US Army Corps of Engineers®
Alaska District

Integrated Feasibility Report and Environmental Assessment

Robe Lake Ecosystem Restoration
Valdez, Alaska

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SEPTEMBER 2023

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Robe Lake Ecosystem Restoration

Valdez, Alaska

Prepared By:

U.S. Army Corps of Engineers
Alaska District

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EXECUTIVE SUMMARY

Robe Lake is located within the northern portion of Prince William Sound in southcentral Alaska and lies within the city limits of Valdez. Robe Lake is the largest freshwater lake in the Valdez area, with three tributary streams: Brownie Creek, Deep Creek, and Old Corbin Creek. In the 1950s a gravel berm was constructed on Corbin Creek, which heads at the terminus of Corbin Glacier, to divert flow and prevent flooding and washout of the Richardson Highway. Prior to this diversion, the main channel of Corbin Creek originally flowed into Robe Lake. Currently, Corbin Creek is a tributary of Valdez Glacier Stream and now does not flow into Robe Lake. Corbin Creek's historic channel is now known as Old Corbin Creek, a relic channel with minimal flow.

At Robe Lake, human induced hydrologic impacts resulting from the diversion of Corbin Creek have resulted in broad scale effects. The loss of cold, turbid, glacial flow from the Corbin Creek tributary has led to an excessive overgrowth of macrophytes. The macrophytes have impacted salmonid habitat by reducing available rearing and spawning habitat. Current mitigation requires mechanical harvesting of excess macrophytes. Mechanical harvesting of excess macrophytes has a high operational cost and is time-consuming.

A Continuing Authorities Program (CAP) feasibility study was initiated with the City of Valdez and the Native Village of Tatitlek on 10 June 2022 with the execution of the Feasibility Cost Share Agreement (FCSA). The U.S. Army Corps of Engineers (USACE) worked with the City of Valdez, the Native Village of Tatitlek, and the Valdez Fisheries Development Association (VFDA) to find a solution to reduce excess overgrowth of macrophytes. Authority is provided by Section 206 of the Water Resources Development Act (WRDA) of 1996 (33 U.S.C. §2330), as amended.

This study evaluated several alternatives based on environmental, hydrological, and economic factors. The recommended plan, Alternative B-3, is outlined as follows: the entire flow of current Corbin Creek would be rerouted back into Old Corbin Creek. To direct flow, a diversion dike would run parallel to existing Corbin Creek, and perpendicular to Old Corbin Creek. An approximately 275-foot-long channel would be excavated to connect Old Corbin Creek to Corbin Creek. Approximately 1.5 miles of Old Corbin Creek would be excavated to deepen channel geometry. The culverts under the local trail system, known as the ALPETCO trail on Old Corbin Creek would be replaced with a trail bridge. An approximately 450-foot-long berm will be placed in the low-lying area between the two bluffs near the Old Corbin Creek culverts to prevent overland flow from entering historic channels that flow towards the Robe River subdivision. The two culverts with a diameter of approximately 12.75 ft. at the Robe River crossing would be replaced with three culverts with a diameter of approximately14 ft. for increased flow capacity and to improve fish passage.

Old Corbin Creek would be enhanced through nature-based features, such as stream bed improvements to mimic the narrow and deep channel geometry seen on other creeks (i.e., Brownie Creek and Deep Creek). These improvements include channelization of Old Corbin Creek to accommodate increased flows, adding pools-riffle complexes, and increasing the amount of large woody debris. These nature-based features would be implemented to work in concert with natural processes to mimic natural conditions.

This Integrated Feasibility Report and Environmental Assessment (IFR-EA) presents a range of measures and alternatives that could address the identified problem and contribute to the National Ecosystem Restoration (NER) objectives. The measures and alternatives aimed to improve the Robe Lake ecosystem function in a self-sustaining way that reduces the amount of human intervention and maintenance required, while improving existing salmonid rearing and spawning habitat.

LIST OF ACRONYMS AND ABBREVIATIONS

°F	*Degrees Fahrenheit*
2D	*Two Dimensional*
AAEC	*Average Annual Economic Cost*
AAHU	*Average Annual Habitat Units*
ACS	*Alaska Community Survey*
ADFG	*Alaska Department of Fish and Game*
AEP	*Annual Exceedance Probabilities*
AHRS	*Alaska Heritage Resources Survey*
AKDOT	*Alaska Department of Transportation*
APE	*Area of Potential Effect*
AS	*Alaska Statute*
AWC	*Anadromous Waters Catalogue*
BGEPA	*Bald and Golden Eagle Protection Act*
BP	*Before Present*
CAA	*Clean Air Act*
CAP	*Continuing Authorities Program*
CE/ICA	*Cost-Effectiveness and Incremental Cost Analysis*
CEJST	*Climate and Economic Justice Screening Tool*
CEQ	*Council on Environmental Quality*
CWA	*Clean Water Act*
D&I	*Design and Implementation*
EA	*Environmental Assessment*
eDNA	*Environmental DNA*
EFH	*Essential Fish Habitat*
EJScreen	*Environmental Justice Screening and Mapping Tool*
EO	*Executive Order*
EOP	*Environmental Operating Principles*
EPA	*Environmental Protection Agency*
EQ	*Environmental Quality*
ER	*Engineer Regulations*
ERDC	*Engineers Research and Design Center*
ESA	*Endangered Species Act*
FCSA	*Feasibility Cost Sharing Agreement*
FEMA	*Federal Emergency Management Agency*
FFE	*First-floor Elevation*
FONSI	*Finding of No Significant Impact*
FWCA	*Fish and Wildlife Coordination Act*
FWOP	*Future Without Project*
HEC-FDA	*Hydrologic Engineering Center's Flood Damage Reduction Analysis*
HEC-RAS	*Hydrologic Engineering Center's River Analysis System*
HWM	*High Water Mark*
IFR-EA	*Integrated Feasibility Report and Environmental Assessment*
LERRDs	*Lands, Easements, Rights-of-way, Relocations, and Disposal*
LiDAR	*Light Detection and Ranging*
MBTA	*Migratory Bird Treaty Act*
MCACES	*Micro-Computer Aided Cost Estimating System*
NAAQS	*National Ambient Air Quality Standards*
NAVD88	*North American Vertical Datum of 1988*

NCBI SRA	*National Center for Biotechnology Information Sequence Read Archive*
NEC	*National Evaluation Criteria*
NED	*National Economic Development*
NEPA	*National Environmental Policy Act*
NER	*National Ecosystem Restoration*
NMFS	*National Marine Fisheries Service*
NOAA	*National Oceanic and Atmospheric Administration*
NPS	*National Parks Service*
NRHP	*National Register of Historic Places*
NWI	*National Wetlands Inventory*
O&M	*Operations and Maintenance*
OMRR&R	*Operations, Maintenance, Repair, Replacement, and Rehabilitation*
OSE	*Other Social Effects*
P&G	*Principles and Guidelines*
PPA	*Project Partnership Agreement*
RED	*Regional Economic Development*
ROM	*Rough Order of Magnitude*
SHPO	*State Historic Preservation Officer*
SLC	*Sea Level Change*
USACE	*United States Army Corps of Engineers*
USC	*United States Code*
USFWS	*United States Fish and Wildlife Service*
USGS	*United States Geological Society*
VFDA	*Valdez Fisheries Development Association*
WRC	*Water Resources Council*
WRDA	*Water Resources Development Act*

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1.0 INTRODUCTION

1.1 Introduction

This Robe Lake Ecosystem Restoration Integrated Feasibility Report and Environmental Assessment (IFR-EA) documents the United States Army Corps of Engineers (USACE) planning and decision-making process for recommended ecosystem restoration alternatives and measures at Robe Lake in Valdez, Alaska.

This feasibility study was requested by the City of Valdez and the Native Village of Tatitlek (the non-Federal sponsors), in response to conditions that have led to a degraded aquatic ecosystem at Robe Lake, in Valdez, Alaska. The Feasibility Cost Share Agreement (FCSA) was signed on 10 June 2022 by the United States Army Corps of Engineers (USACE), Alaska District.

1.2 USACE Planning Process

For this project the focus is evaluating the feasibility of an array of reasonable alternative plans that aim to restore and improve salmonid habitat within Robe Lake to a less degraded state. To support sound decision making, the USACE planning process includes six steps as a rational framework that is documented in a feasibility report that culminates in the selection and description of a Recommended Plan in Step 6. This feasibility report is integrated with an Environmental Assessment (EA) which describes the environment of the area(s) to be affected or created by the alternatives under consideration.

The six planning process steps and associated report sections are listed below:

Planning Step Description	Reports Section(s)
Step 1 - Identifying problems, opportunities, objectives, and constraints	1.0
Step 2 - Inventorying and forecasting conditions	2.0
Step 3 - Formulating alternative plans	3.0
Step 4 - Evaluating alternative plans	3.0
Step 5 - Comparing alternative plans	4.0
Step 6 - Selecting a plan	5.0

The six steps, though presented and discussed in a sequential manner in this report, usually occur iteratively during the study, and sometimes concurrently. Iterations of the steps are conducted as necessary to formulate efficient, effective, complete, and acceptable plans. Details concerning the selection criteria are presented as applicable throughout this report, but in general the overall goal is to identify a plan that demonstrates the highest benefits and is environmentally acceptable. A more detailed description of each step is presented in each associated report section.

1.3 Study Authority

This feasibility study was conducted by USACE Alaska District under authority granted under the Continuing Authorities Program (CAP) Section 206 of the Water Resources Development Act (WRDA) of 1996 (33 U.S. Code (USC) §2330), as amended.

Section 206 states:

> *"The Secretary may carry out a project to restore and protect an aquatic ecosystem or estuary if the Secretary determines that the project will improve the quality of the environment and is in the public interest; or will improve the elements and features of an estuary; and is cost-effective. A project under this section may include removal of a dam. A project under this section may include measures to improve habitat or passage for anadromous fish, including installing fish bypass structures on small water diversions; modifying tide gates; and restoring or reconnecting floodplains and wetlands that are important for anadromous fish habitat or passage. A project that includes measures under this paragraph shall be formulated to maximize benefits for the anadromous fish species benefitted by the project. In carrying out a project to restore and protect an aquatic ecosystem or estuary, the Secretary shall consider, and may include, with the consent of the non-Federal interest, a natural feature or nature-based feature, as such terms are defined in section 2289a of this title, if the Secretary determines that inclusion of such features is consistent with the requirements of subsection (a)."*

Ecosystem Restoration (Engineer Regulation (ER) 1105-2-100, Chapter 3-5)

> *"The Corps of Engineers incorporated ecosystem restoration as a project purpose within the Civil Works program in response to the increasing National emphasis on environmental restoration and preservation. Historically, Corps involvement in environmental issues focused on compliance with National Environmental Policy Act (NEPA) requirements related to flood protection, navigation, and other project purposes. The ecosystem restoration purpose shall be carried out in addition to activities related to NEPA compliance. Ecosystem restoration features shall be considered as single purpose projects or as a part of multiple purpose projects along with navigation, flood protection and other purposes, wherever those restoration features improve the value and function of the ecosystem. Ecosystem restoration projects should be formulated in a systems context to improve the potential for long-term survival of aquatic, wetland, and terrestrial complexes as self-regulating, functioning systems. Similar to other project purposes, the value of ecosystem restoration outputs shall equal or exceed their cost."*

1.4 Study Area

Robe Lake is located within the northern portion of Prince William Sound (Figure 1A) in southcentral Alaska and lies within the city limits of Valdez (Figure 1B). Robe Lake is the largest freshwater lake in the Valdez area, with three tributary streams: Brownie Creek, Deep Creek, and Old Corbin Creek (Figure 2). Robe Lake empties into Robe River, which then flows under the Richardson Highway into the Lowe River.

In the 1950s a gravel berm was constructed on Corbin Creek, which heads at the terminus of Corbin Glacier, to divert flow and prevent flooding and washout of the Richardson Highway. Prior to this diversion, the main channel of Corbin Creek originally flowed into Robe Lake (Figure 3). Currently, Corbin Creek is a tributary of Valdez Glacier Stream and does not flow into Robe Lake (Figure 2). Corbin Creek's historic channel is now known as Old Corbin Creek, a relic channel with minimal flow.

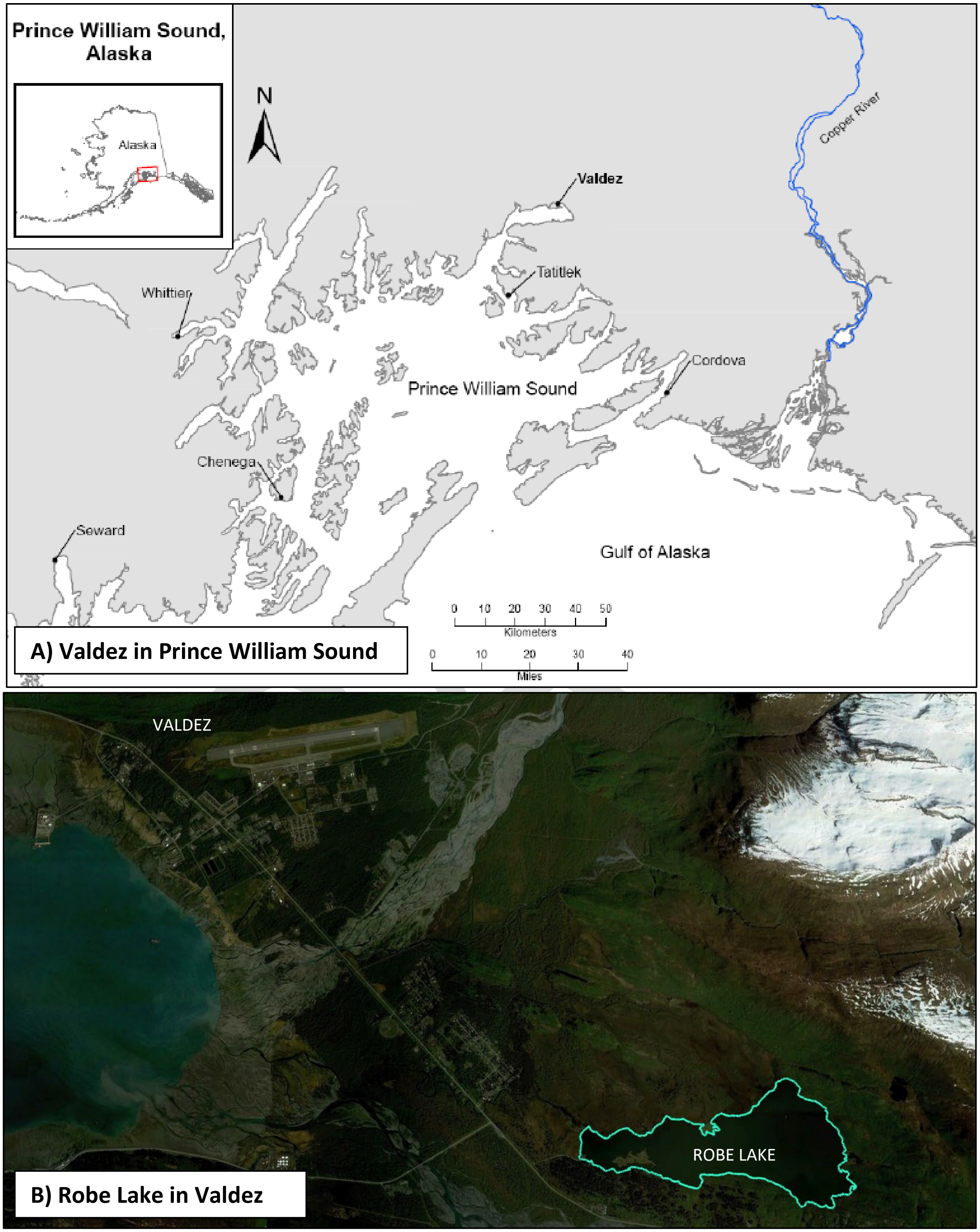


Figure 1. Location and vicinity Valdez and Robe Lake.

A) shows the location of Valdez within Prince William Sound, Alaska; B) shows the location of Robe Lake within the Valdez area.

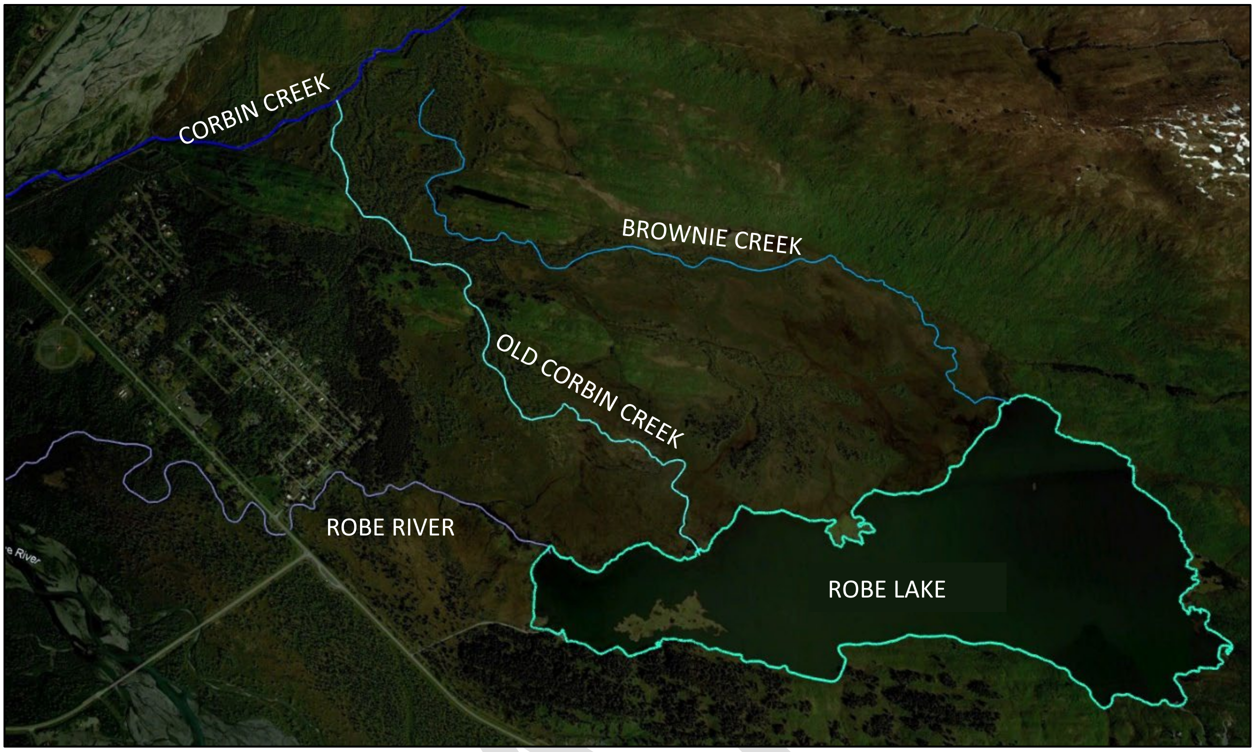


Figure 2. Current imagery of Robe Lake and the surrounding area.

The boundaries of the tributaries Old Corbin Creek and Brownie Creek, perimeter of Robe Lake, and the outflow of Robe River are highlighted.

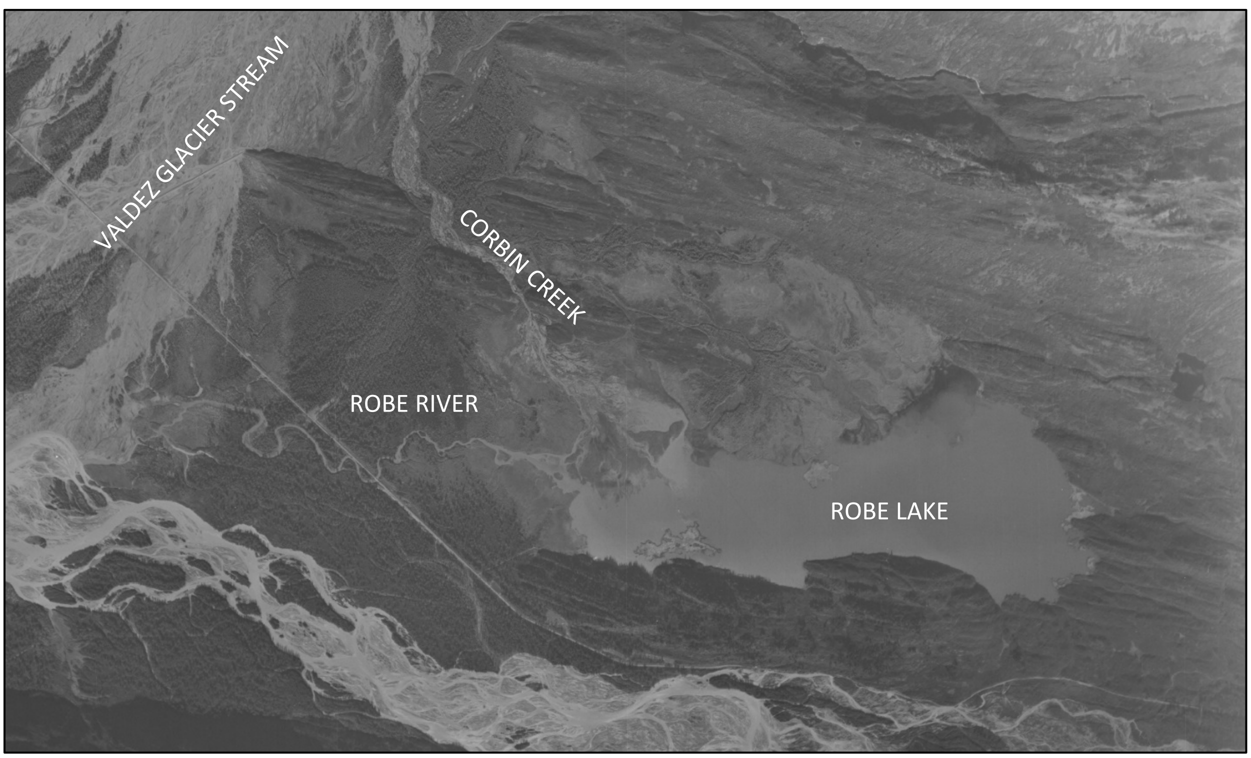


Figure 3. Historic imagery of Robe Lake and the surrounding area.

1.5 Background and History

Robe Lake supports stocks of various anadromous fish species and is an important salmon (*Oncorhynchus* spp.) spawning and rearing site in the Valdez area. However, the berm constructed to re-direct the flow of Corbin Creek has altered the ecology and watershed dynamics of the lake. The loss of cold, turbid, glacial flow input from the Corbin Creek tributary has facilitated an overgrowth of macrophytes. The overgrowth of macrophytes has reduced the available rearing and spawning habitat for salmonid species.

Valdez Fisheries Development Association (VFDA) has a long history of maintaining salmonid spawning habitat within the Robe Lake watershed. VFDA has conducted mechanical weed harvesting of excess macrophytes since the 1990s (Figure 4). However, mechanical harvesting of excess macrophytes has a high operational cost, is time-consuming, and has limited overall success.

Figure 4. Mechanical weed harvesting of macrophytes at Robe Lake by VFDA.

1.6 Purpose and Need

USACE CAP is a delegated authority to plan, design, and construct certain types of water resource and environmental restoration projects without specific Congressional authorization. CAP Section 206 provides authority for projects that restore degraded ecosystem function and values, including abiotic and biotic processes, to a less degraded ecological condition. These CAP projects are of relatively small scope, cost, and complexity.

The purpose of this study is to improve the Robe Lake ecosystem function in a self-sustaining way that reduces the amount of human intervention and maintenance required, while improving existing salmonid rearing and spawning habitat. USACE and the non-Federal sponsors have determined that restoring these ecological processes at Robe Lake would facilitate habitat improvement for salmonid species.

1.7 Problems and Opportunities

Problem Statement:
At Robe Lake, human induced hydrologic impacts resulting from a diversion of Corbin Creek have resulted in broad scale effects. The loss of cold, turbid, glacial flow from the Corbin Creek tributary has led to an excessive overgrowth of macrophytes. The macrophytes have impacted salmonid habitat by reducing available rearing and spawning habitat. Current mitigation requires mechanical harvesting of excess macrophytes. Mechanical harvesting of excess macrophytes has a high operational cost and is time-consuming.

Opportunities:

- Decommission heavy machinery used to mitigate the overgrowth of macrophytes. This would reduce operational cost and environmental hazards (i.e., accidents, fuel spills).
- Enhance habitat for wildlife species within the area (i.e., migratory birds).
- Implement improvements to the Robe River crossing on Richardson Highway that incorporate fish passage, ecosystem connectivity, and flood risk mitigation.
- Increase accessibility for recreational activities within the Robe Lake watershed.

1.8 Objectives and Constraints

Objectives:
The planning goal is to formulate an effective and achievable measure or set of measures that will result in selecting an alternative plan that will meet the objectives listed below:

- Restore the water quality within Robe Lake to a healthy, productive, self-sustaining system with natural flow regime.
- Increase the quality and/or quantity of salmonid habitat, in addition to improving existing salmonid habitat.

- Decrease the overall maintenance required to control the overgrowth of macrophytes.

Constraints:
- Project costs must be within CAP limits ($10 million Federal).
- Proposed alternative must avoid inducing flood damages within the study area.
- USACE policy requires that acceptable recommended plans not induce flooding.

