surface observations to coarse-scale global climate model fields. Dynamical approaches use a physical model that simulates the climate and weather processes occurring at the finer scales. Table 2 lists the three downscaling approaches used in this project.

Table 2. Downscaling methods used in this study.

ID	Name	Type	Citation
MACA	Multivariate Adaptive Constructed Analogs	Statistical	Abatzoglou and Brown 2012
BCSD	Bias Correction and Spatial Disaggregation	Statistical	Wood et al. 2004
WRF	Weather Research and Forecasting Mesoscale Climate Model	Dynamical	Skamarock et al. 2008, Salathé et al. 2010

Downscaling methods typically require an observationally-based historical dataset: either as a basis for the statistical downscaling or for applying corrections to the dynamically downscaled projections. All of the datasets used in this study are based on either the Livneh et al. (2013) or Hamlet et al. (2013) estimates of daily gridded meteorological fields.

2.4 Hydrologic model

A hydrologic model is used to translate from downscaled climate projections to changes in hydrology: snowpack, soil saturation, runoff, baseflow, etc. All of the datasets in this study were developed using the Variable Infiltration Capacity (VIC) macroscale hydrologic model (http://vic.readthedocs.io, Liang et al. 1994). VIC is a distributed model, providing gridded estimates of surface and sub-surface flows (runoff and baseflow, respectively), which can then be processed to estimate streamflow at select locations (see Section 3.2, below). Although there are differences in the model version and parameters used in each implementation, the datasets used in this study are all similar in terms of the VIC model configuration.

2.5 Time Periods

Flow projections were assessed for three future time periods: the 2030s (2020-2049), 2050s (2040-2069), and 2080s (2070-2099). However, not all datasets extended through 2099. In those cases, summaries were only created for the future time periods for which data exist. Future changes were assessed relative to 1970-1999, with the exception of the WSU dataset, as described below.

2.6 Datasets

2.6.1 MACA

A set of hydrologic projections that were developed as part of the Integrated Scenarios of the Future Northwest Environment project (Mote et al. 2014). Climate projections stem from the statistically downscaled MACA approach, and are based on the latest global climate model projections (CMIP5, Taylor et al. 2012). The MACA downscaling is applied to the top 10 GCMs based on the ranking of Rupp et al. (2013), each for both a low and a high greenhouse gas scenario (RCPs 4.5 and 8.5, respectively), for a total of 20 future climate scenarios. The projections extend from 1950-2099. Hydrologic simulations were made using VIC version 4.1.2.

Citation: Mote et al. 2014

URL: http://climate.nkn.uidaho.edu/IntegratedScenarios
http://maca.northwestknowledge.net

2.6.2 bcMACA

A modified version of the MACA dataset in which average monthly temperature and precipitation was adjusted (or bias-corrected, hence *bc*MACA) to match the estimates derived from the observationally-based Parameter-Elevation Regressions on Independent Slopes dataset (PRISM, version AN81M monthly, Daly et al. 2008). Over the U.S. the monthly time series was used to apply the adjustments, while over Canada the long-term average for each month was adjusted to match the long-term average from PRISM.

Projections are based on the same models and scenarios as MACA. Hydrologic simulations were made using VIC version 4.1.2.

Citation: Mauger et al. 2016

URL: https://cig.uw.edu/datasets/hydrology-in-the-chehalis-basin/
http://cses.washington.edu/rocinante/MACA/bc/

2.6.3 WSU

A new set of hydrologic projections developed for the 2016 Columbia River Basin Long-term Water Supply and Demand Forecast (Hall et al. 2016). Hydrologic model simulations are driven by the same MACA projections described in Section 2.6.1 above, except that only five of the 10 GCMs were used, each again for both a low and a high greenhouse gas scenario, adding up to a total of 10 future scenarios. Hydrologic simulations are performed using VIC-CropSyst v2.0 and run for two 31-year time periods: 1981-2011 and 2020-2050. This means that future changes are only available for the 2030s, and that changes for this time period are assessed relative to 1981-2010 instead of 1970-1999 as with each of the other datasets.

Citation: Hall et al. 2016

URL: http://www.ecy.wa.gov/programs/wr/cwp/2016Forecast.html

2.6.4 HB2860

A previous set of projections, developed with funding from Washington State House Bill #2860 (HB2860, Hamlet et al. 2013). Climate projections stem from the statistically downscaled BCSD approach, and are based on the previous set of global climate model projections (CMIP3, Meehl et al. 2007). The BCSD downscaling was applied to seven GCMs based on the ranking of Mote and Salathé (2010). In this project we analyzed results for a moderate greenhouse gas scenario (A1B). The projections extend from 1950-2099. Hydrologic simulations were made using VIC version 4.0.7.

Citation: Hamlet et al. 2013

URL: http://warm.atmos.washington.edu/2860/

2.6.5 bcWRF

Regional Climate Model simulations using the WRF model (Skamarock et al. 2008, Salathé et al. 2010). Projections stem from two GCMs selected from the previous set of global climate model projections (CMIP3, Meehl et al. 2007), both for a moderate greenhouse gas scenario (A1B). Daily temperature and precipitation from the WRF model were bilinearly interpolated to the 0.0625-degree grid, and bias-corrected (hence *bc*WRF, see Mauger et al. 2016) to match the daily statistics from Livneh et al. 2013 and the long-term monthly averages from PRISM (Daly et al. 2008). The projections extend from 1970-2069, meaning that future changes are not available for the 2080s. Hydrologic simulations were performed using VIC version 4.1.2.

Citation: Salathé et al. 2010

URL: http://cses.washington.edu/rocinante/WRF/

2.6.6 Summary of Datasets

Table 3 summarizes the details related to each of the five datasets used in this study. Note that even with the same VIC model version, simulations can result in different estimates of hydrologic conditions. Specifically, differences in the soil characteristics, vegetation properties, and the specification of sub-grid scale topographic variations can all have an effect on the model simulations. These have not been compared as part of the current study.

Table 3. Summary of the features of each of the five datasets used in this study. The column "Climate Models" lists the number of global climate model projections included in the projections.

	Greenhouse Gas Scenario			**Climate Models**		**Downscaling**		**Hydrologic Model**			**Years**		
	Low	Moderate	High	New (CMIP5)	Old (CMIP3)	Statistical	Dynamical	VIC v4.0.7	VIC v4.1.2	VIC-CropSyst v2.0	2030s	2050s	2080s
MACA	✓		✓	**10**		✓			✓		✓	✓	✓
bcMACA	✓		✓	**10**		✓			✓		✓	✓	✓
WSU	✓		✓	**5**		✓				✓	✓		
HB2860		✓			**7**	✓		✓			✓	✓	✓
bcWRF		✓			**2**		✓		✓		✓	✓	

3 Approach

The VIC hydrologic model produces gridded estimates of surface runoff and sub-surface flows on the model grid. Since any particular streamflow site may contain multiple grid cells within its catchment area, an additional step is needed to estimate total streamflow at each location. This process is referred to as streamflow "routing", because flows are routed through the stream network. Once daily streamflow estimates have been obtained at each site, an additional step is needed to estimate daily streamflow extremes. This section describes the post-processing steps used to obtain estimates of streamflow for select sites and metrics.

3.1 Streamflow sites

We assessed changes in streamflow for the three creeks and seven alpine lakes listed in Table 4. Daily flows were estimated at the mouth of the three creeks, while monthly average flows were assessed for the alpine lakes. The drainage area for each alpine lake is small compared to the spatial resolution of the datasets we are using (the area of each gird cell is about 12.6 sq. mi.). Since the smaller scales may result in greater uncertainties, projections for the alpine lakes were only evaluated at monthly time scales. As discussed in Section 4, this may be the most appropriate focus for the three creeks as well.

Table 4. Streamflow projections were developed for each of these sites. The final column lists the time step used for the projections (monthly or daily). The latitude and longitude refers to the output point of each lake or creek.

Site	*Latitude*	*Longitude*	*Area*	*Freq.*
Icicle Creek	47.58002N	120.66620W	214 sq. mi.	Daily
Peshastin Creek	47.55748N	120.57460W	136 sq. mi.	Daily
Mission Creek	47.52159N	120.47606W	93 sq. mi.	Daily
Square Lake	47.64692N	121.11992W	1.6 sq. mi.	Monthly
Klonaqua Lakes	47.59455N	121.06960W	1.3 sq. mi.	Monthly
Eightmile Lake	47.52035N	120.86521W	5.9 sq. mi.	Monthly
Colchuck Lake	47.49196N	120.83358W	1.5 sq. mi.	Monthly
Upper Snow Lake	47.48216N	120.75726W	4.2 sq. mi.	Monthly
Lower Snow Lake	47.48454N	120.74580W	4.8 sq. mi.	Monthly
Nada Lake	47.49611N	120.73874W	1.5 sq. mi.	Monthly

This analysis uses off-the-shelf models which were calibrated for these locations. In addition, the models do not account for flow regulation. Both factors could impact the absolute flow estimates (i.e.: the flow rate, in cfs). As a result, this analysis emphasizes relative changes in streamflow at each site. This information can be combined with knowledge of both existing and proposed flow modifications in order to produce absolute estimates of future flows under various management alternatives.

3.2 Streamflow

VIC simulations of surface and sub-surface flows from each grid cell (sometimes referred to as runoff and baseflow, respectively) were used to produce the routed streamflows at each site using a daily-time-step routing model developed by Lohmann et al. (1996). The within-cell routing uses a Unit Hydrograph (UH) approach to represent the temporal distribution of flow at the outlet point from an impulse input at each source point. The channel routing uses the linearized Saint-Venant equation to represent the flow at a downstream point as a function of the water velocity and the diffusivity, both of which may be estimated from geographical data (Lohmann et al. 1998). The river routing model assumes all runoff and baseflow exit a cell in a single flow direction.

A predetermined routing network provides the upstream-downstream linkage between VIC model grid cells. The three creeks listed in Table 4 were then located on the developed streamflow routing network and verified based on their true latitude-longitude location, the cited watershed area by the USGS and the World Hydro Reference Overlay Map showing flow of the rivers.

Since the catchments for the alpine lakes are all less than half of the area of a single 0.0625-degree grid cell (about 12.6 sq. mi.), routing is not needed for these sites. Instead, we used an area-weighted average for any grid cells that overlap with the catchment area for each lake. Since the gridded climate estimates are not designed for sub-grid scales, where unresolved microclimates may be important, these data are only produced at monthly time scales. Averaging from daily to monthly likely minimizes the impacts of any systematic differences between the climate datasets and the actual conditions present within each catchment.

3.3 Extremes statistics

In addition to monthly average flows, daily streamflow projections were synthesized according to the following metrics:

1. The 10% non-exceedance value (10-year event) for annual daily minimum flows, and
2. The 50%, 10%, and 1% exceedance value (2-, 10-, and 100-year events, respectively) for annual daily maximum flows.

To calculate extreme statistics, the Extreme Value type 1 distribution described Gumbel (EV1), the Log-Pearson type 3 (LP3) and the Generalized Extreme Value (GEV) distribution with L-moments are commonly used. In this study, we apply the GEV distribution with L moment to estimate flood and low flow statistics – following the methodology described in Salathé et al. 2014 and Tohver et al. 2014. These distributions are selected based on findings that indicate it is superior to the LP3 distribution (Rahman et al. 1999 & 2015, Vogal et al. 1993, Nick et al. 2011). Flood flows were computed for return intervals of 2, 10, and 100 years (50%, 10%, and 1% exceedance values). To estimate flood magnitude, the maximum daily flows were extracted for each water year (October to September) at each site. These were ranked for each 30-year period and fitted to the GEV with L-moments (Wang, 1997; Hosking and Wallis 1993; Hosking 1990). Similarly, the low flow statistic was calculated by taking the minimum daily streamflow in each water year and estimating the 10-year extreme (10% non-exceedance value).

4 Results

This section summarizes the results of the analysis. Although the emphasis of this project is on relative changes in flows, comparisons with observations provide useful context for interpreting the results from each dataset. Subsequent sections show the projections, along with one example of a way to synthesize the results.

All of the results presented in this report concern monthly average flows. Changes in daily extremes were also estimated, and these are available on the project website. However, given the approximate nature of the projections, our recommendation is to base decisions on the monthly average flow projections, since these are likely to provide more robust estimates of future conditions.

4.1 Comparison with Observations

4.1.1 Streamflow Observations

We obtained daily gauge observations of streamflow at sites on each of the three creeks (Table 5). As is evident from the observations shown in Figure 3, streamflow in all three creeks is heavily influenced by snowpack. This is particularly true for Icicle Creek, for which flows remain quite low for almost the entire year, then rise sharply for May and June before falling again to low values for the summer.

Figure 3 shows that the various datasets generally do a good job of capturing the seasonal cycle of streamflow for the three creeks. The absolute differences are large in some cases, but overall the timing and distribution of streamflow closely resembles the observations. This is important, since the seasonal pattern of streamflow is governed by the proportion of precipitation that is captured in the snowpack as well as the rate of snow accumulation and melt. A model that does not adequately capture these processes may not be able to accurately represent the consequences of warming for snowpack and, by extension, streamflow.

Table 5. Streamflow gauges used for comparison with model results.

Site	*ID*	*Latitude*	*Longitude*	*Years*
Icicle Creek	USGS #12458000	47.54111N	120.71889W	1936-2016
Peshastin Creek	Ecology #45F070	47.55250N	120.60170W	2002-2016
Mission Creek	Ecology #45E070	47.52140N	120.47470W	2002-2016

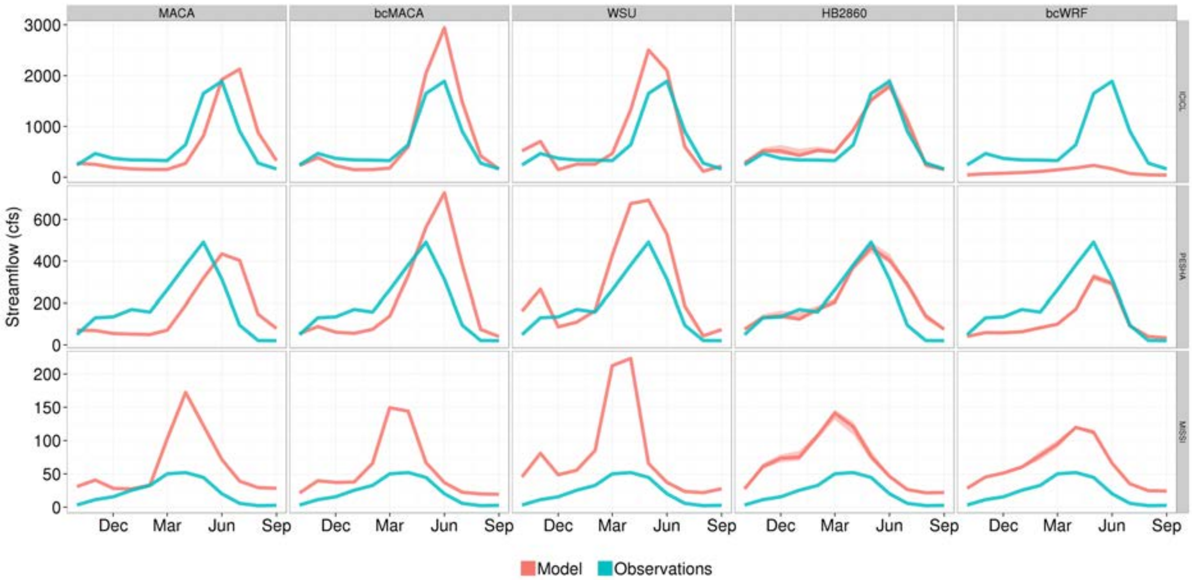

Figure 3. Comparing observed (blue) and simulated (orange) monthly streamflow for each of the five datasets (from left to right: MACA, bcMACA, WSU, HB2860, bcWRF) for Icicle (top), Peshastin (middle), and Mission (bottom) Creeks. Each plot shows the long-term average of monthly flows. For simulated streamflow, the average is for 1970-1999, with the exception of the WSU dataset, for which the 1981-2010 average is shown. For the observed flows, the average is for 1950-2015 for Icicle Creek and 2002-2016 for Peshastin and Mission Creeks.

4.2 Projections

In this section, we focus on the percent changes in monthly streamflow for each streamflow site. Figures 4, 5, and 6 show the projected changes for the three Creeks for the 2030s, 2050s, and 2080s, respectively. The magnitude of the change differs substantially from one dataset to the next. This reflects the uncertainties associated with representing changes in local climate and hydrology; this uncertainty would likely be reduced with careful calibration and improvements to model inputs (climate, soil, and vegetation). On the other hand, the overall pattern of change is remarkably consistent and reflects the expected reductions in snowpack with warming. Warming elevates the snowline, increasing the proportion of precipitation that falls as rain which results in reduced snow accumulation in winter. The combination of reduced snowpack and higher temperatures result in an earlier and less pronounced spring peak in streamflow, along with lower flows throughout the melt season and summer. Each of the datasets shows the same changes in the seasonal cycle of streamflow: increased flow in winter, an earlier peak in streamflow, and decreased flow in summer.

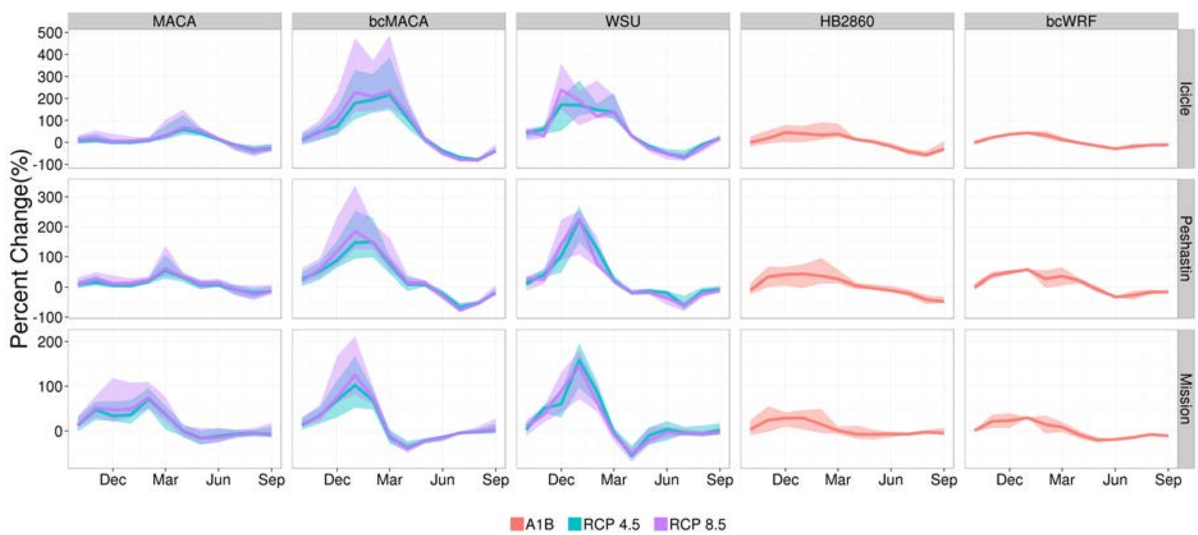

Figure 4. Projected changes in streamflow for the 2030s (2020-2049), relative to historical (see Section 2.5 for details), for Icicle (top), Peshastin (middle), and Mission (bottom) Creeks. Plots show the percent change in streamflow for each month for each of the five datasets (from left to right: MACA, bcMACA, WSU, HB2860, bcWRF). Thick lines show the average projection, while the shaded area shows the range among models for each dataset.

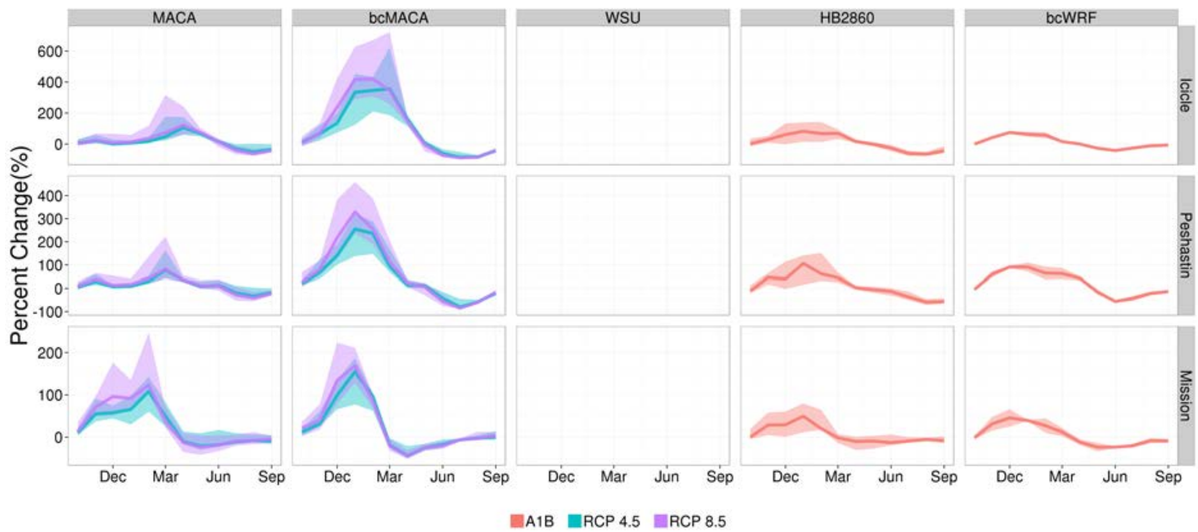

Figure 5. As in Figure 4 except showing results for the 2050s. The WSU plots are blank because the dataset does not include projections for the 2050s.

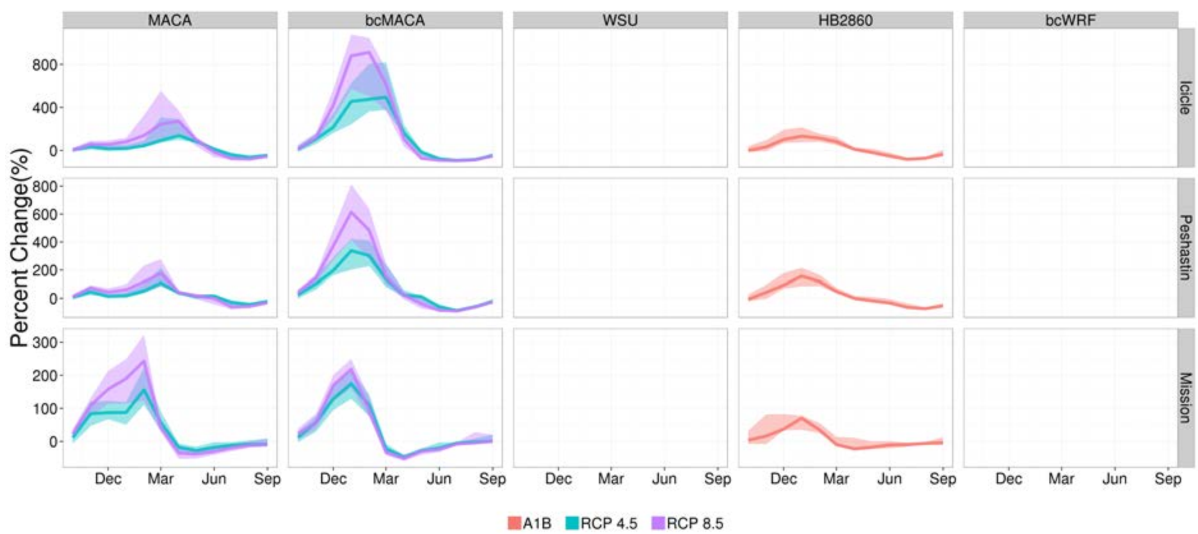

Figure 6. As in Figure 4 except showing results for the 2080s. The WSU and bcWRF plots are blank because neither dataset includes projections for the 2080s.

Changes for the seven regulated alpine lakes are shown in Figures 7, 8, and 9 (2030s, 2050s, and 2080s, respectively). These show a pattern of change that is consistent with the three creeks. This is likely a result of the fact that these are cold high-elevation catchments, which will continue to effectively retain snow in the future.

