US Army Corps of Engineers®
Alaska District

Draft Integrated Feasibility Report and
Draft Environmental Assessment

Lowell Creek Flood Diversion
Seward, Alaska

September 2020

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Seward, Alaska

Prepared By:

U.S. Army Corps of Engineers
Alaska District

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EXECUTIVE SUMMARY

This General Investigations (GI) study is being conducted under the authority granted by Section 5032 of the Water Resources Development Act (WRDA) of 2007. This study evaluates Federal interest and the feasibility of constructing a flood risk management project at Lowell Creek in Seward, Alaska. The current flood diversion system at Lowell Creek was completed in 1940 by the United States Army Corps of Engineers (USACE). The Lowell Creek Flood Diversion project consists of a diversion dam, emergency spillway, and tunnel, with the diversion dam and tunnel entrance located approximately one-tenth of a mile west of the closest buildings of Seward, Alaska (AK), near the mouth of Lowell Creek Canyon.

The purpose of this study is to identify a feasible solution that provides safe, reliable, and efficient flood diversion of the waters from Lowell Creek during precipitation and surge events. The existing flood diversion system in Lowell Creek Canyon does not adequately manage flood events and presents a risk to life, property, and critical infrastructure with little to no warning. Excessive flood waters from the current system continue to threaten life safety in Seward and pose a significant threat of economic damages to the City of Seward. Sedimentation flowing from the outfall creates a tenuous situation with a history of damage and destruction of the bridge on Lowell Point Road as well as flooding of the shellfish hatchery, Alaska SeaLife Center, and the city's sewage treatment facility. This project would reduce risk to life safety, economic damages, and flood fighting and reactionary debris management costs. It would also address landslide issues, which can compound the flooding effects and damages by initiating surge releases.

The current diversion dam and tunnel divert stream flow from the natural stream channel, through Bear Mountain and into Resurrection Bay at the south edge of downtown Seward. The terrain in the basin is mountainous, consisting of steep slopes and loose rock. Therefore, the system is prone to heavy sediment loads and blockage of the tunnel from upstream debris and trees. In addition, the Lowell Creek watershed has been rated by the United States Geological Survey (USGS) as having a high potential for landslide induced surge release flooding, which creates an extremely hazardous flood condition. The tunnel, as designed, is capable of passing a flow of 2,800 Cubic Feet per Second (cfs); however, the estimated probable maximum flood (PMF) for Lowell Creek is 8,400 cfs. If debris forms a landslide dam upstream of the tunnel and that dam is subsequently breached, the resulting surge flow can reach as much as 19,000 cfs during a PMF event. At approximately 2,800 cfs, or sooner if the tunnel becomes blocked by debris, water would aggregate behind the diversion dam, which has little storage capability, and start overflowing the emergency spillway with flows going immediately into downtown Seward, creating a risk to life safety.

In addition to the issues at the tunnel inlet and dam, the tunnel outlet poses additional shortcomings—debris flowing through the tunnel exits at the outfall very close to the bridge on Lowell Point Road. One event in 1986 deposited an estimated 120,000 cubic yards (cy), burying the bridge with 20 feet (ft) of debris. Seward actively combats the debris accumulation during events with heavy machinery to remove debris at the outfall, which presents its hazards. The accumulation of debris not only poses the threat of damaging the bridge and isolating the Lowell Point community but also can damage critical infrastructure, including the city's sewage treatment facility.

As this is a flood diversion structure, the risk to life and safety was incorporated into the study early on, and a hybrid risk assessment was conducted to understand better the life safety risks associated with a potential project.

Seven alternatives, including No Action, were evaluated, which include improving or enlarging the existing tunnel, constructing a new tunnel, and constructing an upstream retention basin, along with nonstructural measures. No alternative produced positive National Economic Development (NED) benefits. A NED policy exception from the Assistant Secretary of the Army for Civil Works (ASA-CW) was obtained. Alternatives were evaluated using total life safety risk as exemplified by average annual life loss (AALL) as a metric for Cost-Effectiveness/Incremental Cost Analysis (CE/ICA). The initial alternatives considered were:

- Alternative 1: No Action
- Alternative 2: Improve Existing Flood Diversion System.
- Alternative 3: Enlarge Current Flood Diversion System to Convey Larger Flow considering two tunnel diameter options below:
  (3A) 18 ft Tunnel
  (3B) 24 ft Tunnel
- Alternative 4: Construct New Flood Diversion System considering two tunnel diameter options below:
  (4A) 18 ft Tunnel
  (4B) 24 ft Tunnel
- Alternative 5: Construct Debris Retention Basin.

A new outfall design is a structural measure applicable to Alternatives 2, 3A, 3B, 4A, and 4B, because these alternatives include modification of the existing and/or creation of a new tunnel. The outfall is evaluated as a separable element because it is a consistent measure applied to each applicable alternative for plan selection purposes. The basic design is relatively consistent, primarily differing in length of the outfall. Five differing design lengths were analyzed: 100 ft, 150 ft, 500 ft, and 750 ft. The designs have been considered during the study, and qualitatively compared to effectiveness, benefits, and the rough-order-magnitude (ROM) cost. The 150 ft outfall with an estimated construction cost of $14 million (M) provides optimal benefits to the community with adequate sedimentation control for the project.

The CE/ICA analysis produced three Best Buy alternatives (No Action, Alternatives 4A, and 4B), one cost-effective plan (Alternative 2), and two non-cost effective plans (Alternatives 3 and 3B). Alternative 4B was eliminated due to exorbitant incremental costs. This alternative would provide similar benefits to Alternative 4A, but at a much higher cost

The Tentatively Selected Plan (TSP) is Alternative 4A: Construct New Flood Diversion System. Structural components of this alternative would include a new 18 ft diameter tunnel upstream from the existing tunnel, refurbishing the existing tunnel, extending the outfall 150 ft to take flow and debris over the road, protecting the tunnel inlet from landslide with a canopy, and improving the low flow diversion system. Non-structural components would include tree removal and implementation of an early warning system and evacuation plan. Alternative 4 has a project first cost of $122,928,000. The total National Economic Development cost, including the cost of operations and maintenance and interest during construction, is $124,618,000.The average annual equivalent cost is $5,768,000, with annual National Economic Development benefits of $1,456,000. Using certified costs for the TSP, the project's benefit-cost ratio is 0.25, with net annual benefits of -$4,312,000. With the approval of the NED exception waiver, CE/ICA was utilized in combination with NED benefits analysis to determine Alternative 4A as the Best Buy plan, which fully met the objectives of the study.

PERTINENT DATA

Existing Lowell Creek Diversion Features (retained in the future with or without project)	
Existing Diversion Dam	
Design crest elevation	Varies approx. 225.7 – 203.2 feet (NAVD88)
Crest width	5 feet
Length	450 feet
Structural height (maximum height above streambed)	25 feet
Existing Uncontrolled Dam weir/spillway	
Crest Elevation	199.0 feet NAVD88
Width	~70 feet
Maximum discharge capacity	1,700 cfs
Existing Tunnel	
Diameter & Shape	10-foot diameter semi-elliptical horseshoe
Length	2,089 feet
Average Grade	-4.2 %
Maximum discharge capacity	Approx. 2,800 cfs
Existing Outfall	
Type	Inverted Flume
Elevation	70.5 feet (NAVD88)
Width	10 feet
Length	109 feet
New Lowell Creek Diversion Features	
New Diversion Dam	
Design crest elevation	
Crest width	
Length	
Structural height (maximum height above streambed)	
New Tunnel	
Diameter & Shape	18-foot diameter horseshoe
Length	2,270 feet
Average Grade	
Maximum discharge capacity	Approximately 8,500 cfs
New Outfall	
Type	Elevated open-channel flume
Elevation at outlet	57.88 ft MLLW
Width	8 ft base and 14 ft top
Grade	-7.0 %
Length	150 feet

Notes:

1. All elevations given in this table are based on the 1945 design drawing elevations rounded to the nearest 10th of a foot, comparing these values with the 2006 LiDAR topographic data, which is in NAVD88, and subtracting 3.5 feet to make the 1945 elevations roughly match the 2006 LiDAR elevations. This is an approximate adjustment.
2. The hydraulic height value given is based on the 2006 LiDAR data.
3. The Source of data is the 2012 inundation report and original contract drawings.