1.9 Study Scope

This study evaluates the feasibility and subsequent effects (i.e., environmental, hydrological, economical) of implementing ecosystem restoration measures at Robe Lake. The *Engineer Regulation 1105-2-100: Planning Guidance Notebook* (ER 1105-2-100) defines the contents of feasibility reports for ecosystem restoration measures. The *Engineer Regulation 200-2-2: Procedures for Implementing NEPA* (ER 200-2-2), directs the contents of environmental assessments. This feasibility study presents the information required by both regulations as an IFR-EA. This document also complies with the regulations for implementing the National Environmental Policy Act (NEPA; 42 U.S.C. §4321as amended) set by the Council on Environmental Quality (CEQ).

2.0 EXISTING AND FUTURE WITHOUT PROJECT CONDITIONS

This section provides forecasting of conditions that are expected to persist at Robe Lake in the absence of ecosystem restoration efforts. The Future Without Project (FWOP) condition forms the basis of evaluation, which alternative plans are formulated against and impacts are assessed. The economic period of the analysis is 50 years, beginning with a base year of 2026.

2.1 Natural Environment

Under the FWOP, human intervention and mechanical harvesting of overabundant aquatic vegetation at Robe Lake would continue. If no action is taken, salmonid habitat within Robe Lake would continue to degrade. Study objectives would not be met, and no project benefits or opportunities would be realized.

2.1.1 Wetlands and Habitat

2.1.1.1 Aquatic Vegetation

Wetlands are areas where the soil is saturated with water, that provide a multitude of ecological functions. Wetlands provide nutrients for primary producers (i.e., macrophytes), refugia for organisms during vulnerable life stages, and habitat for larger organisms within a biome.

The loss of cold, turbid, glacial flow from the Corbin Creek tributary has led to the excessive overgrowth of macrophytes in Robe Lake. The macrophytes have impacted salmonid habitat by reducing available rearing and spawning habitat. Historical studies assessing the habitat at Robe Lake did not identify the problematic macrophytes to species (Koenings et al., 1987; Inter-Fluve et al., 2021). To provide a comprehensive analysis of the existing conditions at Robe Lake, we conducted field surveys to identify these macrophytes to species to examine individual tolerances with respect to changes in environmental conditions. A project objective is to decrease the overall maintenance required to control the overgrowth of macrophytes, therefore knowing the community composition of aquatic vegetation in Robe Lake is important for understanding species level environmental tolerances. Results of the field survey conducted in May 2023 found that macrophyte species within Robe Lake were not fully in green up. However, various species of sedge (*Carex* spp.) and common mare's-tail (*Hippuris vulgaris*) were present along the shoreline. Identification of archived macrophyte specimens from VFDA included whorl-leaf watermilfoil (*Myriophyllum verticillatum*), white-stalked pondweed (*Potamogeton praelongus*), and common mare's-tail (*Hippuris vulgaris*). A site visit conducted in August 2023 confirmed that no invasive species were present, and that the three macrophytes species sent as specimens from VFDA for identification were the most abundant species being harvested at Robe Lake.

Under FWOP conditions, it is expected that the excessive overgrowth of macrophytes within Robe Lake will continue. The quality and quantity of salmonid habitat will decrease overtime.

2.1.1.2 Invasive Aquatic Vegetation

There are no invasive species of aquatic vegetation presently observed in Robe Lake. Though not observed as of yet in Robe Lake, *Elodea* spp. (common waterweed or Canadian waterweed) is present in several lakes in Alaska (Figure 5) and is an invasive species of concern. *Elodea* is a hardy aquatic plant that grows in cold, clear, slow-moving water. It is considered a circumpolar invasive plant; its native range extends from Florida to southern British Columbia (National Park Service (NPS), 2020).

Elodea is the first known freshwater invasive plant to be found in Alaska and with it come significant environmental concerns. Once *Elodea* becomes established, it grows rapidly, blocking light and taking up nutrients other plants might use to grow and essentially creating a monoculture (Rorslett et al., 1986; Spicer and Catling, 1988; NPS, 2020). *Elodea* often grows so profusely that it slows stream flow and mixing rates (Spicer and Catling 1988; Gollasch, 2006), allowing sediment and fine particles to settle out of the water and cover the gravel in areas where salmon, whitefish, and grayling spawn (NPS, 2020). Its explosive growth is typically followed by a sudden die back, which then decomposes in the water. The organisms decomposing all the dead vegetation rapidly consume the oxygen in the water, making it difficult for fish and other aquatic organisms to survive (Simberloff and Gibbons, 2004; Buscemi, 1958; Pokorný et al., 1984).

In Prince William Sound, *Elodea* is present in Eyak Lake (which is located near Cordova) and several other water bodies on the Copper River Delta (NPS, 2020; Figure 5). There is reoccurring float plane traffic between Eyak Lake and Robe Lake in the summer months, which increases the potential for *Elodea* to spread to Robe Lake.

However, the risk of *Elodea* becoming established within Robe Lake is relatively low. The risk is overall relatively low given the large distance between Robe Lake and Eyak Lake. Likewise, any potential transport of *Elodea* between these two lakes would likely be limited to “hitchhiking” on float planes since Cordova is off the road system, resulting in a decreased risk of establishment.

Under FWOP conditions, the reduced habitat value of Robe Lake (i.e., reduced turbidity, increased water temperature) provides an opportunity for invasive species to become established. The FWOP condition has a higher risk of an invasive becoming established in Robe Lake given the current degraded environmental state, than the future with project condition.

If *Elodea* were to become established in Robe Lake, the impact to the future with project condition is anticipated to be minimal since the preferred alternative already aims to reduce the overgrowth of native macrophytes by introducing cold, turbid, glacial flow to the system. The projected outcome of implementing the preferred alternative would also reduce the risk of *Elodea* becoming established in the future with project condition. Therefore, any benefits from the project are anticipated to still be achieved.

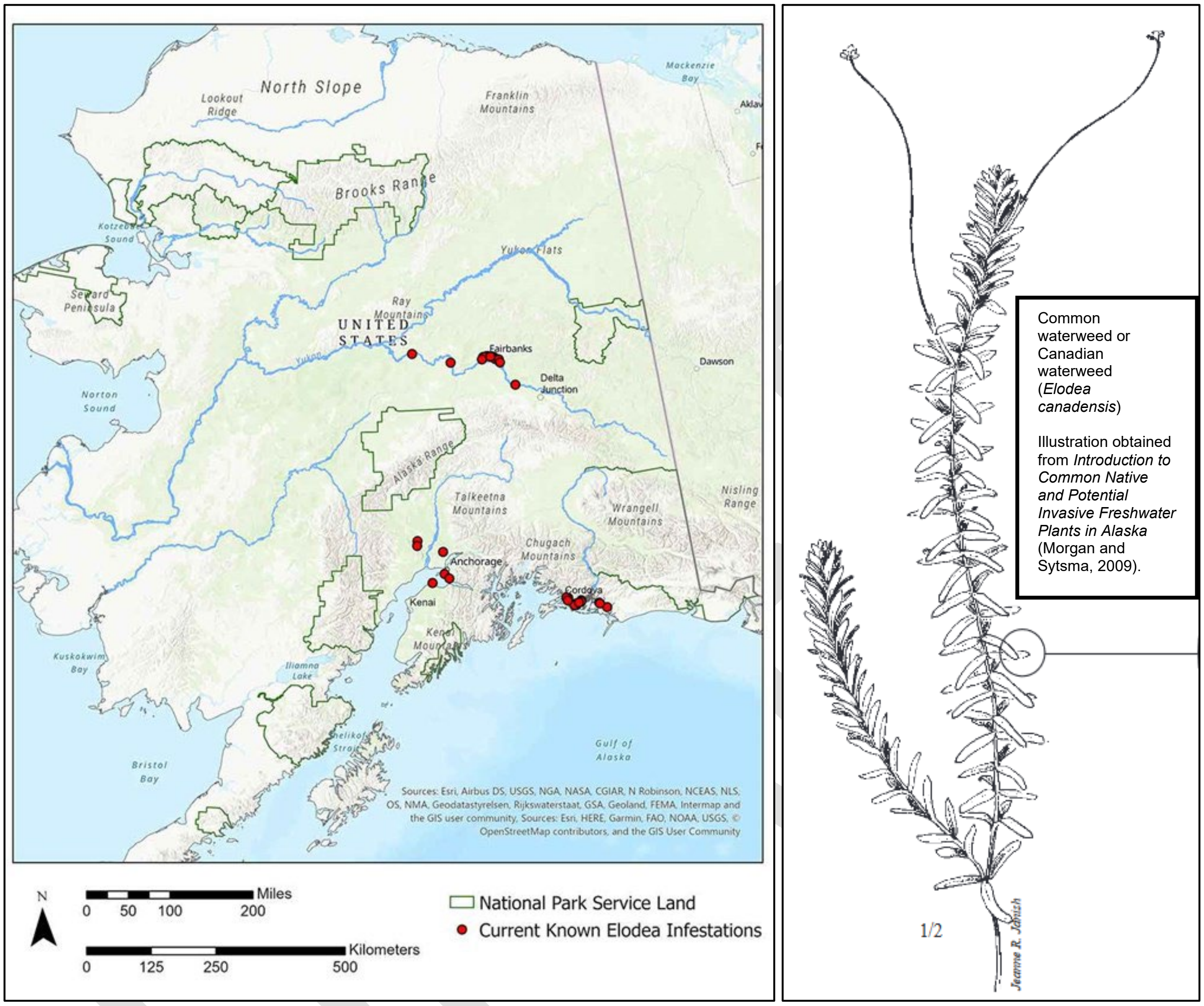


Figure 5. *Elodea* infestations across Alaska.

Current *Elodea* infestations across Alaska (red dots), relative to some of Alaska's largest communities and national parks (green outline). Map obtained from *Elodea: Alaska's First Invasive Aquatic Plant Continues to March Across the State* (NPS, 2020).

2.1.1.3 Special Aquatic Sites

The U.S. Environmental Protection Agency (EPA) identifies six categories of special aquatic sites in their Clean Water Act (CWA) Section 404(b)(1) guidelines: sanctuaries and refuges, wetlands, mudflats, vegetated shallows, coral reefs, and riffle and pool complexes. There are wetlands around the Robe Lake study area, and macrophytes within the littoral buffer are an example of "vegetated shallows".

The key issue at Robe Lake is the overgrowth of macrophytes. These macrophytes grow in vegetated shallows, specifically in the littoral buffer. Though vegetated shallows are classified as a special aquatic site, the aim is to reduce the overgrowth of macrophytes, which will improve overall habitat. Likewise, many areas of extensive overgrowth have already been disturbed during mechanical weed harvesting efforts.

The study area has undergone wetland delineation based off USFWS data from National Wetlands Inventory (USFWS NWI). The wetlands and deep-water habitats in this area were photo interpreted using 1:60,000 scale, color infrared imagery from 1978. The major lacustrine and palustrine wetlands within the study area were classified as L1UBH, L2AB4H, PEM1F, PEM1C, PSS1A, PSS1C, and PSS1/EM1C (Figure 6; Viereck et al., 1992).

L1UBH
Permanently flooded, open water lake with a deep-water habitat (greater than 2.5 meters) characterized by an unconsolidated bottom.

L2AB4H
Permanently flooded, floating-leaved aquatic vegetation growing in shallow water of lakes. Dominant plant is pygmy waterlily (*Nymphaea tetragona*), various pondweeds (*Potamogeton* spp.), and yellow pond-lily (*Nuphar polysepalum*) are also common in some areas.

PEM1F
Semi-permanently flooded emergent marshes. These marsh areas usually exhibit standing water throughout the growing season. This wetland type occurs in patterned bog pools and in depressions and pools not associated with patterned bogs, and along the periphery of ponds and lakes. Dominant vegetation consists primarily of graminoids including tussock cottongrass (*Eriophorum* spp.), sedge (*Carex* spp.), rush (*Juncus* spp.), arrowgrass (*Triglochin* spp.), and various forbs including alkali buttercup (*Ranunculus cymbalaria*), marsh fivefinger (*Potentilla palastris*), and water hemlock (*Cicuta douglaslii*).

PEM1C
Seasonally flooded, persistent emergent marsh. This emergent wetland type may occur on the floodplain of small streams and creeks and along pond margins. Standing water resulting from stream overflow is present early in the growing season. Species of primary importance along low-gradient streams may include variegated horsetail (*Equisetum variegatum*), marsh horsetail (*Equisetum palustre*), marsh fivefinger

(*Potentilla palastris*), panicled bulrush (*Scirpus microcarpus*), and Lyngbye's sedge (*Carex lyngbyaei*). Within and around sedge/sphagnum bog pools; bluejoint (*Calamagrostis canadensis*), various sedges (*Carex* spp.), buckbean (*Menyanthes trifoliata*), and tussock cottongrass (*Eriophorum* spp.), may be found.

PSS1A
Temporarily flooded dense shrub areas on river and stream floodplains consisting primarily of various willow (*Salix* spp.), high bush cranberry (*Viburnum edule*), salmonberry (*Rubus spectabilis*), and mountain alder (*Alnus crispa*). This wetland type often occurs on river bars that have become stable enough to support persistent woody vegetation. Understory vegetation is generally sparse, but may contain Lyngbye's sedge (*Carex lyngbyaei*), bluejoint (*Calamagrostis canadensis*), field horsetail (*Equisetum arvense*), roth lady fern (*Athyrium filix-femina*), Bering's tufted hairgrass (*Deschampsia beringensis*), northern oak fern (*Gymnocarpium dryopteris*), alpine bluegrass (*Poa alpina*), and spike trisetum (*Trisetum spicatum)*. Peat development is usually lacking.

PSS1C
Seasonally flooded dense shrub areas on river and stream floodplains consisting of various willow (*Salix* spp.) and alder (*Alnus* spp.) species. The alder and willow combined may exceed 75% cover in this type of wetland. Terrain may be hummocky with flooded depressions. Mountain alder (*Alnus crispa*) is generally the dominant tall shrub species along with Barclay's willow (*Salix barclayi*), Alaska willow (*Salix alaxensis)*, sweet gale (*Myrica gale*), shrub birch (*Betula glandulosa*), and marsh Labrador tea (*Ledum palustre*). Emergent vegetation, dominated by bluejoint (*Calamagrostis canadensis*), may be present in some areas. This wetland type often occurs on river bars that have become stable enough to support persistent woody vegetation.

PSS1/EM1C
Seasonally flooded areas occurring on floodplains in stream and creek corridors. These wetlands are characterized by a mixture of broad-leaved deciduous shrubs and emergent vegetation. Surface water resulting from stream overflow is present during the early growing season. The substrate consists of an interspersion of hummocks and lower basins and drainageways. Various willow (*Salix* spp.) and alder (*Alnus* spp.) species dominate the hummock areas with emergent vegetation dominating the lower elevation areas. This is one of the most extensive shrub vegetation types. It occurs in some elongated depressions between raised bog ridges, as a floating bog mat along large ponds, and in the drained beaver meadows.

PF01/SS1C
Seasonally flooded areas on river and stream floodplains consisting of a mix of broad-leaved deciduous forest and broad-leaved deciduous shrubs. Dominant tree species is black cottonwood (*Populus balsamifera trichocarpa*). The dominant shrubs in the area are various willow (*Salix* spp.) and alder (*Alnus* spp.) species. The shrubs often occur in bands along the river channels and at a slightly lower elevation than the forested areas.

Under FWOP conditions, it is expected that areas within the project area dominated by shrubs, such as willow (*Salix* spp.) devil's club (*Oplopanax horridus*), and alder (*Alnus* spp.), will continue to encroach on tributaries and channels within the alluvial floodplain further reducing levels of seasonal flow (i.e., Old Corbin Creek; Figure 7). The dredged material extracted from Old Corbin Creek during construction would only be sufficient to ensure the channel has flow capacity. The majority of that material would be placed along the bank of Old Corbin Creek to deepen channel geometry, and enhance nature-based features such as pool-riffle complexes, or fill in low areas to block off other relic channels. See the 404(b)(1) for further details.

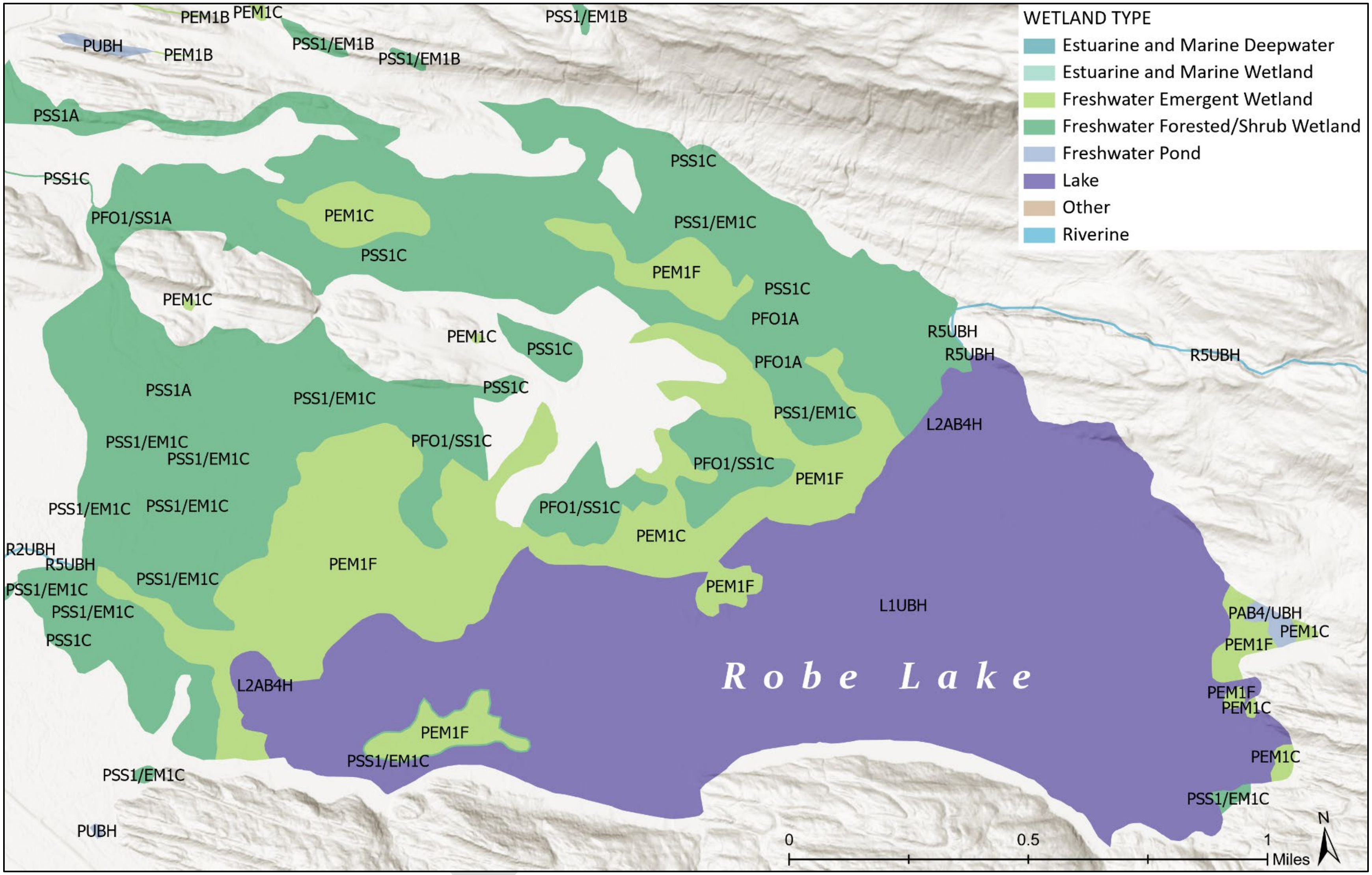


Figure 6. Wetland classification types within Robe Lake.

Major wetland types within Robe Lake area near Valdez, Alaska were classified and described by Viereck et al., 1992.

2.1.1.4 *Essential Fish Habitat*

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act set forth the essential fish habitat (EFH) requirement to identify and protect important habitats of federally managed marine and anadromous fish species. EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Robe Lake is designated as freshwater EFH for all five species of Pacific salmon. These include chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*Oncorhynchus keta*), sockeye salmon (*Oncorhynchus nerka*), coho salmon (*Oncorhynchus kisutch*), and pink salmon (*Oncorhynchus gorbuscha*).

Under FWOP conditions, the quality and quantity of salmon habitat in Robe Lake is expected to continue to decrease overtime. USACE anticipates that the recommended plan will not adversely affect freshwater EFH given that the purpose of this project is to restore the aquatic ecosystem at Robe Lake.

2.1.1.5 *Terrestrial Habitat*

Much of the area around Valdez and Robe Lake was previously glaciated, and is now an alluvial fan. There are still glaciers present within the Valdez area (i.e., Valdez Glacier and Corbin Glacier), and much of the upland habitat remains snow covered year round. The recent deglaciation and large glacial outwash plain decrease the habitat value for many large terrestrial mammals due to the low overall abundance of resources. The low-lying vegetation within the historic floodplain is dominated by shrubs, such as willow (*Salix* spp.) devil’s club (*Oplopanax horridus*), and alder (*Alnus* spp.) (Figure 7). As a result, these areas generally have low animal population densities. The surrounding low-lying deciduous and spruce forests provide a more productive habitat for large terrestrial mammals, but are generally limited.

Under FWOP conditions, the value of low-lying deciduous habitat is expected to remain the same since terrestrial habitat within the area is highly disturbed due to glacial outwash. Along the riparian margins of Old Corbin Creek, the density of low-lying shrubs is anticipated to increase over time. The encroachment of woody vegetation along Old Corbin Creek is anticipated given the hydrological condition of the channel (i.e., minimal flows). This trend is apparent when comparing present day and historical satellite imagery (Figure 2 versus Figure 3, respectively).

Figure 7. Terrestrial habitat along the Old Corbin Creek and floodplain.

2.1.2 Fish and Wildlife

2.1.2.1 Anadromous Fishes

The Alaska Department of Fish and Game (ADFG) identifies anadromous waters within the Robe Lake watershed within its Anadromous Waters Catalogue (AWC; Giefer and Graziano, 2022). Tributaries into Robe Lake that were nominated to have salmonid species occurring include Old Corbin Creek, Brownie Creek, Deep Creek, and the Robe River (Figure 8).

Valdez Glacier Stream is not an anadromous stream in the AWC, given that its headwaters begin at the Valdez Glacier. With the diversion of Corbin Creek into Valdez Glacier Stream, Corbin Creek is also not an anadromous bearing stream. However, Old Corbin Creek is catalogued in the AWC, and has multiple anadromous points (Figure 8). The upper most anadromous nominations on Old Corbin Creek are located just below the gravel berm. Therefore, any redirection of flows from Corbin Creek back into Old Corbin Creek would benefit known anadromous fish habitat. Likewise, since Corbin Creek is at present not an anadromous bearing stream, any redirection of flows away from Valdez Glacier Stream would not affect anadromous fishes.

Under the FWOP conditions, the number of rearing and spawning salmon within Robe Lake is expected to decrease due to the decreasing value of habitat caused by the excessive overgrowth of macrophytes. Likewise, low-lying deciduous shrubs occupying the riparian margins along Old Corbin Creek (Figure 7) are anticipated to increase in abundance over time, encroaching on known anadromous fish habitat.

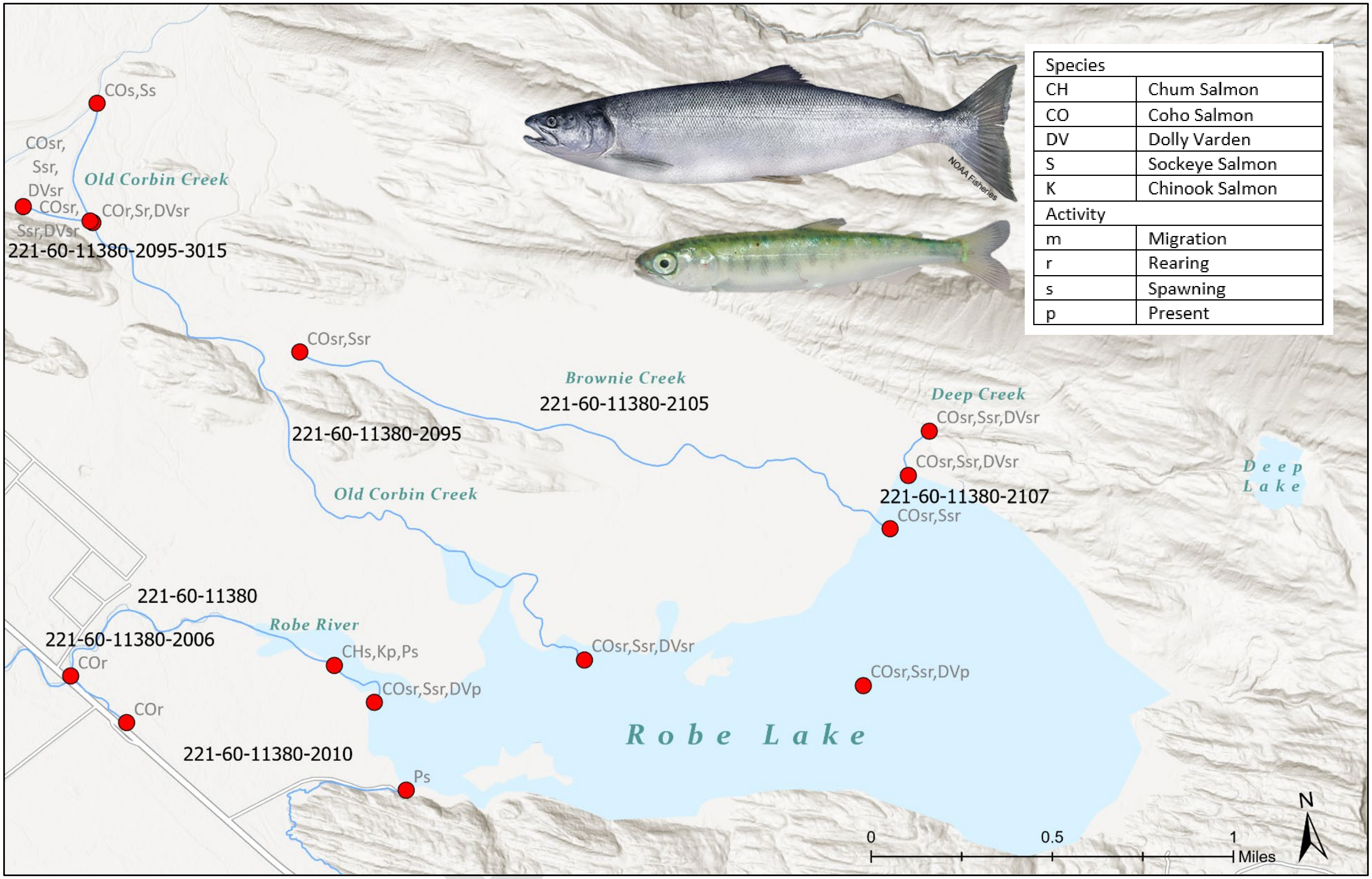


Figure 8. Anadromous waters within the Robe Lake watershed.