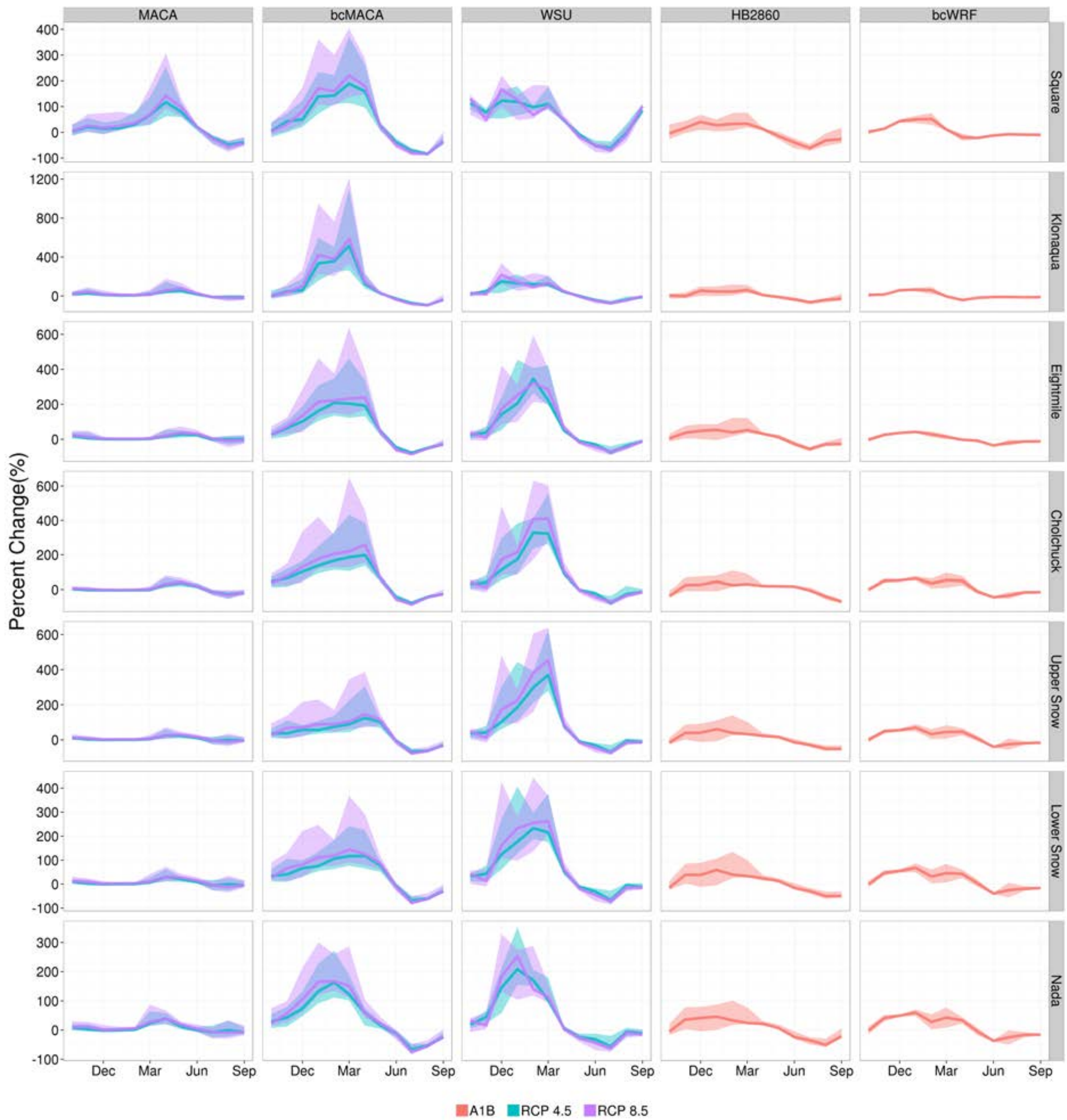

Figure 7. Projected changes in streamflow for the 2030s (2020-2049), relative to historical (see Section 2.5 for details), for the seven Alpine lakes with flow regulation. Plots show the percent change in streamflow for each month for each of the five datasets (from left to right: MACA, bcMACA, WSU, HB2860, bcWRF). Thick lines show the average projection, while the shaded area shows the range among models for each dataset.

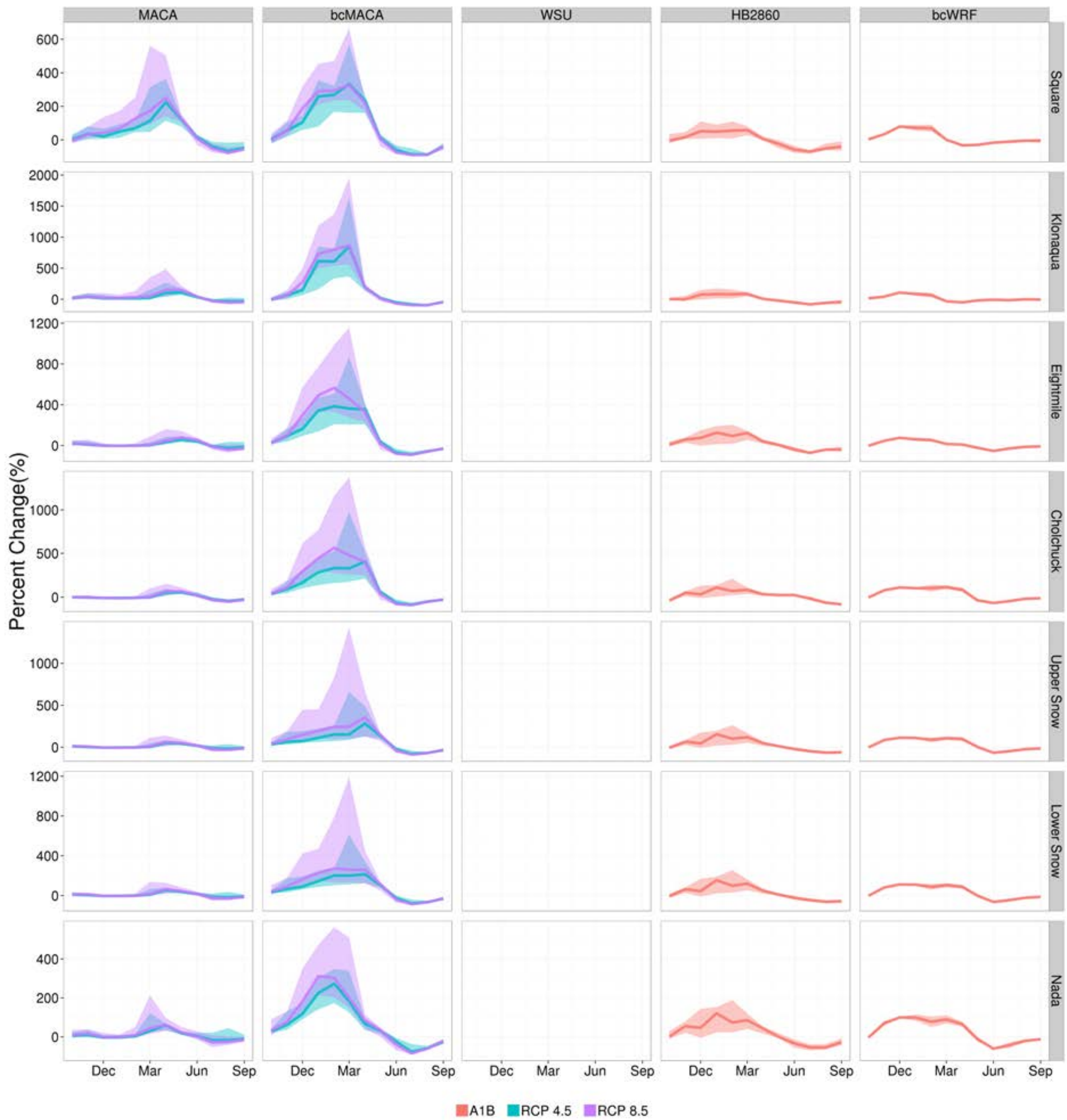

Figure 8. As in Figure 7 except showing results for the 2050s.

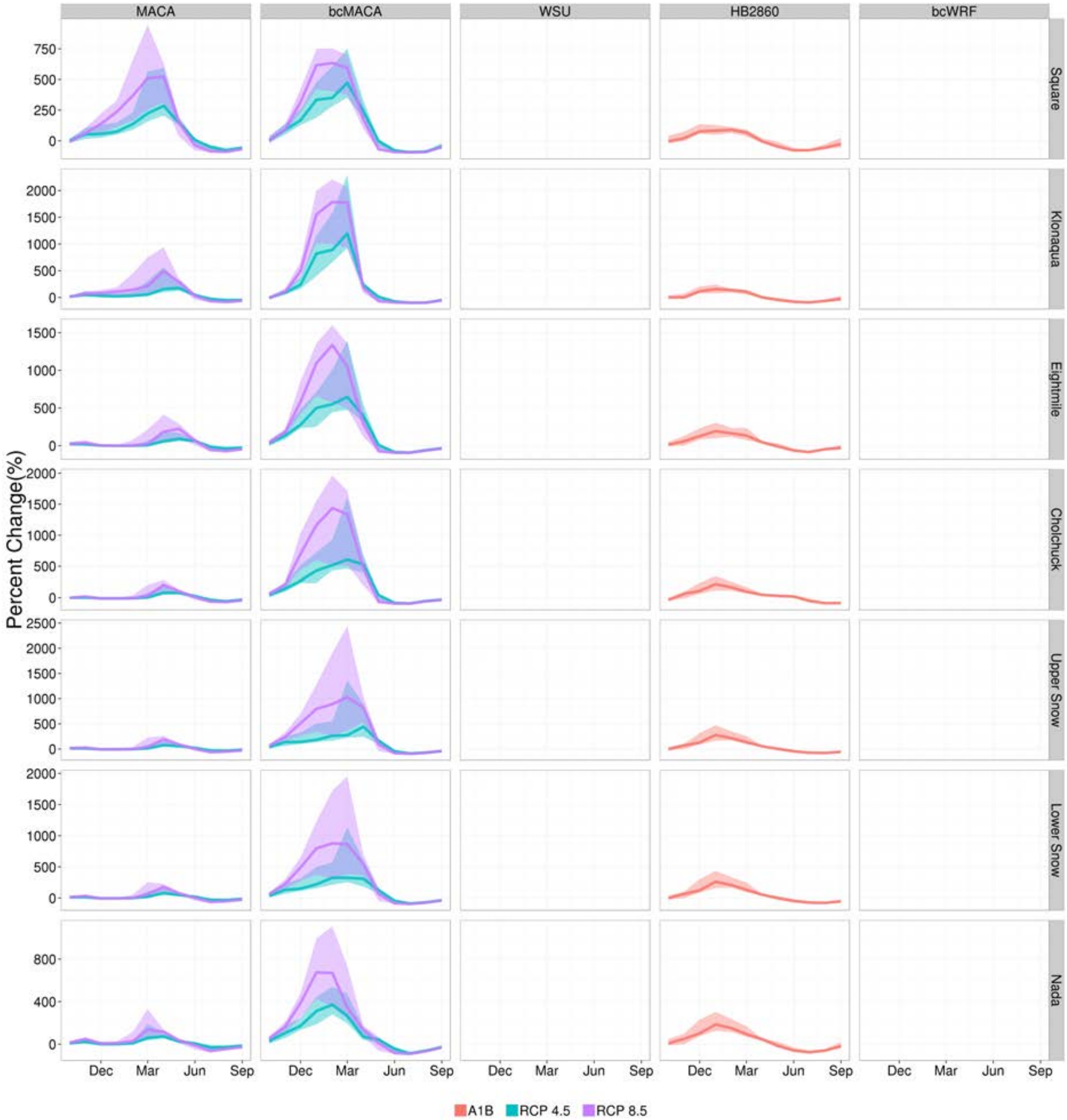

Figure 9. As in Figure 7 except showing results for the 2080s.

4.3 Average projections for Icicle Creek

The purpose of this project is to provide first estimates of changing hydrology in Icicle, Peshastin, and Mission Creeks. To do this we are using five different off-the-shelf datasets, each with its own set of models and assumptions, and none of which is calibrated for this area. Given the large number of future streamflow scenarios, it is not surprising that there is a wide range among the projections.

Although robust decisions can be made in spite of a large range among projections, it can be helpful to simplify the projections for the purpose of evaluating the impacts. Since the projections will primarily be used for a screening-level assessment of proposed infrastructure and management changes, one simple way to distill the results is by considering the average projection for each dataset. This is a very simplistic approach, since it involves averaging over different numbers of models for each dataset (Table 3) and, in some cases, averaging results from two different greenhouse gas scenarios.

Figure 10 shows the average ("average of the averages") and interquartile range for the average projected changes from each of the five datasets. These again reflect the expected patterns of decreased snow accumulation in winter, earlier melt, and dramatic decreases in streamflow in summer.

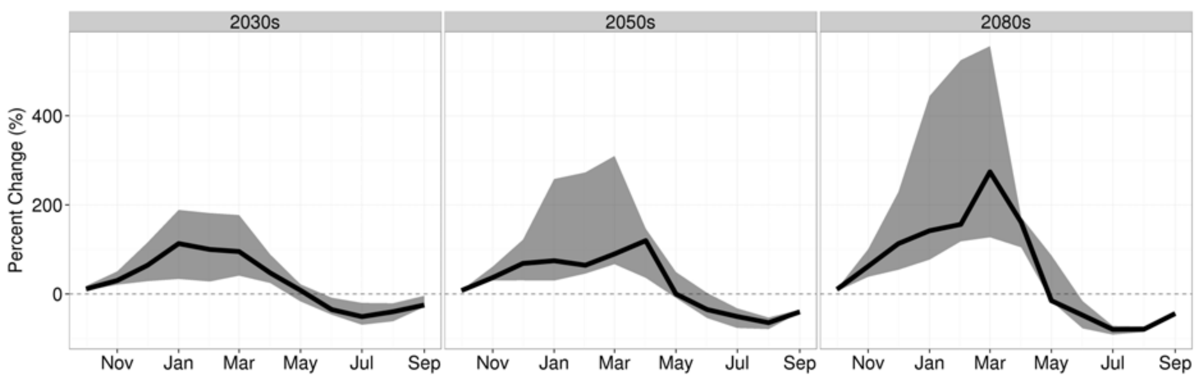

Figure 10. Projected changes in streamflow for the average among all scenarios within each dataset. The thick line is the "average of the averages", while the shaded area shows the interquartile range among the five average projections constructed from each dataset. Results are shown for 2030s (left), 2050s (middle), and 2080s (right), relative to historical (see Section 2.5 for details).

5 Interpreting the Results

This section describes some of the factors that should be considered in interpreting the results of this analysis.

5.1 None of the models were calibrated

The datasets used in this analysis were all previously developed in other projects without specific considerations given to Icicle, Peshastin, and Mission Creeks. As a result, no special attention was given to optimizing the models for these areas. This means two things: (1) the model inputs – the climate, soil, and vegetation patterns assumed for these locations – were not optimized to best represent the conditions found in the three creeks, and (2) the models were not calibrated to ensure that streamflow estimates match observed flows at each location. As a result, the absolute flows estimated for each location are not expected to match the observations exactly. In general, however, the models are expected to capture the seasonal cycle of flows (i.e.: relative changes in flows from month to month), even if the absolute flows do not match the observations. Daily streamflow estimates are more sensitive to deficiencies in model inputs or the model itself, and should also be regarded with greater caution than monthly average flows.

5.2 The hydrologic simulations assume no change in land cover

Streamflow is influenced by more than just temperature and precipitation; changes in soils and vegetation can also have an important influence on flows. The simulations analyzed here do not include such changes: land cover and soil characteristics are expected to remain the same throughout the simulations. Landslides and wildfires can reduce vegetation cover and soil water retention. If these or other related changes were to occur these could result in greater changes in streamflow than the current projections imply. If there are areas that are currently experiencing forest regrowth or densification these could also affect streamflow, though the net impact would depend on the balance between changes in snow accumulation, soil water retention, and changes in vegetative water demand as trees mature.

5.3 "Average of the averages" is just one approach

In the previous section, we presented results in which the average projection for each dataset was used. This is just one approach to synthesizing the results, and may not be the best approach for every application. In this case, averaging was deemed appropriate because of the screening-level nature of the Programmatic Environmental Impact Statement (PEIS) and the fact that none of the models had been calibrated for these watersheds.

In general, however, averaging across models is not recommended because it suppresses the range among model projections, which can provide important information for planning. For example, some planning contexts may require consideration of the worst-case scenario, while others may involve identifying approaches that are robust across a broad range of projections. In such cases, it would not be appropriate to consider only the average projections as opposed to the full range among different models and greenhouse gas scenarios.

Another reason one might want to take a different approach is if one dataset is considered more accurate than the others. This could be based on knowledge about how the datasets were developed, or based on the comparisons with observations. In this case, projections from just that dataset could be considered in lieu of lumping all datasets together as equals.

Ultimately, the best approach is to have a well-calibrated model that accurately represents the climate, soil, and vegetation characteristics of the watershed, and to be cognizant of potential biases in either the inputs or the model itself in order to appropriately interpret its results. The purpose of our current analysis is to provide a preliminary estimate of the impacts of climate change, the implications of which will help determine if more detailed modeling is necessary.

5.4 Can I trust these projections?

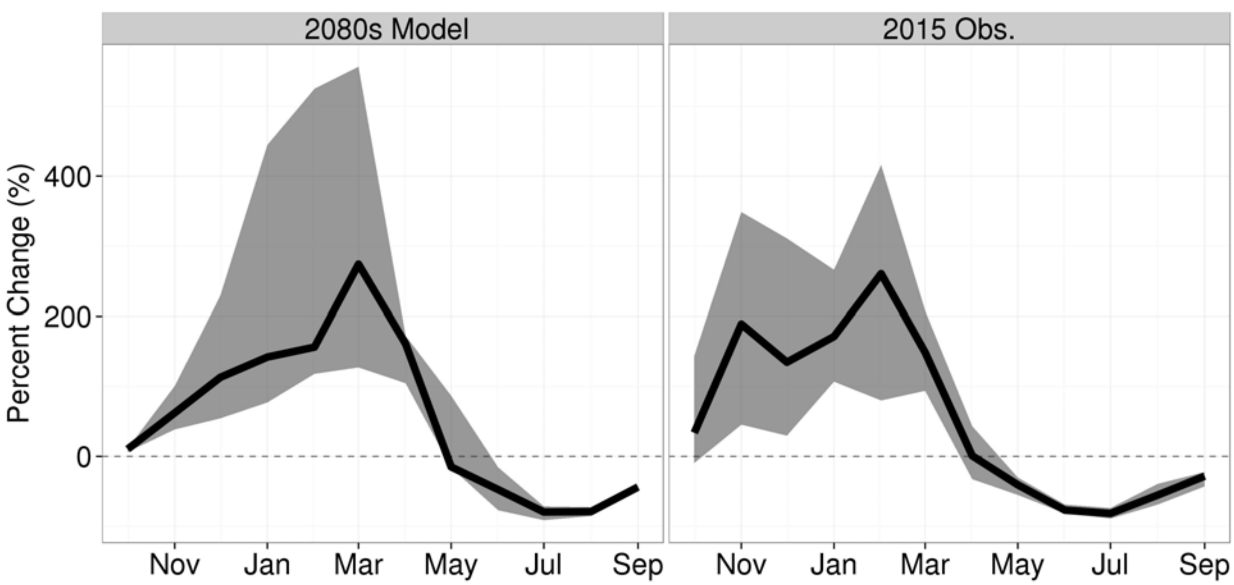

Figure 11. Comparing the projected changes for the 2080s (relative to 1970-1999, left panel) to the percent difference for 2015 flows relative to observed monthly flows for 1950-1999 (right panel). For each month, the average is shown (thick line) as well as the interquartile range (shaded area). For the 2080s projections (left), these are calculated from the five average projections constructed from each dataset. For the 2015 flows, the average and interquartile range is calculated by comparing monthly flows in 2015 to monthly flow for 1950-1999.

Table 6. Projected changes shown in Figure 11.

Month	2080s	2015
Oct	+10% (+6 to +11%)	+34% (-10 to +144%)
Nov	+62% (+38 to +101%)	+189% (+45 to +349%)
Dec	+113% (+54 to +229%)	+135% (+30 to +311%)
Jan	+142% (+77 to +444%)	+171% (+107 to +266%)
Feb	+156% (+118 to +525%)	+260% (+80 to +416%)
Mar	+274% (+127 to +556%)	+149% (+94 to +208%)
Apr	+161% (+105 to +172%)	+1% (-33 to +43%)
May	-15% (-16 to +87%)	-41% (-55 to -30%)
Jun	-48% (-77 to -16%)	-77% (-82 to -69%)
Jul	-80% (-91 to -72%)	-82% (-89 to -74%)
Aug	-79% (-85 to -73%)	-55% (-69 to -39%)
Sep	-44% (-50 to -42%)	-28% (-43 to -22%)

Model biases can lead to projections that are outside of the realm of what is physically possible. This is likely to be the case for a number of the individual model projections presented in the previous section. But which ones? This can be a challenging question to answer. Although many issues could be at play (ranging from hydrologic model formulation to greenhouse gas scenarios), one quick way to evaluate results is to compare model simulations to observed flows under similar conditions. For example: how does the model represent changes in streamflow during warm vs. cool years, and how does that compare to what we see in the observations? The same question could be asked about wet and dry years, or years with big vs. relatively low intensity rain events.

One specific example is the year 2015, in which statewide average temperatures for December through February exceeded the historical average by 4.6°F. These warmer temperatures led to drastically lower snow accumulation, earlier snowmelt, and a dramatic decrease in summer streamflow. Climate models project that temperatures will increase by 4.6°F, on average, by somewhere in between 2050 and 2100. On average, models project that 2015 conditions will become routine by the 2070s.

Figure 10 shows the percent difference between monthly flows for the year 2015 and the average, from observations, for the years 1950-1999. This longer time period was necessitated by the fact that the Icicle Creek gauge was not in operation from 1971-1993. Results were nearly identical for other choices of the historical reference period (e.g., 1950-2015). Alongside this plot are the 2080s projections; this figure is identical to the right-hand panel in Figure 10 above. In order to facilitate a direct comparison, Table 6 lists the average projection for the 2080s alongside the average monthly changes for 2015. Although the timing appears shifted by about one month, the overall magnitudes are very similar. This suggests that the model projections we presented above are robust, and is just one example of a way to produce an independent check on the results of this study.

6 Project Outputs

The following subsections describe the project outputs. These can all be accessed at the project website: https://cig.uw.edu/icicle_work_group_projections/

6.1 Data Archive

An online archive contains all of the observed and modeled streamflow data used in this study, as well as figures synthesizing the results. This includes the raw gridded hydrologic model projections as well as the streamflow time series for each of the 10 sites. All streamflow files are stored in a comma-delimited format (.csv) with a header line that describes the file's contents.

6.2 Tableau Tool

Figure 11. Screenshot of the online tool. The tool has two tabs: one showing the percent changes for each metric, facilitating comparisons across all datasets, and the other showing the full seasonal cycle of historical and future monthly flows, in which only one dataset and scenario can be viewed at a time.

As a complement to the reference data products, we have also produced a tool that is intended to allow users to easily visualize and query the projections across all datasets (Figure 11). The tool includes two tabs: one for viewing percent changes across all datasets, another for viewing the change in the seasonal cycle for one particular dataset and scenario. In each, users can select a streamflow site (Table 4) and a future time period (2030s, 2050s, 2080s) to visualize.

The percent changes tab is designed to facilitate comparisons across datasets. Users select a streamflow site (Table 4), a future time period, and a metric (e.g. January average streamflow). The visualization shows the percent changes for each of the five datasets, organized by greenhouse gas scenario. Individual model projections are shown, as well as the model averages.

The monthly streamflow tab is designed to allow users to view the change in the seasonality of streamflow with warming. Users select a streamflow site (Table 4), a future time period, a dataset, and a greenhouse gas scenario. The visualization shows historical and future monthly average streamflow for the water year (Oct-Sep) for all models included in the selected dataset.