Economics	
Item	**Total ($)**
Total Average Annual Equivalent Cost	$5,768,000
Total Average Annual Equivalent Benefit	$1,456,000
Net Annual National Economic Development Benefits	($4,312,000)
Benefit-Cost Ratio	0.25

TENTATIVELY SELECTED PLAN

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LIST OF ACRONYMS AND ABBREVIATIONS

AAEQ	Average Annual Equivalent
AALL	Average Annual Life Loss
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AdH	Adaptive Hydraulics
ADNR	Alaska Department of Natural Resources
AEP	Annual Exceedance Probability
AHRS	Alaska Heritage Resources Survey
APE	Area of Potential Effect
APF	Annual Probability of Failure
AVSP	Alaska Visitor Statistics Program
BCR	Benefit-Cost Ratio
C	Celsius
CAA	Clean Air Act
CAP	Continuing Authorities Program
CE/ICA	Cost-Effectiveness and Incremental Cost Analysis
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic Feet Per Second
CWA	Clean Water Act
CWBS	Cost-Work Breakdown Structure
CY	Cubic Yards
DSAC	Dam Safety Action Classification
DERP	Defense Environmental Remediation Program
DLWD	Department of Labor & Workforce Development
DPS	Distinct Population Segment
E	Exponent
EFH	Essential Fish Habitat
EA	Environmental Assessment
EM	Engineering Manual
EPA	Environmental Protection Agency
EQ	Environmental Quality
ER	Engineer Regulations
ERM	Environmental Resources Management
EJ	Environmental Justice
ESA	Endangered Species Act
Etc.	Et Cetera
F	Fahrenheit

FCSA	Federal Cost Sharing Agreement
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
FWCA	Fish and Wildlife Coordination Act
FWOP	Future Without Project
FWP	Future With Project
ft	Foot/Feet
GMSL	Global Mean Sea Level
GNF	General Navigation Feature
H	Horizontal
HAPC	Habitat areas of particular concern
HEC-RAS	Hydraulic Engineering Center's River Analysis System
H&H	Hydraulics and Hydrology
HTRW	Hazardous, Toxic, or Radioactive Waste
IDF	Inflow Design Flood
IES	Issue Evaluation Study
IFR/EA	Integrated Feasibility Report and Environmental Assessment
IPPC	Intergovernmental Panel on Climate Change
KFNP	Kenai Fjords National Park
LERRD	Lands, Easements, Rights of Way, Relocations, and Disposal Area
LiDAR	Light Detection and Ranging
LSF	Local Service Facilities
MBTA	Migratory Bird Treaty Act
$\mu g/m^3$	Micrograms per cubic meter
M	Million
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
MPRSA	Marine Protection, Research and Sanctuaries Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
M_w	Moment Magnitude
N/A	Not Applicable
NAAQS	National Ambient Air Quality Standards
NAVD88	North American Vertical Datum of 1988
NED	National Economic Development
NEPA	National Environmental Policy Act
NFS	Non-Federal Sponsor
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service

NRC	National Research Council
NRHP	National Register of Historic Places
O&M	Operation and Maintenance
OCT	Opportunity Cost of Time
OHA	Office of History and Archaeology
OMRR&R	Operation, Maintenance, Repair, Replacement, and Rehabilitation
OSE	Other Social Effects
PA	Periodic Assessment
PDT	Project Delivery Team
PMF	Probable Maximum Flood
pH	Power of Hydrogen
PPA	Project Partnership Agreement
RED	Regional Economic Development
R	Republican
ROI	Region of Influence
ROM	Rough Order of Magnitude
RSLC	Relative Sea Level Change
SHPO	State Historic Preservation Officer
SLC	Sea Level Change
SPRA	Screening Portfolio Risk Assessment
U.S.	United States
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
V	Vertical
WRDA	Water Resources Development Act

1. INTRODUCTION

1.1 Project and Study Authority

This General Investigations (GI) Study was authorized by Section 5032 of the Water Resources Development Act (WRDA) of 2007. Section 5032 directs the U.S. Army Corps of Engineers (USACE) to assume long-term maintenance responsibilities for the Lowell Creek Flood Diversion tunnel until 08 November 2022, or until an alternative (alt) method of flood diversion is constructed and operational, whichever is earlier. The legislation also directs the USACE to study whether an alternative method of flood diversion at Lowell Canyon is feasible. The legislative language follows.

SEC. 5032. LOWELL CREEK TUNNEL, SEWARD, ALASKA

(a) LONG-TERM MAINTENANCE AND REPAIR

(1) Maintenance and Repair: The Secretary shall assume responsibility for the long-term maintenance and repair of the Lowell Creek tunnel, Seward, Alaska.

(2) Duration of Responsibilities: The responsibility of the Secretary for long-term maintenance and repair of the tunnel shall continue until an alternative method of flood diversion is constructed and operational under this section or 15 years after the date of enactment of this Act, whichever is earlier.

(b) STUDY. The Secretary shall conduct a study to determine whether an alternative method of flood diversion in Lowell Canyon is feasible.

(c) CONSTRUCTION

(1) Alternative Methods: If the Secretary determines under the study conducted under subsection (b) that an alternative method of flood diversion in Lowell Canyon is feasible, the Secretary shall carry out the alternative method.

(2) Federal Share: The Federal share of the cost of carrying out an alternative method under paragraph (1) shall be the same as the Federal share of the cost of the construction of the Lowell Creek tunnel.

USACE implementation guidance for the authority specific to the study portion states:

At such time as funds are appropriated for such work, the District should conduct a reconnaissance study to determine whether an alternative method of flood diversion in Lowell Canyon is feasible in accordance with procedural guidance contained in ER 1105-2-100. If the reconnaissance study determines that there is at least one feasible solution, once funds are appropriated for such work, the District should conduct a feasibility study in accordance with current budgetary policy and procedural guidance contained in ER 1105-2-100 for projects authorized without a report. The costs of the feasibility study will be shared 50 percent Federal and 50 percent non-Federal pursuant to a Feasibility Cost Sharing Agreement. The feasibility report will be submitted to the POD RIT for policy compliance review by HQUSACE and approval by the Secretary.

Upon approval of a report that documents a feasible alternative to flood diversion in Lowell Canyon and receipt of Federal funding for construction of such alternative, a *project partnership agreement (PPA) addressing design and construction of the approved plan may be executed in accordance with the current guidance on the preparation of, approval, and execution of PPAs. The design and construction of the approved plan shall be accomplished at Federal expense, and the non-Federal sponsor shall provide, at no cost to the Government, all lands, easements, and rights-of-way.*

1.2 Scope of the Study

This study evaluates the feasibility and environmental effects of implementing flood risk management improvements at Lowell Creek in Seward, Alaska. The USACE Regulation (ER) 1105-2-100, “Planning Guidance Notebook,” defines the contents of feasibility reports for flood risk management. ER 200-2-2, “Procedures for Implementing NEPA,” directs the contents of environmental assessments. This document presents the information required by both regulations as an Integrated Feasibility Report and Environmental Assessment (IFR/EA). It also complies with the Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA, 42 U.S.C. 4321 et seq.).

The Alaska District is primarily responsible for conducting studies for flood risk management improvements at Lowell Creek in Seward, Alaska. The analyses conducted for this study were made possible with assistance from many individuals and agencies, including the City of Seward, Kenai Peninsula Borough, the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Alaska Department of Fish and Game (ADFG), Alaska Department of Environmental Conservation (ADEC), Alaska Department of Natural Resources (ADNR), Alaska State Historic Preservation Office (SHPO), and many members of the interested public who contributed information and constructive criticism to improve the quality of this IFR/EA.

1.3 Non-Federal Sponsor (NFS)

The non-Federal sponsor for this project is the City of Seward.

1.4 Congressional District

The study area lies wholly within the State of Alaska, with the Congressional delegation of Senator Lisa Murkowski (R), Senator Dan Sullivan (R), and Representative Don Young (R).

1.5 Related Reports and Studies

<u>USACE Reports</u>

Letter from the Secretary of War Transmitted to Congress (1937) - This letter provides the basis of design and historical information about Lowell Creek and the previous flood control project.

Operation and Maintenance Manual (1946) – The District completed the operation and maintenance manual with these responsibilities turned over to the city in 1946.

Historical Data: *Flood Control Project on Lowell Creek at Seward, Alaska (1949)* – This provides a brief overview of the early history of Lowell Creek and the Flood Control Project.

Lowell Creek Dam, Phase I Inspection Report, National Dam Safety Program (1978) – This report was part of a nationwide effort to ensure implementation of the National Dam Safety Program. No critical deficiencies were discovered.

Flood Damage Reduction Revised Reconnaissance Report, Seward, Alaska (1992) – This report presents a reconnaissance level study of the possibility of modifying or replacing the Lowell Creek Flood Project at Seward. Based on the findings in this report, a feasibility study is recommended.

Position Paper: Scoping the Initial Project Management Plan for Lowell Creek at Seward, Alaska (1995) – This paper argues that only alternatives that provide an emergency spillway for flows that exceed the tunnel capacity be considered in the feasibility report.

Reconnaissance Report Modifications to Completed Project Lowell Creek, Seward, Alaska (2007). This report presents a reconnaissance level study of the Lowell Creek tunnel and diversion dam at Seward, Alaska, including deficiencies inherent in the original project, ramifications of the deficiencies, and proposed solutions.