Robe Lake is shown with respect to anadromous waters and nominations identified with the ADFG Anadromous Waters Catalogue (AWC). The AWC codes for anadromous streams are shown with respect to the nominations (red points), which are labeled with species present and activity. Photographs of adult and juvenile sockeye salmon obtained from the NOAA species profile and Johnson et al., 2015.

An emerging method that improves detection of many aquatic species is environmental DNA (eDNA), which determines the presence of a species based on the collection, extraction, and amplification of DNA from the environment (Ficetola et al., 2008; Laramie et al., 2015). eDNA can be obtained from various environmental samples and reveals important information about present and past biodiversity within an ecosystem. Sampling of eDNA occurred mid-winter in November and was limited to locations that were assessable with open water (Figure 9). Molecular analysis and the bioinformatics pipeline are described in the Environmental Appendix.

Taxonomic assessment of the freshwater community within Robe Lake and the Robe River using eDNA detected a range of fish species (Table 1). In general, eDNA data detected the presence of three salmonid species at both site 1 and site 2. These salmonid species were coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*Oncorhynchus nerka*), and Dolly Varden (*Salvelinus malma*). Three-spined stickleback (*Gasterosteus aculeatus*) was only detected at site 1. The relatively limited range of fish species detected in eDNA is likely due to the sampling date occurring during winter months. If resampling of these sites had taken place to account for changes in species composition over time, it is anticipated that a greater diversity in species would have been detected.

The presence of some birds and one mammal were also detected in eDNA samples (Table 1). Though the detection of birds and mammals was not the focus or aim of the eDNA analysis, incidental amplification of non-target taxa are inevitable (Ritter et al., 2022). Bird species detected included a diverse range of waterfowl, i.e., mallard (*Anas platyrhynchos*), common goldeneye (*Bucephala clangula*), and white-winged scoter (*Melanitta deglandi*). In addition to waterfowl, American crow (*Corvus brachyrhynchos*) and bald eagle (*Haliaeetus leucocephalus*) were detected at site 1. The only mammal detected was coyote (*Canis latrans*) at site 1. These incidental detections of non-target taxa within eDNA data do provide some insight into the bird and mammal species that may be present within the Robe Lake watershed. However, given the molecular and bioinformatic approaches used, the interpretation of the presence and absence of non-target taxa within eDNA data warrants caution.

Figure 9. Sampling sites for eDNA at Robe Lake.

Sampling occurred on 2 November 2022. Site 1 (pink icon, 1) was located near the culvert on the unnamed tributary flowing into Robe Lake. Site 2 (pink icon, 2) was located directly upstream from the two 12.75 ft. Robe River culverts located under the Richardson Highway.

Table 1. Species detected with eDNA at Robe Lake, Valdez Alaska.

Sequences with low taxonomic resolution were classified to the lowest taxon given percent sequence identity. As a taxonomic assessment, species were sorted by scientific name rather than common name to improve clarity of eDNA results. Original raw sequence data are archived on National Center for Biotechnology Information Sequence Read Archive (NCBI SRA) under BioProject number PRJNA950049. Species illustrations for avian taxa were obtained from individual species profiles on Birds of the World; photographs of fish species were obtained from Johnson et al., 2015.

Species	Scientific Name	SITE 1	SITE 2
Mallard	*Anas platyrhynchos*	.	.
unidentified dabbling duck	*Anas sp.*	.	.
Bufflehead	*Bucephala albeola*		.
Common goldeneye	*Bucephala clangula*	.	.
Coyote	*Canis latrans*	.	
American crow	*Corvus brachyrhynchos*	.	
Tundra swan	*Cygnus columbianus*		.
Three-spined stickleback	*Gasterosteus aculeatus*	.	
Bald eagle	*Haliaeetus leucocephalus*	.	
White-winged scoter	*Melanitta deglandi*	.	.
Common merganser	*Mergus merganser*	.	
Coho salmon	*Oncorhynchus kisutch*	.	.
Sockeye salmon	*Oncorhynchus nerka*	.	.
Dolly Varden	*Salvelinus malma*	.	.





2.1.2.2 Resident and Migratory Avian Species

The area around Valdez supports both resident and migratory avian species. Robe Lake provides important breeding and nesting habitat for migratory waterfowl and shorebirds. Various species of waterfowl, especially dabbling and diving ducks, are present within the Robe Lake area during the summer months. Except for the state-managed game bird species, all native birds in Alaska, including active nests, eggs, and nestlings, are protected under the Federal Migratory Bird Treaty Act (MBTA). Migratory birds are expected to be present within the project area, however the effect of this project on these species is expected to be minimal.

The Bald and Golden Eagle Protection Act (BGEPA) prohibits takings such as killing eagles or destroying nests, as well as regulates human activity or construction that may interfere with eagles' normal breeding, feeding, or sheltering habits. Bald eagles (*Haliaeetus leucocephalus*) are often observed around Robe Lake and the greater Valdez area. This species breeds near aquatic ecosystems with forested shorelines. It is an opportunistic forager, scavenging prey items when available, pirating food from other species when it can, and capturing its own prey when needed (Buehler, 2022). Bald eagles may be seen nesting, foraging, or scavenging anywhere along Robe Lake, often congregating around anadromous streams where salmon are spawning. The range for golden eagles (*Aquila chrysaetos*) includes most of Alaska, but the density of breeding territories varies greatly, and are probably highest in the mountainous regions of interior and northern Alaska and lowest in coastal areas (Katzner et al., 2020).

Under FWOP conditions, resident and migratory avian species will continue to use the area surrounding Robe Lake. Therefore, under FWOP conditions there will be no effect on resident and migratory avian species.

2.1.2.3 Terrestrial Mammals

The surrounding wetland habitat of Robe Lake and its tributaries support various species of small terrestrial mammals and semi-aquatic furbearing species, e.g., beaver (*Castor canadensis*). The upper reaches of Brownie Creek that flow near the ridge contain numerous beaver pond complexes, all of which were well populated with adult coho salmon (Inter-Fluve et al., 2021). Likewise, coho salmon were observed to be spawning in the channel and coarse substrates above the most upstream beaver pond (Inter-Fluve et al., 2021). Given these observations by Inter-Fluve et al., 2021, it is presumed that these beaver ponds offer excellent habitat for adult salmon holding, and juvenile salmon rearing.

Under FWOP conditions, small terrestrial and semi-aquatic mammals will continue to occupy Robe Lake and the surrounding areas. Given that the recommended plan aims to meet the project objective to restore the water quality within Robe Lake to a healthy, productive, self-sustaining system with natural flow regime, it is expected that the quality of habitat for semi-aquatic species would improve as a direct effect of implementing the project.

Large terrestrial mammal species found within the Valdez area include mountain goat (*Oreamnos americanus*), moose (*Alces alces*), Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), black bear (*Ursus americanus*), brown bear (*Ursus arctos*), coyote (*Canis latrans*), and wolf (*Canis lupus*).

Under FWOP conditions, terrestrial mammals will continue to occupy habitat within Robe Lake and the surrounding areas. Given that the glacial outwash plain decreases the habitat value for many large terrestrial mammals due to the low overall abundance of resources, the recommended plan is anticipated to have a minimal effect on terrestrial mammals.

2.1.2.4 Threatened and Endangered Species

No Federal or State threatened or endangered species listed under the Endangered Species Act (ESA) are known to occur within the project's footprint, as proposed. The Environmental Appendix details the coordination efforts with the USFWS under the precepts of the Fish and Wildlife Coordination Act (FWCA; PL 85-624).

There is no critical habitat designated for threatened or endangered species listed under the ESA within the project's footprint, as proposed. Avian species that are present within the Robe Lake area that fall under the MBTA and BGEPA are described in Section 2.1.2.2 Resident and Migratory Avian Species. Therefore, under FWOP conditions there will be no effect on Federal or State threatened or endangered species.

2.1.3 Subsistence, Commercial, and Recreational Fishing Use

In Alaska, salmon have long served as an important traditional subsistence resource for indigenous and non-indigenous peoples. Robe Lake provides spawning and rearing habitat for many species of salmon, which has a direct effect on the continuation of traditional subsistence practices.

In Valdez, commercial and recreational salmon fishing most often occurs in the fjord Port Valdez or the greater area within Prince William Sound, a saltwater environment. However, Robe Lake provides critical rearing and spawning habitat for salmon that are ultimately harvested in Port Valdez. Likewise, Robe Lake provides an opportunity for sport fishing in a freshwater environment.

2.2 Physical Environment

2.2.1 Cultural Resources

2.2.1.1 Prehistory

During the Pleistocene, Prince William Sound was engulfed by the Cordilleran Ice sheet until approximately 9,000 before present (BP) (de Laguna, 1956; Yarborough and Yarborough, 1998). As the ice sheet receded, people began to migrate into the area; the oldest cultural materials in this area date to around 4,400 BP (Yarborough and Yarborough, 1998; Steffian et al., 2016). Archaeological research by de Laguna (1956) in 1930 and 1933 at the Palugvik archaeological site and by Yarborough and

Yarborough (1998) at the Uqciuvit archaeological site in 1988 have been key in reconstructing the cultural chronology of the area, which is broken up into four phases (Table 2). Additional ethnographic research by de Laguna (1956) has also served to help reconstruct regional information.

Table 2. Cultural chronology for Prince William Sound.

Cultural Phase	Chronology	Primary Artifact Types	Subsistence Strategy
Uqciuvit	4400 – 3300 BP	ground slate tools, chipped stone tools, red ochre	marine mammal hunting, shellfish collection
Neoglacial Interval	3200 – 2500 BP	[glacial advance]	[glacial advance]
Palugvik	2500 – 850 BP	ground slate tools, osseous tools, awls, needles, labrets, harpoons	marine mammal hunting, land mammal hunting
Chugach	850 – 150 BP	fire cracked rock, ground slate tools, quartz gravers, copper bipoints, labrets, shell beads	fishing, marine mammal hunting, land mammal hunting

Yarborough and Yarborough 1998; Steffian et al., 2016

2.2.1.2 Recent History

At the time of Euroamerican contact in the late 1770s, there were thought to be eight politically distinct Tribal Nations in Prince William Sound, related by a common language (de Laguna, 1956). Inter- and intra-tribal warfare was not uncommon, as demonstrated by the defensive aspects of archaeological site selection such as the use of small islands with steep bluffs for settlements or having difficult shorelines for landing watercraft (Steffian et al., 2016).

The first recorded Euroamerican contact made with the Chugach Sugpiaq was by Captain James Cook and his crew aboard the ships *Resolution* and *Discovery* in 1778. In 1783, Potap Zaikof's expedition sailed into the vicinity of Kayak Island near the southern entrance of Prince William Sound (Bancroft, 1959). Due to the atrocities committed during Zaikof's expedition, the Chugach retaliated by attacking a shore party and later a Russian camp. English, Russian, and Spanish fur traders sent expeditions into Prince William Sound between 1788 and 1799. Unlike the English and Spanish, the Russian fur traders established settlements in Prince William Sound (Lethcoe and Lethcoe, 2001). In 1799, the Russian Emperor granted monopoly of the fur trade in Prince William Sound to the Russian American Company (Bancroft, 1959).

The sale of Alaska by Russia to the United States in 1867 via the Treaty of Cession increased the influx of settlers into Prince William Sound. By late the 1800s, commercial fishing and mining had become the main economic interest of Euromericans in the region. In 1889, commercial salmon canning began in eastern Prince William Sound, replacing what was left of the sea otter pelt trade with canning operations (Yarborough, 2000).

The first recorded permanent settlement in the Valdez area is associated with the Klondike and Copper River Gold Rush, which began in 1898 (LaChance, 1995). The historical trail was on the western side of the Valdez Glacier Stream and crossed to the eastern side of the stream just below Valdez Glacier Lake (Lethcoe and Lethcoe, 1996).

2.2.1.3 Known Cultural Resources

There are four known cultural resource sites within the project's Area of Potential Effect (APE) (Table 3). The Richardson Highway Segment A Milepost 0–116 (VAL-00533) is a historical roadway that connects Valdez to Fairbanks, Alaska. VAL-00533 was determined to be not eligible for inclusion in the National Register of Historic Places (NRHP) on 25 February 2019. Three additional cultural resources, the Abandoned Low Water Bridge (VAL-00660), Corbin Creek Gravel Berm (VAL-00661), and Old Corbin Creek Culverts (VAL-00662), were identified during an USACE archaeological survey (USACE 2023); determinations of their eligibility for listing in the NRHP have been submitted to the Alaska State Historic Preservation Officer (SHPO).

Table 3. List of known AHRS sites in general project vicinity.

AHRS #	Site Name	NRHP Status	In APE
VAL-00202	Valdez Glacier Trail	Unevaluated	No
VAL-00533	Richardson Highway Segment A	Not Eligible	Yes
VAL-00660	Abandoned Low Water Bridge	Pending	Yes
VAL-00661	Corbin Creek Gravel Berm	Pending	Yes
VAL-00662	Old Corbin Creek Culverts	Pending	Yes

2.2.2 Climate

Robe Lake is located in the coastal maritime climatic zone of Prince William Sound, characterized by high precipitation and mild temperatures. Summers typically are cool and winter temperatures usually are relatively mild in Valdez. The mean annual temperature is 33.8 degrees Fahrenheit (°F); the average summer temperature is 50.5°F, while winter mean temperature is 24.4°F. Cold polar air masses often meet warm, moist maritime air masses in this region. These combine to produce average annual precipitation of more than 5.2 feet annually. Winds are generally from the north-northwest between October and March and from the southwest between May and August.

2.2.3 Noise

Wind, rain, and stream flows are the most prominent sounds of ambient noise at Robe Lake. The Valdez State Airport is located approximately two miles northwest of Robe Lake. Small engine aircraft are the primary aircraft using the Valdez State Airport. The airport's use is sporadic and thus ambient sound emanating from the airport is inconsistent. The Richardson Highway runs adjacent to Robe Lake, but ambient traffic noise is minimal. During weed harvesting operations, which occur throughout the summer months, ambient noise levels are higher.

2.2.4 Air Quality

Air quality in Valdez is strongly influenced by sources of contaminants and the topographic and meteorological characteristics that affect air movement and the dispersion of pollutants. Air quality around Valdez is generally considered good despite the presence of a large crude oil storage facility at the Alyeska Terminal complex, and tanker traffic that transports crude oil for distribution. Other potential sources of air pollution in the Valdez area include the fleet of diesel-powered vessels that occupy the Port of Valdez; fumes and exhaust from combustible engines (i.e., generators, automobiles, aircraft, the weed harvester); and woodsmoke from wood burning stoves during winter the winter months.

If the concentration of one or more criteria pollutants in a geographic area is found to exceed the regulated or 'threshold' level for one or more of the Clean Air Act (CAA) National Ambient Air Quality Standards (NAAQS), the area may be classified as a nonattainment area. Areas with concentrations of criteria pollutants that are below the levels established by the NAAQS are considered either attainment or unclassifiable areas. Valdez is in an unclassified area, and overall air quality is good.

2.2.5 Hydraulics and Hydrology

2.2.5.1 Lake Bathymetry

Koenings et al., 1987 provides a summary of the morphologic and hydrologic characteristics of Robe Lake (Figure 10). In summary, the bathymetry of Robe Lake is relatively shallow, with a mean depth of 10 feet, and maximum depth of 16 feet. The maximum depth of the basin is located in the southeast corner of the lake, which becomes shallow moving west towards the outflow of the Robe River. The lake has a surface area of 682 acres and a volume of 6,890 acre-feet. The annual discharge from the catchment area surrounding Robe Lake was estimated to be 20,511 acre-feet, resulting in a theoretical residence time of about 4 months.

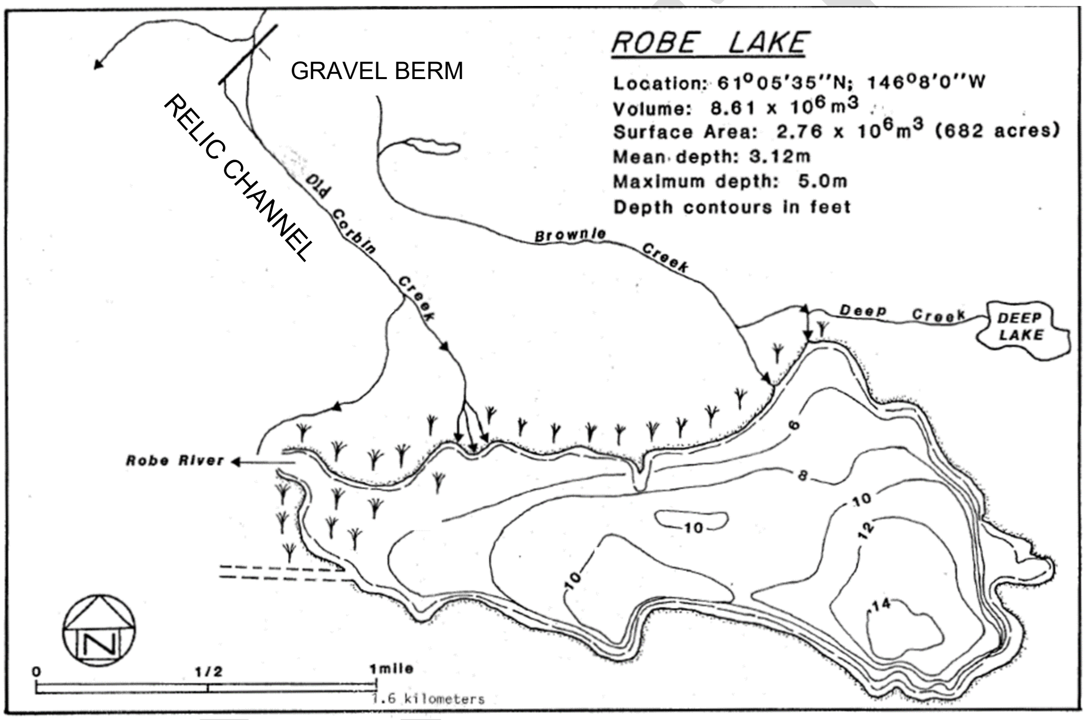


Figure 10. Morphometric map of Robe Lake relative to the surrounding tributaries.

Illustration of Robe Lake was obtained from Koenings et al., 1987.

2.2.5.2 Stream Flow

Three tributary streams flow into Robe Lake: Brownie Creek, Deep Creek, and Old Corbin Creek. Corbin Creek, and subsequent flows from Valdez Glacier Stream, used to flow through Old Corbin Creek and into Robe Lake. In 1956, a gravel berm (Figure 11) was constructed to divert any flows from Valdez Glacier Stream and Corbin Creek from Robe Lake due to concern with washing out the Richardson Highway.

At present, the gravel berm was observed to be overgrown with shrubs and understory vegetation, namely willow (*Salix* spp.), alder (*Alnus* spp.), and devil's club (*Oplopanax horridus*). Areas of the berm with well-drained soils supported stands of cottonwood (*Populus* spp.) and spruce (*Picea* spp.), a typical habitat observed on alluvial floodplains within the boreal forest. Sections of the berm were observed to be eroded away, as was evident by the Light Detection and Ranging (LiDAR) imagery (Figure 11).

There are no gages on any of the creeks within the Robe Lake watershed, so U.S. Geological Survey (USGS) regression equations were used to come up with the peak flow rates for each of the eight annual exceedance probabilities (AEP) (50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2%) or the 2, 5, 10, 25, 50, 100, 200, and 500 year average return periods, respectively. AEP is the chance that an event can be exceeded in any given year, and average return period intervals do not constitute a non-occurrence period between extreme events. The regression equations are based on the average annual precipitation and the drainage area of the watershed. A nearby gage (Solomon Gulch Bypass) within the area of Valdez of similar size and slope to Corbin Creek that contained 30-minute instantaneous flow measurements was used to obtain a hydrograph for input into the Hydrologic Engineering Center's River Analysis System (HEC-RAS) unsteady flow module. The hydrograph was scaled to meet the peak flow for each AEP that was determined from the USGS regression equations for the Robe Lake watershed. See the Hydrology and Hydraulics Appendix for further details.

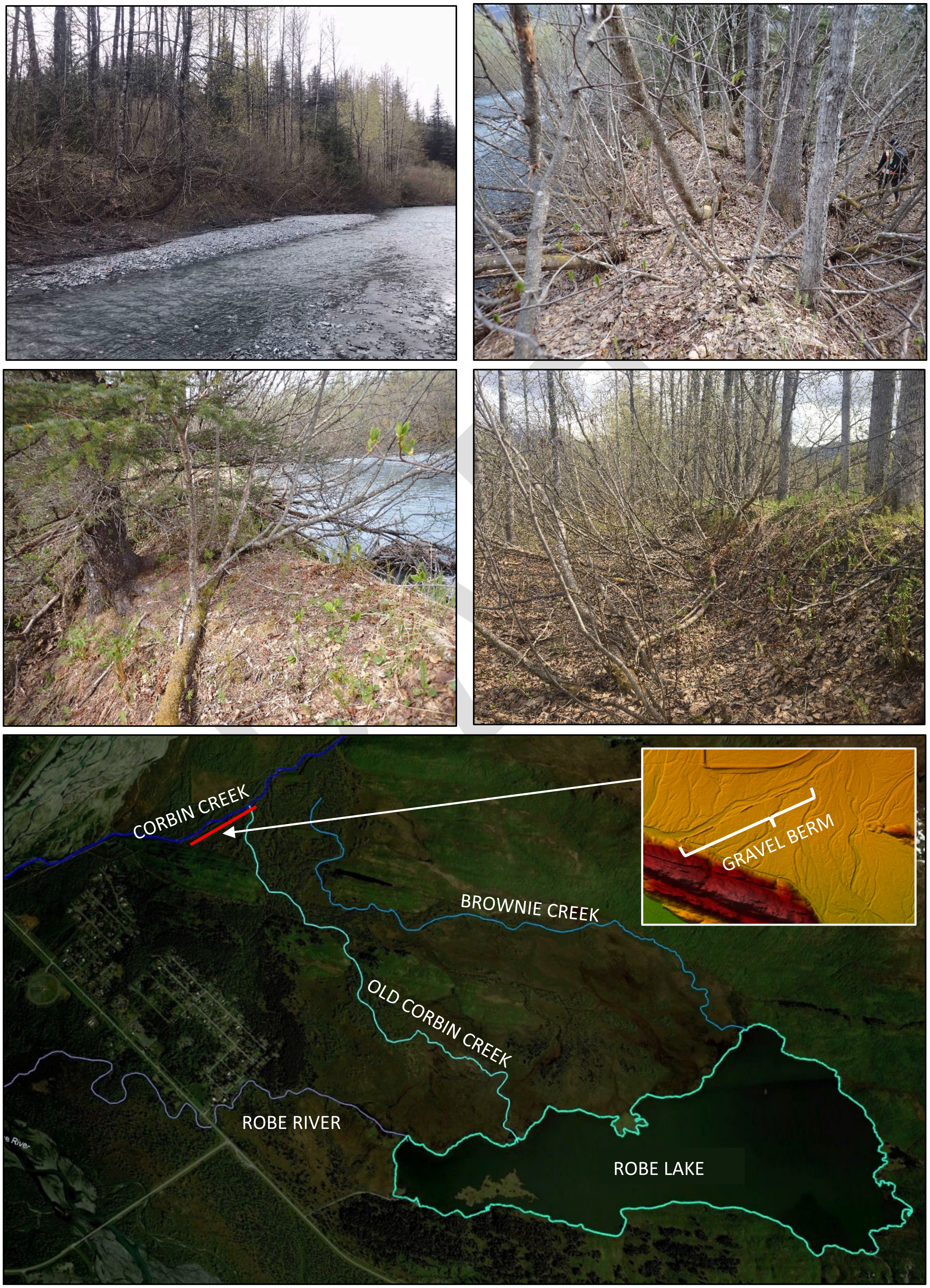
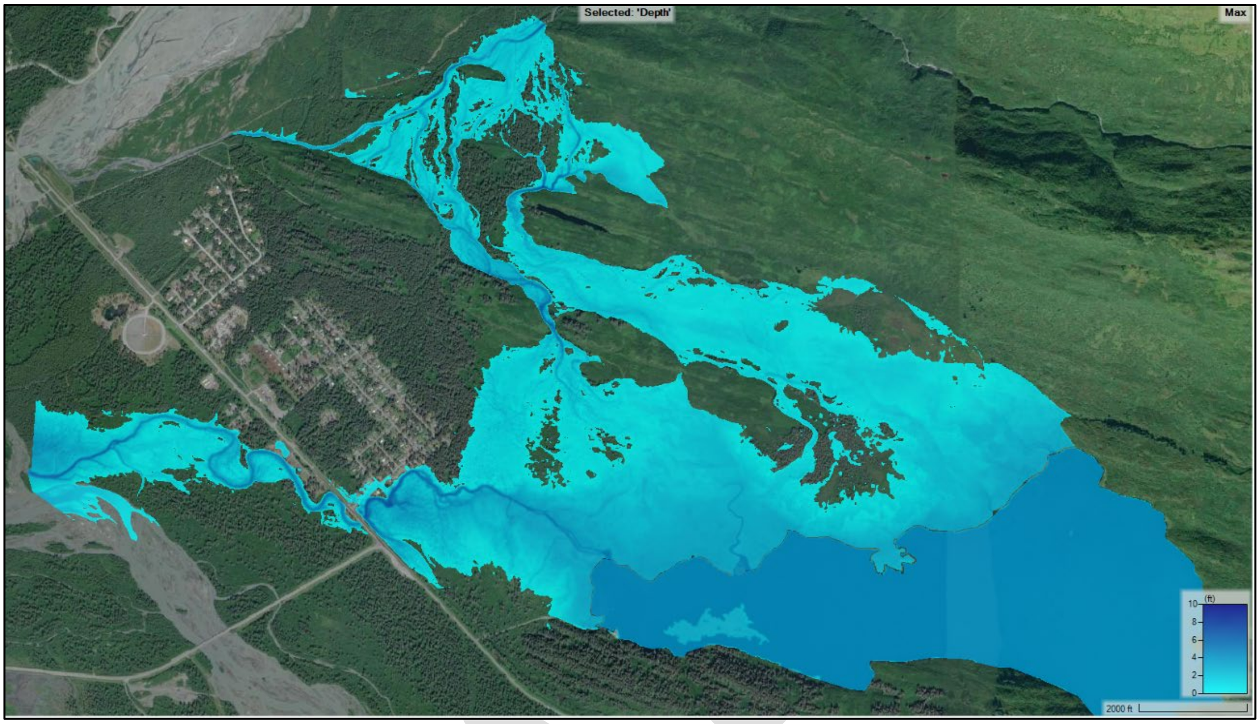


Figure 11. Photographs and LiDAR imagery of gravel berm along Corbin Creek.