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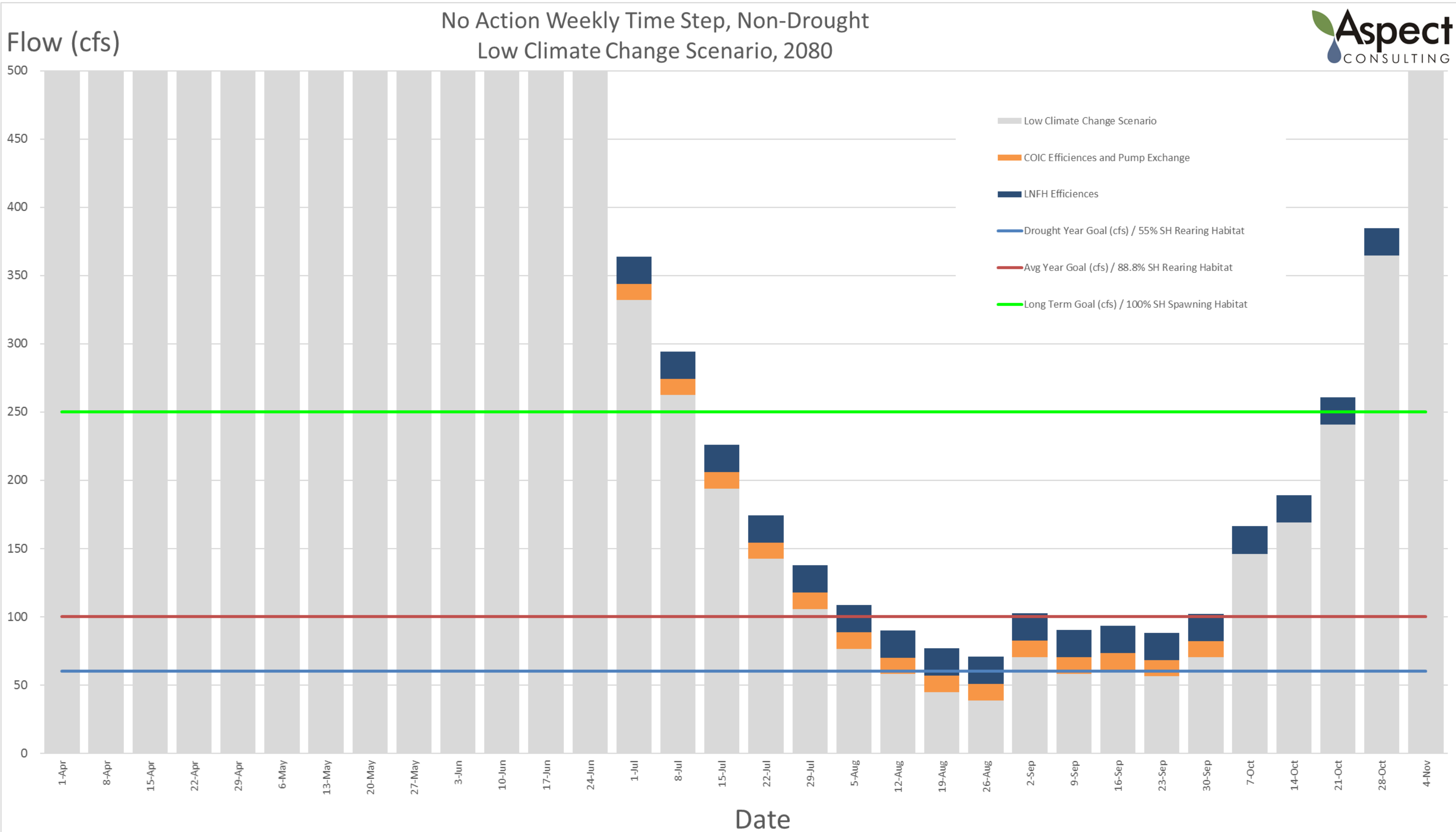

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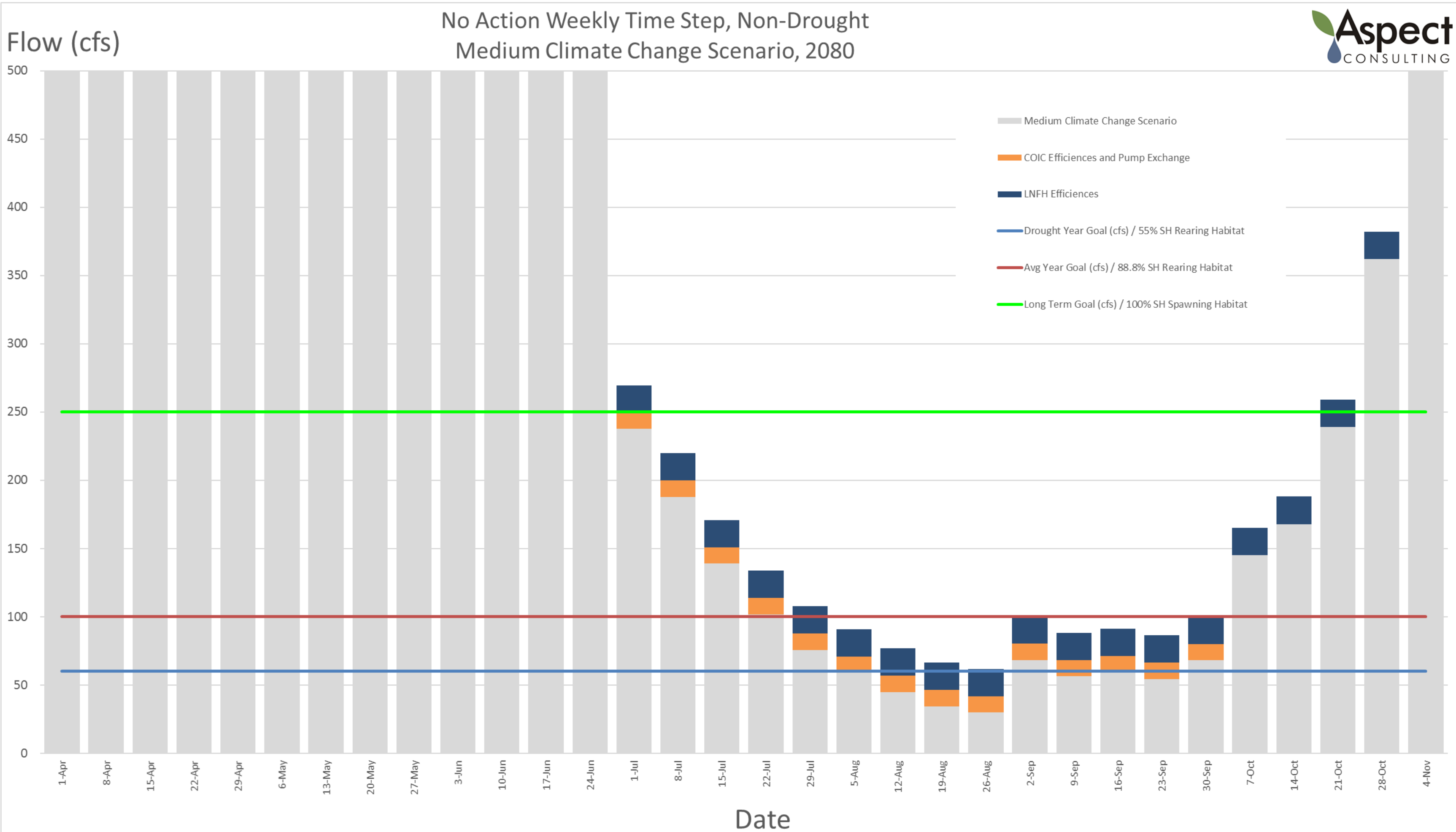

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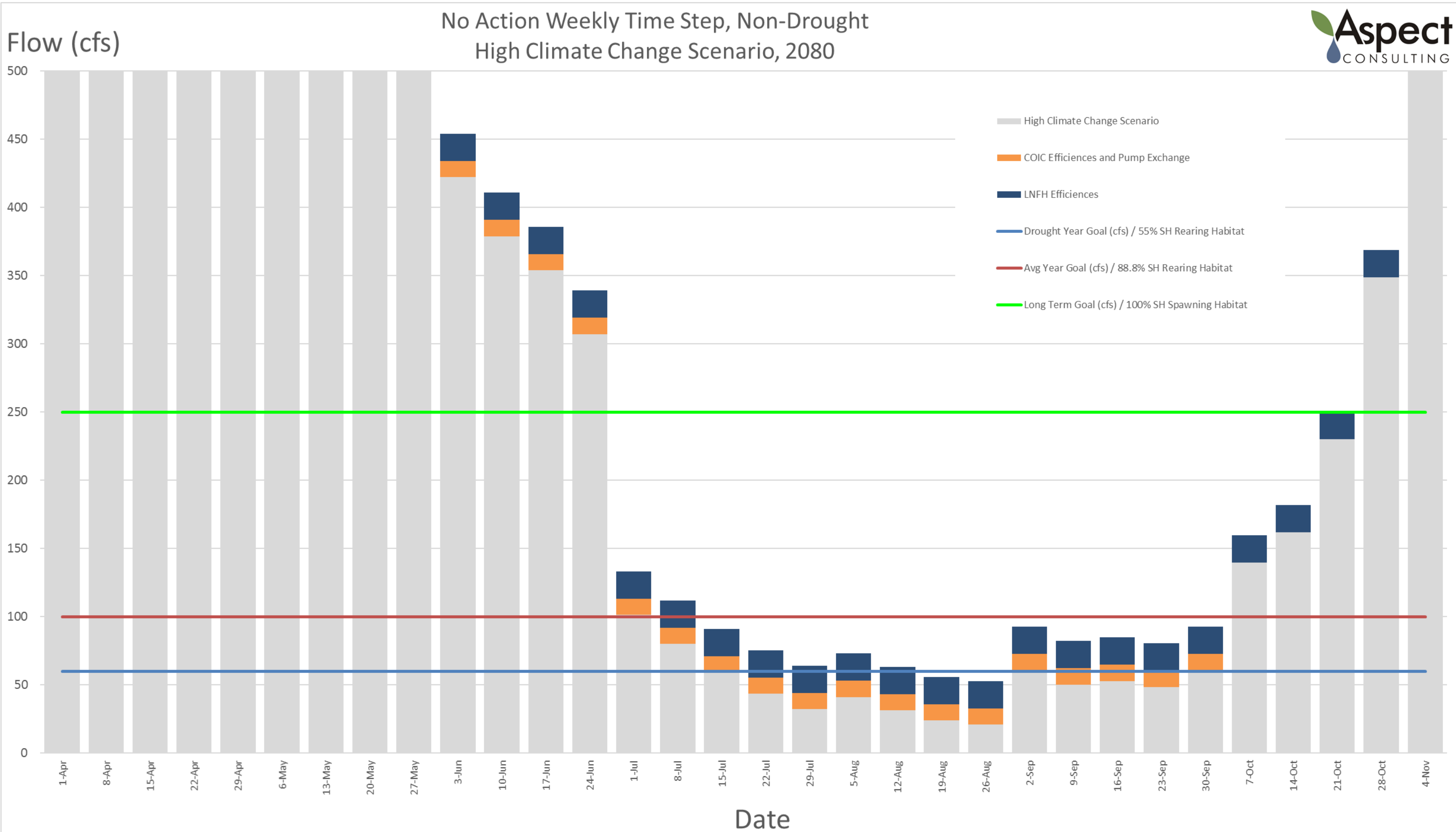
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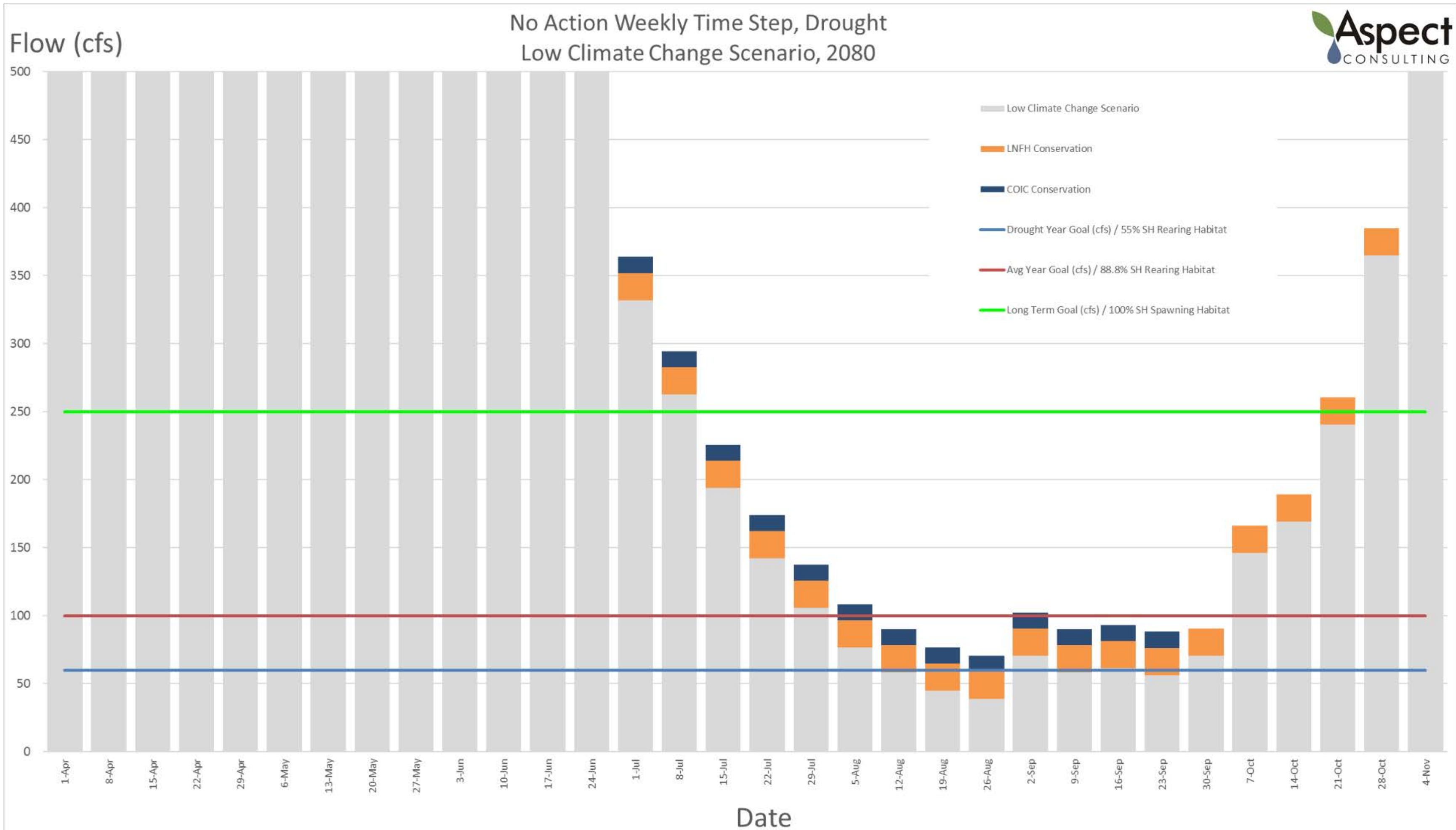

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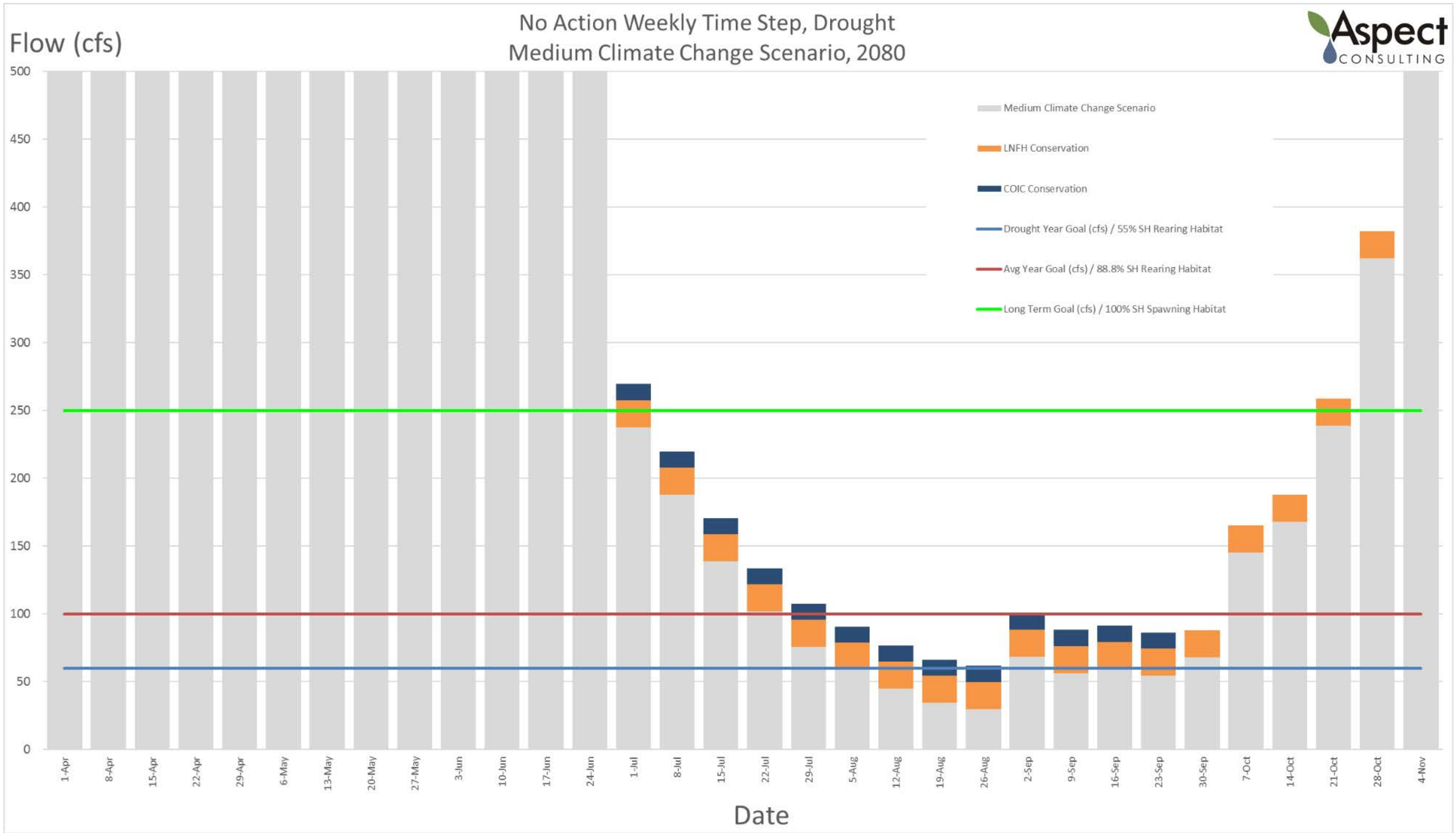

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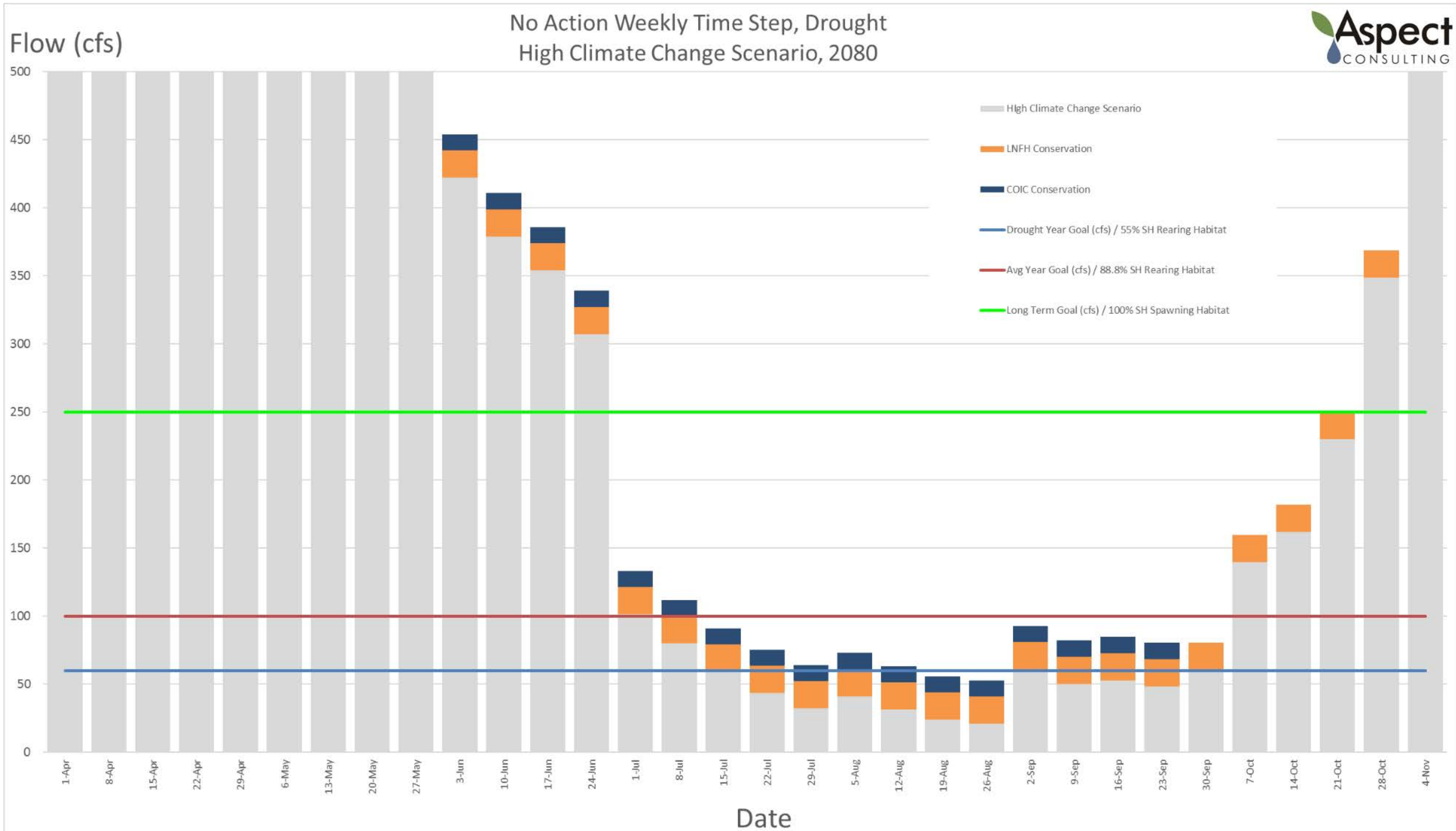
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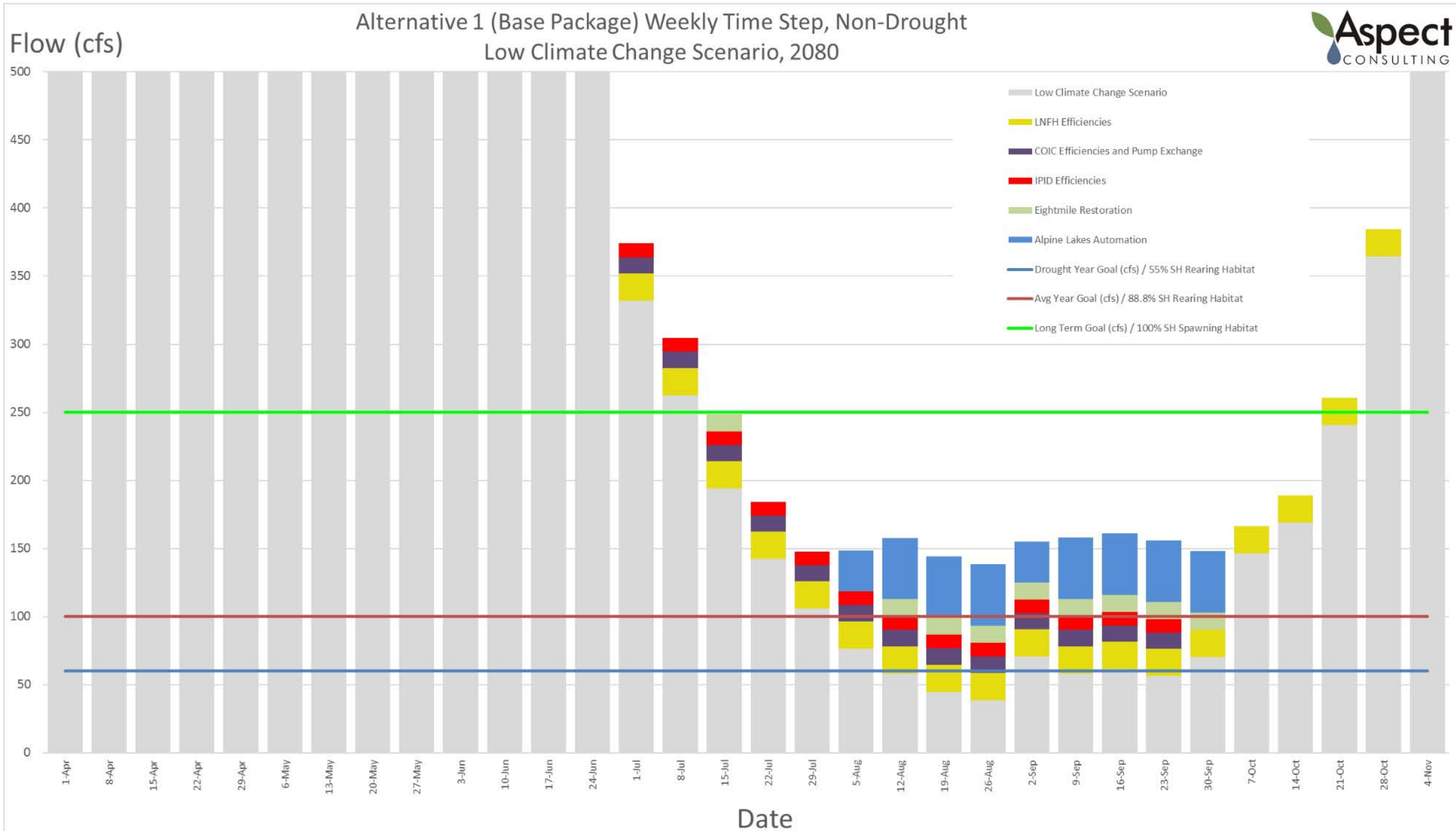