Lowell Creek Dam, Seward, Alaska, Interim Risk Reduction Measures Plan (2011) – This assessment classified the Lowell Creek Dam as a Dam Safety Action Classification (DSAC) III dam. This classification places the Lowell Creek Dam in a category of “high priority,” which is considered conditionally unsafe, requiring immediate attention to reduce risk from potential failure modes. Implementation of seven interim risk reduction measures were recommended to reduce the probability of potential uncontrolled debris flows through Seward.

Seward, Alaska, Planning Assistance to States Flood Risk Management (2011) - This report provides flood mitigation information including risk assessment and hydrologic, economic, and environmental elements that will assist in the long-term management of water resources development in the vicinity of Seward, Alaska. Although Lowell Creek was not included in the analysis, the report provides an overview of flooding threats persistent throughout Seward.

Lowell Creek Inundation Study, Seward, Alaska (2012) - This report was prepared to assist with an emergency action plan for the City of Seward during extreme flooding scenarios in the Lowell Creek Watershed. Four downstream flooding scenarios were modeled: 100-Year Flood with the complete failure of the Lowell Creek Tunnel, Probable Maximum Flood (PMF) with the tunnel operational, PMF with debris dam surge release, and PMF with an uncertain alluvial fan flow path.

Lowell Creek Flood Damage Reduction, Trip Report; Lowell Creek Tunnel Inspection (2013) – This report documents the 2013 inspection done on the Lowell Creek tunnel by USACE.

Lowell Creek Tunnel, Seward, Alaska, Operations, and Maintenance Letter Report (2015) - This report presents a summary of the repair and maintenance that has been done on the Lowell Creek Tunnel in Seward, Alaska and the associated costs of these activities. This report also outlines the estimated extent of the long-term maintenance and repair that will be required at the Lowell Creek Tunnel for the 15 years after the enactment of the Water Resources Development Act of 2007.

In addition to the above reports, there are project inspection reports and letter reports documenting project maintenance and repairs.

Reports by Others

CH2M HILL (1979) Reconnaissance Feasibility Study Hydroelectric Potential on Lowell Creek.

U.S. Geological Survey (USGS). 1988. Flood of October 1986 at Seward, Alaska, Water-Resources Investigations Report 87-4278.

Seward/Bear Creek Flood Service Area. 2013. Flood Hazard Mitigation Plan, Jun 2013.

1.6 Study Location

The Lowell Creek Flood Diversion System is in Seward, Alaska. It reroutes Lowell Creek through Bear Mountain and around the City of Seward to Resurrection Bay (Figure 1). The City of Seward, with a population of 2,545 (2019 population estimate according to the Alaska Department of Labor and Workforce Development, Research and Analysis Section), lies immediately below the flood diversion system at the head of Resurrection Bay on the Kenai Peninsula, 125 miles south of Anchorage by the highway. It has one of the two ice-free ports in Alaska with road and rail connections to the state’s interior.

Figure 1. Location of Seward, Alaska

1.6.1 Existing Infrastructure and Facilities

The main components of the existing Lowell Creek Flood Diversion System include a diversion dam, emergency spillway, tunnel, and outfall (Figure 2). More detailed drawings depicting the key features of the existing system and the proposed project are included in Appendix B. The pertinent data for these existing components are presented in Table 1.

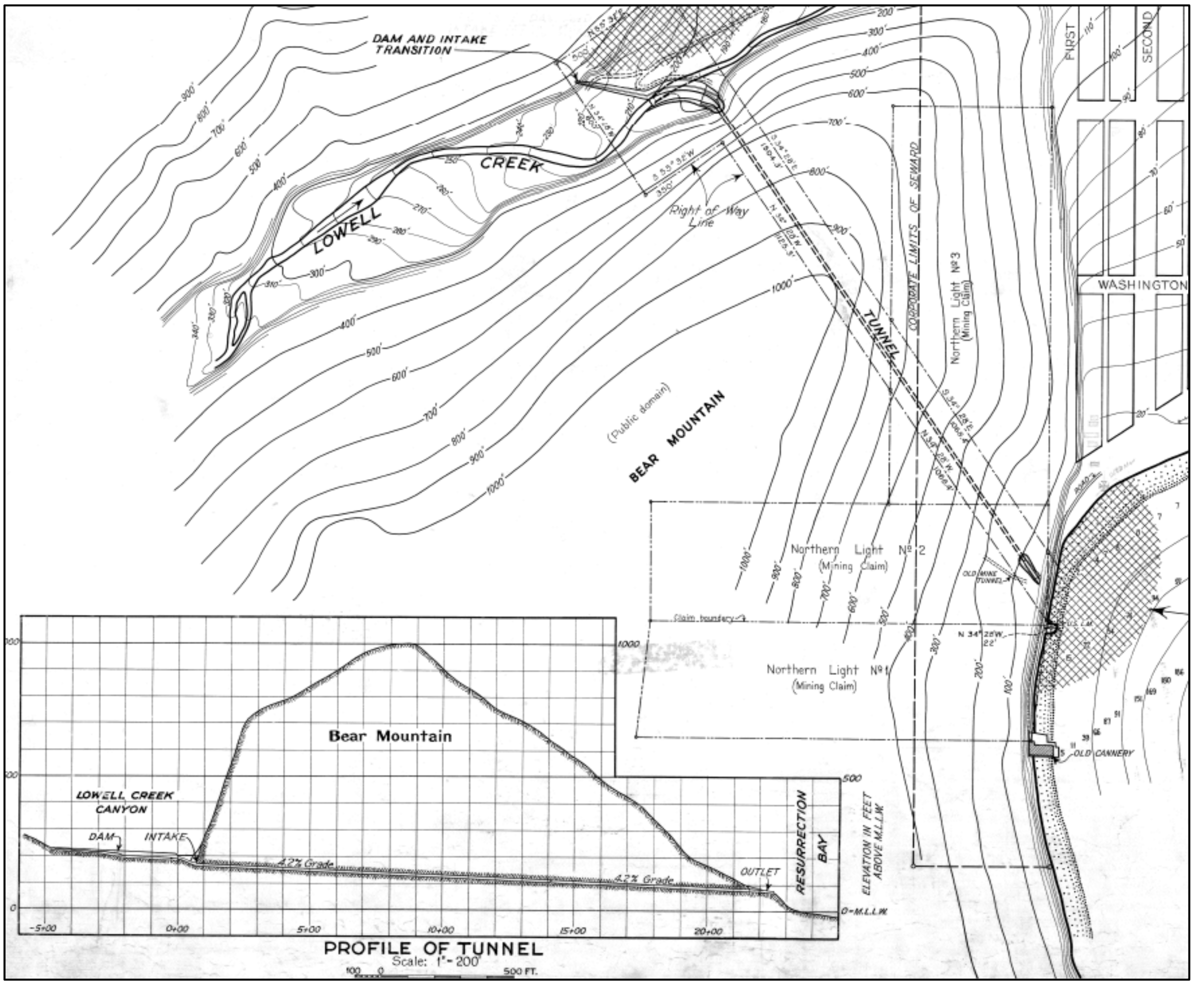

Figure 2. Existing System Overview

Table 1. Existing Lowell Creek Flood Diversion System Components

Lowell Creek Diversion Dam	
Type	**Diversion Dam**
Design crest elevation	Varies approx. 225.7 – 203.2 feet (NAVD88)
Crest width	5 feet
Length	450 feet
Structural height (maximum height above streambed)	25 feet
Lowell Creek Dam Emergency Spillway	
Type	**Uncontrolled weir**
Crest Elevation	199.0 feet NAVD88
Width	40 feet
Maximum discharge capacity	1,700 cfs
Lowell Creek Tunnel	
Type	**Tunnel**
Size	10-foot diameter, semi-elliptical/horseshoe-shaped
Length	2,089 feet
Average Grade	-4.2 %
Maximum discharge capacity	Approx. 2,800 cfs
Lowell Creek Tunnel Outfall	
Type	**Inverted Flume**
Elevation	70.5 feet (NAVD88)
Width	10 feet
Length	109 feet

Notes:

1. All elevations given in Table 1 are based on the 1945 design drawing elevations rounded to the nearest 10th of a foot, comparing these values with the 2006 LiDAR topographic data, which is in NAVD88, and subtracting 3.5 feet to make the 1945 elevations roughly match the 2006 LiDAR elevations. The adjustment is approximate.
2. The hydraulic height value given is based on the 2006 LiDAR data.
3. The Source of data is the 2012 inundation report and 1945 design drawings.

Reservoir Data

No reservoir data is available for the system as it does not retain a pool, and no flow gage is present at the inlet to obtain flow data. It has been noted that the storage area has been near full (within 0.7 foot of spillway) during the 1986 event.