2.2.5.3 Hydraulic Modeling

The HEC-RAS software (version 6.3.1) was used to model the Robe Lake system. An unsteady, two dimensional (2D) model was created to model the effectiveness of alternatives for Robe Lake and determine flood extents associated with each flood event. The Robe River subdivision is present along the Robe River, so any alternative that is selected cannot induce flood damages to this area above the baseline condition. Outputs from the HEC-RAS model (hierarchical data format grids) were used in the Hydrologic Engineering Center's Flood Damage Reduction Analysis (HEC-FDA) to compare the baseline conditions to the proposed alternatives.

Under FWOP conditions, flooding is observed within the Robe River subdivision along the Robe River (Figure 12). At present, the gravel berm is permeable during high water events, and there are low points in the berm from wear and tear over the project's life. The continued growth of understory vegetation and shrubs on the gravel berm will continue to erode the structure, making more low points, and leading to overland flooding to occur during high water events (Figure 11; Figure 12). See the Hydrology and Hydraulics Appendix for further details on the HEC-RAS hydraulic model.



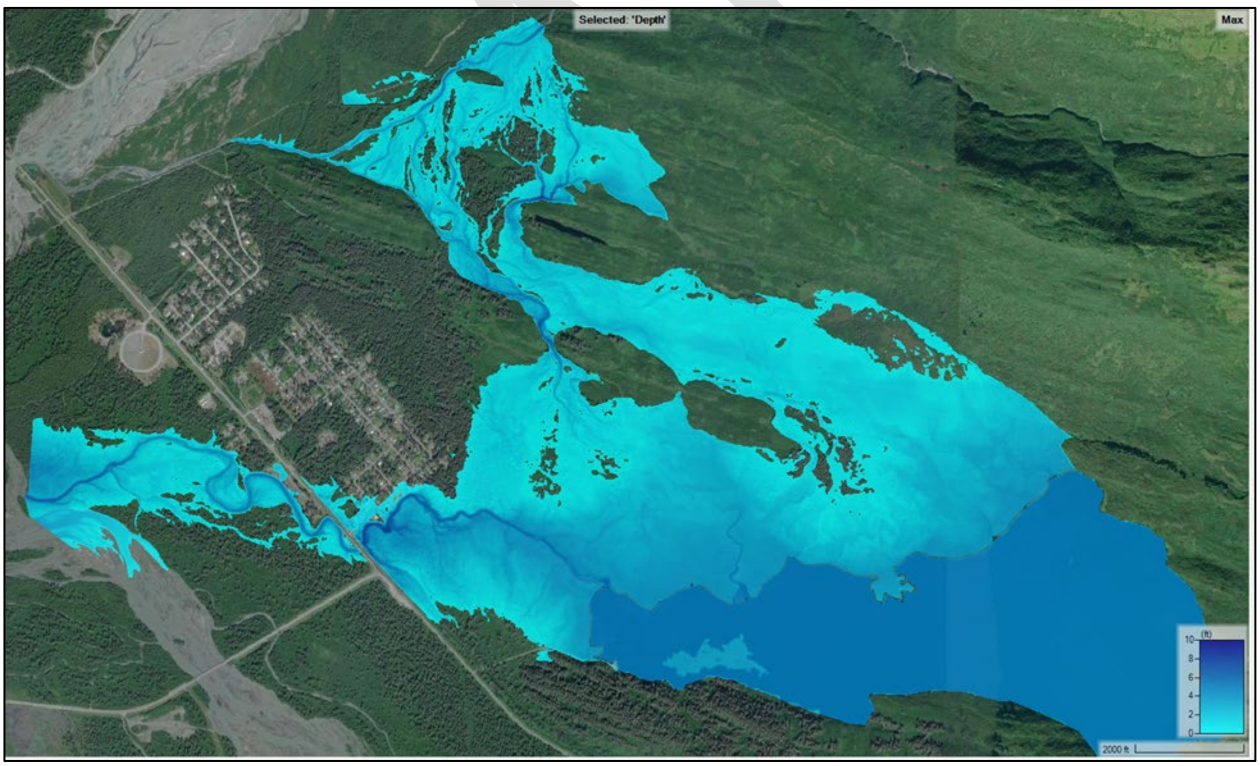


Figure 12. FWOP conditions; 100-year flood (top) and 500-year flood (bottom).

The terminology of 100-year flood event is equivalent to the "*1% Percent Annual Exceedance Probability*". The terminology for the 500-year flood event is equivalent to the "*0.2% Percent Annual Exceedance Probability*".

2.2.5.4 Water Quality

Presently, the direct and indirect effects of the extensive macrophyte overgrowth permeates every aspect of the assessment of the Robe Lake water quality (Koenings et al., 1987). In summary from the 1987 study, during mid-July, the macrophytes begin to grow out of partially decayed old-growth vegetation stands from prior years. Because of extended daylight hours during the summer months, the lake quickly warms – stimulating explosive new growth from these stands. Likewise, the warming lake temperatures increases the rate of decay of the prior-year vegetation stands; resulting in increased ammonium levels. The release of ammonium during decay is accompanied by a greater rate of nitrogen uptake to satisfy the metabolic depends on the growing macrophytes. The uptake of nitrogen is so extensive, that inorganic nitrogen disappears from the water column during the fall months.

During the onset of freeze-up, the decay process of current-year macrophytes begins to deplete dissolved oxygen within Robe Lake. Koenings et al., 1987 hypothesized that if temperatures under the ice warm above a 40°F threshold, that the entire supply of dissolved oxygen would be depleted, and consequently, rearing salmonids would suffocate. This process already takes place on a small-scale during April and May under the ice.

Under FWOP conditions, it is anticipated that the concentration of dissolved oxygen will continue to decrease during the winter months. The cumulation of multiple environmental factors, especially the increased growth in macrophytes and subsequent decay, are anticipated to continue to degrade the water quality of Robe Lake over time.

2.2.5.5 Sea Level Change

USACE requires that planning studies and engineering designs consider alternatives that are formulated and evaluated for future rates of relative sea level change. All USACE sea level change projections for Valdez show a downward trend except for the high sea level change (SLC) prediction. The high SLC prediction shows a slight increase, with a maximum change of -0.3 feet to the mean sea level (see the Hydraulics and Hydrology Appendix for details).

Therefore, under FWOP conditions a decrease in sea level over time is anticipated to not impact Robe Lake, since the Robe Lake is not located along the coast and is located inland at approximately 12.5 ft. above sea level.

2.2.5.6 Storm Surge

Valdez is located near the head of Port Valdez, a deep fjord, that does not experience significant storm surges due to wind stresses. Storm surge can be shown to be inversely dependent on water depth. That is, for a given wind speed, storm surge is less in deep water than in shallow water. There may be a surge elevation between +2.1 feet and -1.2 feet on occasion due to atmospheric pressure differentials. However, there is also a 12.5-foot difference in elevation between the inlet and the outlet of the Robe River, with the inlet also being almost 8 feet above the highest observed water level. Therefore, storm surge and coastal water levels were determined to not have an impact on the water surface elevation in the Robe River, where induced flooding to nearby residential areas is of concern.

2.2.6 Geology and Topography

2.2.6.1 Geology

Bedrock in the area consists of thickly inter-bedded slate and greywacke of the late-Cretaceous Valdez Group. The areal topography indicates the area has been glaciated. The subsurface conditions of the area surrounding Robe Lake and vicinity have been geologically influenced by the Valdez Glacier Stream and the Lowe River creating an outwash delta. Drilling performed in 1979 at a site approximately 2.5 miles northwest of the project area encountered bedrock at depths between 60 feet and 327 feet below ground surface. A series of resistant bedrock ridges remain in the general area of Valdez. The bedrock encountered in 1979 at differing depths could be further evidence of these ridges.

Under FWOP conditions, it is not anticipated that the geology of the area surrounding Robe Lake will change.

2.2.6.2 Soils and Sedimentation

Soil-forming processes have not progressed much in the Valdez area. The dominance of mechanical weathering and the steepness of the slopes have allowed formation of only a thin mantle of soil. Below about 2000 feet NAVD88, vegetation dominated by alder shrub binds the soils. Above this elevation, soil is removed rapidly by landslides and soil creep, thus retarding, or preventing the development of soil-holding vegetation. Without benefit of supporting vegetation, the accumulated debris is drawn down by gravity and precipitation, causing active mass wasting. Robe Lake is situated on the glacial outwash plain of Valdez Glacier. The alluvial fan is prone to aggradation from periods of high flow and flooding events. Tributaries within the Robe Lake watershed are glacially sourced with a mixed sediment load, and historical imagery identifies several historical flow paths, including Old Corbin Creek.

The subsurface soils (as inferred from historic geotechnical investigations) of the outwash plain generally consist of a thick section of medium dense to dense, well to poorly graded gravel and silty gravel with cobbles with layers of silt and sand that extends down to bedrock.

Under FWOP conditions, soils and sedimentation rates are not anticipated to change given that soil-forming processes have not progressed much in the area. Likewise, Robe Lake is situated on an alluvial fan, and as a result the path of its tributaries naturally meandered as Valdez Glacier receded (Figure 3).

2.2.6.3 Topography

Robe Lake lies within a glacial outwash plane which is responsible for the topography in the area. The glacial outwash plane is generally flat with braided streams throughout. These braided streams regularly change paths to create new channels and leave behind relic channels in the landscape. The glacial outwash plane is bounded to the north, west, and east by the Chugach Mountains, and drains south into Port Valdez.

Under FWOP conditions, topography of the landscape surrounding Robe Lake is not anticipated to change or alter.

2.2.6.4 Seismicity

Robe Lake is located in an area of high seismicity. The area regularly experiences earthquakes that originate from several faults in the area including the Alaska-Aleutian Megathrust and the Denali Fault. Faults in the surrounding area are active and are capable of generating significant earthquakes. This activity is evidenced by the 1964 Great Alaska Earthquake which forced the residents of Valdez to rebuild the town in a completely new location.

Though seismicity heavily impacted the coastline during the 1964 Great Alaska Earthquake; under FWOP conditions seismicity is not anticipated to alter the inland landscape surrounding Robe Lake. Seismicity may impact the proposed project if a seismic induced tsunami were to occur, however the proposed project itself will not impact seismicity within the area.

2.3 Built Environment

Existing infrastructure within the vicinity of the Robe Lake watershed include the Robe River subdivision, a cemetery, and other infrastructure along the Richardson Highway (Figure 13). At the Robe River crossing on the Richardson Highway, there are two culverts with a diameter of approximately 12.75-foot (Figure 14). Along the ALPETCO trail system at the Old Corbin Creek crossing there are two culverts with a diameter of approximately 24-inches (Figure 15).

Under FWOP conditions, based on hydrological modeling conducted by USACE, there is a risk that the Robe River will flood housing and adjacent infrastructure within the Robe River subdivision. USACE policy requires that acceptable recommended plans not induce flooding.

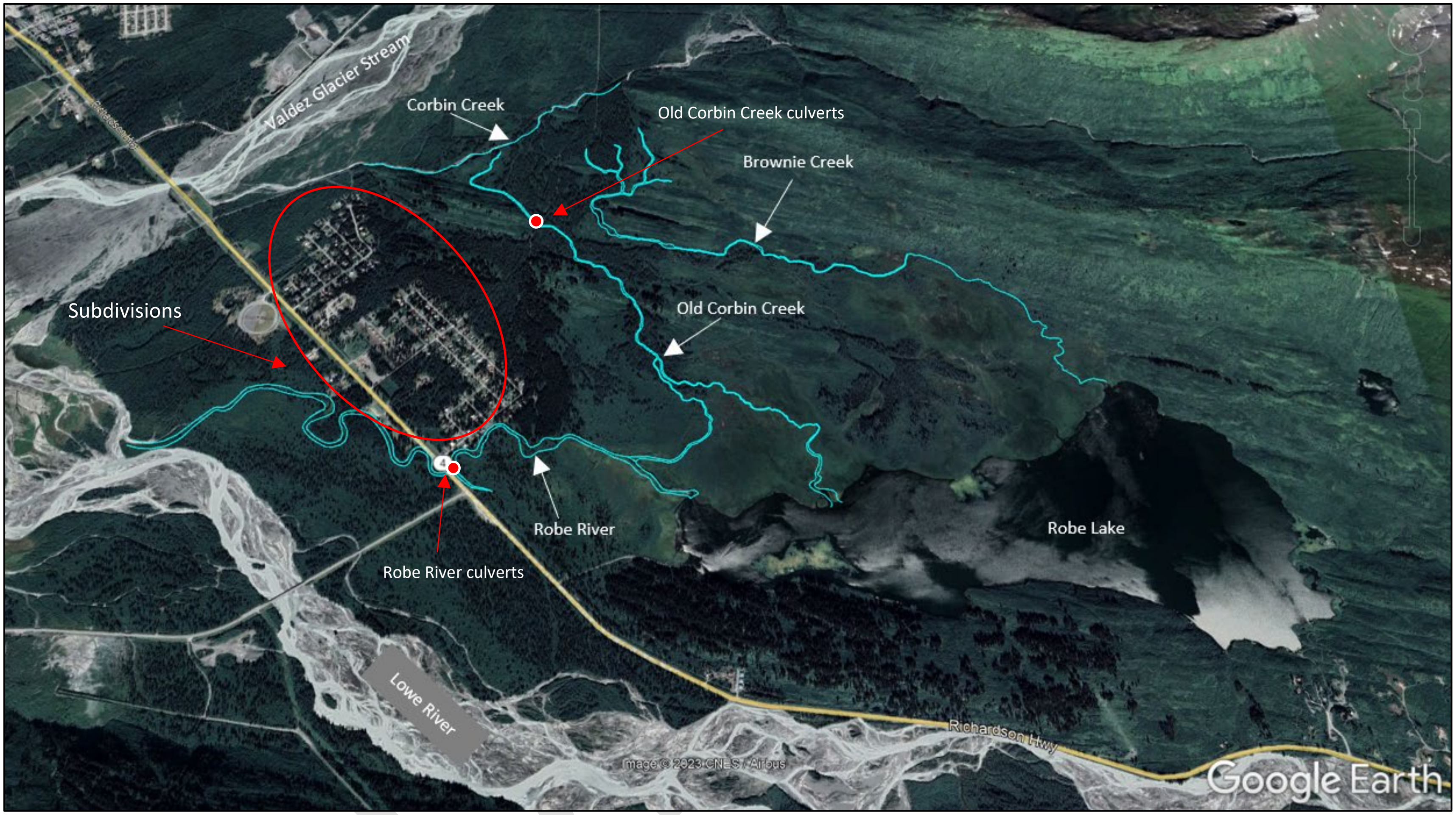


Figure 13. Built environment and existing infrastructure near Robe Lake.

Figure 14. 12.75 ft. diameter culverts on Robe River under the Richardson Highway.

Photographs of the two 12.75 ft. diameter culverts are shown during the summer months (left) versus the winter months (right).

Figure 15. 24-inch diameter culverts on Old Corbin Creek under the ALPETCO trails.

Photographs of the two 24-inch diameter culverts are shown during the summer months (left) versus the winter months (right).

2.4 Economic Environment

2.4.1 Population & Economy

Robe Lake is within the city limits of Valdez and the Chugach Census Area. Table 4, Table 5, and Table 6 represent the existing and trending population and demographics for the Chugach Census Area, for which the Valdez area makes up roughly 50% of the population. The population, as projected by the American Community Survey (ACS), is estimated to hold relatively steady for the next twenty-five years. Most of the population identifies as white (~76%), with the next highest ethnicity identifying as two or more races (~10%).

Table 4. Current and projected population of Valdez, Alaska.

Year	Current or Projected Population	Average Annual Growth Rate
2023	7,102	-
2025	7,001	0.0%
2030	6,946	-0.2%
2035	6,855	-0.3%
2040	6,758	-0.3%
2045	6,652	-0.3%
2050	6,547	-0.3%

Table 5. Age and gender profile for Valdez and Alaska, 2020.

Area	Population	Male	Female	Under 5 years old	Under 20 years old	Over 65 years old
Alaska	736,990	384,653	352,337	52,302	200,779	87,629
Valdez City	3,985	2021	1791	266	868	507

2020 ACS 5-year estimate subject tables.

Table 6. Ethnic profile for Valdez and Alaska, 2020.

	Alaska	Valdez	Percentage of Valdez Population
TOTAL	733,391	3,985	-
White	435,392	3,015	75.66
Alaska Native/Native American	111,575	309	7.75
African American	21,898	33	0.83
Asian	44,032	103	2.58
Other	30,970	113	2.84
More than one race	89,524	412	10.34

US Census Bureau, Decennial Census 2020, and American Community Survey Estimates.

Valdez's economy is based on oil, tourism, commercial fishing, shipping/transportation, and city and state government.

The unemployment rate for Valdez is roughly 4.3%,roughly the same as that for Alaska. The per capita income in Valdez is $44,859, which is higher than Alaska's $39,509 as of 2021. The city's median household income is also higher than the State's, at $99,151 versus $80,287 for Alaska (U.S. Census Bureau, 2022). It is important to note that Alaska's high cost of living is a factor in how these should be interpreted.

2.4.2 Environmental Justice & Protection of Children

Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations, was issued in 1994. The purpose of this EO is to avoid disproportionate adverse environmental, economic, social, or health effects from federal activities on minority and low-income populations. EO 13045, Protection of Children from Environmental Health and Safety Risks, was issued in 1997 to identify and assess environmental health and safety risks that may disproportionately affect children.

In accordance with the Assistant Secretary of the Army for Civil Works Memorandum on Implementation of Environmental Justice and the Justice 40 Initiative, March 15, 2022, USACE employs the Council on Environmental Quality’s Climate and Economic Justice Screening Tool (CEJST) and the Environmental Protection Agency’s Environmental Justice Screening and Mapping Tool (EJScreen) to provide a consistent government-side identification of communities with environmental justice concerns.

Both EJScreen and CEJST use the Chugach Census Area as their unit of analysis, and Valdez falls within the block group 02261000300. Both screening tools use percentiles to indicate how local residents compare to everyone else in the nation or state. EJScreen population and demographic data for block group 02261000300 was collected in 2021 (EJScreen, 2023a). CEJST population and demographic data for block group 02261000300 was collected in the year 2010 (CEJST, 2023), which is not as contemporary as data collected during the 2020 U.S. Census which is reported in 2.4.1 Population & Economy.

Valdez, which falls within block group 02261000300, is not categorized as a disadvantaged community according to EJScreen or CEJST. Socioeconomic indicators on EJScreen indicate a smaller percentage of the population with residents that experience low income, unemployment, and low life expectancy when compared to the State of Alaska or the United States (Table 7). Likewise, EJScreen indicates that there are no communities within the selected location, that are a “Justice40 (CEJST)” disadvantaged community (Table 7). A limitation of EJScreen is that it relies on demographic and environmental estimates that involve substantial uncertainty. This is especially true when looking at a small geographic area, such as a single Census block group (i.e., block group 02261000300). Valdez is not highlighted as a disadvantaged community on the CEJST map. CEJST categorizes communities as disadvantaged if it is in a census tract that is at or above the threshold for one or more environmental, climate, or other burdens; and is at or above the threshold for an associated socioeconomic burden (CEJST, 2023). The determination by CEJST is also reflected in the EJScreen data listed in Table 7, where no communities within the selected location are listed as a “Justice40 (CEJST)” disadvantaged community.

Relevant to this discussion is the fact that Valdez does meet the economically disadvantaged community definition per the Secretary of the Army (Implementation Guidance for Section 160 of the Water Resources Development Act of 2020, Definition of Economically Disadvantaged Community). A community can qualify as economically disadvantaged if the community is within the proximity of an Alaska Native Village. Per this definition Valdez is within the proximity of the Native Village of Tatitlek, which is located approximately 20 miles away by air. The Native Village of Tatitlek is one of the non-Federal sponsors on this study.

Under FWOP conditions, USACE anticipates no disproportionate adverse effects on minority or low-income populations, or children. The ratio of minority residents in Valdez is not meaningfully greater than the surrounding area. The number of individuals and families living below the weighted average poverty level in Valdez also is not meaningfully greater than the other communities in the Chugach Census Area. There are children in the project area; however, USACE anticipates no disproportionate health or safety risks to children as a result of the preferred alternative. Rather, the project should create a safer environment for children by removing potential flood risks. It is anticipated that FWOP conditions may have an effect on these populations if a 100-year or 500-year flood event was to occur given FWOP hydrologic conditions.

Table 7. EJScreen results for block group 02261000300.

Valdez falls within the boundary of block group 02261000300. See the following section for discussion on the limitations and caveats of environmental justice screening tools, such as EJScreen and CEJST.

SELECTED VARIABLES	VALUE	STATE AVERAGE	PERCENTILE IN STATE	USA AVERAGE	PERCENTILE IN USA
POLLUTION AND SOURCES					
Particulate Matter ($\mu g/m^3$)	N/A	N/A	N/A	8.08	N/A
Ozone (ppb)	N/A	N/A	N/A	61.6	N/A
Diesel Particulate Matter ($\mu g/m^3$)	0.000468	0.22	7	0.261	0
Air Toxics Cancer Risk* (lifetime risk per million)	7	25	6	25	0
Air Toxics Respiratory HI*	0.07	0.33	5	0.31	0
Toxic Releases to Air	0.12	76	18	4,600	3
Traffic Proximity (daily traffic count/distance to road)	NaN	100	NaN	210	NaN
Lead Paint (% Pre-1960 Housing)	0.15	0.087	81	0.3	42
Superfund Proximity (site count/km distance)	0.0043	0.075	20	0.13	0
RMP Facility Proximity (facility count/km distance)	1.8	0.36	96	0.43	95
Hazardous Waste Proximity (facility count/km distance)	0.014	0.18	20	1.9	1
Underground Storage Tanks (count/km^2)	0.034	3	34	3.9	24
Wastewater Discharge (toxicity-weighted concentration/m distance)	N/A	N/A	N/A	22	N/A
SOCIOECONOMIC INDICATORS					
Demographic Index	23%	33%	30	35%	37
Supplemental Demographic Index	7%	12%	19	14%	18
People of Color	36%	42%	48	39%	55
Low Income	9%	25%	15	31%	16
Unemployment Rate	1%	7%	16	6%	24
Limited English Speaking Households	3%	2%	79	5%	69
Less Than High School Education	7%	7%	63	12%	46
Under Age 5	5%	6%	45	6%	54
Over Age 64	14%	14%	58	17%	42
Low Life Expectancy	17%	19%	24	20%	26

*Diesel particulate matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

Sites reporting to EPA within defined area:

Superfund 0
Hazardous Waste, Treatment, Storage, and Disposal Facilities 0
Water Dischargers 37
Air Pollution 2
Brownfields 2
Toxic Release Inventory 1

Other community features within defined area:

Schools 3
Hospitals 1
Places of Worship 0

Other environmental data:

Air Non-attainment .... No
Impaired Waters .... No

Selected location contains American Indian Reservation Lands* .... Yes
Selected location contains a "Justice40 (CEJST)" disadvantaged community .... No
Selected location contains an EPA IRA disadvantaged community .... Yes

Report for Tract: 02063000300

2.4.2.1 Limitations and Caveats of EJScreen and CEJST

For the City of Valdez, EJScreen and CEJST do not provide information and data at a level useful for an environmental justice analysis exclusively using these tools. EJScreen and CEJST are only screening tools that examine some of the relevant issues related to environmental justice, and it is important to understand that there is uncertainty in the data included. These screening tools may offer some preliminary insight into environmental justice concerns, but they cannot provide data on every environmental impact and demographic factor that may be important to any location. Therefore, initial results should be supplemented with additional information and local knowledge whenever appropriate, for a more complete picture of a location (EJScreen, 2023b). In order provide a more thorough socioeconomic analysis, additional population and demographic data was collected for Valdez from other Federal sources (ACS, 2020; U.S. Census Bureau, 2022), which is reported in 2.4.1 Population & Economy.