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Drought Year Goal (cfs) / 55% SH Rearing Habitat
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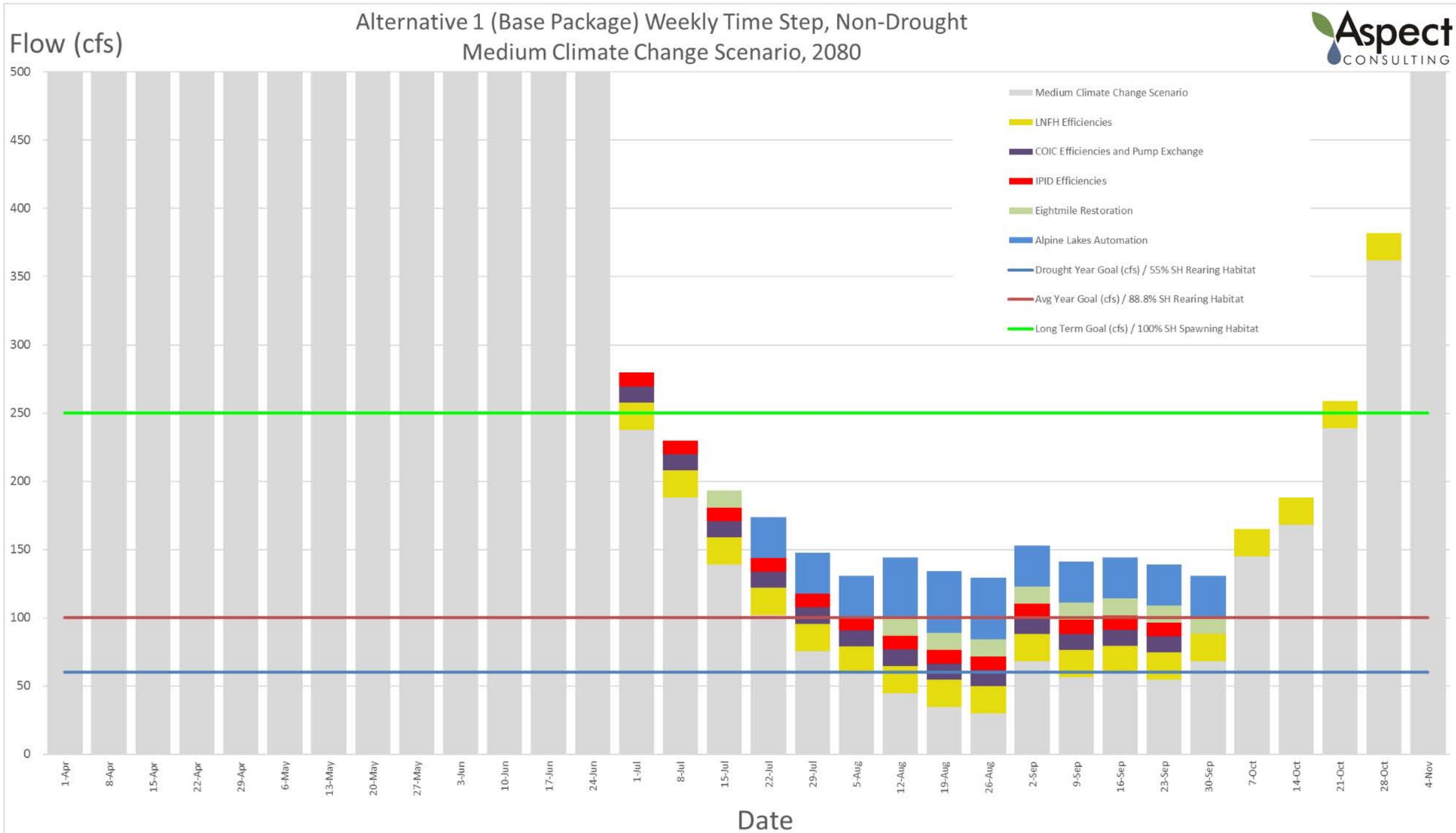

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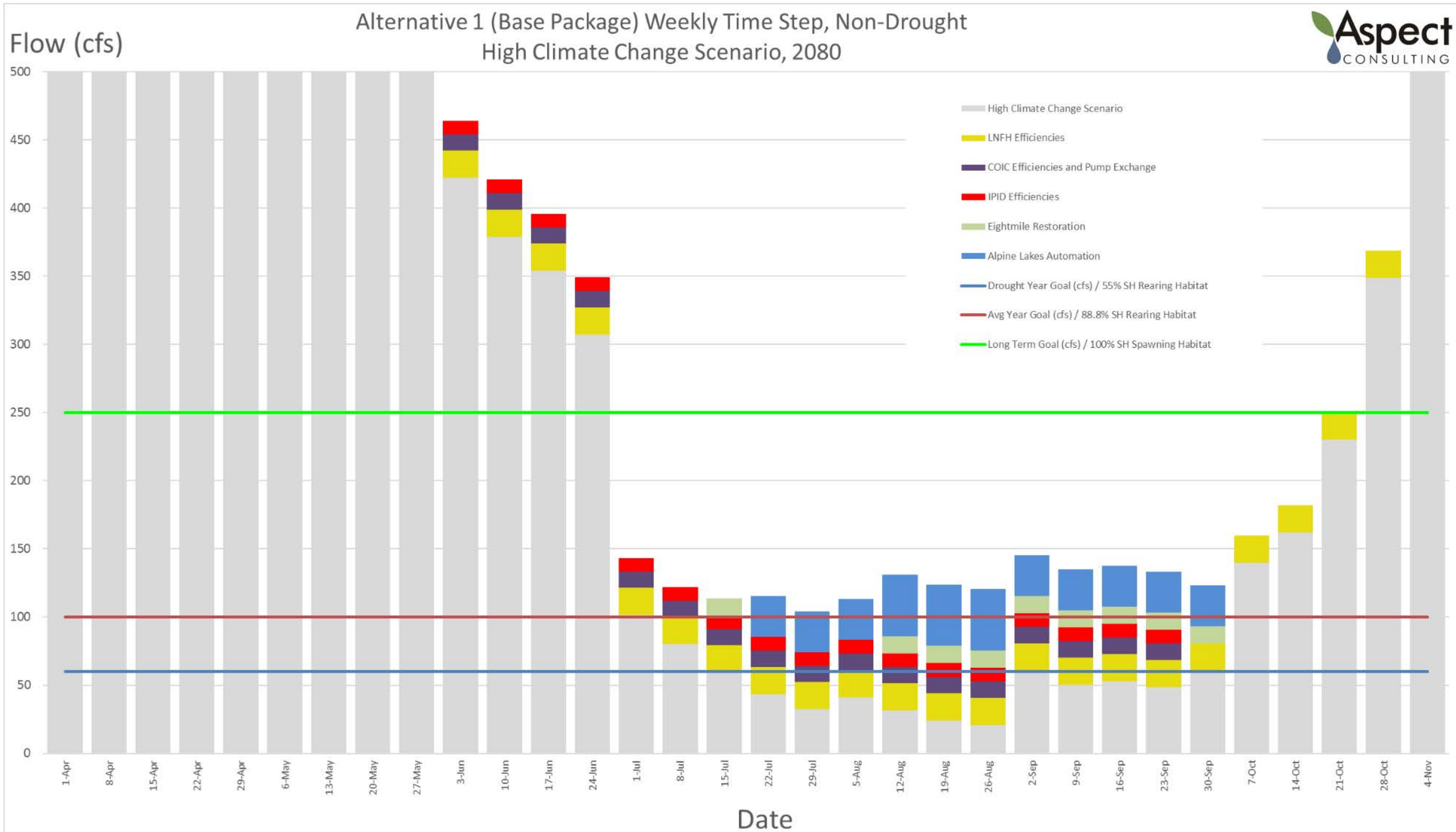
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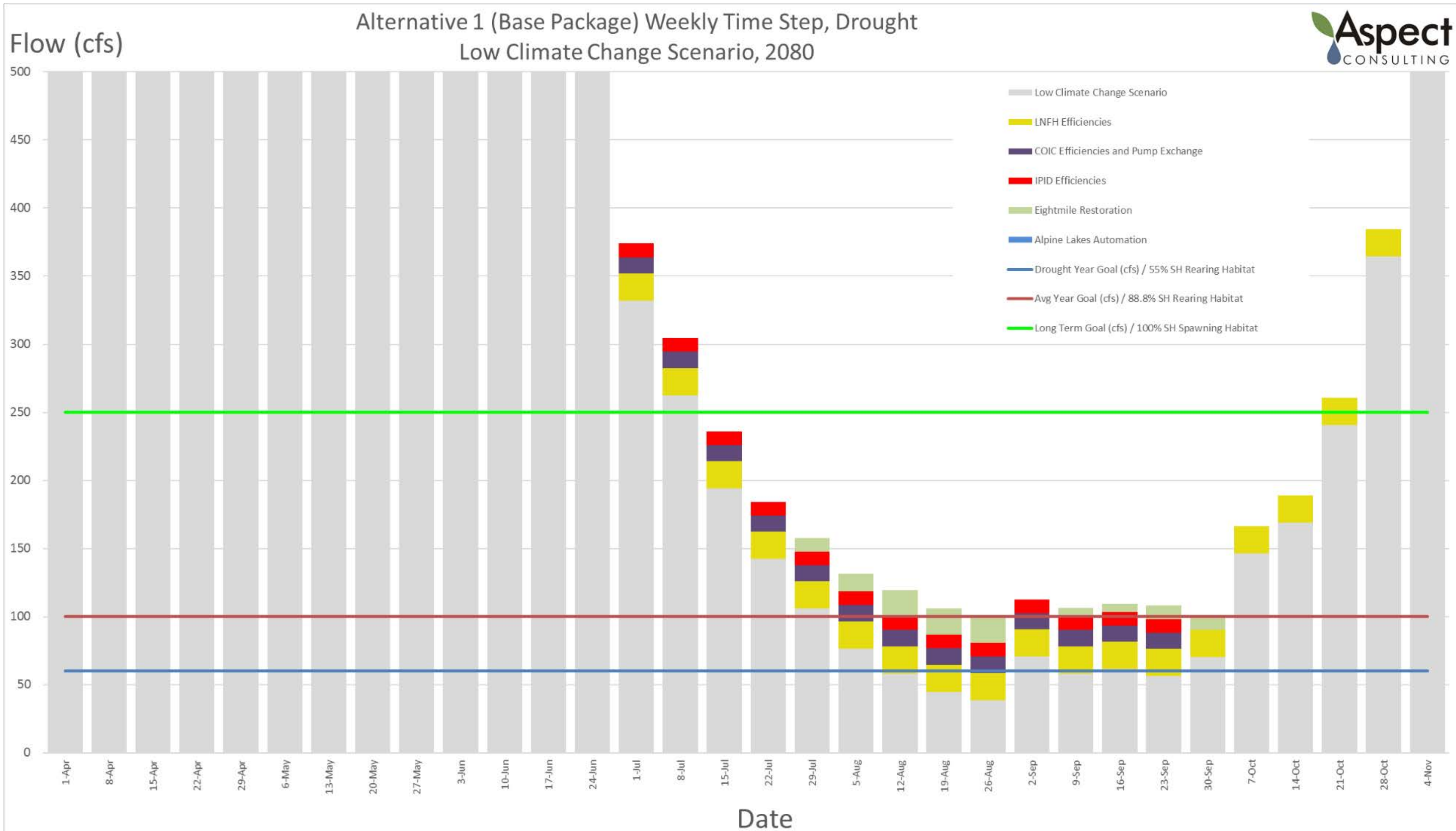

Alternative 1 (Base Package) Weekly Time Step, Drought
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Low Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
IPID Efficiencies
Eightmile Restoration
Alpine Lakes Automation
Drought Year Goal (cfs) / 55% SH Rearing Habitat
Avg Year Goal (cfs) / 88.8% SH Rearing Habitat
Long Term Goal (cfs) / 100% SH Spawning Habitat
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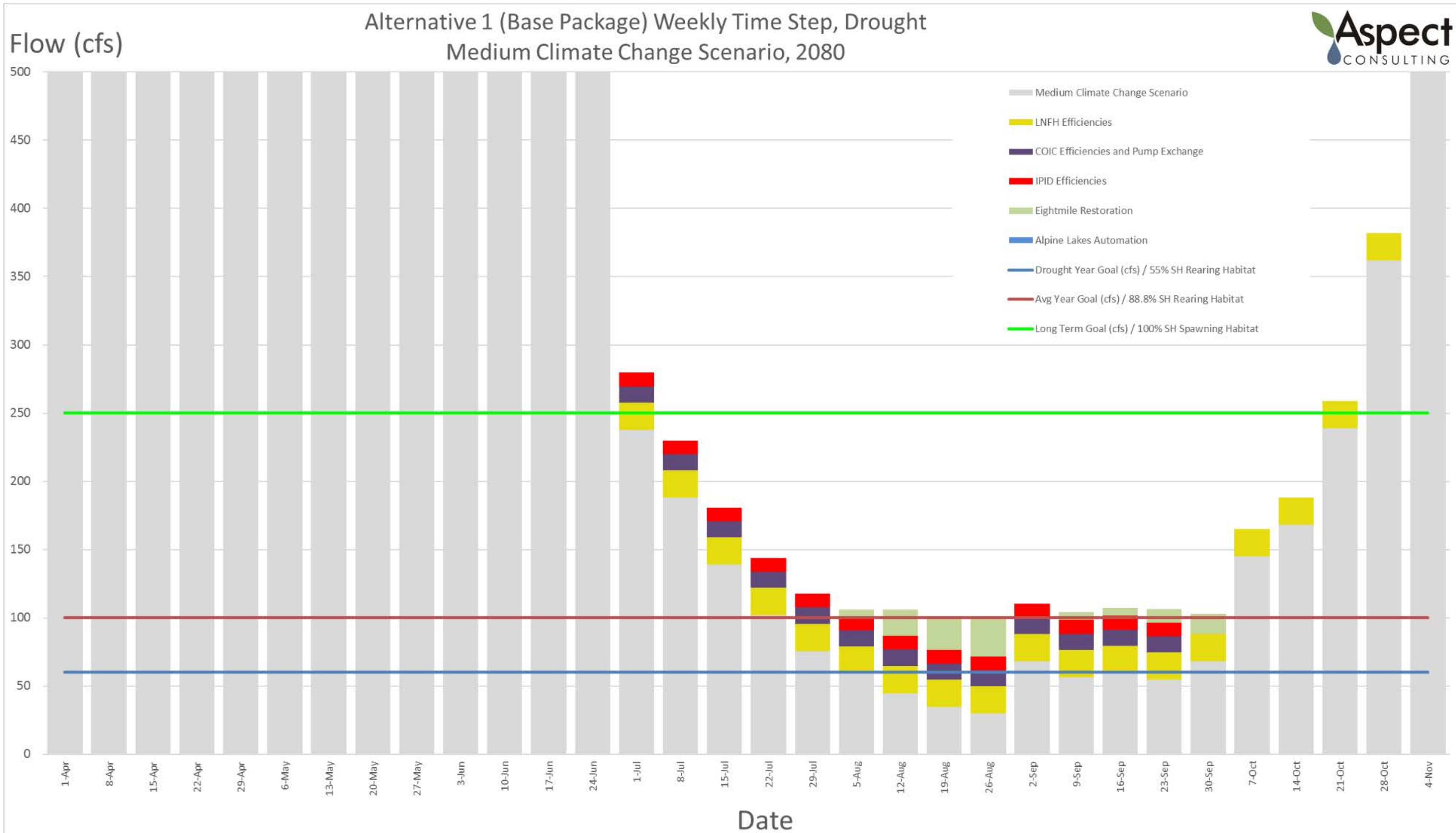
Date



Alternative 1 (Base Package) Weekly Time Step, Drought
Medium Climate Change Scenario, 2080
Flow (cfs)
Aspect
CONSULTING
Medium Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
IPID Efficiencies
Eightmile Restoration
Alpine Lakes Automation
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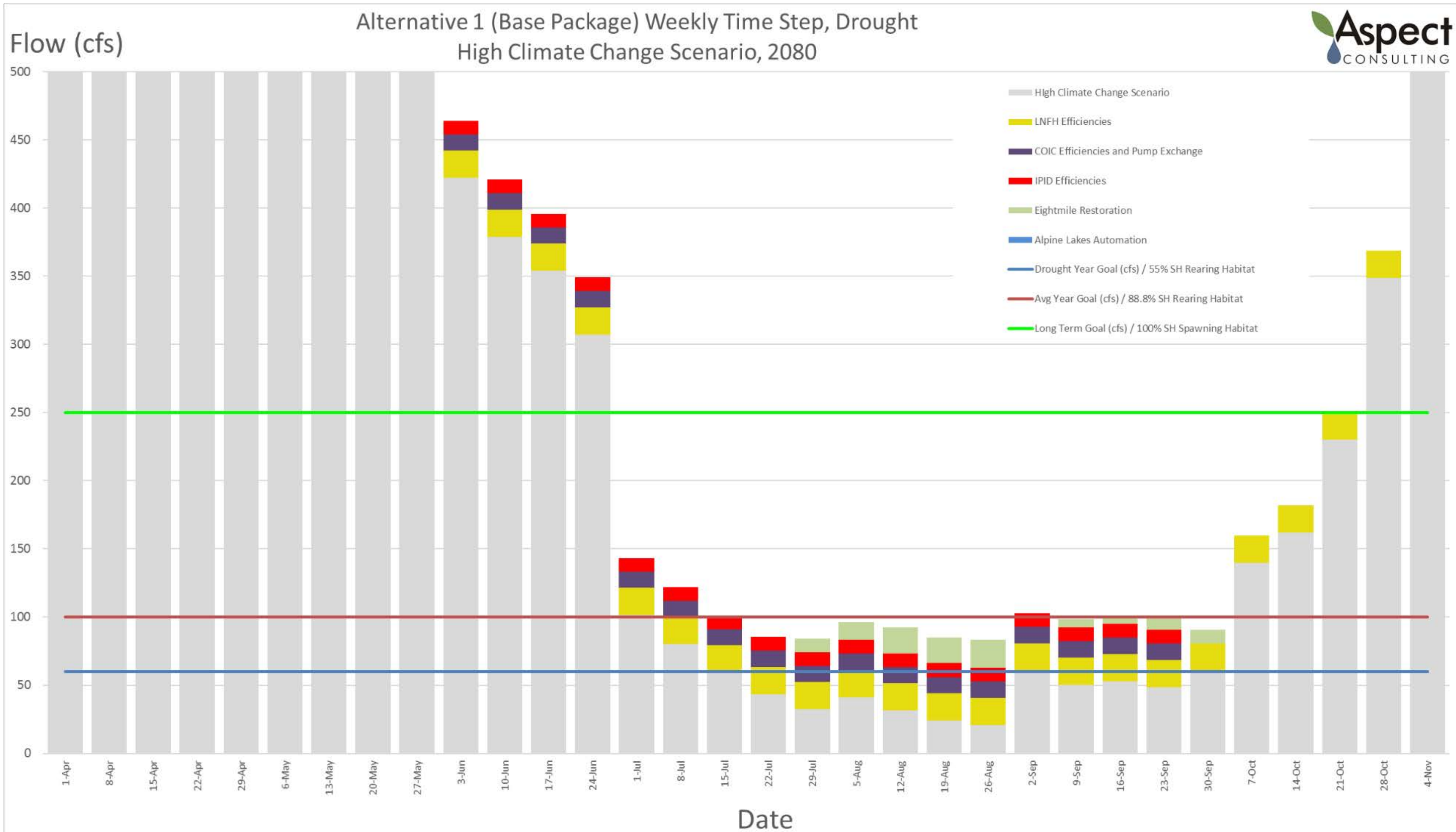

Alternative 1 (Base Package) Weekly Time Step, Drought
High Climate Change Scenario, 2080
Flow (cfs)
Aspect CONSULTING
High Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
IPID Efficiencies
Eightmile Restoration
Alpine Lakes Automation
Drought Year Goal (cfs) / 55% SH Rearing Habitat
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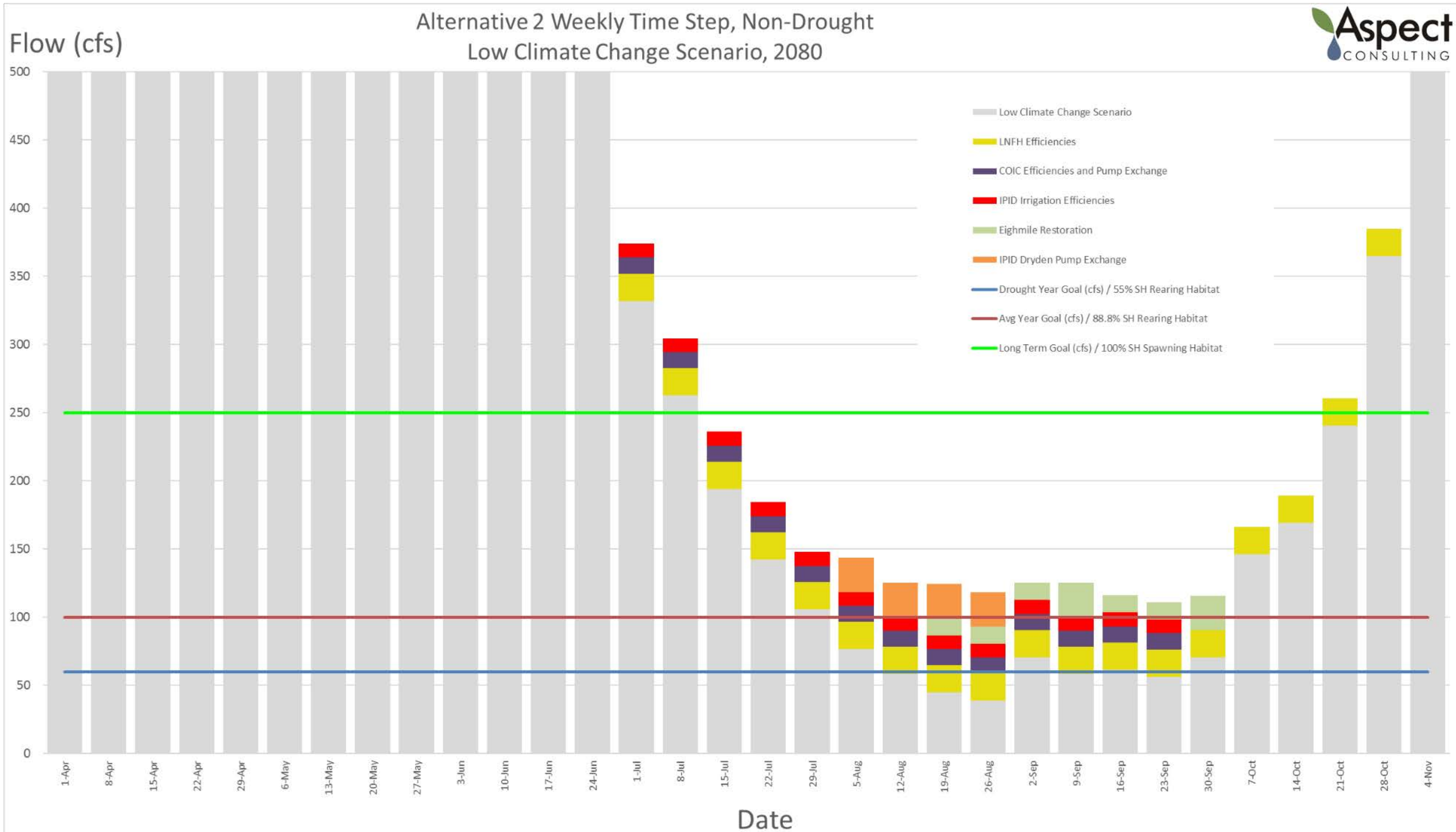
Date