Dam

The diversion dam consists of a 450 feet long rock-filled embankment with a crest elevation that varies from 203.2 to 225.7 feet, the North American Vertical Datum of 1988 (NAVD88), and a maximum height of 25 feet (Figure 3). The dam is designed to divert water into the tunnel and is not intended to impound water for long periods. The upstream slope at one horizontal to one vertical (1H:1V) is lined with a reinforced concrete slab. The downstream slope at two horizontal to one vertical (2H:1V) is lined with a grouted rock fill. The rock-fill for the embankment was specified to range in size from one-half cubic feet to one cubic yard, of which not less than 25 percent shall be in pieces of five cubic feet or more in volume. Rock chips and spalls were specified to be included only to the extent necessary to fill the voids between the larger stones. Rock slabs having an average thickness of less than 25 percent the average width were not allowed. The left abutment of the dam is constructed against the canyon wall, with the rock-cut to a four horizontal to one vertical (4H:1V) slope and a concrete slab attached with dowels against the rock face. The dam's right abutment dam is tied into the tunnel entrance, which is cast into the rock of Bear Mountain. A 12-inch drain pipe was also installed for use during maintenance operations; however, debris has plugged this pipe, and it is not usable.

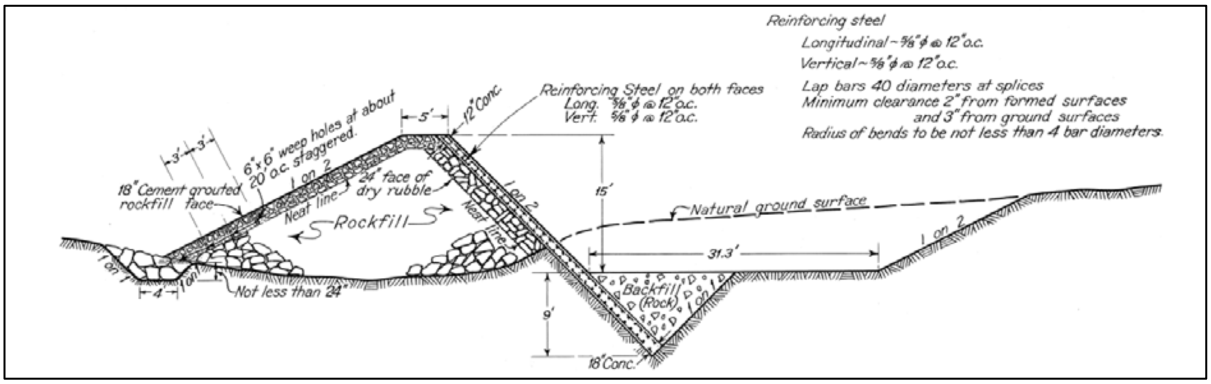

Figure 3. Typical Embankment Cross-section

The City of Seward placed a water line under the left abutment in 1985. During the installation of this water line, a section of the dam was removed to facilitate construction. During the rebuilding of this dam section, fill soil was used as core material for the dam. It is not known what compaction requirements were required for the backfill material.

Spillway

The emergency spillway is an uncontrolled weir with a discharge capacity of 1,700 cubic feet per second (cfs). The downstream side of the dam is three horizontal to one vertical (3H:1V) at the spillway and is protected by the same grouted rock fill. The spillway is a 40-foot long section of the dam with a crest elevation of 199.0 feet NAVD88. Water flowing over the spillway has no channel to enter and would flow directly into downtown Seward in less than one-minute time. The first structures to be impacted by flow are a retirement center and the Seward Hospital. A PMF event would have catastrophic damages. Additional details can be found in Appendix B: Geotechnical Appendix.

Floodway

The Lowell Creek Flood Diversion System provides essentially no floodwater storage, functioning only to divert water into the Lowell Creek Tunnel. The project also does not include a channel downstream from the spillway to convey water. Once passing over the spillway, flood water will flow unimpeded down gradient through a highly developed area of Seward with as many as 298 structures at risk. The original channel before diversion was down what is now Jefferson Street. Flood flows would begin on Jefferson Street but would spread over the populated alluvial fan. Peak water levels would reach populated areas of Seward with essentially no warning time. The diversion dam would be overwhelmed in seconds with all flow and debris diverted down the historic Lowell Creek channel reaching the town in just a few minutes. This limited warning time, coupled with uncertain flow paths, makes an effective evacuation very difficult.

Tunnel

The tunnel consists of a ten-foot-high horseshoe-shaped tunnel through Bear Mountain that is 2,089 feet long, with an average grade of 4.2 percent. It is designed with a sharp drop at the intake transition; this accelerates the water to approximately 43 feet per second and facilitates debris movement through the tunnel. The tunnel was constructed with drill and blast techniques. The bedrock was supported with timbers and lagging until the placement of the tunnel liner. It is believed the timber supports were left in place during liner construction, and no contact grouting was performed after the liner was emplaced. The tunnel is lined with concrete throughout and was originally armored with 40-pound railroad rails welded to the channel cross ties embedded in the invert. Sheet 2 of the 1945 original drawings has details that can be found in Appendix B. The outside curve side of the tunnel is also rail lined at the intake. The spaces between rails were filled with concrete during subsequent tunnel repairs. The tunnel capacity, assuming the spillway crest is wholly filled, has been computed to 2,800 cfs.

Outfall

The tunnel discharges to an outfall, which consists of a trapezoidal concrete flume ten feet wide at the bottom and 109 feet long. The flume invert is 70.5 feet NAVD88, which allows for the accumulation of debris that is carried through the tunnel. The flume exits over a near-vertical rock cliff. At the toe of the cliff, the debris forms a creek channel, which continues until about 500 feet to tidewater. A two-lane bridge crosses the channel about 100 feet from the toe of the mountain.

1.6.2 Climate

The Gulf of Alaska coast of the Kenai Peninsula has relatively mild winters and cool summers; mean winter lows range from 0 to 20 °F, while mean highs in the summer are below 60 °F. The extreme mountain relief and its effect on the coastal maritime climate cause great local variations in weather in the Resurrection Bay-Seward area. The lifting and cooling of moist air masses at the mountain fronts cause a rapid increase in precipitation with increasing elevations along the windward side of the mountains. Mean annual precipitation ranges from 67 inches at Seward to more than 100 inches in the high-elevation glaciated areas. About 40 percent of the total annual precipitation falls like rain from September through November. Beginning in early October, the precipitation above an altitude of 2,100 feet is usually in the form of snow, most of which is stored in mountain and glacier snowpack. Severe flooding on Lowell Creek normally mirrors the October through November rainfall period, with one known major flood occurring as late as early December. Seward averages 172 days with precipitation a year.

1.6.3 Topography

Lowell Creek drains a 4.02 square mile basin between Mount Marathon and Bear Mountain to the west of Seward (Figure 4). The terrain in the basin is mountainous, consisting of steep slopes of loose rock. Due to the steep slopes of the basin and the rocky nature of the material, rain falling in Lowell Creek Canyon has a high runoff percentage and a low time of concentration.