3.0 PLAN FORMULATION AND EVALUATION

3.1 Planning Framework

Alternative plans are formulated to meet four study criteria: completeness, effectiveness, efficiency, and acceptability (defined in Section 3.4.3). Mitigation of adverse effects is an integral component of each alternative plan. During the planning process, a range of alternative measures were identified and screened. Alternatives were then compared using the four evaluation criteria: completeness, effectiveness, efficiency, and acceptability. This process was conducted following the iterative six-step planning process (Figure 16). Problems, opportunities, objectives, and constraints were inventoried and forecasted. Measures to achieve the planning objectives were identified; then compared, evaluated, and screened. Alternative plans were then developed off of these measures and compared.

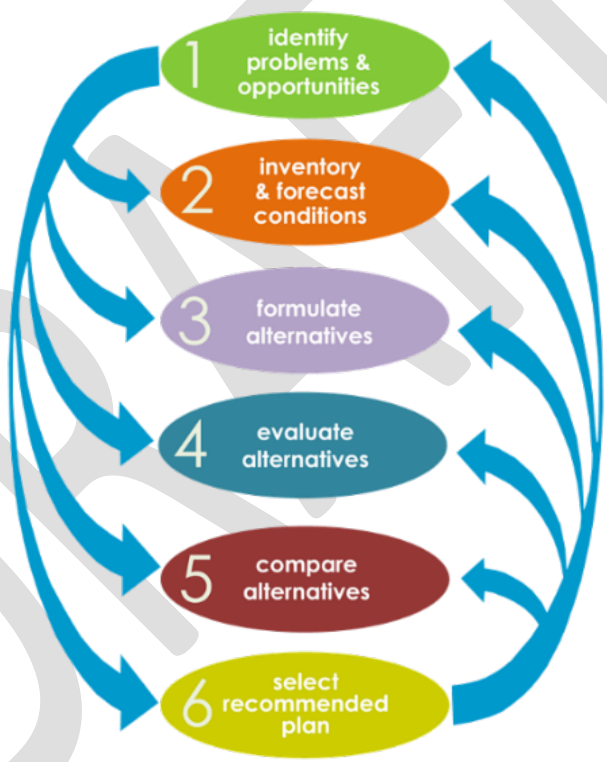


Figure 16. Iterative six-step planning process.

3.2 Management Measures

Plan formulation is the process of building alternative plans that meet planning objectives and avoid planning constraints. Alternatives are a set of one or more management measures functioning together to address the study objectives. A management measure is a feature or activity that can be implemented at a specific location to address one or more of the objectives. A feature is a "structural" element that requires construction or on-site assembly. An activity is defined as a “non-structural” action.

Incorporation of natural and nature-based features into a Section 206 ecosystem restoration project must be considered under the Implementation Guidance for Section 1184 of WRDA 2016 and Section 1149 of WRDA 2018. Natural features are those created through natural processes (i.e., physical, biological, geological, and chemical), while nature-based features are constructed elements that work in concert with natural processes or to mimic conditions which would occur in the area absent of human activities. Nature-based features are to be included in Section 206 projects, with the consent of the Sponsor, if they are cost effective features that will improve the quality of the environment and are in the public interest or they will improve the features of an estuary.

During the public charrette held on the 19 August 2022, several measures were identified (Table 8). Following the charrette, USACE evaluated structural and non-structural measures using the established criteria set by the National Evaluation Criteria (NEC). These criteria include acceptability, completeness, effectiveness, and efficiency. In addition, the project delivery team used specific screening criteria to evaluate each measure’s impacts with respect to salmonid rearing and spawning activities; flood-risk to existing infrastructure; and subsequent effects on habitat and watershed dynamics.

Table 8. List of possible measures.

Asterisks (*) indicate measures that were initially screened (e.g., feasibility, cost, implementation, engineering design) and not carried forward to create the initial array of alternatives.

STRUCTURAL	NON-STRUCTURAL
Remove Corbin Creek gravel berm*	Old Corbin Creek stream bed improvements
Divert Corbin Creek into Old Corbin Creek	Brownie Creek stream bed improvements*
Divert portion of Corbin Creek into Old Corbin Creek	Brownie Creek enhancement*
Divert portion of Corbin Creek into Brownie Creek	Chemical (herbicide or nutrient enhancement)
Deepen portions of Old Corbin Creek	Artificial aeration
Deepen portions of Brownie Creek	Mechanical weed harvesting
Deepen portions of Deep Creek*	Enhancement of nature-based features
Construct a berm between two high points near ALPETCO trails	-
Replace two culverts at Robe River crossing with three culverts	-
Replace two culverts at Robe River crossing with a bridge	-
Replace two culverts at Old Corbin Creek crossing with a bridge	-
Levee on Robe River for flood mitigation*	-
Floodwall on Robe River for flood mitigation*	-
Excess dredged material used for channel improvements	-

Measures were then compiled together and summarized into alternatives (Table 9). Viable alternatives must meet the planning objectives, make a significant contribution to the solution of problems identified, and achieve some of the opportunities. The alternatives are described in 3.3 Arrays of Alternatives. Criteria discussing how the alternatives and measures were screened is described in 3.4 Plan Evaluation.

3.3 Arrays of Alternatives

Six main alternatives were developed, Alternatives A, B, C, D, E, and F. For Alternatives A and B, sub-alternatives were developed that contained slight variations. Prior to the construction of the gravel berm that diverted the flow of Corbin Creek into Valdez Glacier Stream; the influx of cold, turbid, glacial flows from Corbin Creek into Robe Lake suppressed the overgrowth of macrophytes. Thus, the alternatives developed aimed to divert flow from Corbin Creek back into Robe Lake, either through Old Corbin Creek or Brownie Creek. To ensure that no induced flooding occurred with a diversion of flow, sub-alternatives were developed with different measures to reduce the risk of flooding and inundation. Table 9 compares the different measures between each alternative and sub-alternative. Figure 17 illustrates the extent of each alternative's measures.

3.3.1 Alternative A

The entire flow of Corbin Creek would be rerouted back into Old Corbin Creek by constructing a training dike across Corbin Creek. The reestablished flow into Old Corbin Creek would not be controlled, modified, improved, or enhanced. No additional measures or improvements to existing natural features would be implemented. Old Corbin Creek is a natural feature and over time the system would mimic the narrow and deep channel geometry seen on other creeks (i.e., Brownie Creek and Deep Creek).

3.3.1.1 Alternative A-1

Alternative A, with the following additional measures. A channel approximately 275-foot-long would be excavated along Old Corbin Creek to connect to Corbin Creek. The culverts under the trail system locally known as the ALPETCO trail on Old Corbin Creek would be replaced with a trail bridge. A berm approximately 450-foot-long would be placed in the low-lying area between the two bluffs near the Old Corbin Creek culverts to prevent overland flow from entering historic channels that flow towards the Robe River subdivision.

3.3.1.2 Alternative A-2

Alternative A-1, with the following additional measures. The two culverts with a diameter of approximately 12.75 ft. at the Robe River crossing would be replaced with three culverts with a diameter of approximately 12.75 ft. for increased flow capacity and to improve fish passage.

3.3.1.3 Alternative A-3

Alternative A-1, with the following additional measures. The two culverts with a diameter of approximately 12.75 ft. at the Robe River crossing would be replaced with three culverts with a diameter of approximately 14 ft.

3.3.2 Alternative B

The entire flow of Corbin Creek would be rerouted back into Old Corbin Creek. To direct flow, a diversion dike would run parallel to existing Corbin Creek, and perpendicular to Old Corbin Creek. Old Corbin Creek would be enhanced through nature-based features, such as stream bed improvements to mimic the narrow and deep channel geometry seen on other creeks (i.e., Brownie Creek and Deep Creek). These improvements include channelization of Old Corbin Creek to accommodate increased flows, adding pools-riffle complexes, and increasing amount of large woody debris. These nature-based features would be implemented to work in concert with natural processes to mimic natural conditions.

Additionally, a channel approximately 275-foot-long would be excavated to connect Old Corbin Creek to Corbin Creek. Approximately 1.5 miles of Old Corbin Creek will be excavated to deepen channel geometry. The culverts under ALPETCO trail system on Old Corbin Creek would be replaced with a trail bridge. A berm approximately 450-foot-long would be placed in the low-lying area between the two bluffs near the Old Corbin Creek culverts to prevent overland flow from entering historic channels that flow towards the Robe River subdivision.

3.3.2.1 Alternative B-1

Alternative B, with the following additional measures. The two culverts with a diameter of approximately 12.75 ft. at the Robe River crossing would be replaced with a Department of Transportation (DOT) bridge with an approximately 50-foot span for increased flow capacity and to improve fish passage.

3.3.2.2 Alternative B-2

Alternative B, with the following additional measures. The two culverts with a diameter of approximately 12.75 ft. at the Robe River crossing would be replaced with three culverts with a diameter of approximately 12.75 ft.

3.3.2.3 Alternative B-3

Alternative B, with the following additional measures. The two culverts with a diameter of approximately 12.75 ft. at the Robe River crossing would be replaced with three culverts with a diameter of approximately 14 ft.

3.3.3 Alternative C

A portion of flow from Corbin Creek would be diverted via a weir system back into Old Corbin Creek to supplement the current levels of flow. Old Corbin Creek would undergo channelization improvements that deepen the existing channel mimic natural conditions.

The broad crested weir would be constructed on Corbin Creek out of sheet pile, with rock placed on either side for scour protection. Flow would spill over into Corbin Creek at the roughly 25-year flow event. A channel approximately 275-foot-long would need to be dredged to connect Old Corbin Creek to Corbin Creek. The culverts under

ALPETCO trail system on Old Corbin Creek would be replaced with a trail bridge. A berm approximately 450-foot-long would be placed in the low-lying area between the two bluffs near the Old Corbin Creek culverts to prevent overland flow from entering historic channels that flow towards the Robe River subdivision.

3.3.4 Alternative D

Corbin Creek would be diverted into Brownie Creek via a diversion dike constructed across Corbin Creek. A channel approximately 3,115-foot-long would be excavated to connect Corbin Creek to Brownie Creek.

The complex channel geometry of Brownie Creek currently provides excellent habitat for juvenile salmonids, and this existing habitat should be conserved. Diverted flows into Brownie Creek have the potential to mix with wetlands prior to reaching Robe Lake. Additional channelization improvements may be necessary to offset potential losses in turbidity or increases in water temperature.

3.3.5 Alternative E

Only nonstructural measures would be implemented to control the overgrowth of macrophytes within Robe Lake. A combination of chemical herbicide, artificial aeration, nutrient enhancement, and continuous mechanical harvesting of excess macrophytes would be implemented.

3.3.6 Alternative F (No Action Alternative)

No action would be taken to restore Robe Lake. Human intervention and mechanical harvesting of overabundant macrophytes would continue.

Table 9. Initial array of alternatives developed from measures.

See Figure 17 for the extent of each alternative's measures.

	MEASURES										
	TRAINING DIKE ON CORBIN CREEK	CHANNELIZATION OLD CORBIN CREEK	REPLACE ALPETCO CULVERTS WITH BRIDGE	BERM IN LOW AREA BETWEEN BLUFS NEAR ALPETCO CULVERTS	REPLACE ROBE RIVER CULVERTS WITH THREE 12.75'	REPLACE ROBE RIVER CULVERTS WITH THREE 14'	REPLACE ROBE RIVER CULVERTS WITH DOT BRIDGE	WEIR ON CORBIN CREEK	CHANELIZATION ON BROWNIE CREEK	NON-STRUCTURAL (NATURE BASED)	NON-STRUCTURAL (HERBICIDE, MECHANICAL HARVESTING)
Alternative A	✓										
Alternative A-1	✓	✓	✓	✓							
Alternative A-2	✓	✓	✓	✓	✓						
Alternative A-3	✓	✓	✓	✓		✓					
Alternative B	✓	✓	✓	✓						✓	
Alternative B-1	✓	✓	✓	✓			✓			✓	
Alternative B-2	✓	✓	✓	✓	✓					✓	
Alternative B-3	✓	✓	✓	✓		✓				✓	
Alternative C		✓	✓	✓				✓			
Alternative D	✓								✓		
Alternative E											✓
Alternative F											

Note that Alternative F is the no-action alternative.

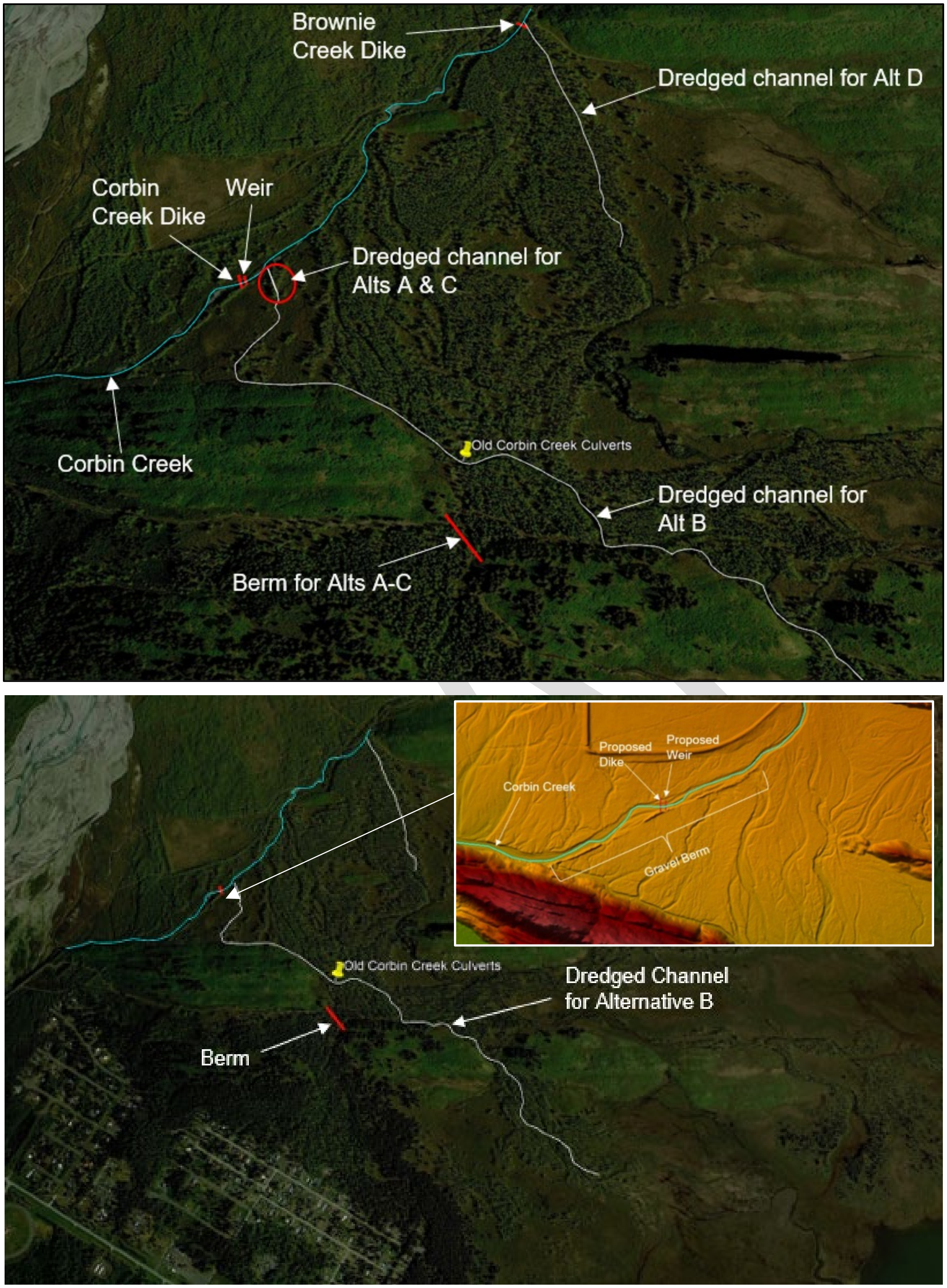


Figure 17. Layout of the array of alternatives considered.

See Figure 13 for location of Robe River culverts on the Richardson Highway. Alternatives A and C have the same dredged beginning portion that is circled in red. Alternative B is dredged further down for approximately 1.5 miles.

3.4 Plan Evaluation

3.4.1 Federal Objective

The objectives of Federal water and land resources planning are to contribute to National Economic Development (NED) in a way that protects the Nation's environment and increases the net value of goods and services provided to the economy of the United States as a whole and to contribute to National Ecosystem Restoration (NER) in a way to increase the net quantity and/or quality of desired ecosystem resources.

Ecosystem restoration efforts at Robe Lake to improve salmonid habitat quantity and quality represent a high priority under the current administration guidelines for producing NER benefits. Planning for an ecosystem restoration at Robe Lake project is consistent with the NER objective and considers environmental, social, and economic factors.

3.4.2 Contribution to Objectives and Avoidance of Constraints

Screening criteria were applied for each potential alternative. The screening criteria included whether each alternative met the study objectives and was within the CAP cost limits (Table 10).

Table 10. Initial array of alternatives with respect to project objectives.

	SCREENING CRITERIA					
	OBJECTIVE 1	OBJECTIVE 2	OBJECTIVE 3	NO INDUCED FLOODING	COST	CARRIED FORWARD?
Alternative A	✓				✓	NO
Alternative A-1	✓	✓	✓		✓	NO
Alternative A-2	✓	✓	✓		✓	NO
Alternative A-3	✓	✓	✓	✓	✓	YES
Alternative B	✓	✓			✓	NO
Alternative B-1	✓	✓	✓	✓		YES
Alternative B-2	✓	✓	✓		✓	NO
Alternative B-3	✓	✓	✓	✓	✓	YES
Alternative C	✓	✓	✓		✓	NO
Alternative D		✓	✓		✓	NO
Alternative E		✓			✓	NO
Alternative F				✓	✓	YES

OBJECTIVE 1 – Restore the water quality within Robe Lake to a healthy, productive, self-sustaining system with natural flow regime.
OBJECTIVE 2 – Increase the quality and/or quantity of salmonid habitat, in addition to improving existing salmonid habitat.
OBJECTIVE 3 – Decrease the overall maintenance required to control the overgrowth of macrophytes.
NO INDUCED FLOODING – There was no induced flooding present when modeling the alternative.
COST – within CAP limits (with contingency).

3.4.3 P&G Criteria – Effectiveness, Efficiency, Acceptance, and Completeness

The Water Resources Council's Federal Principles and Guidelines document establishes four criteria for the evaluation of water resources projects (WRC P&G, 1983). The four study criteria that alternative plans are evaluated for include: effectiveness, efficiency, acceptance, and completeness. Each alternative was evaluated and screened against these four criteria (Table 11).

- *Effectiveness* is defined as the extent to which an alternative alleviates the specified problems and achieves the specified opportunities.
- *Efficiency* is defined as the as the extent to which an alternative alleviates the specified problems and achieves the specified opportunities at the least cost.
- *Acceptability* is defined as the viability and appropriateness of an alternative from the perspective of the Nation's general public and consistency with Federal laws, authorities, and public policies. It does not include local or regional preferences for particular solutions or political expediency.
- *Completeness* is defined as the extent to which an alternative provides and accounts for all features, investments, and/or other actions necessary to realize the planned effects, including any necessary actions by others. It does not necessarily mean that alternative actions need to be larger in scope or scale.

Table 11. Initial array of alternatives with respect to P&G screening criteria.

	P&G CRITERIA				
	EFFECTIVNESS	EFFICENCY	ACCEPTABILITY	COMPLETNESS	CARRIED FORWARD?
Alternative A	✓	✓			NO
Alternative A-1	✓	✓	✓		NO
Alternative A-2	✓	✓			NO
Alternative A-3	✓	✓	✓	✓	YES
Alternative B	✓	✓			NO
Alternative B-1	✓		✓	✓	YES
Alternative B-2	✓	✓			NO
Alternative B-3	✓	✓	✓	✓	YES
Alternative C	✓				NO
Alternative D		✓			NO
Alternative E		✓			NO
Alternative F			✓		YES

Effectiveness – extent an alternative alleviates problems and achieves opportunities.
Efficiency – extent an alternative alleviates problems and achieves opportunities, least cost.
Acceptability – viability of alternative with respect to laws, authorities, and policies.
Completeness – extent an alternative provides and accounts for features, investments, or actions necessary to realize effects.

3.4.4 Resource Significance

The significance of ecosystem outputs for aquatic ecosystem restoration projects is a key metric in plan evaluation. Because of the challenge of dealing with non-monetized benefits, the concept of significant of outputs plays and important role in ecosystem restoration evaluation. The significance of expected ecosystem restoration outputs is used in conjunction with information from the CE/ICA to help determine whether an alternative should be recommended.

Salmonid species, especially the five Pacific salmon species (*Oncorhynchus* spp.) are a significant natural resource in Alaska. Alaska is one of the world's greatest strongholds for healthy stocks of wild Pacific salmon and intact salmon producing ecosystems (ADFG, 2019). Salmon are an essential natural resource, are an important indicator species for ecosystem health and function, and are interwoven within the culture and economy of Alaska (ADFG, 2019). Because fish and wildlife were recognized as critically important to Alaska, the Alaska Department of Fish and Game (ADFG) was created as a cabinet level department run by a commissioner, who answers directly to the governor. The directives of the constitution were included in statute by the legislature under Alaska Statute (AS) 16.05.020.

State of Alaska regulations define four categories of users who may harvest salmon: commercial, subsistence, sport, and personal use. In Alaska, the subsistence use of wild resources, is a crucial component for the traditional way of life for many indigenous and non-indigenous peoples. Subsistence use is defined as the noncommercial, customary, and traditional uses for a variety of purposes (AS 16.05.940[32]). All five Pacific salmon species in Alaska are a key subsistence resource. Under Alaska's subsistence statute, the Alaska Board of Fisheries must identify fish stocks that support subsistence fisheries and, if there is a harvestable surplus of these stocks, adopt regulations that provide reasonable opportunities for these subsistence uses to take place. Whenever it is necessary to restrict harvests, subsistence fisheries have a preference over other uses of the stock (AS 16.05.258). While a priority is provided for subsistence uses in Alaska, commercial fishing accounts for the vast majority of salmon harvested (ADFG, 2019).

Alaska has four state laws that work together to protect salmon spawning and rearing habitats: the Anadromous Fish Act, the Fishway Act, the Alaska Forest Resources and Practices Act, and the Alaska Water Use Act (ADFG, 2019). The Anadromous Fish Act (AS 16.05.871) requires ADFG to identify rivers and streams that are important for salmon spawning, rearing, and migration. The Fishway Act (AS 16.05.841) complements the Anadromous Fish Act by requiring fish passage to be provided in streams frequented by all species of fish; requiring that dams or obstructions built across a fish stream allow effective fish passage. The Alaska Forest Resources and Practices Act (AS 41.17) governs timber harvest activities and aims to prevent adverse impacts to fish habitat and water quality, including the retention of trees as buffers along salmon streams to provide habitat, ensure bank stability, and protect water quality. The Alaska Water Use Act (AS 46.15) protects stream flow and water necessary for salmon passage, spawning, incubation, and rearing. When combined together, these four state laws provide protection for salmon and their habitats, a critical natural resource in Alaska.

At the Federal level, NOAA Alaska Regional Office works with the Alaska Fisheries Science Center and the North Pacific Fishery Management Council to manage Alaska's sustainable fisheries, which includes Pacific salmon. These governmental entities work through the Council process authorized under the Magnuson-Stevens Fishery Conservation and Management Act to develop measures for best management of Alaska's fisheries, considering arrange of factors such as the health of salmon stocks and economic impact of the salmon fishery. The goal is to create a sustainable harvest while allowing for future fishing opportunities in perpetuity.

Throughout Alaska, salmon are a principal food source for many families and are important to the cultural and spiritual vitality of many Alaskans (ADFG, 2019). The significance of outputs in this ecosystem restoration study at Robe Lake aims to improve the quality and quantity of existing salmonid habitat. These improvements to Robe Lake directly support State laws that outline the importance of wild salmon as a natural resource, and the habitat that they rely on.