Alternative 2 Weekly Time Step, Non-Drought
Low Climate Change Scenario, 2080
Flow (cfs)
Aspect CONSULTING
Low Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
IPID Irrigation Efficiencies
Eighmile Restoration
IPID Dryden Pump Exchange
Drought Year Goal (cfs) / 55% SH Rearing Habitat
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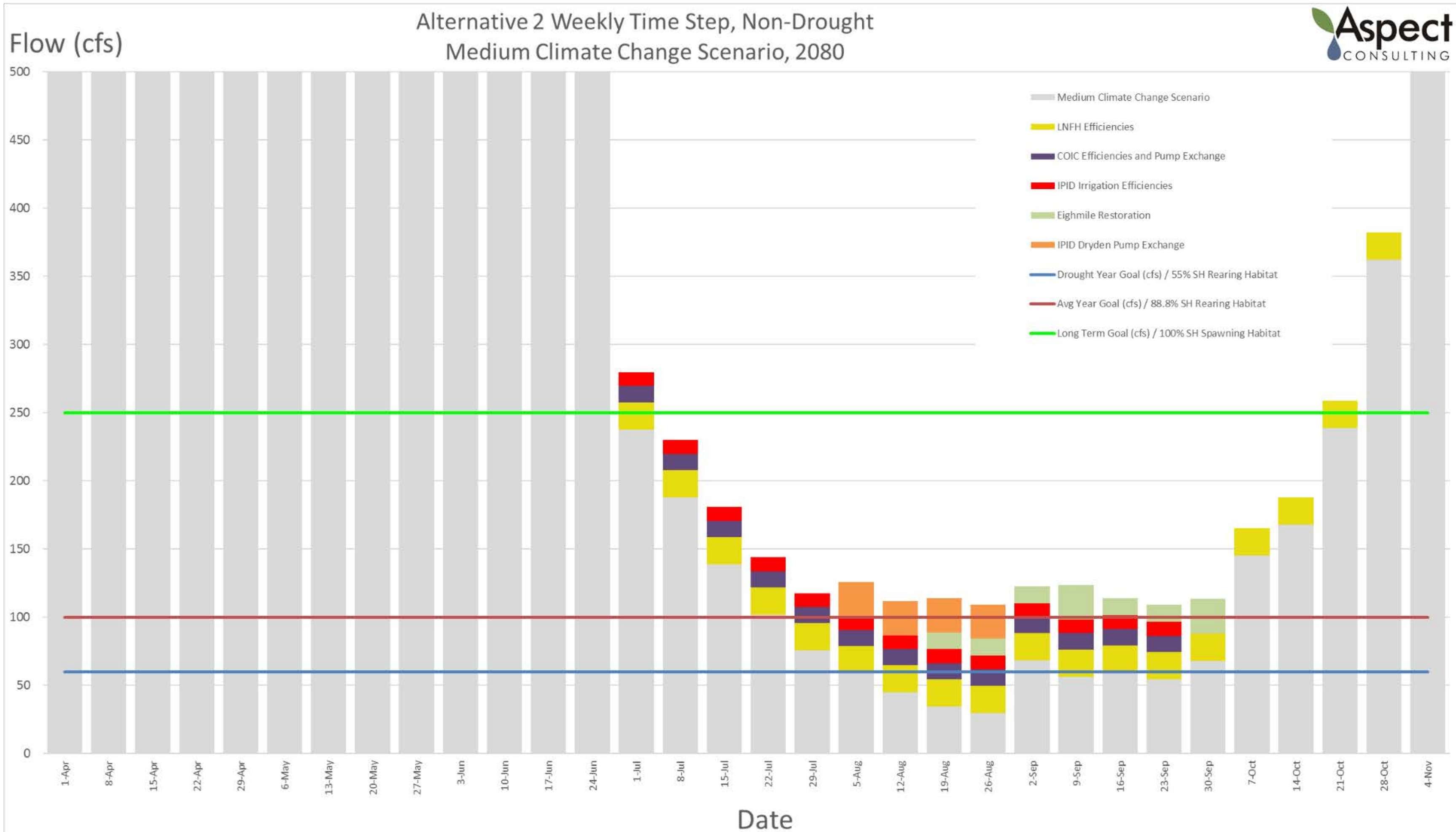
Date



Alternative 2 Weekly Time Step, Non-Drought
Medium Climate Change Scenario, 2080
Flow (cfs)
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Medium Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
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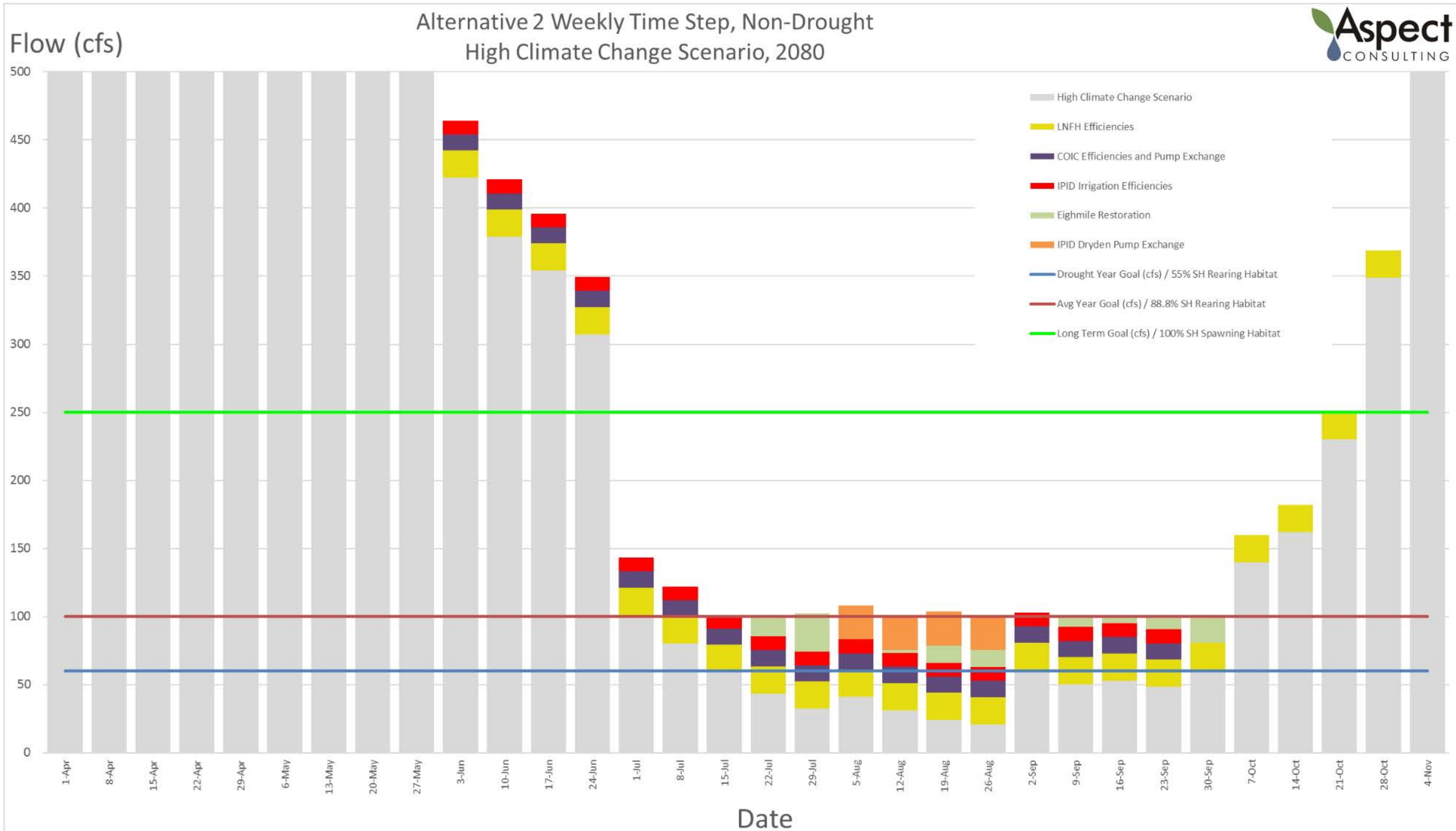

Alternative 2 Weekly Time Step, Non-Drought
High Climate Change Scenario, 2080
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High Climate Change Scenario
LNFH Efficiencies
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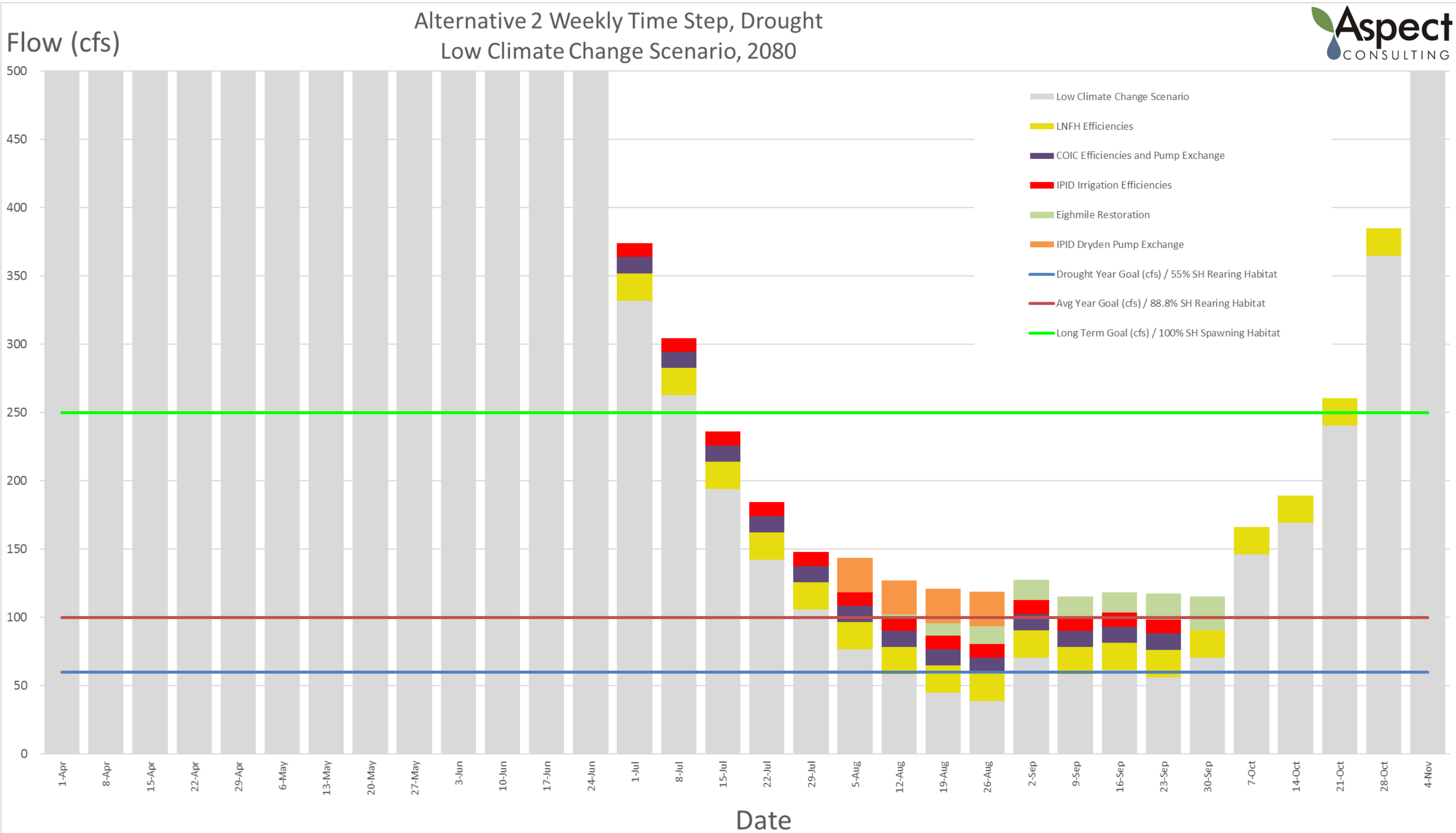
Alternative 2 Weekly Time Step, Drought
Low Climate Change Scenario, 2080
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Low Climate Change Scenario
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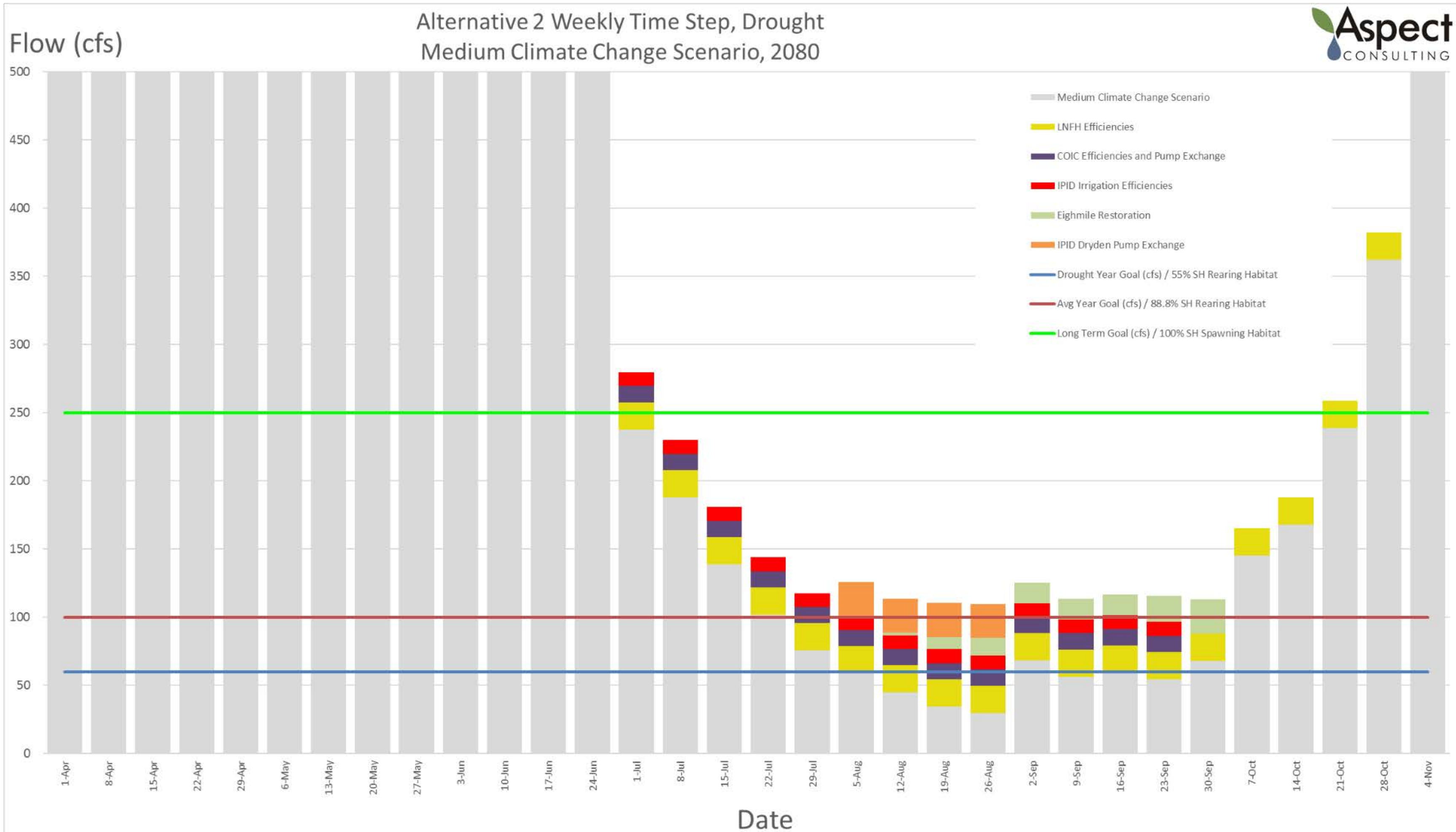

Alternative 2 Weekly Time Step, Drought
Medium Climate Change Scenario, 2080
Flow (cfs)
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Medium Climate Change Scenario
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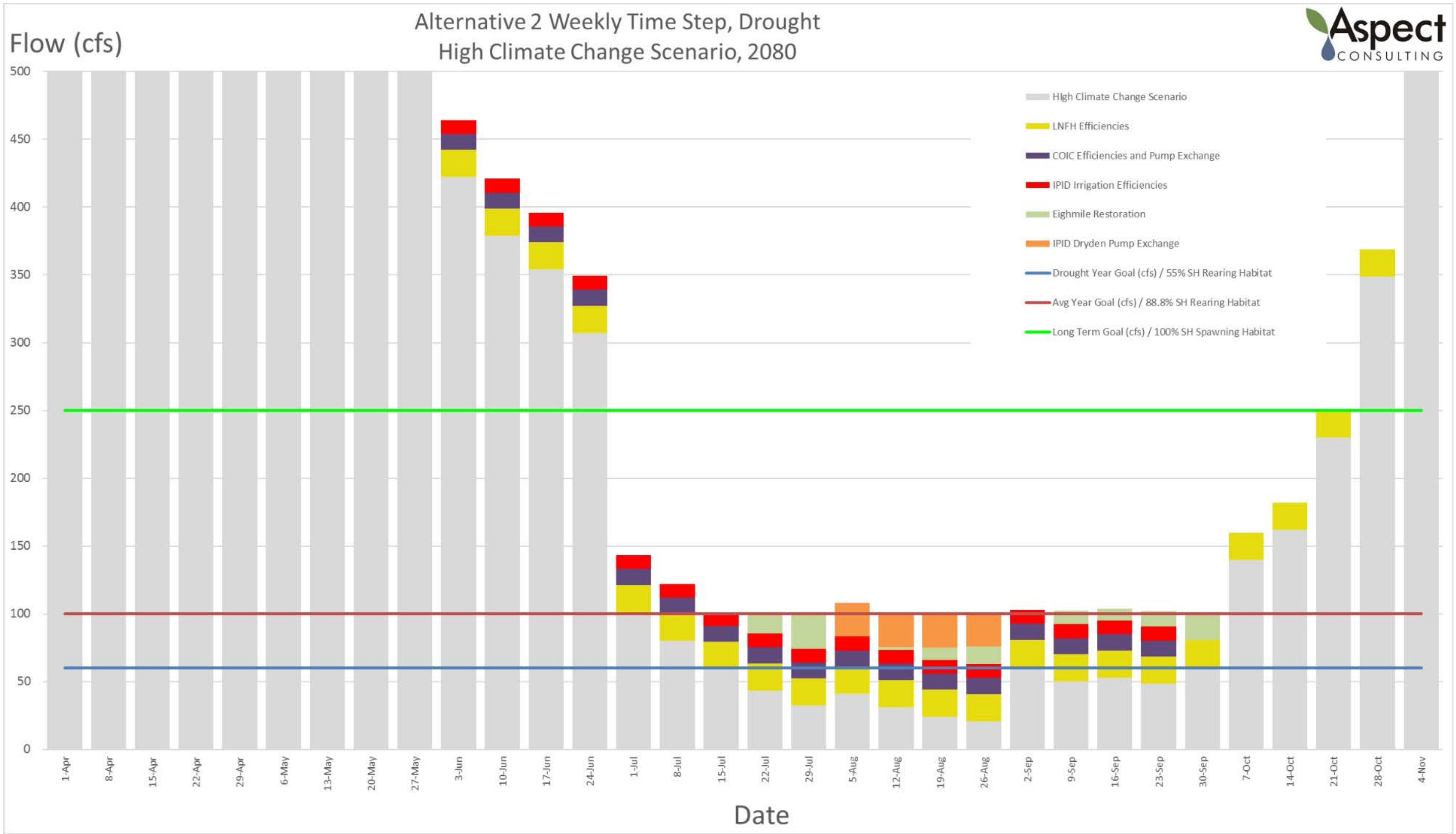