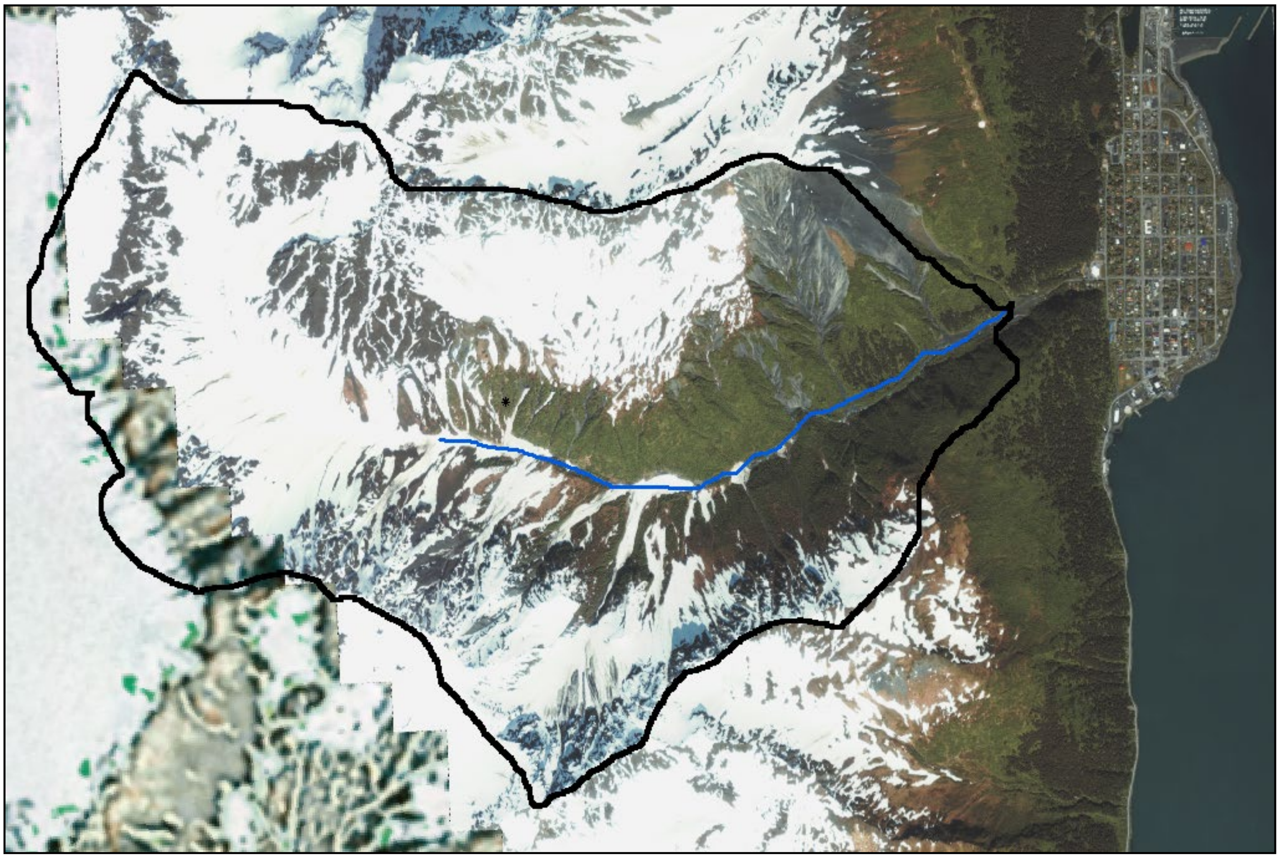

Figure 5. Lowell Creek Drainage Area

There are several creeks in the Seward area, most notable for this study is Spruce Creek (Figure 5). Spruce Creek provided data that was translated as a proxy for Lowell Creek.

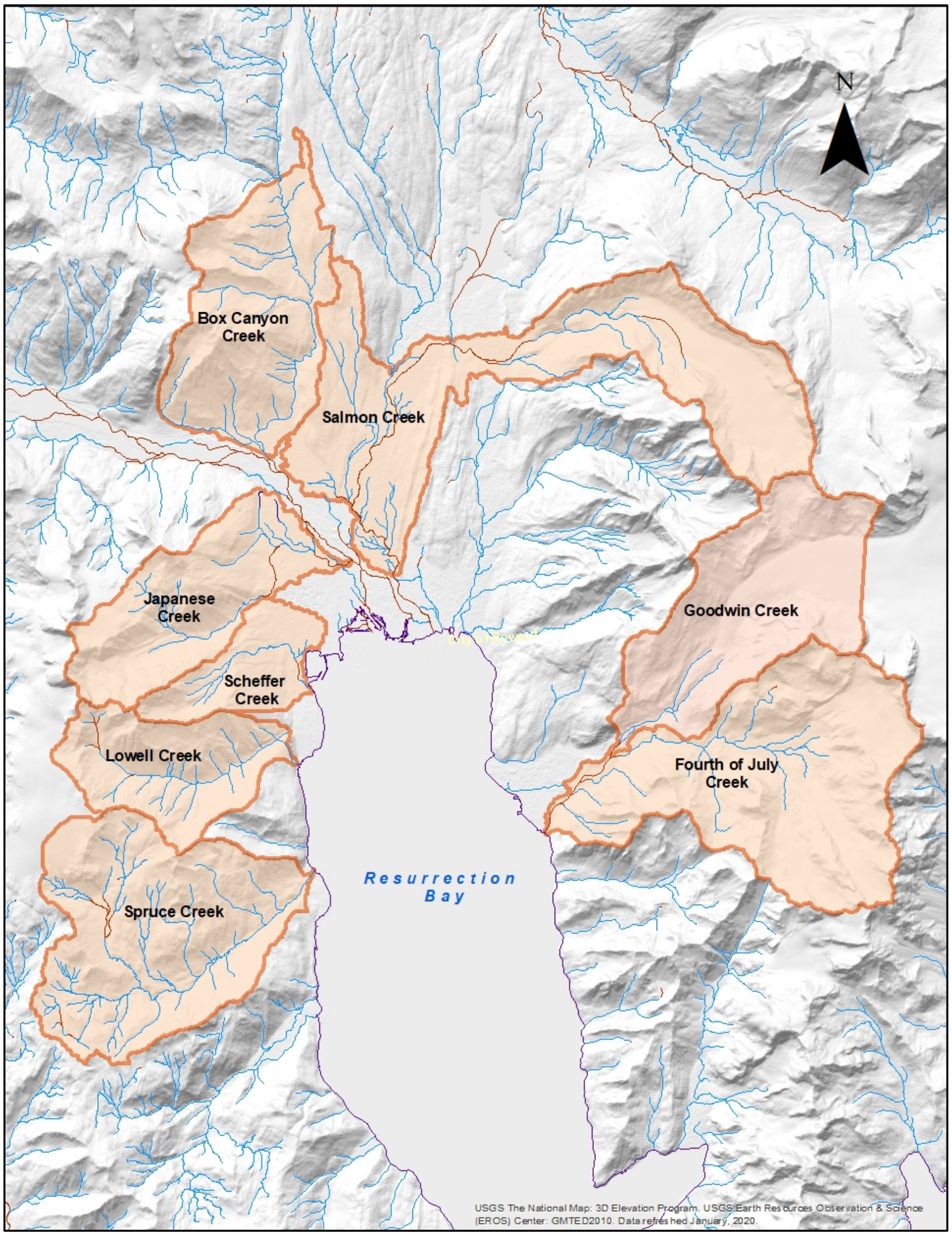

Figure 6. Watersheds in the Seward Area and their spatial relation to Lowell Creek.

1.6.4 Geology

Seward is located on the Kenai Peninsula at the north end of Resurrection Bay. The Kenai Mountains are composed primarily of sedimentary rocks that show a wide range of character and varying degrees of metamorphism. The material was deposited as impure sand and mud. With time and pressure, the sediments were cemented into shale and impure sandstone. It was further altered during the folding of the mountains, due to plate tectonics. The common geologic structure now appears as hard shale, or argillite, and greywacke, or impure quartzite, although locally metamorphism has proceeded far enough to convert them to slate or schist. Surface weathering in this area is significant with temperature fluctuation (freeze/thaw cycle) and high rain quantities noted for the surrounding geographic regain. With these factors, the rock structure within this drainage basin produces great quantities of trap rock or shingle, which has a very flat angle of repose and is readily transported by water action. Recent satellite imagery indicates that there is still significant landslide activity within this drainage basin. The City of Seward was built on an alluvial fan delta, made from these sediments, which was deposited from Lowell Creek’s old drainage paths.

Alternating units of greywacke and phyllite constitute virtually all of the bedrock near Seward. The rocks in the site area are of the greywacke complex of which the shale member is at the site. It is through the shale member that the tunnel passes. The bedding of the shale is steeply dripping at about 65 degrees to the west and strikes north-south. The rock cleaves parallel to the bedding planes. The shale appears quite competent for the tunnel. The main structural trend of the rocks in the Seward area is from near north to approximately north 20 degrees east. Beds and cleavage commonly dip 70 degrees west or northwest to near vertical.

Small faults, shear zones, and joints are common. The rocks are commonly offset a few inches vertically to several feet along these faults. The shear zones, mostly less than five feet wide, commonly are made up of angular pieces of greywacke or phyllite a few inches to a few feet long, though some are composed of finely ground rock fragments or a bluish-gray clayey gouge. The more massive greywacke is characterized in many places by a major and a secondary joint system. North of Lowell Point, where the joints are well exposed, the major set strikes north 60-70 degrees west and dips approximately 85 degrees northeast, and the secondary set trends northeastward. Most of the joints are filled with quartz, but some are filled with calcite.

The rocks in the Kenai Peninsula bordering Resurrection Bay are of the greywacke complex, which forms a crescent from the southern tip of the Kenai Peninsula northeast to Valdez thence eastward towards Yakutat. The greywacke series is composed of conglomerate beds and thick beds of shale with some thin limestone members. Unconsolidated glacial and fluvial deposits overlie the bedrock except on the steep, higher slopes. Remnants of the lateral moraines flank the main valley of Resurrection River and extend up the sides of tributary valleys to a maximum altitude of about 1,500 feet. The moraines are heavily vegetated in most places, but where exposed, consist of smaller amounts of clay-sized particles, cobbles, and large boulders. Glaciers in the Seward area have been retreating and thinning in recent years. Continuation of this trend would create and leave additional areas of unconsolidated moraine material subject to accelerated erosion and deposition by streams. Terminal or recessional moraines in mountain glaciated areas may be sufficiently well-preserved so that they dam the stream that replaces the melting glacier.

1.6.5 Seismicity

Alaska is the most seismically active state in the United States (U.S.). An average of one magnitude eight or greater earthquake in every 13 years has occurred in Alaska, one M7-8 earthquake has occurred every two years, and six M6-7 earthquakes occur every year. Crustal deformation in Alaska is dominated by the subduction of the Pacific Plate and the Yakutat microplate beneath the North American plate. Earthquakes with a magnitude (M_w) greater than 5.5 that have occurred between 1900 and 2004 in Alaska can be seen in Figure 6.