3.4.4.1 The General Salmonid Habitat Model

Salmonid species are critically important in freshwater, estuarine, and marine ecosystems. In Alaska, salmon are a key natural resource that have high economical, commercial, and subsistence value. Robe Lake is an important salmon (*Oncorhynchus* spp.) spawning and rearing site in the Valdez area. Therefore, restoration alternatives must be evaluated within the context of changes in habitat suitability for salmonid species. Improving the quality of existing salmonid habitat within Robe Lake is a planning objective that must be met.

The *General Salmonid Habitat Model* was developed by the U.S. Army Corps of Engineers Research and Design Center (ERDC) to assist in the plan formulation process for ecosystem restoration and mitigation projects (Herman et al., 2018; Herman et al., 2019a; Herman et al., 2019b). The certified model generates relative differences in habitat quality between proposed alternative future scenarios. The model is scalable, meaning various parameters may be measured at different landscape scales (i.e., tributary vs. watershed). This model is appropriate for use in any planning project focused on the restoration of streams, rivers, and estuaries, because the parameters are measures of ecosystem level structure, function, and process.

Throughout the implementation of using the *General Salmonid Habitat Model* to refine restoration alternatives, caveats and considerations were taken into account. For instance, the model was developed for stream and riverine restoration projects in Pacific Northwest ecosystems. Therefore, certain parameters in the model needed to be modified to fit the Robe Lake system, in Alaska. To do this, USACE worked with authors of the model to optimize and modify two parameters. These two parameters were *Edge Cover (1)* and *Bioenergetics Temperature (2)*. The *Edge Cover (1)* parameter was modified to have a negative effect above a 45% cover threshold in the littoral buffer to capture unsuitability of macrophyte overgrowth. The *Bioenergetics Temperature (2)* parameter was shifted to encompass lower ideal temperatures for salmon species in Alaska (Weber Scannell, 1992).

USACE Alaska District held a habitat modeling workshop on February 7th, 2023 to implement the *General Salmonid Habitat Model*. During the workshop, USACE Alaska District collaborated with other agencies to determine initial baseline and forecast parameter inputs. The goal of the workshop was to evaluate the restoration alternatives with respect to changes in habitat suitability indices given the parameter input. Each alternative was evaluated against each parameter; for both the tributary and watershed calculators. The results of this workshop were used to infer changes in habitat suitability for the CE/ICA. The detailed results of these data can be found in the Economic Appendix.

Restoration benefits are calculated by subtracting the FWOP AAHUs from the future with project AAHUs. For the comparison of measures, both environmental outputs and costs were annualized over a 50-year period of analysis. The resulting benefits are then used, along with annual costs, to identify cost-effective plans and perform incremental cost analysis. Figure 18 shows the annualized habitat units which were used as the input for the CE/ICA.

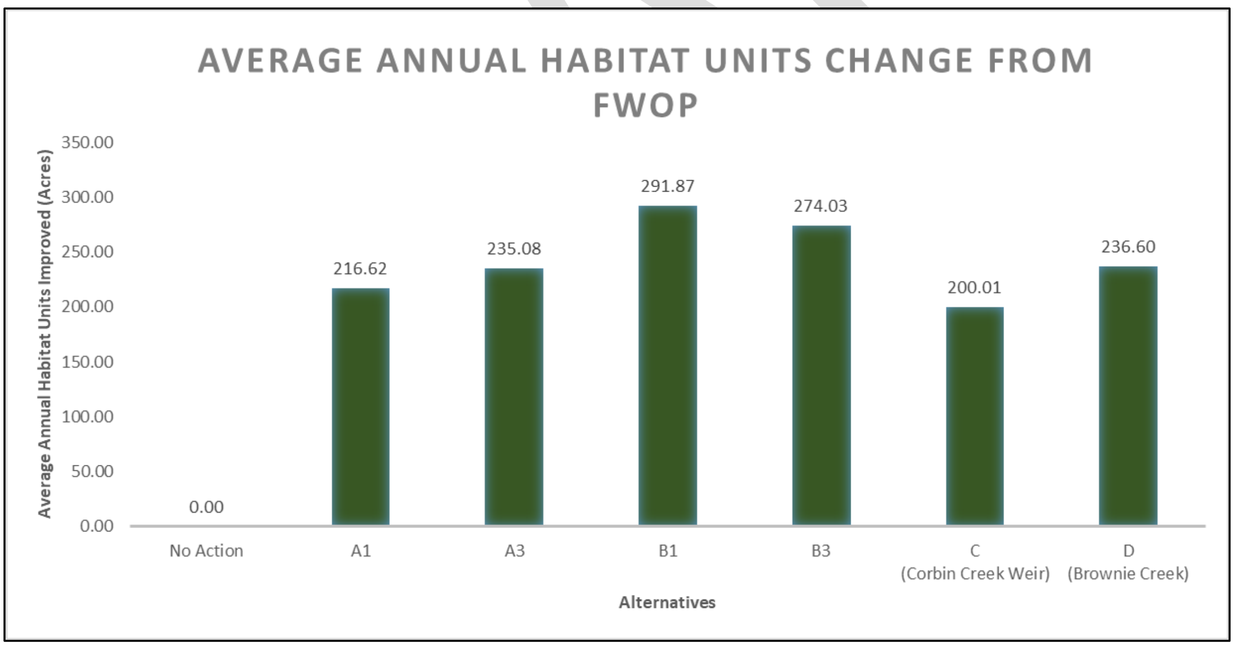


Figure 18. Annualized habitat units for alternatives carried forward to the CE/ICA.

3.4.5 System of Accounts

To present the most comprehensive analysis of the benefits and the costs for this ecosystem restoration project, the alternatives were evaluated using the four accounts established in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies:

- *The National Economic Development (NED)*: Displays changes in the economic value of the national output of goods and services.
- *The Environmental Quality (EQ)*: Displays effects on significant natural and cultural resources.
- *The Regional Economic Development (RED)*: Displays the regional and localized economic impacts that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output, and population.
- *The Other Social Effects (OSE)*: Registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.

The results from the analysis of each of the four economic accounts are summarized in Table 12. The cost-effectiveness and incremental cost analysis (CE/ICA), average annual economic cost (AAEC), average annual habitat units restored (AAHUs, in units of acres), are also summarized in Table 12. For further details on the four economic accounts see the Economic Appendix. Alternatives A-3, B-3, B-1, and F are identified as best buy plans through the CE/ICA, meaning these alternatives provide the greatest increase in output for the least increase in cost. The NER plan was determined to be Alternative B-3. The extra incremental cost of additional improved habitat units from Alternative A-3 to Alternative B-3 is justified in 3.4.5.1 National Ecosystem Restoration (NER).

Table 12. Summary of four economic accounts for each alternative.

Alternative B-3 is the NER plan.

	AAHUs (acres)	AAEC ($1000)	CE/ICA Results	NED (AAEC)	EQ	RED	OSE
Alternative A-3	235	$281	Best Buy	$32,000	Positive	Increased employment and income for the region and state	Increased recreation and subsistence possibilities
Alternative B-1	292	$811	Best Buy	$32,000	Positive	Increased employment and income for the region and state	Increased recreation and subsistence possibilities
Alternative B-3	274	$512	Best Buy	$32,000	Positive	Increased employment and income for the region and state	Increased recreation and subsistence possibilities
Alternative F	0	$0	Best Buy	$0	Neutral	Neutral	Neutral

3.4.5.1 National Ecosystem Restoration (NER)

The underlying objective of ecosystem restoration studies as described in ER 1105-2-100 is to contribute to NER. Contributions to NER output are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource as a function of improvement in habitat quality and/or quantity and expressed quantitatively. Ecosystem restoration plans shall be formulated and evaluated in terms of their net contributions to increases in ecosystem value (expressed in non-monetary units). See the Economic Appendix for further NER plan details.

USACE determined that Alternative B-3 is the NER plan for this project. Alternative B-3 provides the highest number of AAHUs while remaining within the cost limitations of the CAP 206 authority. The additional habitat units Alternative B-3 provides over Alternative A-3 are critical in the opinion of USACE. These additional units are derived from the management measure of dredging approximately 1.5 miles of Old Corbin Creek. These habitat units will provide the most ideal habitat for spawning and rearing salmon, given that these will occur in the tributary of Old Corbin Creek rather than Robe Lake.

In addition to enhanced habitat within Old Corbin Creek, USACE believes that Alternative B-3 is more likely to realize the benefits in habitat suitability within the time period modeled by the *General Salmonid Habitat Model,* a certified planning model that assists in the plan formulation process for ecosystem restoration and mitigation projects (Herman et al., 2018; Herman et al., 2019a; Herman et al., 2019b). The additional dredging and channelization in Alternative B-3 will control the flow of water into Robe Lake, which will mitigate any uncertainty that the diverted water will not reach Robe Lake. Alternative A-3 does not include additional measures to channelize the water into Robe Lake, it only redirects the water flow into Old Corbin Creek and leaves water to create its own channel.

3.4.5.2 Environmental Quality (EQ)

For each alternative plan, positive and negative EQ benefits must be analyzed consistently with current guidance. The benefit assessment can be quantitative or qualitative and, if appropriate, monetized. The analysis must distinguish between national and regional benefits while ensuring benefits are not accounted for more than once. For this project, environmental restoration benefits will be captured for the CE/ICA using the *General Salmonid Habitat Model*, and any other secondary environmental benefits will be captured in the environmental quality section.

3.4.5.2.1 Environmental Impacts

USACE biologists investigated project effects on protected resources (i.e., threatened and endangered species, avian species, essential fish habitat, and special aquatic sites); as well as effects on the abiotic environment such as climate, noise, and air quality. It is expected that no adverse effects would occur on these protected resources, climate, noise, and air quality with the implementation of any of the proposed project alternatives. Environmental benefits, other than the benefits accounted for in the CE/ICA analysis, would occur within essential fish habitat, as well as to climate, noise, and air quality.

3.4.5.2.2 Effects on Essential Fish Habitat

Currently Valdez Glacier Stream and Corbin Creek are not listed as anadromous waters within the ADFG AWC (Giefer and Graziano, 2022); however, with a diversion of Corbin Creek into Old Corbin Creek, known anadromous habitat will be beneficially impacted as it will provide improved habitat and rearing grounds for all types of aquatic species in Robe Lake (e.g., zooplankton and macroinvertebrates).

3.4.5.2.3 Effects on Noise and Air Quality

Alternatives A, B, C, and D (and their respective sub-alternatives) aim to reduce the water temperature in Robe Lake with a diversion of flow, which will reduce the overgrowth of macrophytes. Currently, VFDA uses a mechanical weed harvester to help control the macrophyte overgrowth in Robe Lake. The proposed alternatives aim to reduce the need for mechanical intervention once the benefits of the implemented alternative are realized, which is projected to be about five years (see the Economic Appendix). Air pollution and noise is anticipated to be reduced in the project area after the use of the weed harvester is no longer needed.

Air quality and airborne noise higher than ambient levels within the project area may be affected during the construction period from the use of construction equipment, vehicles, and generators. USACE concluded that any increase in pollutant emissions and airborne noise caused by the project would be transient, highly localized, and would dissipate after construction. The magnitude of effects on air quality and airborne noise during construction would be minor.

3.4.5.2.4 Effects on Climate

Burning of fossil fuels via the weed harvester in the project area will be reduced when the weed harvester is no longer needed, which is expected to be after five years of project construction completion. Any other activities due to project implementation would be too limited in physical scope of duration to have any discernable effect on climate.

3.4.5.2.5 Effects on Cultural Resources

Three cultural resources have been identified in the project area: the abandoned low water wooden bridge, the Corbin Creek gravel berm, and the Old Corbin Creek culverts (Table 3). USACE archeologists have determined these to be cultural resources, but not historic properties. The low water wooden bridge would not be impacted by any of the alternatives. The Corbin Creek gravel berm and the Old Corbin Creek culverts would be impacted negatively (by the EQ analysis) from the implementation of any project alternative as the culverts and the berm would be removed and replaced during project construction.

The Corbin Creek gravel berm initially used to divert water away from Robe Lake has degraded over time, and does not function as originally intended during a flood event. USACE has determined that the Old Corbin Creek culverts need to be removed as they are undersized, have been occluded by riparian vegetation, and don't meet the requirements for fish passage. The alternatives proposed recommend the removal and replacement of the Old Corbin Creek culverts with a trail bridge that meets current size requirements and fish passage standards.

3.4.5.2.6 EQ Summary

The primary benefits of this project involve improving the salmonid spawning and rearing habitat in Robe Lake. However, secondary benefits to the environment and cultural resources were determined to be significant by USACE biologists and archaeologists. All alternatives show a positive effect for secondary environmental effects, while demolition and replacement of two cultural resources in the project area present as a negative effect. It is important to note that the cultural resources are not historical properties. Table 13 shows a summary of the final EQ category determination.

Table 13. EQ determination summary.

Asterisks (*) indicates cultural resources affected by project alternatives, which are not historic properties. However according to EQ, the degradation or demolition of a manmade structure 50 years old or older suggests a negative impact to cultural resources.

	Secondary Environmental Effects	Cultural Resources*	EQ
Alternative A-1	Positive	Negative	Positive
Alternative A-2	Positive	Negative	Positive
Alternative A-3	Positive	Negative	Positive
Alternative B-1	Positive	Negative	Positive
Alternative B-2	Positive	Negative	Positive
Alternative B-3	Positive	Negative	Positive
Alternative C	Positive	Negative	Positive
Alternative D	Positive	Negative	Positive
Alternative E	Neutral	Neutral	Neutral
Alternative F	Neutral	Neutral	Neutral

3.4.5.3 Regional Economic Development (RED)

The RED account measures change in the distribution of regional economic activity that would result from each alternative (Table 14). Evaluations of regional effects are measured using a nationally consistent income, employment, output, and population projection. These impacts occur from the construction of the project and from the contribution to a regional economy from the functioning of the project. The Economic Appendix provides further details on the RED account for each alternative carried forward to the CE/ICA.

Table 14. RED national summary by alternative.

	Local Capture	Output	Jobs	Labor Income	Value Added
Alternative A-3	$6,275,233	$20,038,249	162	$10,765,413	$11,109,395
Alternative B-1	$21,004,027	$67,070,649	544	$36,033,250	$37,184,603
Alternative B-3	$12,161,277	$38,833,731	315	$20,863,158	$21,529,788

Jobs are presented in full-time equivalence (FTE).

3.4.5.4 Other Social Effects (OSE)

Prior to the construction of the gravel berm that diverted Corbin Creek in the 1950s, the water flow from Corbin Creek into Robe Lake was navigable via boat, and conditions were good for recreational boating and swimming on Robe Lake. However, it was assessed that during the summer months, the extensive overgrowth of macrophytes made the lake unfit for recreational use, including swimming, boating, fishing, or operating float planes; urging the return of Robe Lake to the major recreation area it once was (Koenings et al., 1987).

Robe Lake is the largest freshwater lake in the Valdez area. In addition to providing spawning and rearing habitat for salmonid species, Robe Lake also offers wildlife viewing and recreational opportunities for both Valdez residents and visitors (Inter-Fluve et al., 2021). Controlling the overgrowth of macrophytes within Robe Lake has the potential to increase opportunities for recreation, including increased accessibility for motorboats, kayaks, canoes, and paddle boards.

4.0 PLAN COMPARISON AND SELECTION

The environmental benefits and costs presented Sections 4.1 and 4.3 were the inputs for the CE/ICA. The CE/ICA aimed to evaluate the alternatives' effectiveness and efficiency at producing environmental outputs. The intermediate product of a CE/ICA is the identification of a set of best buy plans. Best buy plans are alternatives that provide the greatest increase in environmental output for the least increase in cost. A cost-effective alternative is one where no other alternative can achieve the same level of output at a lower cost or greater level of output at the same or less cost. Initially, all cost-effective alternatives are arrayed by increasing output to clearly show changes in cost (i.e., increments of cost) relative to changes in output (i.e., increments of output) of each cost-effective alternative plan compared to the FWOP condition. The plan with the lowest incremental costs per unit of output of all plans is therefore considered the first best buy plan.

After the first best buy plan is identified, all larger cost-effective plans are compared to the first best buy plan in terms of increases in (increments of) cost and increases in (increments of) output. The alternative plan with the lowest incremental cost per unit of output (for all cost-effective plans larger than the first best buy plan) is the second best buy plan. This process is continued until all the best buy alternative plans are identified. Evaluation of the best buys from the initial analysis identified an array of best buy alternatives for comparison over the entire watershed. USACE compared the best buys from each project area to determine whether the incremental environmental benefits justified the incremental costs. Based on this comparison, a single best buy alternative was selected from the project area.

4.1 Flood Risk

The proposed alternatives for this project (excluding Alternatives E and F) involve increasing streamflow into Robe Lake and correspondingly increasing the streamflow on the Robe River.

The Robe River subdivision, located west of Robe Lake and just north of Robe River, became an area of focus to ensure no induced flooding in the future with project conditions (Figure 13).

If water depth during a flood event under any proposed alternative was greater than the expected water depth during a flood event in the FWOP condition, a flood risk analysis effort was undertaken. USACE did not carry forward any alternatives that induced flooding (Acceptability in Table 11). The methodology to estimated flood risk and induced flooding is detailed in the Economic Appendix. Figure 19 and Figure 20 show the existing condition and FWOP condition during a 1.0% and a 0.2% Annual Exceedance Probability (AEP) flood event (respectively). USACE screened out all alternatives that induced any level of flooding relative to the FFE.

Three alternatives that did not induce flooding were carried forward to the CE/ICA (Acceptability in Table 11). These alternatives were Alternative A-3, Alternative B-1, and Alternative B-3, along with Alternative F (no action).

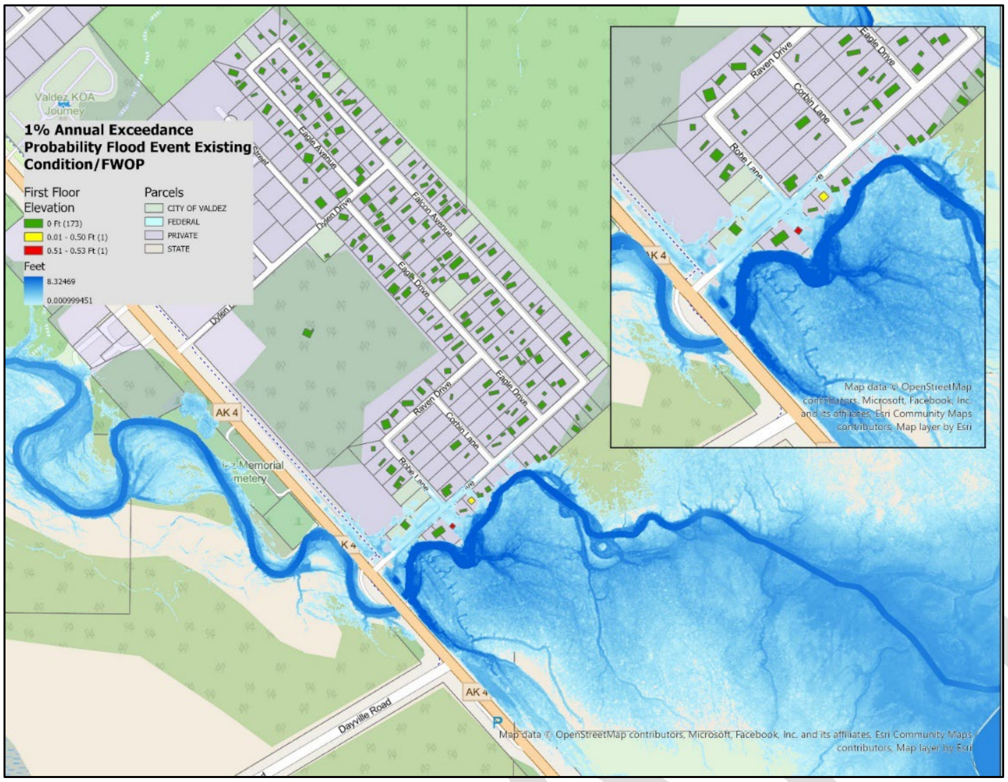


Figure 19. FWOP conditions; 1.0% AEP flood event.

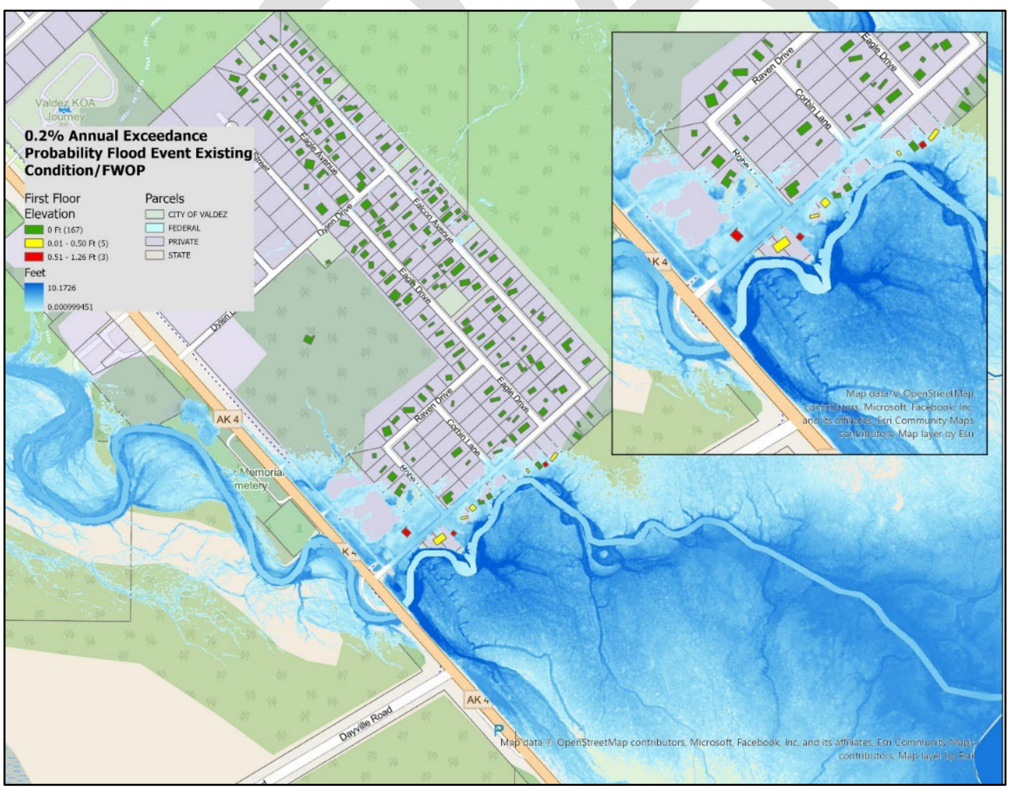


Figure 20. FWOP conditions, 0.2% AEP flood event.

4.2 Costs for CE/ICA

4.2.1 Future Without Project Costs

Due to the excessive overgrowth of macrophytes in Robe Lake, VFDA regularly harvests the excess vegetation. From the years 2021 to 2023, VFDA has budgeted an average of $31,506 annually for weed harvesting labor and mechanical maintenance. VFDA purchased a new weed harvester in 2023 for $289,355 with an expected service life of 25 years. VFDA would need to purchase two weed harvesters for the 50-year period of analysis. After annualizing and discounting the costs, the FWOP costs are approximately $43,000 annually.

4.2.2 Future With Project Costs

USACE developed Rough Order of Magnitude (ROM) cost estimates for the alternatives, including those to construct and maintain facilities. The Cost Engineering Appendix details the procedures used to calculate these estimates. Cost risk contingencies were included to account for uncertain items such as using dredged material for channel improvements, contouring, and enhancement of nature-based features. No dredged material extracted from Old Corbin Creek is anticipated to be removed from the project site, the material will simply be re-contoured. Contingencies represent allowances to cover unknowns, uncertainties, and/or unanticipated conditions that cannot adequately evaluate the data on hand when the cost estimate is prepared. Still, it must be represented by a sufficient cost to cover the identified risks. Project costs were developed without escalation and are in 2023 dollars. The ROM costs for each alternative are displayed in Table 15.

Table 15. Summary of ROM cost estimates for alternatives.