Alternative 2 Weekly Time Step, Drought
High Climate Change Scenario, 2080
Flow (cfs)
Aspect
CONSULTING
High Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
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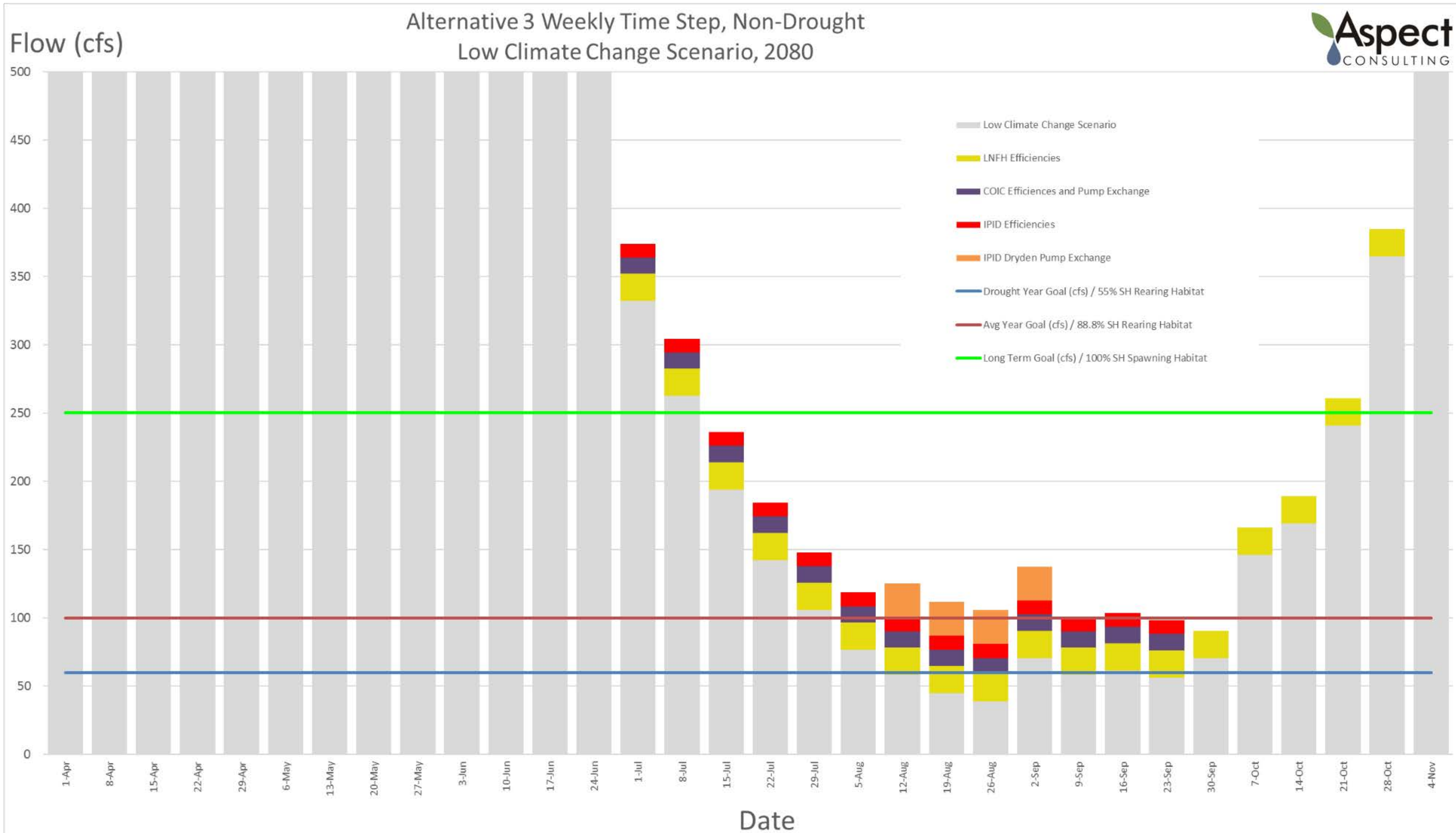
Alternative 3 Weekly Time Step, Non-Drought
Low Climate Change Scenario, 2080
Flow (cfs)
Aspect CONSULTING
Low Climate Change Scenario
LNFH Efficiencies
COIC Efficiences and Pump Exchange
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IPID Dryden Pump Exchange
Drought Year Goal (cfs) / 55% SH Rearing Habitat
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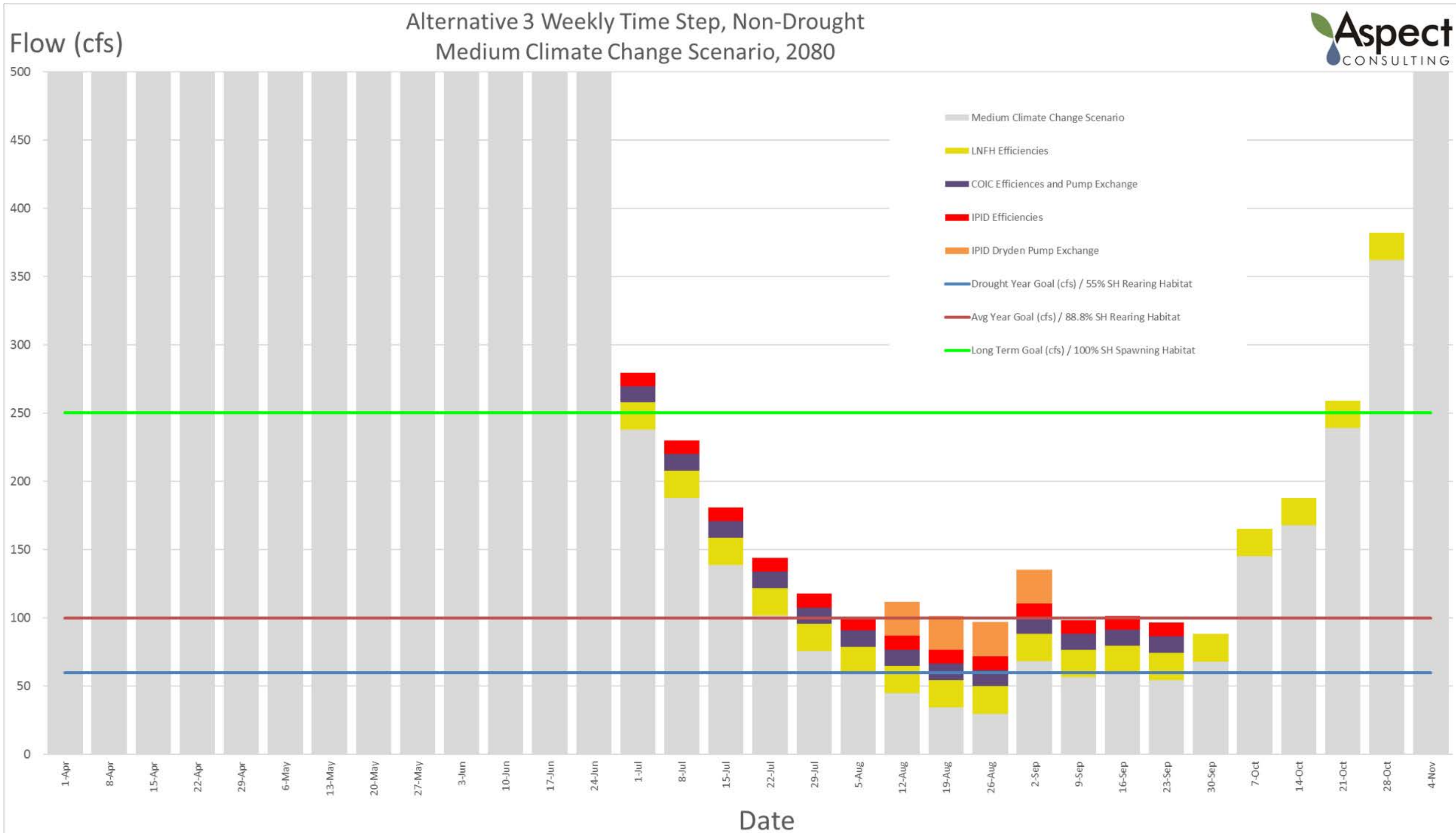

Alternative 3 Weekly Time Step, Non-Drought
Medium Climate Change Scenario, 2080
Flow (cfs)
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Medium Climate Change Scenario
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COIC Efficiences and Pump Exchange
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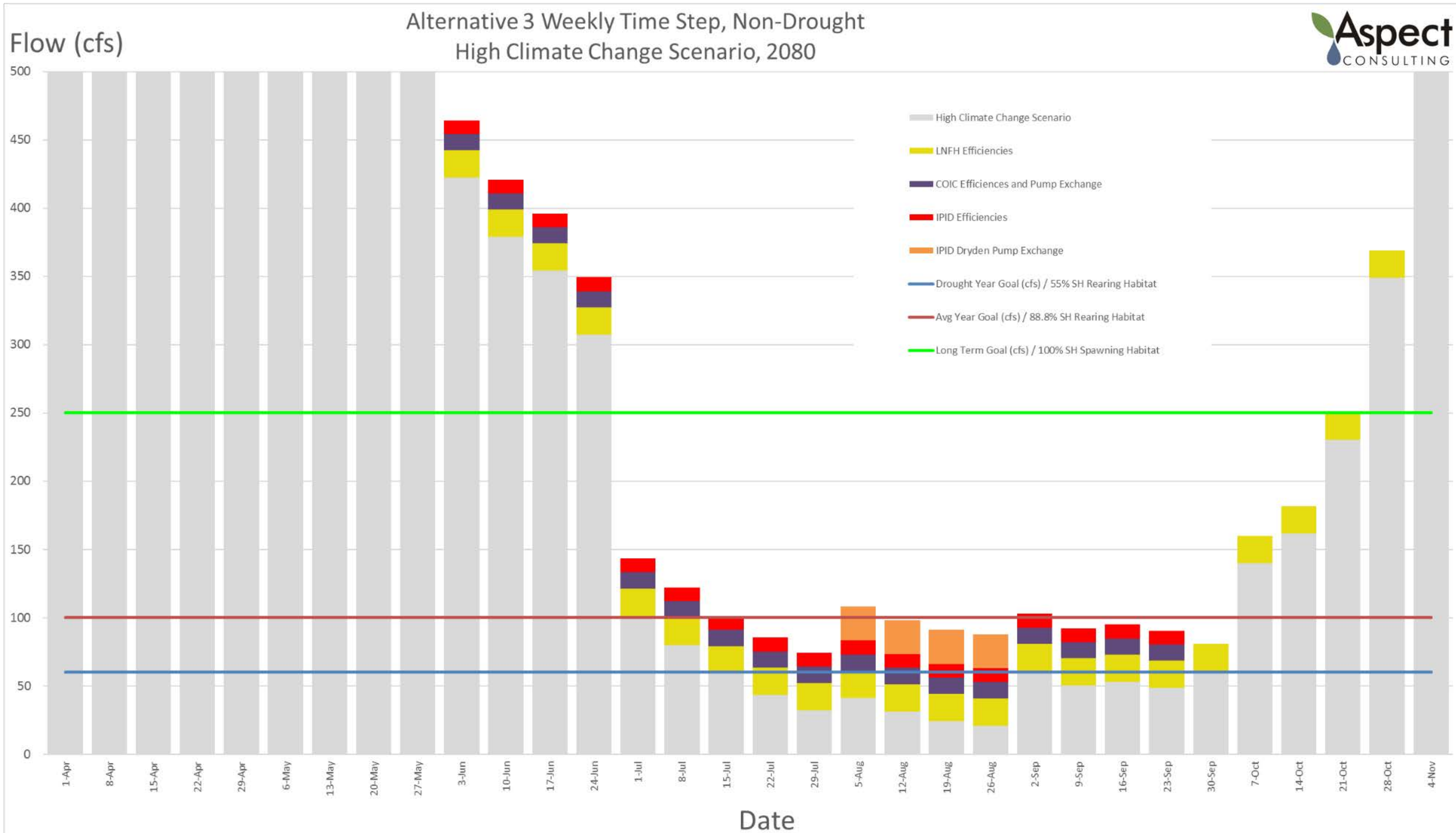

Alternative 3 Weekly Time Step, Non-Drought
High Climate Change Scenario, 2080
Flow (cfs)
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High Climate Change Scenario
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COIC Efficiences and Pump Exchange
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Drought Year Goal (cfs) / 55% SH Rearing Habitat
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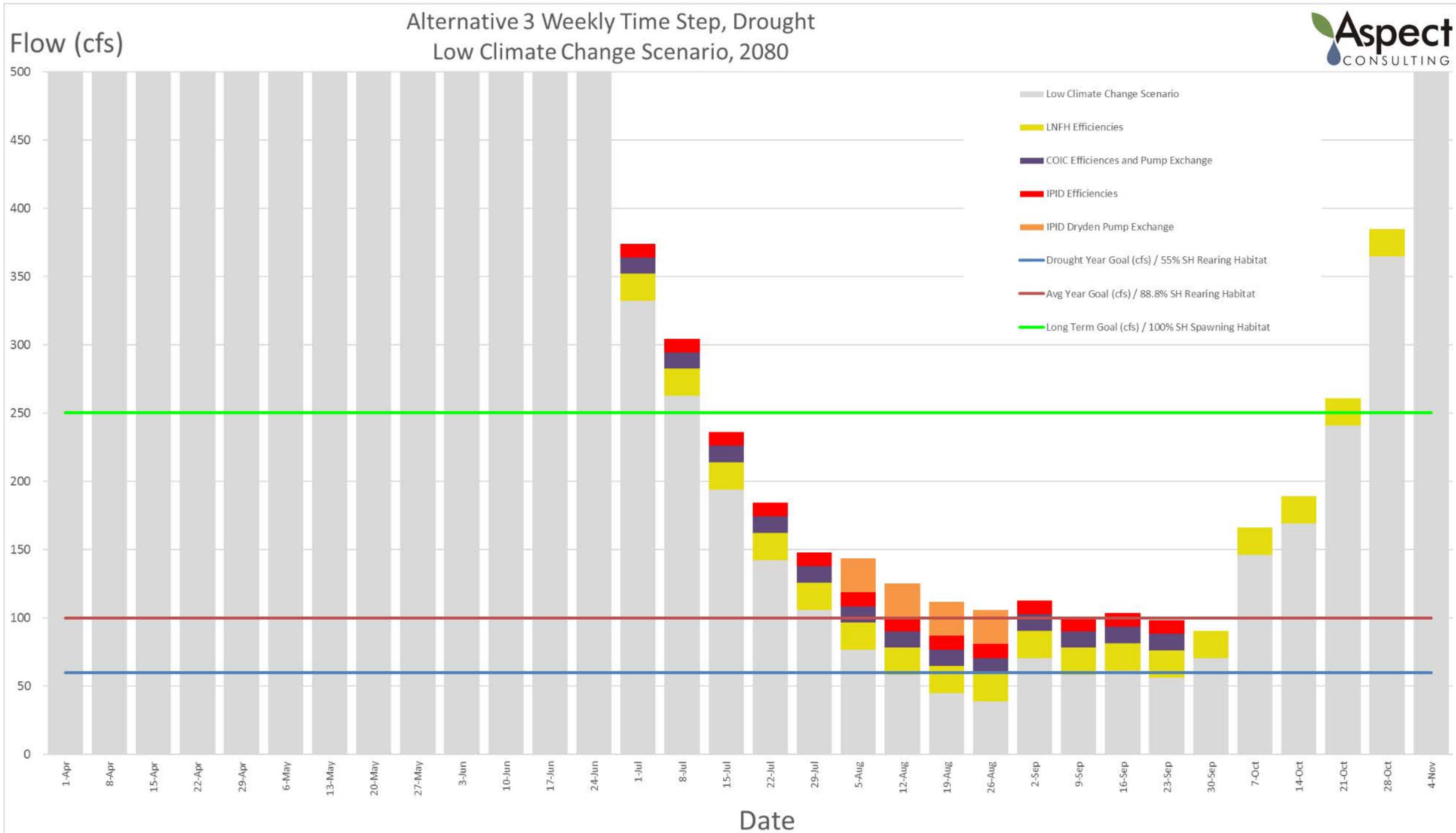
Alternative 3 Weekly Time Step, Drought
Low Climate Change Scenario, 2080
Aspect
CONSULTING
Flow (cfs)
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Low Climate Change Scenario
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COIC Efficiences and Pump Exchange
IPID Efficiencies
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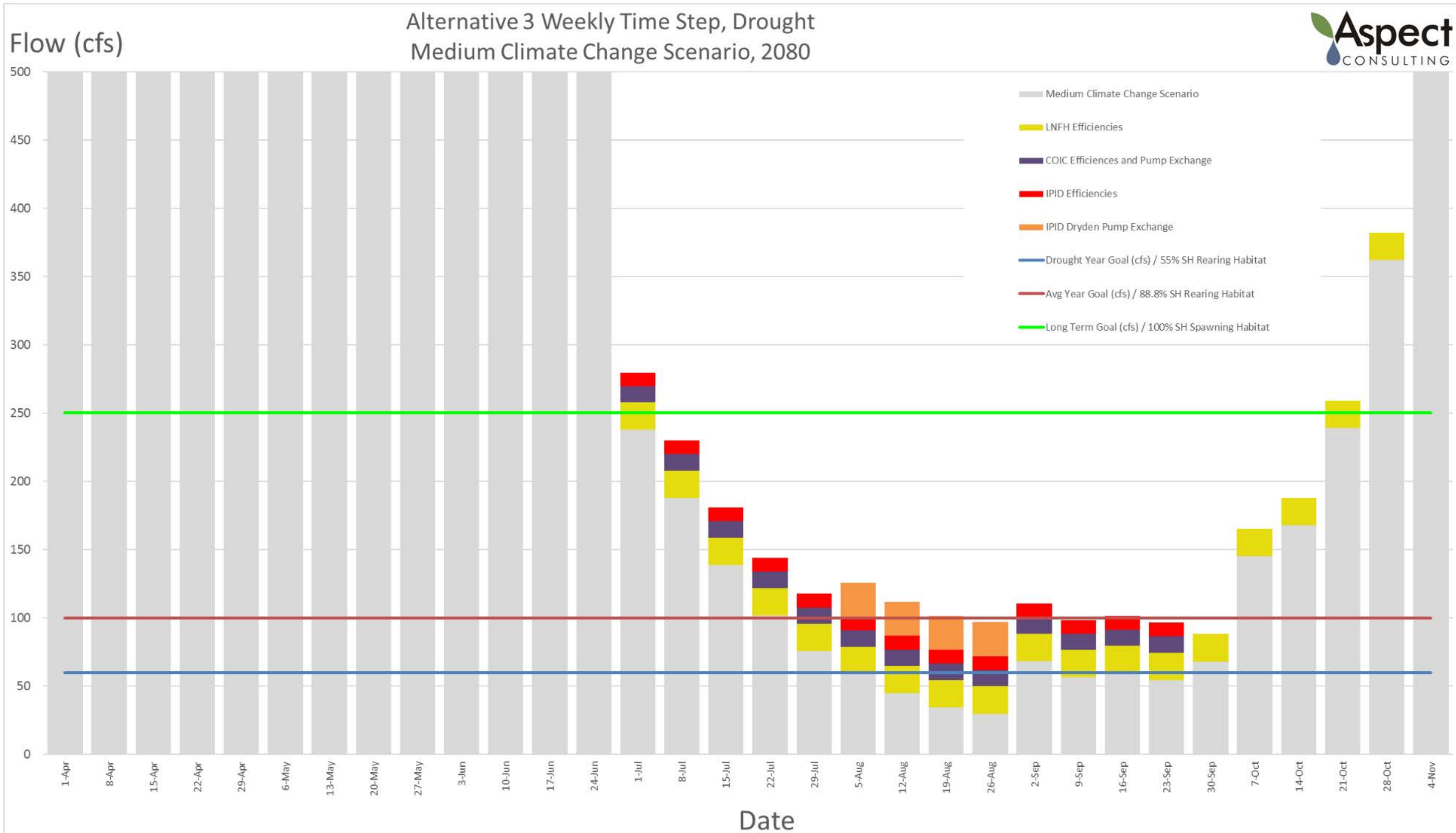
Alternative 3 Weekly Time Step, Drought
Medium Climate Change Scenario, 2080
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Medium Climate Change Scenario
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COIC Efficiences and Pump Exchange
IPID Efficiencies
IPID Dryden Pump Exchange
Drought Year Goal (cfs) / 55% SH Rearing Habitat
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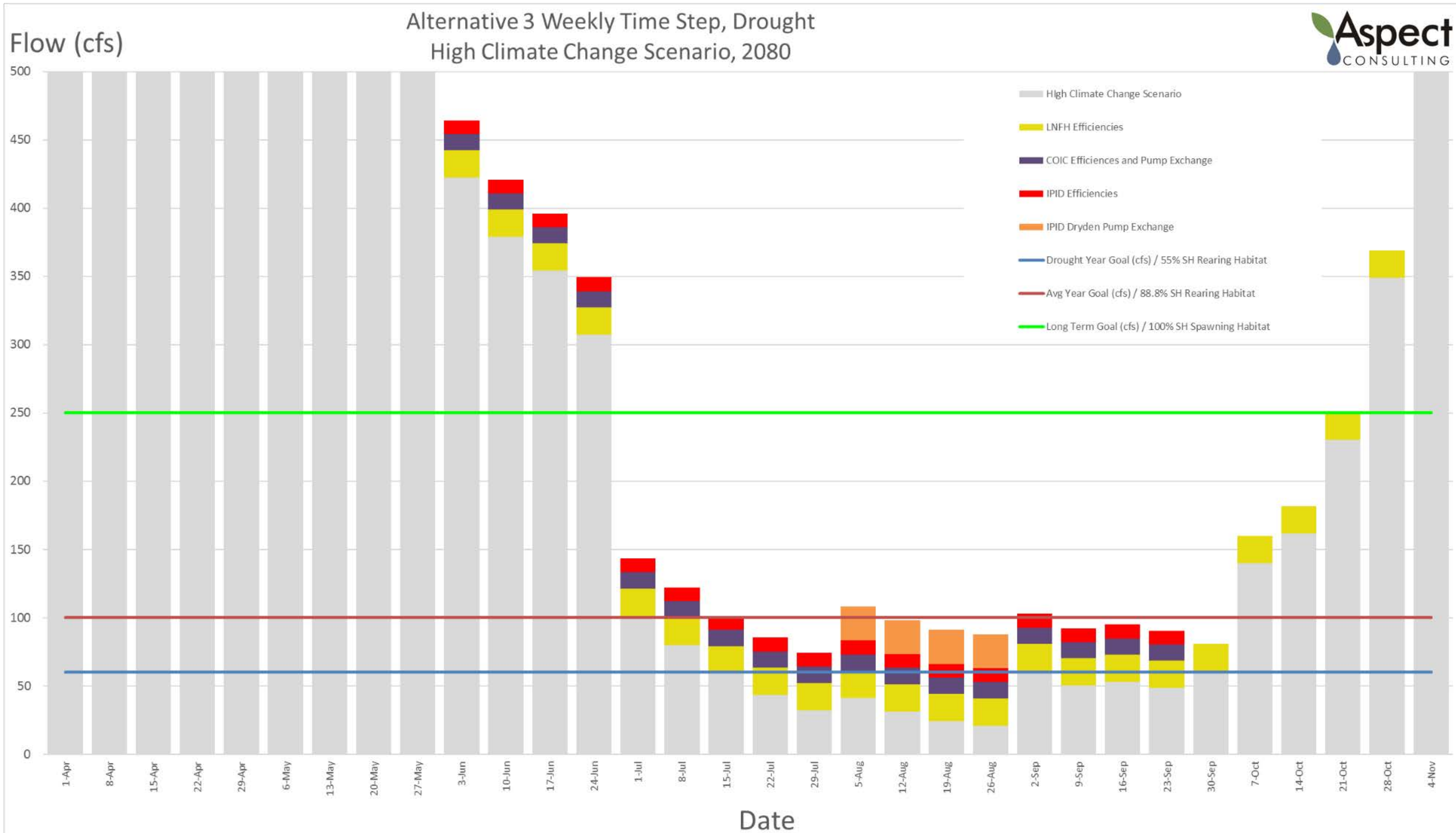