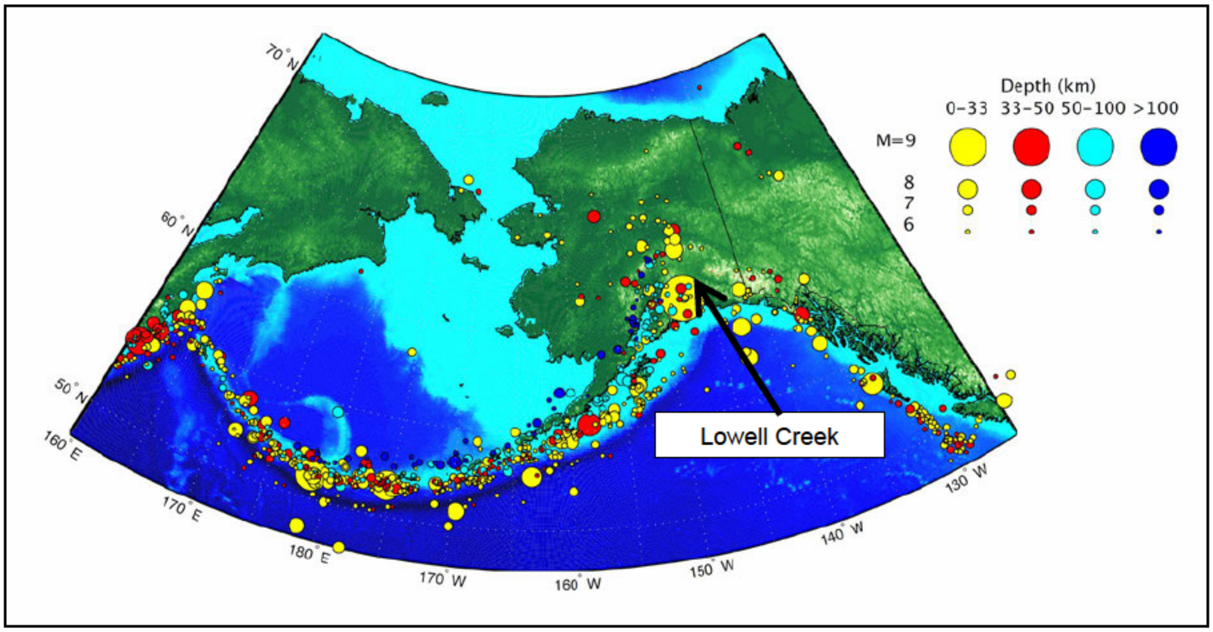

Figure 7. Alaska Earthquakes with Mw ≥ 5.5 from 1900 to 2004 (Wesson et al. 2007)

Most of the seismicity in Alaska is associated with the Alaska-Aleutian megathrust fault, which runs along the Aleutian arc (see Figure 6). The fault is where the northwestward-moving Pacific plate is subducting beneath the North American plate (Wesson et al. 2007). The Alaska-Aleutian subduction zone is the source for the 1938 M8.3 Alaska Peninsula earthquake, the 1946 M7.8 Unimak earthquake, 1957 M8.6 Fox Islands earthquake, 1964 M9.2 Prince William Sound earthquake, and the 1965 M8.7 Rat Islands earthquake (Koehler et al. 2012). The 1964 Prince William Sound earthquake M_w 9.2 is the second-largest earthquake in the world ever recorded. Other significant sources of seismicity include the Denali fault in south-central Alaska and a series of northwest-striking right-lateral strike-slip faults that run along the panhandle of southeast Alaska. These faults form the northeast boundary of the Pacific Plate (Wesson et al. 2007). The 2002 Denali fault earthquake M_w 7.9 is the largest earthquake to occur on land in the U.S. since the 1906 San Francisco earthquake. The Denali fault ruptured over a distance of 340 kilometers, with up to eight meters of offset during the event (Wesson et al. 2007).

The effects of the Prince William Sound earthquake on the City of Seward are described in Lemke (1967) and summarized as follows. Strong ground motion lasted three to four minutes in Seward. During the earthquake, a 50 to 400 feet wide strip of land along the Seward waterfront slid into Resurrection Bay as a result of large-scale submarine land sliding. Waves generated by the slide and later tsunami waves inundated the shore.

Wave run-up was as much as 30 feet above mean lower low water and caused significant damage to the city. Damage from the strong ground motions were comparatively minor. Tectonic subsidence of about 3.5 feet resulted in low areas being inundated at high tide. The earthquake reactivated old slides and triggered new ones in the mountains. Snow avalanches were triggered in Lowell canyon; two in the lowermost mile of the canyon reached the creek bed and piled up snow, rock fragments, and broken trees as high as 30 feet.

There are no seismic instruments at the project. According to a Lowell Creek Tunnel Repair Report dated August 2001, the 1964 Alaska earthquake did not affect the project.

2. PLANNING CRITERIA/PURPOSE AND NEED FOR THE PROPOSED ACTION*

2.1 Problem

2.1.1 Problem Statement

The existing flood diversion system in Lowell Canyon does not adequately manage flood events and presents a risk to life, property, and critical infrastructure with little to no warning. The tunnel inlet at Bear Mountain is capable of transporting relatively low flows (up to 2800 cfs) through the system and is prone to blockages from upstream debris. However, either a higher flow event or tunnel blockage would lead to flows going immediately into downtown Seward. In addition, the area at the tunnel outfall near Resurrection Bay is prone to the accumulation of debris and sediments at the bridge on the only road to the Lowell Point community. On multiple occasions, the bridge has been damaged, destroyed, and/or buried under as much as 20 feet of debris. The damage to the bridge has led to the isolation of Lowell Point and damage to critical infrastructure and the Alaska SeaLife Center.

2.2 Purpose and Need

The purpose of the project is to improve the flood risk management of flows associated with Lowell Creek at Seward, Alaska. The need for the project is to reduce damages and life loss due to uncontrolled flows from Lowell Creek, which are associated with large precipitation events.

2.3 Opportunities

The project would help provide the following opportunities at Seward through flood risk management:

- Reduce outfall operations and maintenance
- Enhance advanced warning and evacuation time and capabilities
- Address landslide issues
- Reduce impact on docks and businesses at the outlet
- Maintain access to roads and evacuation routes
- Reduce impacts from seismic or other events
- Allow beneficial use of removed material
- Provide ecological benefits

2.4 National Objectives

Federal Interest in improving the Lowell Creek Flood Diversion System at Seward, Alaska, has been documented previously in USACE reports from 1992 and 2011. Anticipated benefits include flood damage reduction benefits for structures, vehicles, and infrastructure (such as the costs to repair roads, bridges, sewers, power lines, etc.), as well as reductions in emergency costs and future operation and maintenance costs. Improvements to life safety will also be realized by reducing the risk of the existing flood diversion system capacity being surpassed, though, to date, such an event has not occurred—the LifeSim modeling estimates of potential damages from a PMF event range from $19.65M to $24.54M. The construction of the original flood diversion system was completed in 1940. Since then, USACE spent an estimated $6.7M maintaining the system, while the City of Seward has spent over $4M. [redacted] Thus far, an array of potential alternatives ranging from smaller-scale improvements to the existing system to full replacement of the existing system ($156 M) have been identified.

2.5 Study Objectives

The overarching objective of this study is to improve flood risk management at Lowell Creek in Seward and to realize any associated opportunities that may arise from doing so to improve the quality of life for the residents of Seward.

Planning objectives for the study include the following:

- Reduce risk to public health, life, and safety from flooding of Lowell Creek to the City of Seward, Alaska
- Reduce flood damages to property and critical infrastructure in the City of Seward
- Reduce the cost of emergency response and management of post-flood event cleanup
- Reduce operation and maintenance costs

2.6 Study Constraints

Constraints are restrictions that limit the planning process related to laws, policies, and resource availability. There are no known legal constraints at this time. Additional constraints for this study include:

- Modifications must comply with federal and state dam safety regulations
- Tolerable Risk Guidelines are only applicable to the incremental risk and cannot be used for plan determination for this study (Planning Bulletin 2019-04 and ECB 2019-15 detail the use for tolerable risk guidelines and define the risk to be considered with them as incremental risk)
- Impacts to historic sites and/or sites of cultural importance should be avoided or minimized
- Impacts on environmental resources and environmental quality should be avoided or minimized

2.7 National Evaluation Criteria

The Water Resources Council's Federal Principles and Guidelines document establishes four criteria for the evaluation of water resources projects. These criteria and their definitions are explained below.

2.7.1 Acceptability

Acceptability is defined as "the viability and appropriateness of an alternative from the perspective of the Nation's general public and consistency with existing Federal laws, authorities, and public policies. It does not include local or regional preferences for particular solutions or political expediency."

2.7.2 Completeness

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 large in scope or scale."

2.7.3 Effectiveness

Effectiveness is defined as "the extent to which an alternative alleviates the specified problems and achieves the specified opportunities."

2.7.4 Efficiency

Efficiency is defined as "the extent to which an alternative alleviates the specified problems and realizes the specified opportunities at the least cost."