	Alternative A-1	Alternative A-3	Alternative B-1	Alternative B-3	Alternative C *	Alternative C **	Alternative D	Abbreviated Risk Analysis Contingency	Alternative A-1	Alternative A-3	Alternative B-1	Alternative B-3	Alternative C *	Alternative C **	Alternative D
	Estimated Construction Cost (via Micro-Computer Aided Cost Estimating System, MCACES)							(percentage)	Estimated Construction Cost + Abbreviated Risk Analysis Contingency						
Clearing and Grubbing	$137,517	$137,517	$137,517	$137,517	$137,517	$137,517	$137,517	46%	$200,800	$200,800	$200,800	$200,800	$200,800	$200,800	$200,800
Temporary Access Road	$182,142	$182,142	$223,313	$223,313	$182,142	$182,142	$200,575	57%	$286,000	$286,000	$350,600	$350,600	$286,000	$286,000	$314,900
Diversion Training Dike	$1,342,427	$1,342,427	$1,342,427	$1,342,427			$1,901,715	34%	$1,798,900	$1,798,900	$1,798,900	$1,798,900			$2,548,300
Weir					$443,667	$585,684		48%					$656,600	$866,800	
Excavate 275-foot-long channel to connect Old Corbin Creek to Corbin Creek	$185,565	$185,565	$185,565	$185,565	$185,565	$185,565		54%	$285,800	$285,800	$285,800	$285,800	$285,800	$285,800	
Dredge 1.5 miles of Old Corbin Creek			$3,036,872	$3,036,872				54%			$4,676,800	$4,676,800			
Replace Robe River culverts with 50-foot DOT bridge			$6,205,833					47%			$9,122,600				
Remove Robe River culverts			$105,398					25%			$131,700				
Remove culverts on Old Corbin Creek and replace with a trail bridge	$85,131	$85,131	$85,131	$85,131	$85,131	$85,131		25%	$106,400	$106,400	$106,400	$106,400	$106,400	$106,400	
450-foot berm	$184,124	$184,124	$184,124	$184,124	$184,124	$184,124		24%	$228,300	$228,300	$228,314	$228,300	$228,300	$228,300	
Remove/Replace Robe River culverts with three 14-foot diameter culverts		$1,695,629		$1,695,629				25%		$2,119,500		$2,119,500			
Dredge Corbin Creek to Brownie Creek							$1,542,760	62%							$2,499,271
Real Estate	$46,570	$46,570	$56,170	$56,170	$46,570	$46,570	$50,000		$46,600	$46,600	$56,200	$56,200	$46,600	$46,600	$50,000
Mobilization and Demobilization => 10% of Estimated Construction Cost	$211,691	$381,254	$1,150,618	$689,058	$121,815	$136,016	$378,257		$290,600	$502,600	$1,690,200	$976,700	$176,400	$197,400	$556,300
Design Costs (ROM) => escalated to Midpoint of Con. FY25	$1,680,000	$1,680,000	$1,680,000	$1,680,000	$1,680,000	$1,680,000	$1,680,000		$1,680,000	$1,680,000	$1,680,000	$1,680,000	$1,680,000	$1,680,000	$1,680,000
Construction Management => 8% of Estimated Construction Cost	$169,352	$305,003	$920,494	$551,246	$97,452	$108,813	$302,605		$232,500	$402,100	$1,352,200	$781,400	$141,100	$157,900	$445,100
Project Cost (Rounded)	$4,224,500	$6,225,400	$15,313,500	$9,867,000	$3,164,000	$3,332,000	$6,193,000		$5,155,900	$7,657,000	$21,680,500	$13,261,400	$3,808,000	$4,056,000	$8,294,700

*Alternative C with a concrete weir.

**Alternative C with a steel sheet pile weir.

The cost-effectiveness analysis evaluates a plan's level of outputs against its cost. The subsequent incremental cost analysis evaluates a variety of alternatives of different scales to arrive at a "best buy" option. Best buy plans are considered most efficient, which provide the greatest increase in output for the least increase in cost. These analyses help to inform whether or not the next unit of benefit is "worth it". The costs variable for a CE/ICA refer to the AAEC of each alternative. These costs include project first costs, interest during construction, and operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs. The costs are amortized using the Federal discount rate for 2023 of 2.5% over the 50-year period of analysis. The annual average costs used in the CE/ICA is summarized in Table 16.

Table 16. Alternative cost estimates (present value).

	Project First Costs	Interest During Construction	OMRR&R	Total Economic Cost	Average Annual Economic Cost	Annual Cost per Habitat Unit
Alternative A-3	$7,657,000	$197,000	$102,000	$7,956,500	$281,000	$1,200
Alternative B-1	$21,680,500	$460,000	$871,000	$23,012,000	$811,000	$2,800
Alternative B-3	$13,261,400	$411,000	$871,000	$14,543,000	$513,000	$1,900
Alternative F	$0	$0	$0	$0	$0	$0

For OMRR&R, ecosystem restoration benefits (AAHUs) FWOP conditions were derived assuming that macrophyte harvesting would likely continue without a project.

4.3 Benefits for CE/ICA

4.3.1 Future Without Project Benefits

Ecosystem improvement is expressed in terms of NER benefits per USACE policy which are average annual habitat units (AAHUs) restored, for the Robe Lake ecosystem restoration project, a restored habitat unit is an acre of improved habitat that meets the standard for ideal salmonid spawning and rearing. For further details on determination of ideal spawning and rearing habitat please see the discussion on the *General Salmonid Habitat Model* in the Environmental Appendix.

For this project, habitat is being improved in Robe Lake and whichever tributary (i.e., Old Corbin Creek or Brownie Creek) would be chosen to redirect the flow of Corbin Creek. The study area has a little over 709 acres of habitat; 680 acres stemming from Robe Lake, 19 acres from Old Corbin Creek, and 10 acres from Brownie Creek (Table 17).

Using a mechanical weed harvester, VFDA actively mitigates macrophyte growth in the lake. If the weed harvesting operation were discontinued, the habitat quality in Robe Lake would exponentially decline. However, the VFDA has purchased a new weed harvester and will likely continue to harvest. *The General Salmonid Habitat Model* suggests that with the continued current level of macrophyte mitigation (throughout the 50-year period of analysis), the average annual FWOP suitable habitat units are estimated to be about 320 acres in Robe Lake, 13 acres in Old Corbin Creek, and about 9 acres in Brownie Creek; which annualizes to an average of 342 AAHUs.

Table 17. Total acres of habitat in the study area.

	BASELINE	FWOP
Robe Lake	680	320
Old Corbin Creek	19	13
Brownie Creek	10	9
TOTAL ACRES	709	342

VFDA actively mitigates the overgrowth of macrophytes with mechanical weed harvesting. If the weed harvesting operation were discontinued, the habitat quality in Robe Lake would exponentially decrease. However, the VFDA has purchased a new weed harvester and plans to continue harvesting efforts. The *General Salmonid Habitat Model* suggests that with the continued current level of macrophyte mitigation (throughout the 50-year period of analysis), the average annual FWOP suitable habitat units are about 320 acres in Robe Lake, 13 acres in Old Corbin Creek, and 9 acres in Brownie Creek; which leads to an average of 342 AAHUs (Table 17).

4.3.2 Future With Project Benefits

For the most comprehensive comparison of alternatives, AAHUs were computed for Alternative A-3, Alternative B-1, Alternative B-3, Alternative C, and Alternative D. Alternative C and Alternative D were not carried through the plan selection process due to the possibility of induced flooding in the Robe River subdivision during a flood event. Table 18 shows a summary of the average annual number of improved habitat acres over 50 years after the completion of the construction of alternatives. Figure 18 shows the difference in AAHUs between the no action baseline and the alternatives used as the input for the CE/ICA.

Table 18. Average annual habitat units (AAHUs) by alternative.

	Robe Lake	Old Corbin Creek	Brownie Creek	AAHUs	Change from FWOP	Ranked Order
Alternative A-3	552.17	16.04	8.70	558.45	235.08	4
Alternative B-1	608.52	16.48	8.70	633.70	291.87	1
Alternative B-3	590.62	16.53	8.70	615.85	274.03	2
Alternative C	517.74	15.40	8.70	541.83	200.01	5
Alternative D	556.85	13.13	8.44	578.42	236.60	3
Alternative F	319.99	13.13	8.70	341.82	0.00	-

4.3.2.1 Cost Effectiveness

The restoration benefits and ROM costs presented in the previous sections were used as inputs for the CE/ICA. The purpose of the analysis was to evaluate the effectiveness and efficiency of the alternatives at producing environmental outputs. The end product of a CE/ICA is the identification of a set of best buy plans. Best buy plans are alternatives that provide the greatest increase in environmental output for the least increase in cost. A cost-effective alternative is one where no other alternative can achieve the same level of output at a lower cost, or greater level of output at the same or less cost (Table 19; Figure 21). Initially, all cost-effective alternatives are arrayed by increasing output to clearly show changes in cost (i.e., increments of cost) relative to changes in output (i.e., increments of output) of each cost-effective alternative plan compared to the FWOP condition. The plan with the lowest incremental costs per unit of output of all plans is therefore considered the first best buy plan.

Table 19. Summary of cost-effectiveness results in CE/ICA.

	Average Annual NED Cost ($1000)	Average Annual Habitat Units (Acres)	Cost-Effective
Alternative A-3	281	235	Best Buy
Alternative B-1	811	292	Best Buy
Alternative B-3	513	274	Best Buy
Alternative F	0	0	Best Buy

4.3.2.2 Incremental Cost Analysis

Alternatives A-3, B-3, and B-1 were all compared incrementally after they were determined as best buy plans. It is essential to note that Alternative B-3 is an incrementally larger version of Alternative A-3. Alternative B-3 includes all the same measures as Alternative A-3 with the addition of approximately 1.5 miles of dredging of Old Corbin Creek. Alternative B-1 is not an incrementally "larger" version of Alternative A-3 or Alternative B-3 since Alternative B-1 includes a DOT bridge over the Richardson Highway instead of culverts as in Alternative A-3 and Alternative B-3. The bridge and the culverts are substitutes for each other and provide different restoration benefits, so they are not incrementally larger versions of the same plan. Figure 21 shows the Incremental Cost Analysis box plot with the result of the incremental analysis.

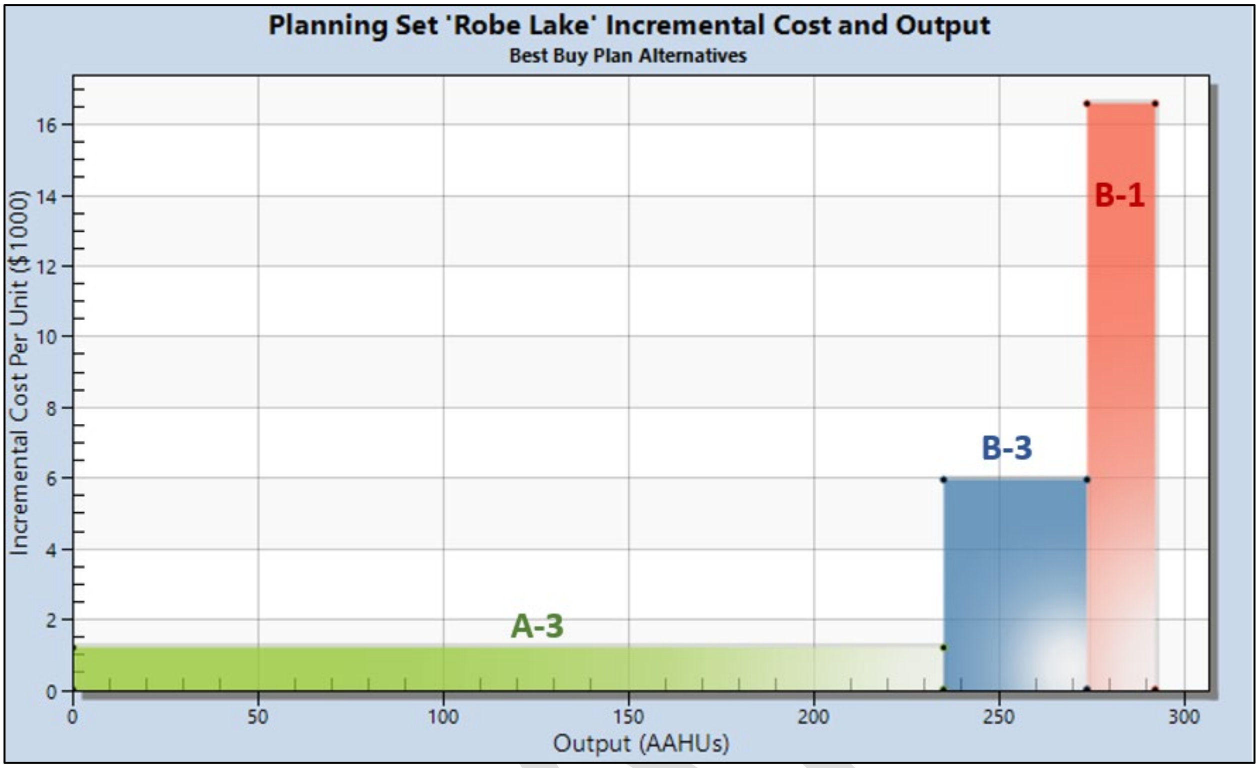


Figure 21. Incremental cost analysis box plot of best buy plans.

Table 20 and Table 21 show the incremental increase in AAHUs from Alternative A-3 to Alternative B-3, and Alternative B-1 to Alternative B-3 (respectively). From Alternative A-3 to Alternative B-3 (Table 20), there is an increase of 39 acres of annual habitat units restored. These additional acres of improved habitat incur at a price of around $6,000 each annually, whereas the base 235 acres are at $1,200 each annually. Although this is a large increase in the price of an improved habitat unit, USACE believes that this increase is economically justified, as discussed in the following section. From Alternative B-1 to Alternative B-3 (Table 21) there are only 18 extra annual habitat units improved. Each of these acres would cost $16,700 which USACE determined to be too high relative to the increase in number of restored habitat units.

Table 20. Incremental benefit and cost summary of Alternative A-3 to Alternative B-3.

	Alternative A-3	Alternative B-3	Incremental Increase from A-3 to B-3
Average Annual Habitat Units	235	274	39
Average Annual Economic Cost	$281,000	$513,000	$232,000
Annual Cost per Habitat Unit	$1,200	$1,900	$700
Annual Cost for additional Habitat Units	-	-	$6,000

Table 21. Incremental benefit and cost summary of Alternative B-3 to Alternative B-1.

	Alternative B-3	Alternative B-1	Incremental Increase from B-1 to B-3
Average Annual Habitat Units	274	292	18
Average Annual Economic Cost	$513,000	$811,000	$299,000
Annual Cost per Habitat Unit	$1,900	$2,800	$900
Annual Cost for additional Habitat Units	-	-	$16,700

4.4 NER Plan Selection

Evaluation of the best buys from the initial analysis identified an array of best buy alternatives for comparison over the entire watershed. Best buys from each project area were compared to determine whether the incremental environmental benefits justified the incremental costs. Based on this comparison, a single best buy alternative, Alternative B-3, was selected from the project area.

USACE determined that Alternative B-3 is the NER plan for this project per USACE policy. Alternative B-3 provides the highest number of average annual habitat units while remaining under the cost limitations of USACE's CAP program. Alternative B-1 is outside of the limits of the Federal cost share for USACE's CAP program.

The additional habitat units Alternative B-3 provides over Alternative A-3 are critical in the opinion of USACE. Alternative B-3's extra habitat units are derived from dredging approximately 1.5 miles of Old Corbin Creek. These extra habitat units will provide the most ideal habitat for spawning and rearing salmon since these acres are located within known anadromous habitat, and not in Robe Lake. The Environmental Appendix contains more information on ideal spawning and rearing habitat for salmonid species.

In addition to the added habitat and enhancement of nature-based features in Old Corbin Creek, USACE believes that Alternative B-3 is more likely to realize the benefits (restored habitat) within the period modeled by the *General Salmonid Habitat Model*. The controlled water flow into Robe Lake, due to dredging approximately 1.5 miles of Old Corbin Creek, will mitigate any uncertainty of the diverted water flow not reaching the intended destination. Alternative A-3 does not channel the water into Robe Lake. Alternative A-3 only redirects the flow of Corbin Creek into Old Corbin Creek with no additional management measures, leaving water to flow without mitigation or improvements. The channelization of Old Corbin Creek through dredging approximately 1.5 miles will also decrease the likelihood of water pooling near the proposed 450-foot gravel berm during a flood event. See the Hydraulics and Hydrology Appendix for more information about the water flow during a flood event.

5.0 THE RECOMMENDED PLAN

The recommended plan for the Robe Lake Ecosystem Restoration (CAP 206) feasibility study is Alternative B-3. The components, cost and benefits, and risks of Alternative B-3 are described as follows.

5.1 Plan Components

Plan components of Alternative B-3 are summarized visually in Figure 22. The entire flow of Corbin Creek would be rerouted back into Old Corbin Creek. To direct flow, a diversion training dike would run parallel to existing Corbin Creek, and perpendicular to Old Corbin Creek (Figure 23). A channel approximately 275-foot-long would be excavated to connect Old Corbin Creek to Corbin Creek. Approximately 1.5 miles of Old Corbin Creek would be excavated to deepen channel geometry. The culverts under ALPETCO trail system on Old Corbin Creek would be replaced with a trail bridge. A berm approximately 450-foot-long would be placed in the low-lying area between the two bluffs near the Old Corbin Creek culverts to prevent overland flow from entering historic channels that flow towards the Robe River subdivision (Figure 24). The two culverts with a diameter of approximately 12.75 ft. at the Robe River crossing would be replaced with three culverts with a diameter of approximately14 ft. for increased flow capacity and to improved fish passage.

Old Corbin Creek would be enhanced through nature-based features, such as stream bed improvements to mimic the narrow and deep channel geometry seen on other creeks (i.e., Brownie Creek and Deep Creek). These improvements include channelization of Old Corbin Creek to accommodate increased flows, adding pools-riffle complexes, and increasing amount of large woody debris. These nature-based features would be implemented to work in concert with natural processes to mimic natural conditions.

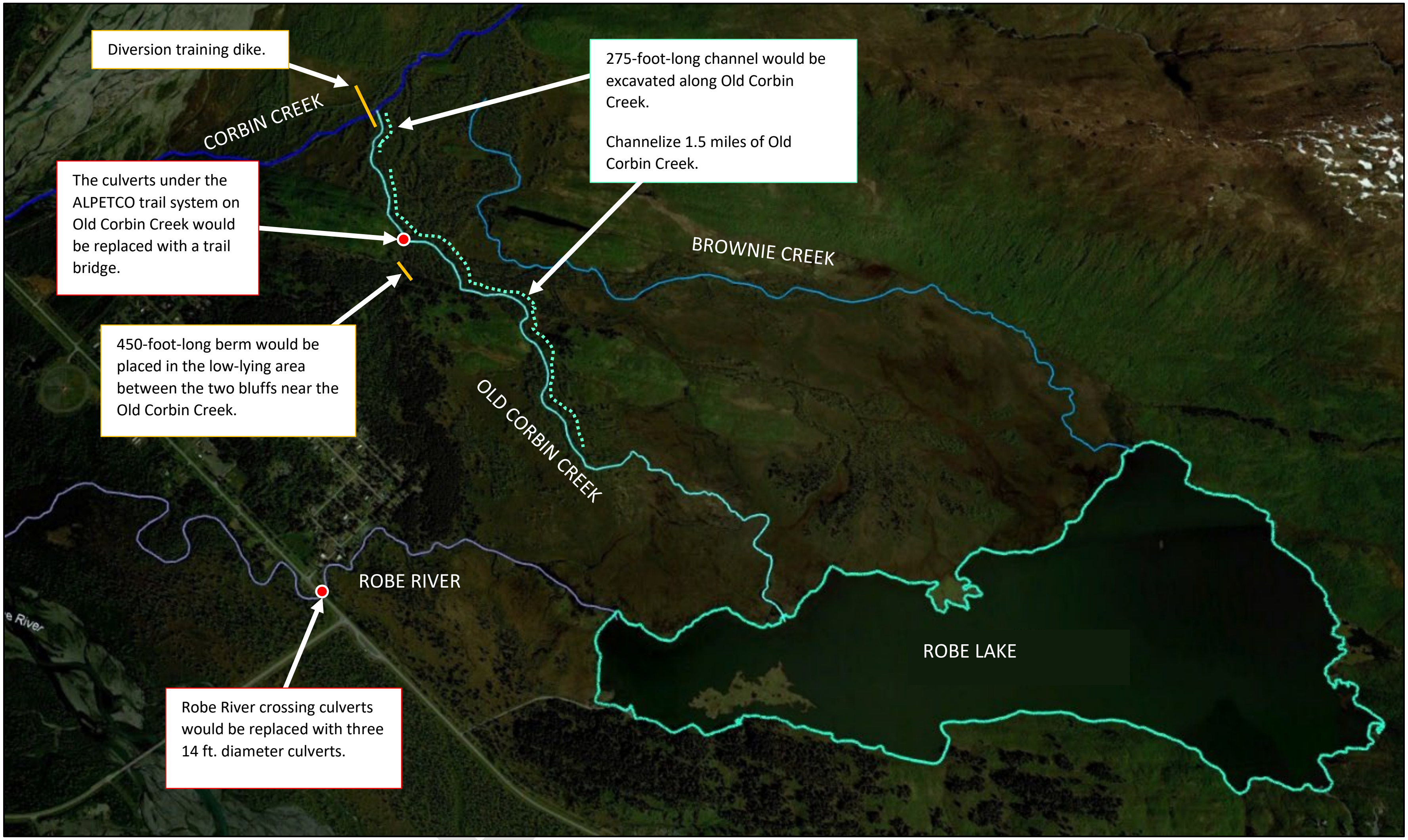


Figure 22. Visualization of Alternative B-3 plan components.

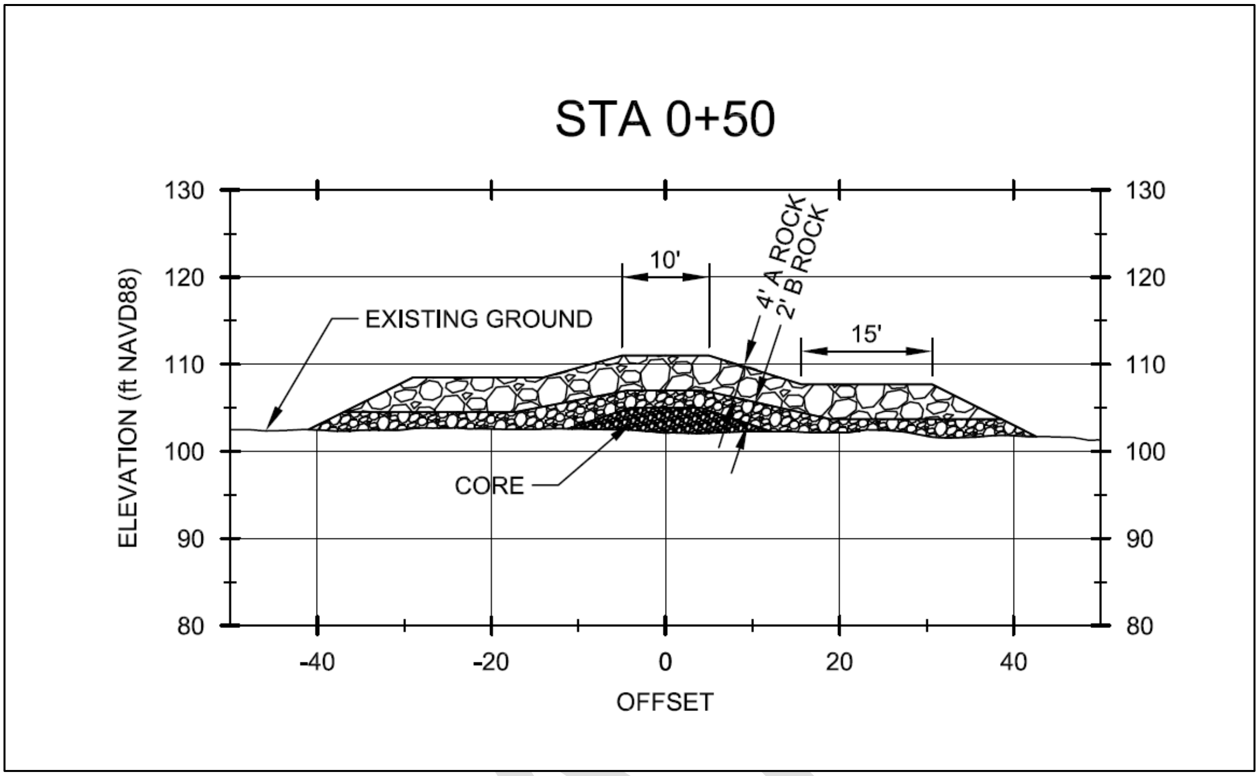


Figure 23. Diversion training dike cross section for Alternative B-3.