Alternative 3 Weekly Time Step, Drought
High Climate Change Scenario, 2080
Flow (cfs)
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High Climate Change Scenario
LNFH Efficiencies
COIC Efficiences and Pump Exchange
IPID Efficiencies
IPID Dryden Pump Exchange
Drought Year Goal (cfs) / 55% SH Rearing Habitat
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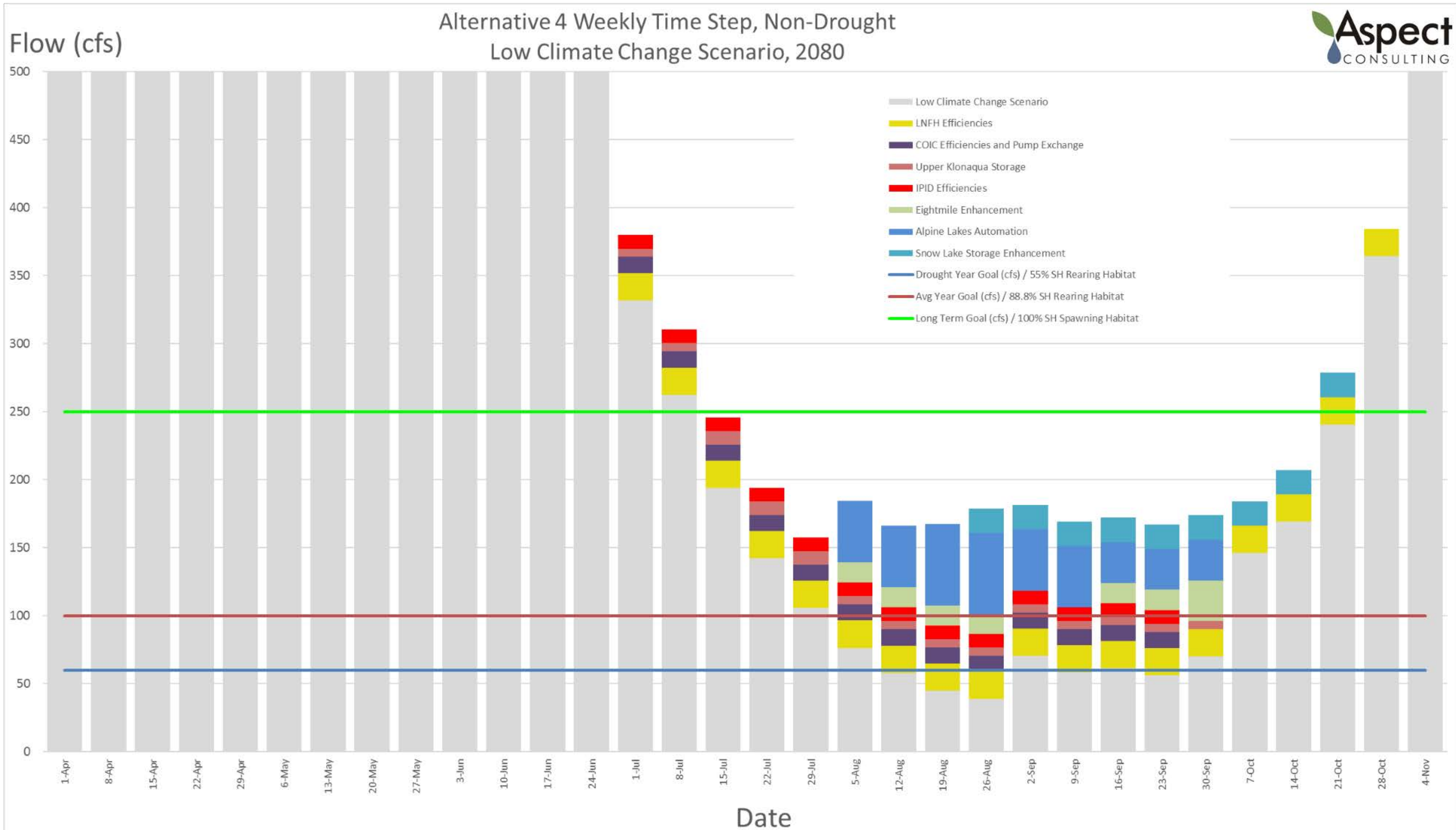
Alternative 4 Weekly Time Step, Non-Drought
Low Climate Change Scenario, 2080
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CONSULTING
Flow (cfs)
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Low Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
Upper Klonaqua Storage
IPID Efficiencies
Eightmile Enhancement
Alpine Lakes Automation
Snow Lake Storage Enhancement
Drought Year Goal (cfs) / 55% SH Rearing Habitat
Avg Year Goal (cfs) / 88.8% SH Rearing Habitat
Long Term Goal (cfs) / 100% SH Spawning Habitat
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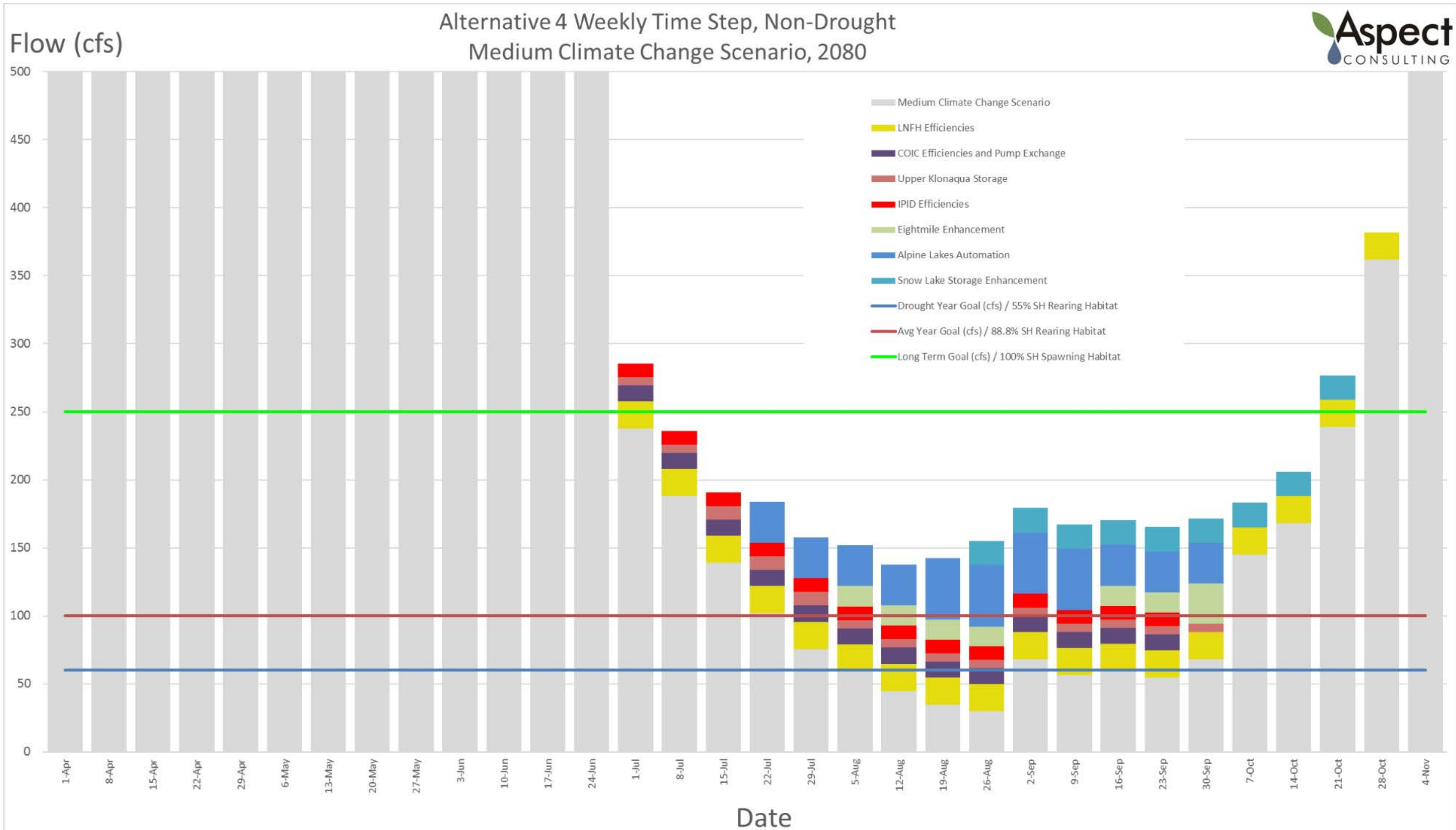
Alternative 4 Weekly Time Step, Non-Drought
Medium Climate Change Scenario, 2080
Flow (cfs)
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Medium Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
Upper Klonaqua Storage
IPID Efficiencies
Eightmile Enhancement
Alpine Lakes Automation
Snow Lake Storage Enhancement
Drought Year Goal (cfs) / 55% SH Rearing Habitat
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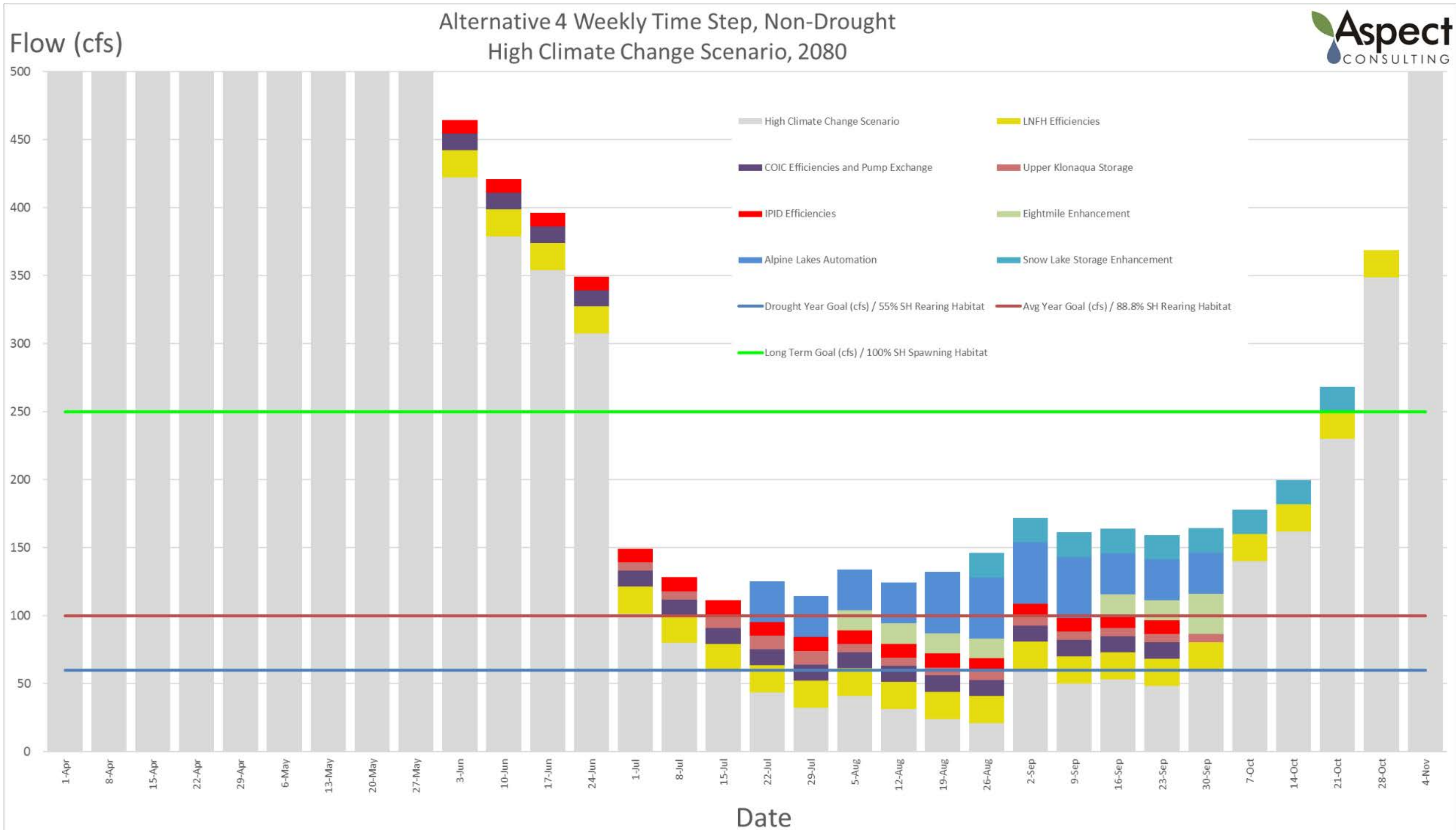

Alternative 4 Weekly Time Step, Non-Drought
High Climate Change Scenario, 2080
Flow (cfs)
Aspect
CONSULTING
High Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
Upper Klonaqua Storage
IPID Efficiencies
Eightmile Enhancement
Alpine Lakes Automation
Snow Lake Storage Enhancement
Drought Year Goal (cfs) / 55% SH Rearing Habitat
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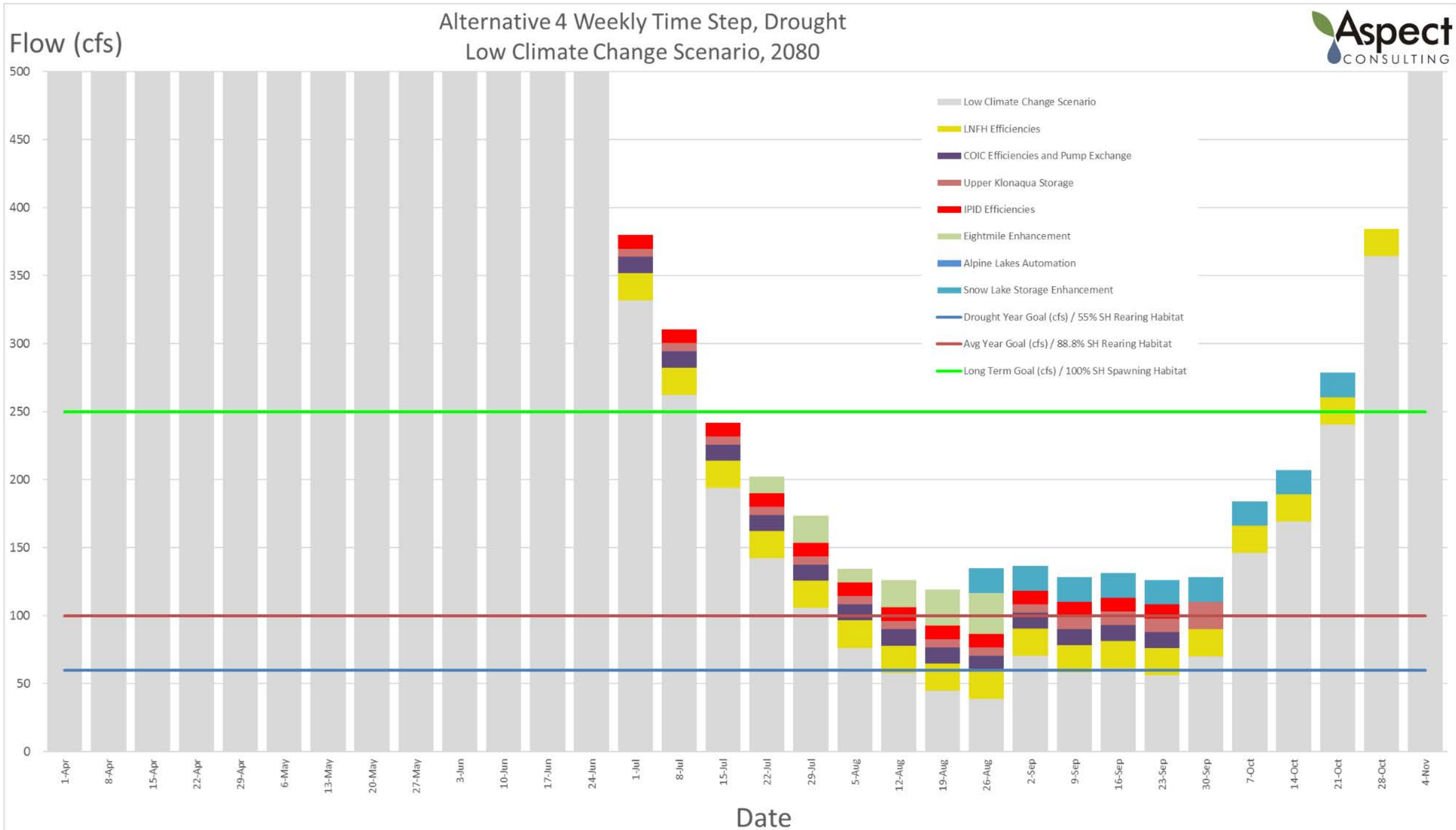

Alternative 4 Weekly Time Step, Drought
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Low Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
Upper Klonaqua Storage
IPID Efficiencies
Eightmile Enhancement
Alpine Lakes Automation
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Drought Year Goal (cfs) / 55% SH Rearing Habitat
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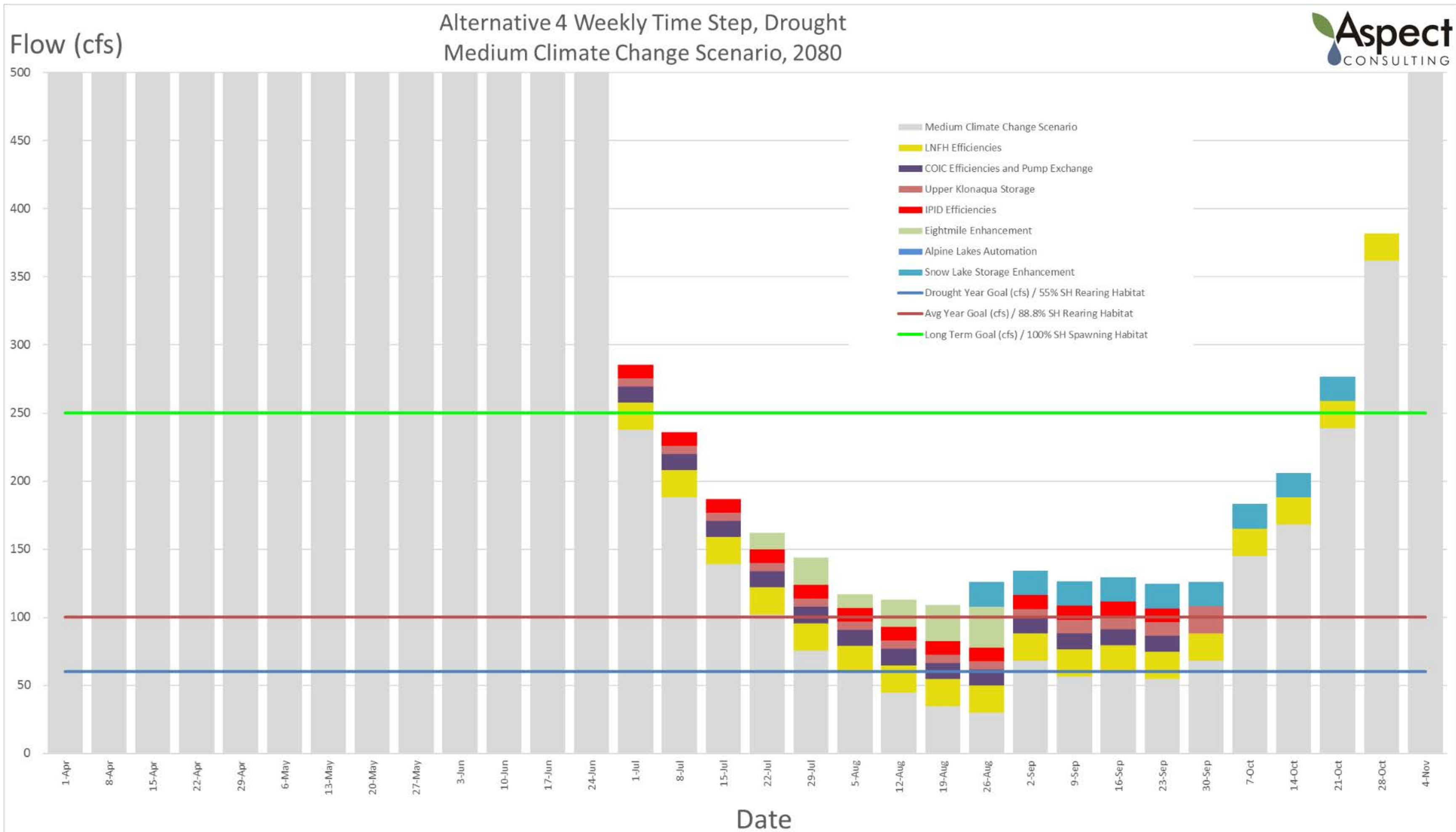
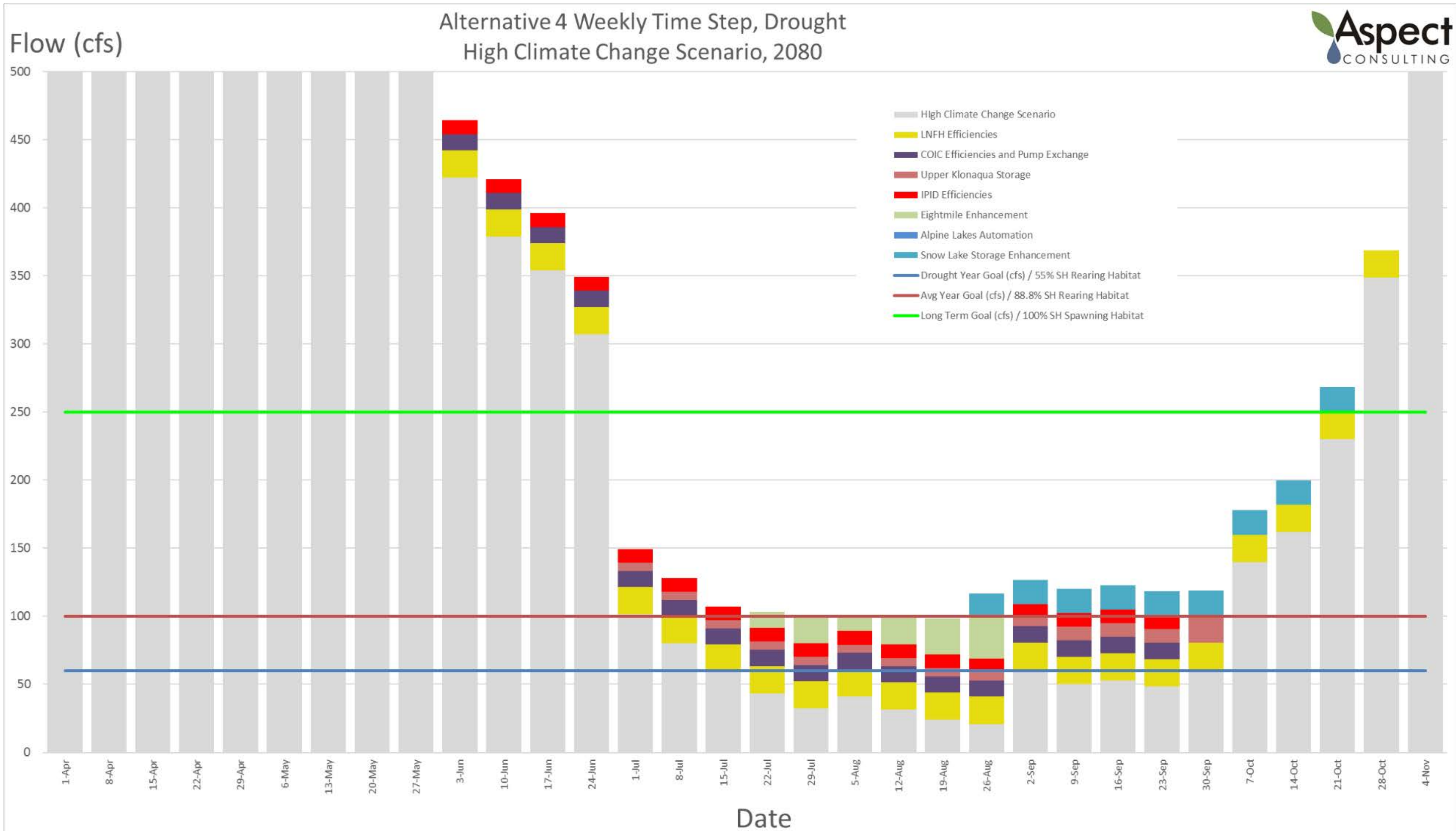
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
7-Oct
14-Oct
21-Oct
28-Oct
4-Nov
Date



Alternative 4 Weekly Time Step, Drought
Medium Climate Change Scenario, 2080
Flow (cfs)
Aspect
CONSULTING
Medium Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
Upper Klonaqua Storage
IPID Efficiencies
Eightmile Enhancement
Alpine Lakes Automation
Snow Lake Storage Enhancement
Drought Year Goal (cfs) / 55% SH Rearing Habitat
Avg Year Goal (cfs) / 88.8% SH Rearing Habitat
Long Term Goal (cfs) / 100% SH Spawning Habitat
0
50
100
150
200
250
300
350
400
450
500
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
7-Oct
14-Oct
21-Oct
28-Oct
4-Nov
Date