2.8 Study Specific Evaluation Criteria

According to USACE's Implementation Guidance (Section 1105 of WRDA 2016), if there is no NED plan and/or the selection of a plan other than the NED plan is based in part or whole on non-monetary units, the recommendation will be supported by a Cost-Effectiveness/Incremental Cost Analysis (CE/ICA). The metric for this study and the results of the CE/ICA analysis are presented in Appendix D: Economics and below in Section 6.5, "Cost-Effectiveness and Incremental Cost Analysis (CE/ICA)."

2.8.1 Risk and Life Safety

The risk to human life is inherent in any flood management project. Lowell Creek Diversion Dam and Tunnel is currently categorized as DSAC 3 based on the Screening Portfolio Risk Assessment (SPRA). The primary reasons for that classification were potential overtopping of the structure from a PMF event or an event with a plugged tunnel from debris. It is imperative to appropriately assess this risk and ensure any actions would not detrimentally increase such risk and would work to alleviate existing risk. To this end, the team conducted a hybrid risk assessment and completed a consistency review of the risk assessment in accordance with ER 1110-2-1156. The assessment was used to determine if there were any potential causes for failure, Potential Failure Modes (PFMs), which would affect the function of the existing diversion dam and tunnel during normal operation. This information was compiled together to develop probable solutions that would mitigate the risks from the failures. It was realized that the current structure did not adhere to the USACE definition of a dam due to lack of water impoundment and that the structure presented little, if any, incremental risk. With these facts in mind, the feasibility study team used Total Risk rather than incremental risk for a feasibility study risk assessment of Lowell Creek Diversion Dam and Tunnel since the incremental risk is used specifically within USACE for dam safety projects. For this assessment, Total Risk was defined as the combination of total life loss [redacted] and the likelihood of failure [redacted]

[redacted]

3. BASELINE CONDITIONS/AFFECTED ENVIRONMENT*

3.1 Physical Environment

Lowell Creek passes through a rocky, rugged canyon near Seward, bordered by steep hillsides and talus-covered slopes. The stream, approximately three miles long above the tunnel, has a drainage area of about 4.1 square miles. Ground cover in the canyon is sparse (30 percent), consisting of low-growing shrubs and patches of isolated spruce and cottonwood trees in the lower portion of the basin. Small glaciers in the upper extent of the basin provide an impervious area of about ten percent of the watershed. Lowell Creek has a gradient of 1,000 feet per mile and transports large amounts of debris, often including boulders, to a one-half cubic yard in volume. On average and using all available data, it is estimated that over 25,000 cubic yards of rock and other debris are carried through the tunnel by stream flow each year. There are no levees downstream, and there are no dams upstream or downstream of the Lowell Creek constructed features, either in the original creek flow path or in the current flow path of the stream.

Seward lies at the head of Resurrection Bay, a deep fjord about 25 miles long on the north shore of the Gulf of Alaska. Near Seward, the bay is two to three miles wide and about 500 feet deep. The water is deep immediately offshore except at the head of the bay and at the toe of alluvial fan-deltas that have formed at the mouths of steep-gradient streams tributary to the bay. The glaciated Kenai Mountains rise steeply above Resurrection Bay and the valley of the Resurrection River, with the highest peaks on the west side of the bay and river reaching elevations of 4,000 to 5,000 feet above sea level.

3.1.1 Aesthetics

Almost the entirety of the existing project is located within Lowell Canyon and inside Bear Mountain and is not visible to the general public or would take significant effort to observe. Also, several safety features such as exclusionary fencing and signage on the crest of the diversion dam have been erected specifically to prevent accidents from people getting too close to the tunnel entrance invert. However, the point of outfall is readily observable in south Seward and forms a somewhat scenic waterfall feature that naturally attracts attention from tourists and residents alike.

3.1.2 Soils/Sediments

Sediments in the Lowell Creek watershed are comprised almost uniformly of greywacke shale that has been mechanically weathered from the surrounding exposed mountain faces. Generally, the in-channel sediments above the diversion dam and tunnel structures are made up of cobbles and boulders. Sediments in the vicinity of the outfall are the same greywacke shale. Still, they have been pulverized by hydrodynamic forces as they traveled the Lowell Creek channel and tunnel system, emerging as coarse sands, gravels, and cobbles. Nearshore intertidal and subtidal benthic sediments near the Lowell Creek outfall are identical to those at the outfall.

3.1.3 Water Quality

According to the Alaska Department of Environmental Conservation's (ADEC) water quality mapping tool, accessed April 2020, the surface waters of Lowell Creek are not categorized as being impaired. There is no infrastructure or otherwise anthropogenic footprint in the upper portions of the Lowell Creek watershed above the diversion dam. Surface flows are variable and heavily influenced by precipitation events.

Similarly, the water quality of Resurrection Bay meets ADEC water quality standards and is not impaired. However, due to glacial activity in the upper watersheds ringing Resurrection Bay, ambient turbidity levels in Resurrection Bay can be elevated for hours to days following regular precipitation events.

3.1.4 Air Quality

Seward is not in or near a "non-attainment," "maintenance," or Class I area (as defined by the Clean Air Act) for any criteria pollutants.

Contributing to Seward's good air quality is the readily observed rigorous atmospheric convection. The terrain surrounding Seward is steep and facilitates orographic forcing on low-pressure systems generated in the Gulf of Alaska and the North Pacific Ocean, resulting in precipitation and varying air pressure gradients.

3.1.5 Hazardous, Toxic, and Radioactive Waste

According to the Alaska Department of Environmental Conservation (ADEC)'s contaminated sites database, accessed April 2020, there are no Hazardous, Toxic, and Radioactive Waste (HTRW) sites, active or otherwise, in the community of Seward or the Lowell Creek watershed.

3.1.6 Noise

Wind, rain, and the sounds of Lowell Creek's surface waters flowing through the existing diversion, tunnel, and outfall are the most prominent sources of ambient noise in the vicinity of the proposed project. The portion of the watershed above the diversion dam is acoustically isolated by Lowell Creek's steep canyon walls, hillside vegetation, and whipping winds. The outfall area, located south of Seward's population center, experiences ambient noise generated by ocean waves, nearby vehicle and vessel traffic, wind, rain, and the sounds generated by surface flows from the exit of the tunnel to where they empty into Resurrection Bay.

3.1.7 Surface Water Stream Flow

There exists only a minimal history of surface water flow measurements for the Lowell Creek system. In-stream gaging of the surface waters of Lowell Creek has been problematic to implement due to the system's bedload during high flow events.

3.2 Biological Resources

3.2.1 Terrestrial Habitat

Vegetation characteristics for the Lowell Creek watershed are little different than previously described in 1978: "approximately 30% of the upland drainage exhibits vegetative cover, and is comprised of low growing alders, small shrubs, and isolated patches of scrub conifers" (USACE 1978). Vegetation does not occur upon the steeper portions of the surrounding slopes. It is limited to an area of transitional slope between creek bankfull and the boundary of the bare rock/scree zone that constitutes the majority of the watershed. The area beneath the tunnel discharge flume to the point where Lowell Creek's surface waters meet Resurrection Bay is completely devoid of vegetation. Discharge velocities and debris deposition in this section are sufficient to preclude vegetation establishment.

3.2.2 Birds

The scope of analysis for birds is an area of approximately100 acres of terrestrial and nearshore marine habitat between the diversion structure and the outlet of the tunnel into Resurrection Bay. This area encompasses the land and water, where both direct and indirect impacts could potentially occur. There are a variety of birds that may occur in this area; the most common birds in the forested areas include the black-billed magpie and Steller's jay. Along the coast, the most common species are pigeon guillemot, red-breasted merganser, common and thick-billed murres, black oystercatcher, black-legged kittiwakes, and a variety of gull species.

Bald eagles are frequently observed in the area of Resurrection Bay, and along with golden eagles, receive special conservation status under the Bald and Golden Eagle Protection Act. Bald eagles in Alaska initiate courtship and nest-building behaviors in January and February, and generally, September through January is considered the non-nesting period (USFWS 2020). No site-specific bald or golden eagle nest surveys have been conducted in Lowell Creek's upper watershed or along the coastal portion of the proposed project area.

3.2.3 Terrestrial Mammals

A list of terrestrial mammals potentially occurring within the Lowell Creek watershed is derived from the adjacent Kenai Fjords National Park (KFNP)'s species account list and includes black bear, brown bear, beaver, coyote, mountain goat, snowshoe hare, little brown bat, lynx, hoary marmot, marten, mink, moose, meadow jumping mouse, northern bog lemming, porcupine, shrew (5 species), red squirrel, vole (4 species), short-tailed weasel, gray wolf, and wolverine.

Lowell Canyon's sparsely vegetated hillsides and steep, talus covered slopes, and flashy hydrologic characteristics likely do not provide suitable habitat for the entirety of the KFNP species list mentioned above. However, terrestrial mammals may utilize portions of the Lowell Creek watershed as a transit corridor between areas of higher habitat quality. Terrestrial mammals would not be expected to utilize the existing project features as a form of preferred habitat and would likely choose to avoid it.