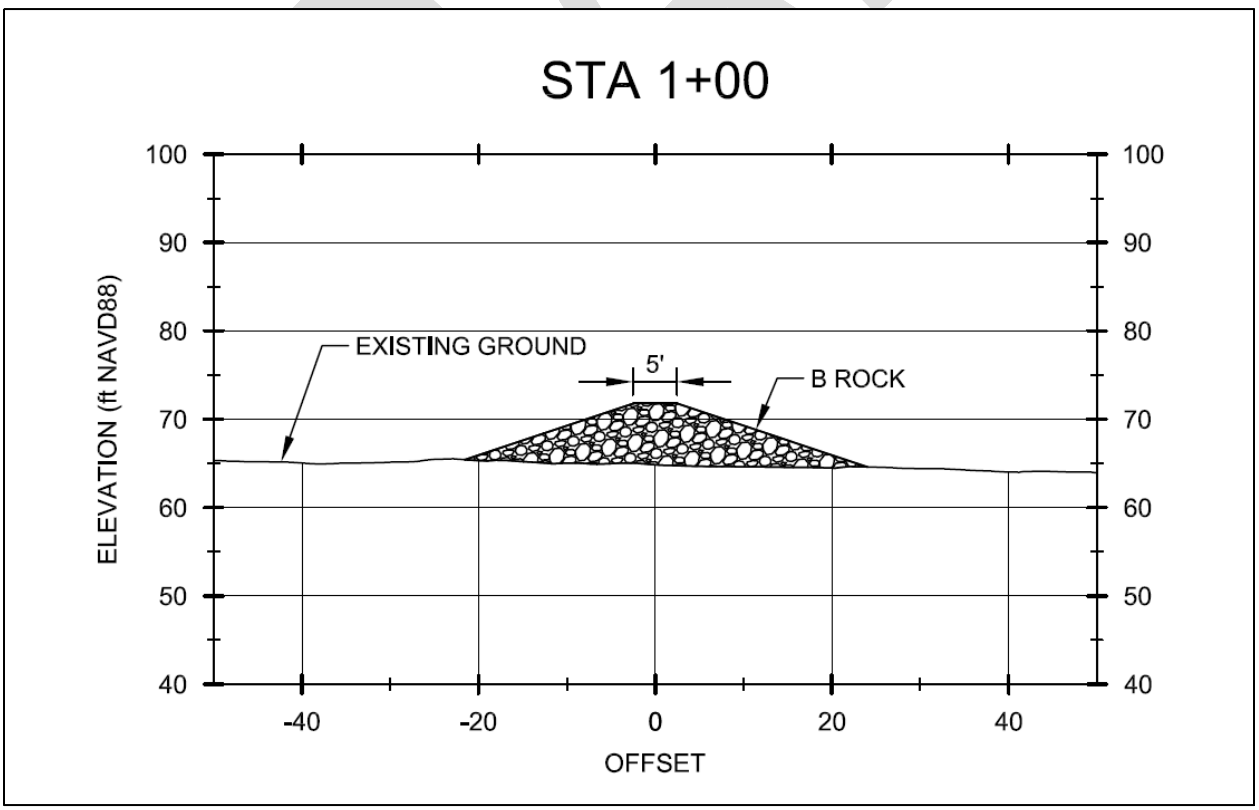


Figure 24. 450-foot-long berm cross section for Alternative B-3.

5.2 Cost Estimate

The ROM cost estimate for Alternative B-3 is given in Table 22. The Cost Engineering Appendix details the procedures used to calculate these estimates. Contingencies represent allowances to cover unknowns, uncertainties, and/or unanticipated conditions. Cost risk contingencies were included to account for uncertain items such as using dredged material for channel improvements, contouring, and enhancement of nature-based features. No dredged material extracted from Old Corbin Creek is anticipated to be removed from the project site, the material will simply be re-contoured. Project costs were developed without escalation and are in 2023 dollars, however these are only initial estimates, and are not the certified cost estimate.

Table 22. Summary of ROM cost estimate for Alternative B-3.

	Alternative B-3	Abbreviated Risk Analysis Contingency	Alternative B-3
	Estimated Construction Cost from MCACES Files	(percentage)	Estimated Construction Cost + Abbreviated Risk Analysis Contingency
Clearing and Grubbing	$137,517	46%	$200,800
Temporary Access Road	$223,313	57%	$350,600
Diversion Training Dike	$1,342,427	34%	$1,798,900
Excavate a 275-foot-long channel to connect Old Corbin Creek to Corbin Creek	$185,565	54%	$285,800
Dredge 1.5 miles of Old Corbin Creek	$3,036,872	54%	$4,676,800
Remove culverts on Old Corbin Creek and replace with trail bridge	$85,131	25%	$106,400
450-foot berm	$184,124	24%	$228,300
Remove/Replace Robe River culverts with three 14-foot diameter culverts	$1,695,629	25%	$2,119,500
Real Estate	$56,170		$56,200
Mobilization and Demobilization => 10% of Estimated Construction Cost	$689,058		$976,700
Design Costs (ROM) => escalated to Midpoint of Con. FY25	$1,680,000		$1,680,000
Construction Management => 8% of Estimated Construction Cost	$551,246		$781,400
Project First Cost	$9,867,052		$13,261,400

5.3 Lands, Easements, Rights-of-Way, Relocations, and Disposal

The requirements for lands, easements, rights-of-way and relocations, and disposal (LERRDs) areas should include the rights to construct, maintain, repair, operate, patrol, and replace ecosystem restoration measures. The non-Federal sponsor is responsible for acquiring all necessary real estate interests required for the project. The non-Federal sponsor will acquire adequate interest in both land and water holdings of the State of Alaska. Should it be determined that additional real estate is required for the project after the completion of the plans and specifications, the non-Federal sponsor will be responsible for providing the additional lands identified. See the Real Estate Appendix for further details regarding real estate considerations.

5.4 Operations, Maintenance, Repair, Replacement, and Rehabilitation

The OMRR&R costs and assumptions for implementation of Alternative B-3 are given in Table 23. The volume of dredged material extracted from Old Corbin Creek would only be sufficient to ensure the channel has flow capacity. The majority of that material would be placed along the bank of Old Corbin Creek for channel improvements, contouring, and enhancement of nature-based features (see the 404(b)(1) for further details). Any temporary fill is anticipated to be removed after construction and placed for future beneficial use at an upland stockpile site within the Valdez quarry.

Table 23. OMRR&R for Alternative B-3.

Dredging OMRR&R (every 10 years)	***Alternative B-3***
Dredging total cost	$4,962,600
% of total for dredging OMRR&R (year 10)	6.5%
OMRR&R cost - Dredging	$322,244
Dredging mobilization/demobilization	$100,000
Total dredging OMRR&R cost	$422,244

Diversion Training Dike OMRR&R (every 10 years)	***Alternative B-3***
Diversion training dike total cost	$1,798,900
% of total for diversion training dike OMRR&R (year 10)	7.5%
OMRR&R cost – Training Dike	$134,918
Diversion training dike mobilization/demobilization	$100,000
Total diversion training dike OMRR&R cost	$234,243

450-foot-long Berm OMRR&R (every 20 years)	***Alternative B-3***
450-foot-long berm total cost	$228,300
% of total for 450-foot-long berm OMRR&R (year 20)	8%
OMRR&R cost - Berm	$18,412
450-foot-long berm mobilization/demobilization	$100,000
Total 450-foot-long berm OMRR&R cost	$118,412

Dredging OMRR&R assumes $100,000 mobilization/demobilization + 6.5% of initial dredge quantity every 10 years.
Diversion training dike OMRR&R assumes $100,000 mobilization/demobilization + 7.5% of initial diversion dike to be replaced every 10 years.
450-foot-long berm OMRR&R assumes $100,000 mobilization/demobilization + 8% of initial cost every 20 years.

5.5 Project Risks

The project has the following implementation risks. The design of the three culverts with a diameter of approximately 14 ft. at the Robe River crossing on the Richardson Highway will need to be coordinated with Alaska Department of Transportation (AKDOT). Early and frequent coordination with AKDOT will be required through the design to mitigate schedule and cost creep. Old Corbin Creek does not have a detailed survey. During the Design and Implementation (D&I) phase a detailed survey may result in unexpected low or high locations, impacting the overall project cost. The survey would need to be completed early in the D&I phase to mitigate the risk.

The hydrological and induced flood map modeling conducted as part of the feasibility study indicates that there would be no induced flooding to the existing infrastructure under the 1% and 0.2% annual exceedance probability. In extreme cases, a flood event beyond these intervals could result in a residual risk of flood impact.

5.6 Cost Sharing

The project D&I phase would have a cost share of 65% Federal and 35% Local (Table 24). The Robe River crossing on the Richardson Highway is a project feature necessary for fish passage and access to spawning and rearing habitat. The LERRDs necessary for the project would consist of construction access and the lands necessary for constructing the diversion dike to divert flow from Corbin Creek into Old Corbin Creek, which must be retained by the non-Federal sponsor in public ownership. All OMRR&R costs would be a non-Federal responsibility.

Table 24. Cost share breakdown.

Total Project First Cost	LERRDs Credit	Local Cash	Federal Cash
$13,261,400	$56,170	$4,621,831	$8,583,400

5.7 Design and Construction

The Feasibility Phase is scheduled to be complete in March 2024. The project is anticipated to begin the D&I phase within six months of an approved decision document. The design of the project is expected to take approximately 18 to 24 months including contract solicitation. The physical construction in anticipated to be completed within one construction season. Environmental considerations (i.e., timing of the return and spawning of salmon) would need to be taken into account. Likewise, construction considerations must also include optimal hydraulic conditions. These considerations could necessitate a phased construction schedule and result in two construction phases over a two season period. Table 25 details the tentative design and construction schedule.

Table 25. Design and Implementation (D&I) timeline.

Project Milestone/Activity	Date
Decision Document Approval	March 2024
Design of Project	October 2024 to October 2025
Construction	October 2025 to December 2026
Fiscal Closeout	Spring 2028

5.8 Environmental Mitigation

Impact evaluations conducted during preparation of this IFREA have determined that no significant adverse impacts would result from implementing Alternative B-3, the recommended plan. This determination by USACE is based on the analysis of existing resource information and informal coordination with relevant local, state, and Federal agencies. No onsite compensatory wetland or other type of mitigation is anticipated to be required for this project.

5.9 Environmental Operating Principles (EOP)

The recommended plan under Alternative B-3 meets USACE EOPs (ER 200-1-5). USACE EOPs were developed to ensure that USACE missions include totally integrated sustainable environmental practices. The EOPs provided corporate direction to ensure the workforce recognizes USACE's role in, and responsibility for, sustainable use, stewardship, and restoration of natural resources across the nation and, through the international reach of its support missions.

The recommended plan aims to improve the Robe Lake ecosystem function in a self-sustaining way that reduces the amount of human intervention and maintenance required, while improving existing salmonid rearing and spawning habitat. By reducing the need for human intervention and mechanical harvesting of excess macrophytes, Alternative B-3 directly relates to the EOPs strong emphasis on environmental sustainability. Specifically, the EOP to "*create mutually supporting economic and environmentally sustainable solutions*".

5.10 Views of the Non-Federal Sponsor

The non-Federal sponsors, the City of Valdez and the Native Village of Tatitlek, support the recommended plan, Alternative B-3.

6.0 ENVIRONMENTAL EFFECTS AND CONSEQUENCES

6.1 Affected Environment and Environmental Consequences

Under the preferred alternative, Alternative B-3, effects on protected resources, cultural and historic resources, and environmental justice will use statutory language for the assessments of potential effects. For all other resource categories, the magnitude of the effects will be evaluated using best professional judgement and criteria that are tiered as follows (Doub, 2014):

- <u>Minor</u>: effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource.
- <u>Moderate</u>: effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- <u>Major</u>: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The environmental effects and consequences between the potential action alternatives (Alternative A-3, Alternative B-1, and Alternative B-3) are in general considered to be same. Therefore, this section only discusses the magnitude effects and evaluation of Alternative B-3, the preferred alternative. The environmental effects and consequences of the FWOP condition with respect to existing conditions is discussed in Section 2.0 Existing and Future Without Project Conditions.

6.1.1 Mitigation, Monitoring, Adaptive Management

The Adaptive Management Plan for the project addresses risks associated with unrealized habitat restoration benefits. Monitoring and continued harvesting of macrophytes maintenance will occur for approximately five years post construction for the wetland and stream restoration features. This plan serves as the overall guide for how to monitor the enhancement actions planned with implementation of Alternative B-3. This plan describes adaptive management for the project (if needed) and provides metrics for evaluating success. This plan is not intended to be a static document, but rather, a dynamic document that will be updated as necessary to reflect the restoration goals and strategies for the project.

6.2 Effects on Protected Resources

6.2.1 Effects on Threatened and Endangered Species

No Federal or State threatened or endangered species listed under the ESA are known to occur with the project's footprint, as proposed. Likewise, there is no critical habitat designated for threatened or endangered species listed under the ESA within the project's footprint, as proposed.

USACE determined that under Alternative B-3, the proposed action will have no effect on threatened or endangered species, since no threatened or endangered species are known to be regularly observed within the project area. If a threatened or endangered species were to be incidentally present within the project area during construction, they are unlikely to be affected by project activities.

6.2.2 Effects on Avian Species - Migratory Birds and Eagles

Migratory birds are expected to be present within the project area; however, the effect on these species is expected to be minimal. USACE determines that under Alternative B-3, the proposed action is unlikely to result in the killing of migratory birds, or destruction of active nests. The magnitude of effects of the proposed action activities may affect, but is not likely to adversely affect migratory birds.

Bald eagles are often observed around Robe Lake and the greater Valdez area. Nesting bald eagles may be within the project area, but are not expected to be at the proposed construction sites. A few transient adult bald eagles may be seen within the proposed action area, but USACE anticipates a very low risk of a taking under the BGEPA. The magnitude of effects of project activities under Alternative B-3 may affect, but is not likely to adversely affect, bald eagles.

6.2.3 Effects on Essential Fish Habitat

Robe Lake is designated as freshwater EFH. USACE determines that the proposed activity under Alternative B-3 will not alter or adversely affect EFH, due to the proposed action being an aquatic ecosystem restoration project within Robe Lake. The magnitude of effects of the proposed action activities on EFH and anadromous waters would be no effect.

Regarding the effect on anadromous waters, the proposed activity under Alternative B-3 may affect, but is not likely to adversely affect, anadromous water and aquatic habitat. Rerouting Corbin Creek into Old Corbin Creek will decrease the temperature of Robe Lake and increase the turbidity with the influx of glacial flows. A major objective of the project is to decrease the overall maintenance required to control the overgrowth of macrophytes, which Alternative B-3 achieves. Likewise, with a diversion of Corbin Creek into Old Corbin Creek, anadromous waters will not be impacted with a diversion away from Valdez Glacier Stream. Valdez Glacier Stream, and its current tributary Corbin Creek are not listed in the ADFG AWC (Figure 8). With a diversion of Corbin Creek into Old Corbin Creek, known anadromous habitat will be beneficially impacted.

The purpose of this CAP Section 206 study is to improve the Robe Lake ecosystem function in a self-sustaining way that reduces the amount of human intervention and maintenance required, while improving existing salmonid rearing and spawning habitat. Given that the recommended plan aims to restore fish habitat to a less degraded state, the magnitude of effects of the recommended plan on anadromous waters and fish species would be minimal.

6.2.4 Effects on Special Aquatic Sites

At Robe Lake, special aquatic sites include wetlands surrounding the perimeter of the lake; riffle and pool complexes of the freshwater tributaries; and vegetated shallows in the littoral buffer. Many areas of Robe Lake that have extensive overgrowth of macrophytes have already been disturbed during mechanical weed harvesting efforts. Given that this ecosystem restoration project aims to restore the Robe Lake watershed to a less degraded state, the proposed action under Alternative B-3 will likely affect, but not adversely affect, most special aquatic sites. The magnitude of effects of the recommended plan on special aquatic sites within the project area (other than macrophytes within the littoral buffer of Robe Lake) is expected to be minimal. The 404(b)(1) provides further details on the wetland impacts of the recommended plan.

6.3 Effects on Cultural Resources

Under Alternative B-3, no historic properties (those cultural resources eligible for listing in the NRHP) are anticipated to be impacted. However, USACE's assessment of "no historic properties affected" is pending concurrence by the SHPO.

6.4 Effects on Climate

Under Alternative B-3, activities would be too limited in physical scope or duration to have any discernable effect on climate; the magnitude of effects would be minor.

6.5 Effects on Noise and Air Quality

Under Alternative B-3, air quality may be affected during the construction period from the use of construction equipment, vehicles, and generators. USACE assesses that any increase in pollutant emissions caused by the project would be transient, highly localized, and would dissipate entirely at the completion of the project. Valdez is not in a CAA "nonattainment" area, and the conformity determination requirements of the CAA would not apply to the proposed action at this time. The magnitude of effects on air quality would be minor.

Under Alternative B-3, construction activities would likely generate airborne noise higher than ambient levels within the project area, which may be noticeable to wildlife or any people in the area. Any disturbances would be short-lived and sporadic. The magnitude of effects from increased airborne noise would be minor.

6.6 Effects on Hydraulics and Hydrology

Under Alternative B-3, Corbin Creek will be rerouted through Old Corbin Creek. The following data collection and analyses will be required for design and implementation. First, a bathymetric survey of each tributary leading into Robe Lake (i.e., Corbin Creek, Old Corbin Creek, Brownie Creek) and the Robe River will be performed to adjust the HEC-RAS model if necessary. Second, a survey the culverts over the Richardson Highway will be conducted to and adjust the HEC-RAS model if necessary. Finally, if a large flood event were to occur, USACE must obtain high water mark (HWM) data and perform a sensitivity analysis within the HEC-RAS model using this contemporary data and hydrograph.

No HWM information was available for this watershed or gage information, and thus the model could not be calibrated to different flood events. The extents of flooding from published Federal Emergency Management Agency (FEMA) flood maps for the area for the 100-year and 500-year events were the only forms of calibration performed.

6.7 Effects on Geology and Topography

Under Alternative B-3, the geology and topography of the area would be generally unaffected. This is a glacial outwash plain that regular experiences trajectory changes to its braided streams. This diversion of flow would likely have no significant effect on the topographical landscape.

6.8 Effects on Environmental Justice and Protection of Children

The proposed ecosystem restoration project at Robe Lake does not have the potential to increase the impact of any of the environmental justice indices identified by EJScreen for block group 02261000300, which includes Valdez (2.4.2 Environmental Justice & Protection of Children). Although some indices may be increased temporarily within the project location during construction, they are not expected to impact the community itself.

In accordance with EO 12898, USACE has determined that the proposed project under Alternative B-3 would not have any adverse environmental or human health impacts that would disproportionately affect minority and/or low-income communities.

In accordance with EO 13045, USACE has determined that there would be no disproportionate health or safety risks to children as a result of the proposed project under Alternative B-3.

7.0 ENVIRONMENTAL COMPLIANCE

7.1 Environmental Compliance Table

Compliance with the following environmental laws, regulations, and EOs is required for the recommended plan under consideration. This project is anticipated to be in full compliance with all environmental laws, regulations, and EOs (Table 26).

Table 26. Status of environmental compliance.

Asterisks (*) indicate that full compliance will be attained upon the signing of the Finding of No Significant Impact (FONSI).

FEDERAL LAW	COMPLIANCE
Clean Air Act	Fully Compliant
Clean Water Act Section 404(b)(1)	In Progress
Endangered Species Act	Fully Compliant
Fish & Wildlife Coordination Act	Fully Compliant
National Environmental Policy Act	Partially Compliant *
National Historic Preservation Act	In Progress
Magnuson-Stevens Fishery Conservation & Management Act	Fully Compliant
Marine Mammal Protection Act	Not Applicable
Migratory Bird Treaty Act	Fully Compliant
Bald Eagle Protection Act	Fully Compliant
Executive Order 12898, Environmental Justice	Fully Compliant
Executive Order 13045, Protection of Children	Fully Compliant

STATE AND LOCAL LAWS	COMPLIANCE
Clean Water Act Section 401	In Progress
Alaska Statute 16.05.871- .45901 Anadromous Fish Act	In Progress
Alaska Statute 16.05.841 Fish Passage Act	In Progress

7.2 Public Involvement

7.2.1 Scoping and Agency Coordination

The following list of Federal agencies were contacted during the scoping period to solicit input on the scope of the impacts and resources affected by the proposed project (Table 27). These inquiries were in regard to environmental coordination under NEPA and the FWCA. No responses requesting to be a cooperating agency were received. All coordination letters can be found in the Correspondence Appendix.

Table 27. Federal agencies contacted during the scoping period.

Asterisks (*) indicate a response received but request to be a coordinating agency on the project was declined.

Agency	Nature of Inquiry	Postmarked Date	Response?
National Marine Fisheries Service (NMFS), Habitat Conservation Division	Coordination under FWCA	04 August 2022	No
U.S. Fish and Wildlife Service (USFWS), Conservation Planning Assistance	Coordination under FWCA	04 August 2022	No
Environmental Protection Agency (EPA), R10	NEPA Cooperating Agency Request	15 August 2022	No *
U.S. Fish and Wildlife Service (USFWS), Conservation Planning Assistance	NEPA Cooperating Agency Request	15 August 2022	No
National Marine Fisheries Service (NMFS), Habitat Conservation Division	NEPA Cooperating Agency Request	26 September 2022	No
Alaska State Historic Preservation Officer (SHPO)	Request for Concurrence on Determinations of Eligibility	11 August 2023	Pending
Alaska State Historic Preservation Officer (SHPO)	Request for Concurrence on Assessment of Effect	30 August 2023	Pending

The draft IFR-EA will be made available for public and agency review, extending for 30 days. Comments on the draft IFRE-EA will be provided in the Correspondence Appendix.

7.2.2 Tribal Consultation

The Native Village of Tatitlek is a co-sponsor of the study has been involved with, and invited to all major decision points of the study. In addition, formal Government to Government notification letters were sent 02 February 2023. No response for formal consultation was received. Should the study move beyond the feasibility phase to the D&I phase, additional coordination and consultation will continue.

7.2.3 List of Statement Recipients

The Correspondence Appendix provides a list of the agencies, organizations, and persons whom USACE sent copies of the draft IFR-EA for review. This will be finalized after the public comment period.

7.2.4 Public Comments Received and Responses

Substantial comments received during the public comment period and actions taken to involve the public and agencies will be compiled and appended in the Correspondence Appendix after the public release of this IFR-EA. Comments received will be addressed in the final EA.

8.0 DISTRICT ENGINEER RECOMMENDATION

I recommend that the selected aquatic ecosystem restoration plan at Robe Lake, Alaska, be constructed generally in accordance with the Recommended Plan herein, and with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to enter into a written project partnership agreement (PPA), as required by Section 221 of Public Law 91-611, as amended, to provide local cooperation satisfactory to the Secretary of the Army. Entering into the PPA will ensure compliance with Federal laws and policies.

My recommendation is subject to cost sharing and other applicable requirements of federal laws, regulations, and policies. Federal implementation of the project for ecosystem restoration includes, but is not limited to, the following required items of local cooperation to be undertaken by the non-federal sponsor in accordance with applicable federal laws, regulations, and policies:

a. Provide the non-federal share of project costs including 35 percent of construction costs allocated to ecosystem restoration, as further specified below:

i. Provide, during design, 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

ii. Provide all lands, easements, and rights-of-way, including those required for relocations and placement areas, and perform all relocations determined by the Federal Government to be required for the project; and

iii. Provide, during construction, any additional contribution necessary to make its total contribution equal to 35 percent of construction costs.

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Ensure that the project or lands, easements, and rights-of-way required for the project shall not be used as a wetlands bank or mitigation credit for any other project;

d. Operate, maintain, repair, rehabilitate, and replace the project or functional portion thereof at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal laws and regulations and any specific directions prescribed by the Federal Government;

e. Hold and save the Federal Government free from all damages arising from design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project, except for damages due to the fault or negligence of the Federal Government or its contractors;

f. Perform, or ensure performance of, any investigations for hazardous toxic, and radioactive wastes (HTRW) that are determined necessary to identify the existence and extent of any HTRW regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §9601-§9675, and any other applicable law, that may exist in, on, or under real property interests that the Federal Government determines to be necessary for construction, operation, and maintenance of the project.

g. Agree, as between the Federal Government and the non-federal sponsor, to be solely responsible for the performance and costs of cleanup and response of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, and maintenance of the project, including the costs of any studies and investigations necessary to determine an appropriate response to the contamination, without reimbursement or credit by the Federal Government;

h. Agree, as between the Federal Government and the non-federal sponsor, that the non-federal sponsor shall be considered the owner and operator of the project for the purpose of CERCLA liability or other applicable law, and to the maximum extent practicable shall carry out its responsibilities in a manner that will not cause HTRW liability to arise under applicable law; and

i. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. §4630 and §4655) and the Uniform Regulations contained in 49 C.F.R. Part 24, in acquiring real property interests necessary for construction, operation, and maintenance of the project including those necessary for relocations, and placement area improvements; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to higher authority as proposals for authorization and implementation funding. However, prior to transmittal to higher authority, the sponsor, the states, interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

____________________________ DATE:

Jeffery S. Palazzini
Colonel, U.S. Army
Commanding

9.0 LIST OF PREPARERS

The IFR-EA was prepared by members of USACE Alaska District (Table 28). The Environmental Resources Section provide the environmental analysis incorporated into this IFR-EA.

Table 28. Preparers of the IFR-EA.

NAME	TITLE	QUALIFICATIONS
Tyler Teese	Archeologist	Anthropology (B.A.)
Chris Floyd	Biologist	Biochemistry and Molecular Biology (M.S.)
Fern Spaulding	Biologist/Planner	Biological Science (M.S.)
Danielle Perkins	Cost Engineer	Civil Engineering (B.S.), and Engineer in Training (E.I.T.)
Rachel Roberts	Economist	Economics (B.S.), and Masters in Public Policy (M.P.P.)
Twain Cacek	Geotechnical Engineer	Geoengineering (M.S.), and Engineer in Training (E.I.T.)
Olivia Jobin	Lead Hydraulic Engineer	Civil Engineering (M.S.), and Professional Engineer (P.E.)
Leif Hammes	Project Manager	Geology (B.S.), and Civil Engineering (M.S.)
Patricia Lemay	Reality Specialist	Bachelor of Business Administration (BBA)

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APPENDICES

Appendices were used to supplement the content of the IFR-EA. The list below represents the general appendices that were applicable to the Robe Lake Ecosystem Restoration CAP 206 feasibility study. These appendices include further technical details and supplemental information. In general, information provided in the report appendices serves to validate and support statements and decisions made in the main report.

A. HYDRAULICS & HYDROLOGY APPENDIX

B. COST ENGINEERING APPENDIX

C. ENVIRONMENTAL APPENDIX

D. REAL ESTATE APPENDIX

E. ECONOMIC APPENDIX

F. GEOTECHNICAL APPENDIX

G. CORRESPONDENCE APPENDIX