Alternative 4 Weekly Time Step, Drought
High Climate Change Scenario, 2080
Flow (cfs)
Aspect
CONSULTING
500
450
400
350
300
250
200
150
100
50
0
High Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
Upper Klonaqua Storage
IPID Efficiencies
Eightmile Enhancement
Alpine Lakes Automation
Snow Lake Storage Enhancement
Drought Year Goal (cfs) / 55% SH Rearing Habitat
Avg Year Goal (cfs) / 88.8% SH Rearing Habitat
Long Term Goal (cfs) / 100% SH Spawning Habitat
1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
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16-Sep
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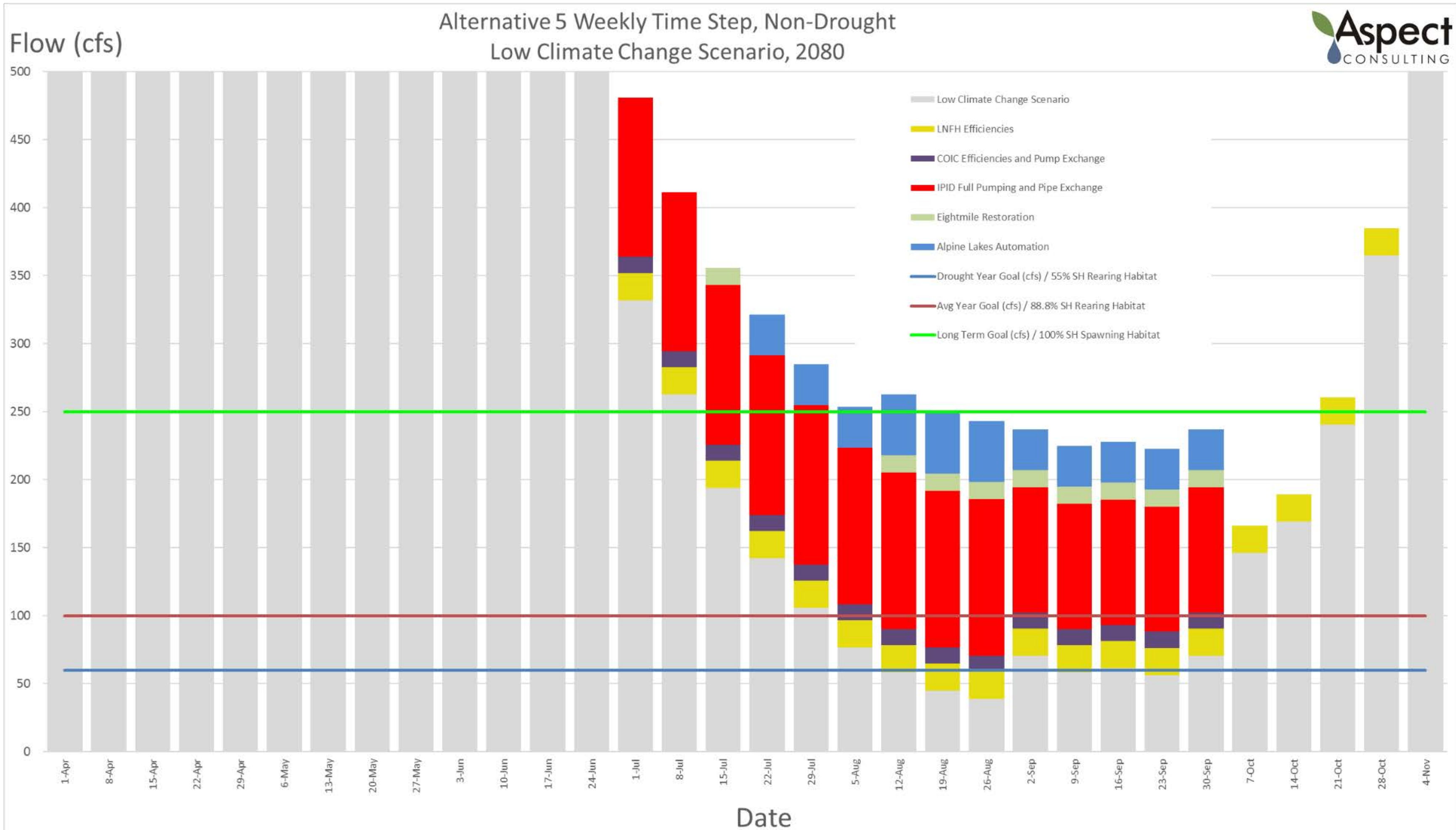
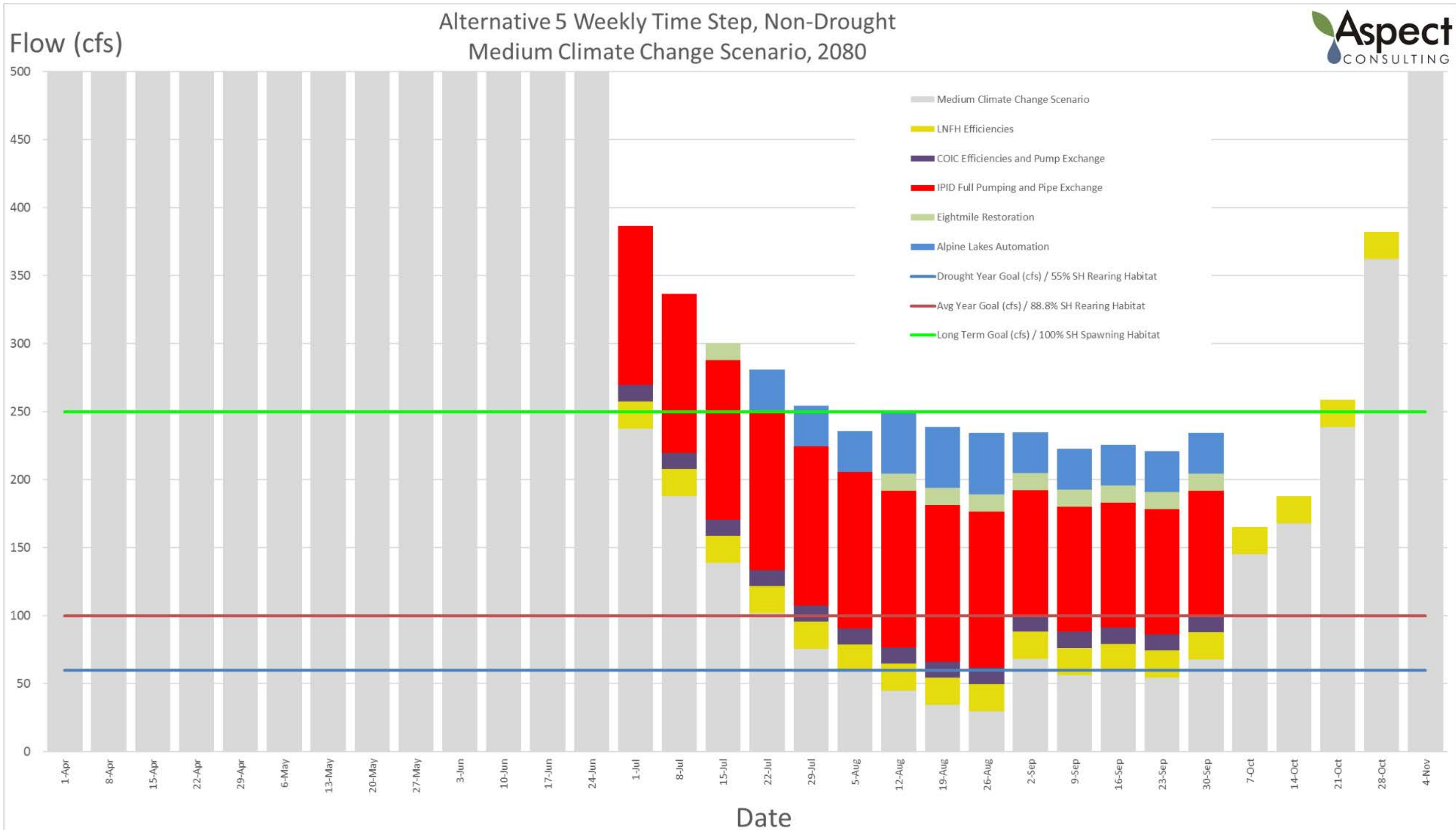
14-Oct
21-Oct
28-Oct
4-Nov
Date


Alternative 5 Weekly Time Step, Non-Drought
Low Climate Change Scenario, 2080
Flow (cfs)
Aspect CONSULTING
Low Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
IPID Full Pumping and Pipe Exchange
Eightmile Restoration
Alpine Lakes Automation
Drought Year Goal (cfs) / 55% SH Rearing Habitat
Avg Year Goal (cfs) / 88.8% SH Rearing Habitat
Long Term Goal (cfs) / 100% SH Spawning Habitat
Date


Alternative 5 Weekly Time Step, Non-Drought
Medium Climate Change Scenario, 2080
Flow (cfs)
Aspect CONSULTING
Medium Climate Change Scenario
LNFH Efficiencies
COIC Efficiencies and Pump Exchange
IPID Full Pumping and Pipe Exchange
Eightmile Restoration
Alpine Lakes Automation
Drought Year Goal (cfs) / 55% SH Rearing Habitat
Avg Year Goal (cfs) / 88.8% SH Rearing Habitat
Long Term Goal (cfs) / 100% SH Spawning Habitat
0
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1-Apr
8-Apr
15-Apr
22-Apr
29-Apr
6-May
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20-May
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15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
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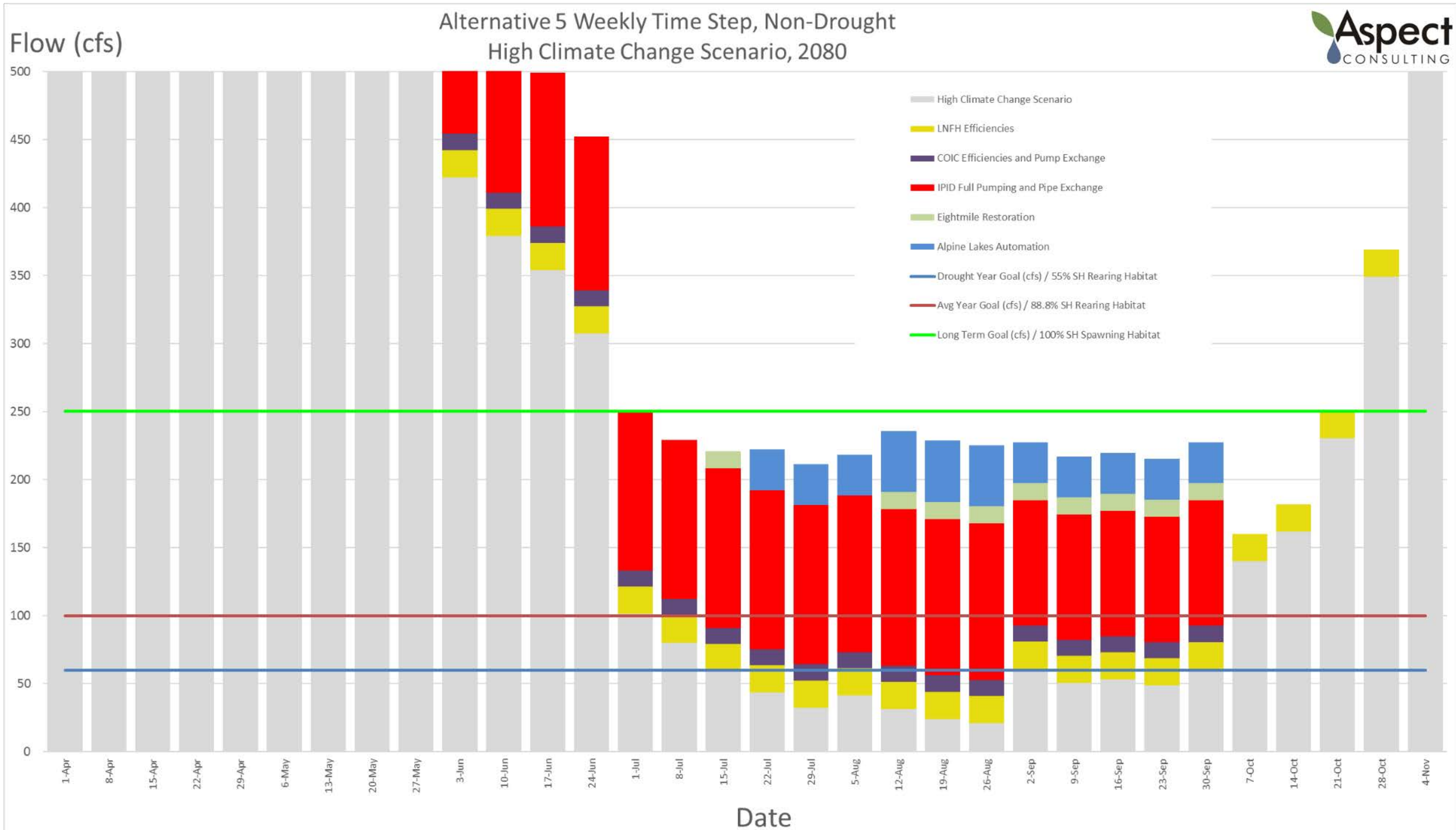
21-Oct
28-Oct
4-Nov
Date


Alternative 5 Weekly Time Step, Non-Drought
High Climate Change Scenario, 2080
Aspect CONSULTING
Flow (cfs)
500
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High Climate Change Scenario
LNFH Efficiencies
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21-Oct
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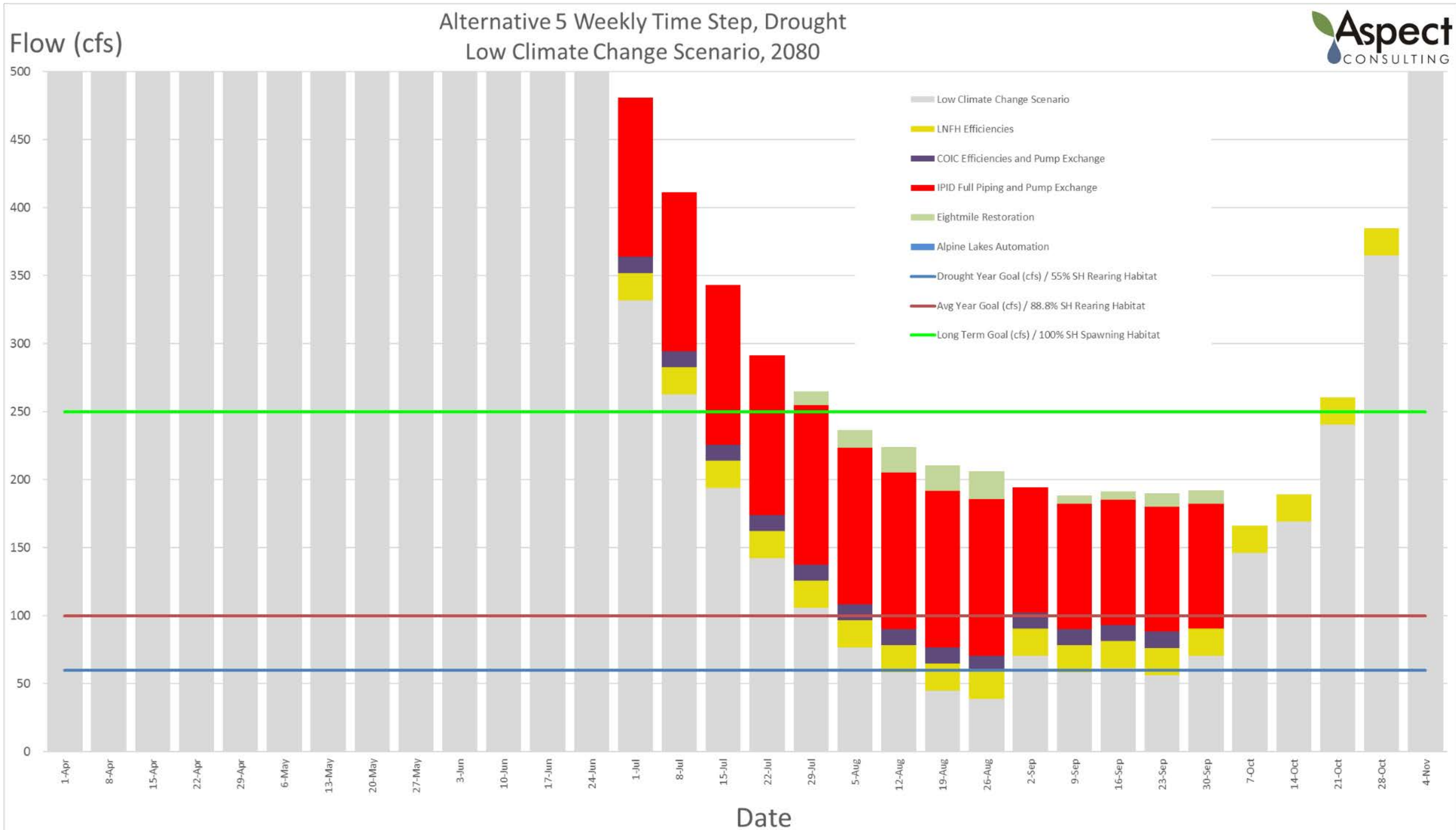
Alternative 5 Weekly Time Step, Drought
Low Climate Change Scenario, 2080
Flow (cfs)
Aspect
CONSULTING
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Low Climate Change Scenario
LNFH Efficiencies
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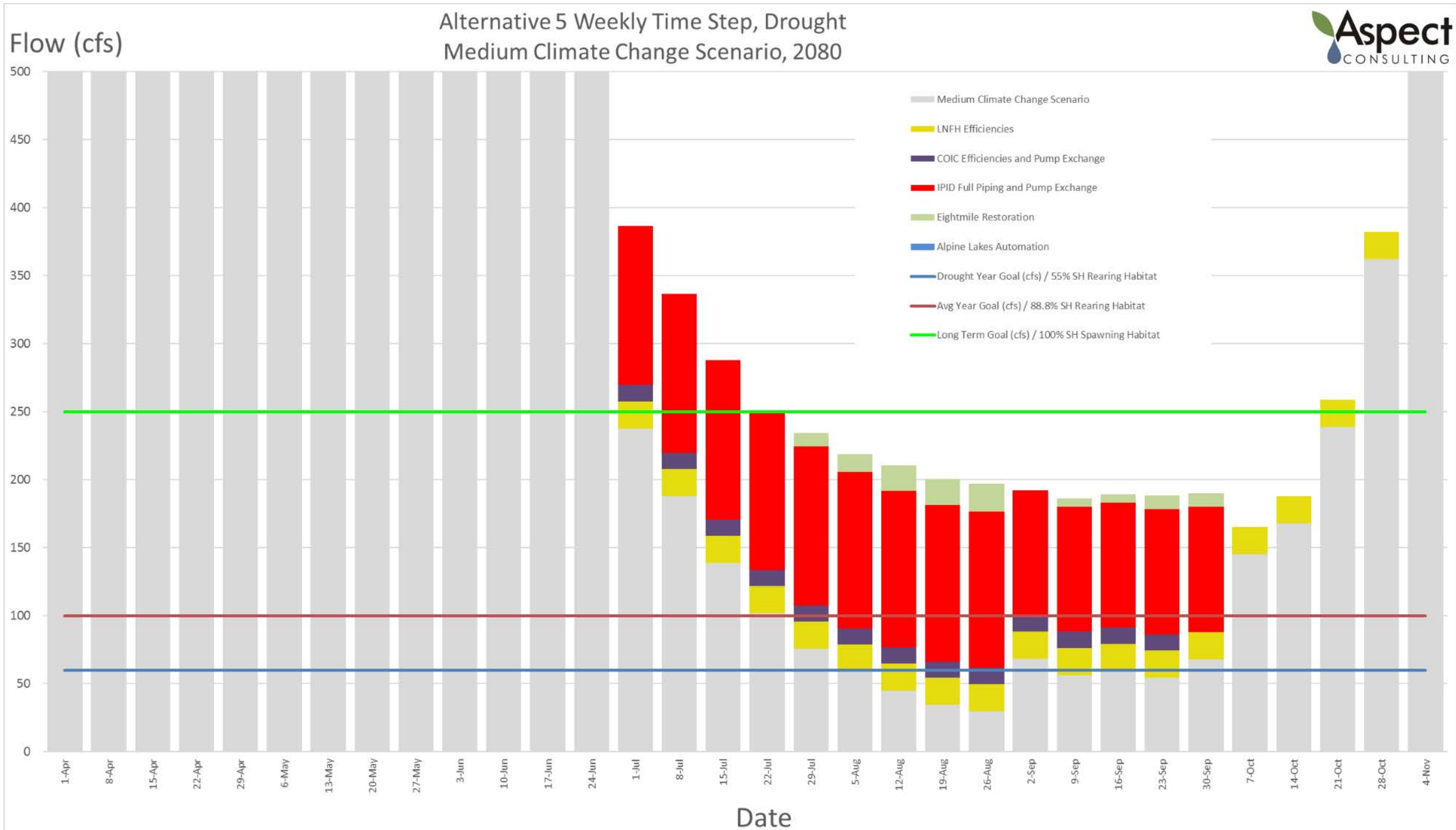
Alternative 5 Weekly Time Step, Drought
Medium Climate Change Scenario, 2080
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CONSULTING
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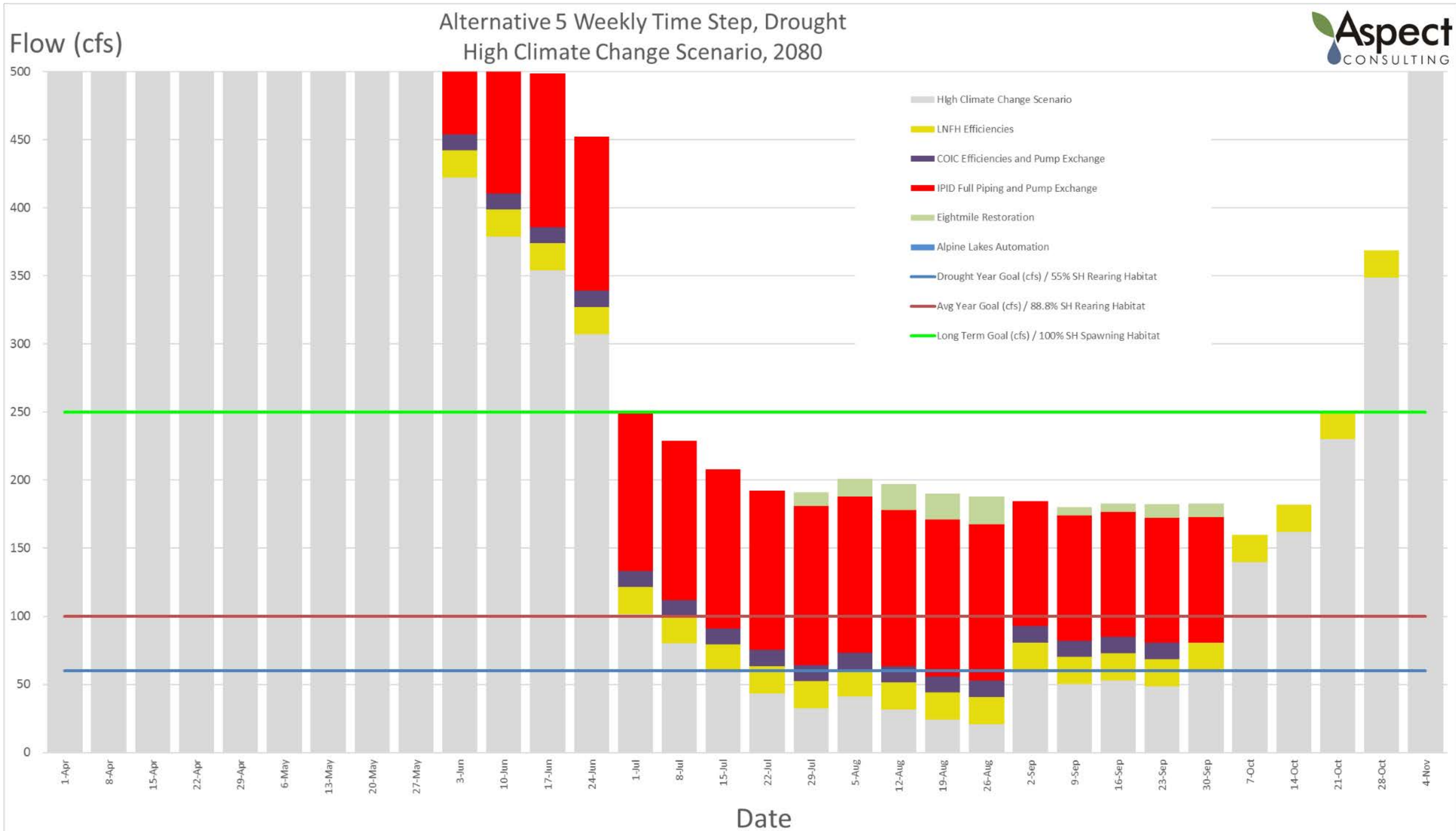

Alternative 5 Weekly Time Step, Drought
High Climate Change Scenario, 2080
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