3.2.4 Freshwater Fish

There are no freshwater fish in Lowell Creek. Furthermore, the existing outfall structure acts as a complete barrier to anadromy.

3.2.5 Marine Habitat

Since the inception of the existing diversion dam, tunnel, and outfall, sediment deposition at the outfall point is actively building an alluvial fan in the same fashion that the alluvium that Seward sits on is also derived from the deposition of Lowell Creek sediments. As such, these depositional sediments encroach into the waters of Resurrection Bay and become intertidal and subtidal components of the marine habitat. This encroachment interface, where Lowell Creek sediments are deposited, is naturally highly disturbed, both through continual deformation of the loose sediments, but also through covering of the exposed sediments by new sediments as the alluvium grows; this condition generally precludes the establishment of marine algae and subsequent invertebrate communities. Based upon available aerial imagery comparisons and multiple site visits, USACE biologists have determined that because of the substrate homogeneity and existing disturbance regime, intertidal and nearshore subtidal marine habitat in the vicinity of the Lowell Creek outfall alluvium is relatively poor when considered against the proximal marine habitats of the greater Resurrection Bay.

3.2.6 Marine Mammals

There are no marine mammals that are known to occur within the project’s footprint, as proposed.

3.2.7 Federal and State Threatened and Endangered Species

There are no Federal or State threatened or endangered species that are known to occur within the project’s footprint, as proposed. The USACE’s coordination efforts with the U. S. Fish and Wildlife Service (USFWS) under the precepts of the Fish and Wildlife Coordination Act are detailed in Appendix H.

3.2.8 Essential Fish Habitat

Lowell Creek is not designated as Essential Fish Habitat (EFH).

3.2.9 Invasive Species

Because of its climate and relative geographic isolation, the establishment of invasive species, both floral and faunal in Alaska is generally curtailed. KFNP maintains a list of established invasive plant species that are observed within the National Park, and it is expected that due to proximity, some of these species may be established in the Lowell Creek watershed. Similarly, the Alaska Department of Fish and Game (ADFG) provides invasive species information on their website along with preventative methods for reducing the risk of invasive species introduction. Currently, the status of invasive species, particularly to the Lowell Creek watershed, is unknown.

3.3 Socio-Economic Conditions

3.3.1 Population

In 2019, the State of Alaska Department of Labor and Workforce Development estimated Seward's population to be 2,545. However, there are multiple census-designated places outside Seward's city limits that are still located within the greater Seward area (Table 2).

Table 2. Area Population

Area	2019 Estimated Population	Distance from Downtown Seward (miles)
City of Seward	2545	0
Lowell Point Census Designated Place (CDP)	94	2
Bear Creek CDP	2,093	5
Crown Point CDP	80	25
Moose Pass CDP	233	28
Primrose CDP	65	18
Total:	**5,110**	

The population is approximately 69 percent White, 17 percent American Indian or Alaska Native, 3 percent African American, 2 percent Asian, and 8 percent two or more races in combination. Other small groups (less than 1 percent) include Pacific Islanders. The population is 58 percent male and 42 percent female. The median age of the population is 38 years.

Seward experiences an increase in the daytime population during the tourism season that ranges from May to September. Seward is known in Alaska as being a tourist destination for its deep-sea fishing, boat tours, hiking trails, the Alaska SeaLife Center, and summer festivals. The Seward 4th of July celebration can draw close to 40,000 people, according to the Seward Chamber of Commerce. Other large draws include halibut and salmon tournaments, music festivals, and craft fairs. Tourists arrive in Seward on various forms of transportation, including cruise ships, ferries, tour buses, passenger vehicles, and trains. Generally, tourists are not familiar with the area being visited and are susceptible to natural disasters, which would include a flood event with little warning time along Lowell Creek.

Tourism visitation data was provided by the Alaska Visitor Statistics Program (AVSP), which is a statewide visitor study funded by the Alaska Department of Commerce. A report was published in 2017 that details tourism data and statistics for the state during the 2016 tourist season. The report estimated that Seward hosted 441,000 tourists during the 2016 calendar year.

3.3.2 Employment & Income

According to the Alaska Department of Labor and Workforce Development, 59 percent of resident workers were employed during 2012 (the last year for which statistics are available). The largest industry is Trade, Transportation, and Utilities with significant employment in Education and Health Services, Leisure and Hospitality, and State and Local Government. A great number of workers are employed through commercial fishing and businesses that support that industry. The mean per capita income in Seward is approximately $27,810, with a median household income of $70,000 and a median family income of $86,875. Approximately 6 percent of residents have incomes lower than the Federal poverty threshold.

3.4 Cultural Resources

Although no prehistoric sites are recorded in the vicinity of the estimated proposed project footprint, the Lowell Creek Diversion Tunnel is located within the project area and identified in the Alaska Historic Resources Survey (AHRS) database as SEW-00011. The structure was visited during a survey in 2018. The survey reaffirmed that there are no other historic properties located in the vicinity upriver of the dam, as well as the spillway area. The site was listed on the National Register of Historic Places (NRHP) in 1977 by the Keeper of the National Register under Criterion C “for its embodiment of pioneering engineering characteristics” (OHA 2018). There are approximately 100 historic properties that have been identified within the downtown Seward area. The historic properties have not been evaluated for the NRHP and include several buildings, features, and districts.

The Seward area has a long history going back 4,000 to 3,500 years ago, with sites identified by archaeologists as semi-permanent settlements which were inhabited depending on seasonal food sources. In 1793, Russian explorers established a fort and harbor at the head of Resurrection Bay. The City of Seward was founded in 1902 and is an important fixture to the growth and history of Alaska (AKDCCED 2019). A more thorough history of the City of Seward can be found in Appendix G: Correspondence, as the Letter to the SHPO.

3.4.1 Area of Potential Effect

The Area of Potential Effect (APE) is a National Historic Preservation Act (NHPA) specific term. The APE includes any areas that would be used for the proposed project. The area generally includes construction sites, access routes, staging areas, worker camp locations, monitoring wells, etc. The APE is defined in the Code of Federal Regulations (36 CFR §800.16(d)) as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist, for the foreseeable future. The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.

3.4.2 Historical Context

Since the city's founding in 1902, Seward has been subjected to damages from the water and sediment transported by Lowell Creek. Efforts to alleviate these threats predate the current flood diversion system. In 1918, a pile and timber-lined channel 100 feet wide by 15 feet deep was excavated across town along Jefferson Street. This channel was completely overtopped with detritus from a single fall flood later that year (Letter from the Secretary of War Transmitted to Congress 1937). In 1929 the Alaska Railroad constructed a 12-foot-wide, 7-foot-deep, 3,300-foot-long, pile-supported, rectangular timber flume. Although initially effective for several years, beginning in 1934, the flume became prone to clogging with debris and overtopping from each flood (Letter from the Secretary of War Transmitted to Congress 1937). The current flood diversion system was identified as an alternative for construction when it was evident that the flume was no longer a viable one.

Lowell Creek is currently ungauged, and there is no known validated historical stream gage data available. Severe flooding on Lowell Creek normally mirrors the October through November rainfall period. Floods are generally of short duration, lasting only 3 or 4 days. Lowell Creek rises very rapidly, with flooding occurring soon after heavy rainfall begins. The existing diversion dam has not been overtopped during any previous flood events. In October 1986, water came to within 1 foot of the spillway crest of the diversion dam. Peak flow on Lowell Creek during the 1966 storm was estimated at 1,200 cfs by the US Geological Survey (USGS). Peak flow on Lowell Creek was estimated to be approximately 2,300 cfs for the 1986 flood and 1,810 cfs for a September 1995 storm. For comparison, the PMF of Lowell Creek is estimated to be 8,400 cfs. During all three storms, the tunnel suffered damage requiring repairs. No damages were reported for the diversion dam. Due to the lack of stream gauge data, there may be additional high flow events not captured above, but high flow events with flooding and significant debris in the outfall area are also known to have occurred in 2006, 2009, 2012, 2015, and 2016, with the first three years noted as requiring significant debris removal as discussed in Section 3.5, "Debris Maintenance and Flooding at Outfall."

3.4.3 Environmental Justice and Protection of Children

Executive Order (E.O.) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," directs Federal agencies to identify and address any disproportionately high and adverse human health or environmental effects of their actions on low-income, minority, and tribal populations, to the greatest extent practicable and permitted by law. An environmental justice (EJ) analysis typically includes the following elements:

a) Identification of any minority and/or low-income status communities in the project area;
b) Identification of any adverse environmental or human health impacts anticipated from the project; and
c) Determination of whether those impacts would disproportionately affect minority and/or low-income communities.

E.O. 13045, “Protection of Children from Environmental Health Risks and Safety Risks,” directs Federal agencies to identify and address environmental health and safety risks that may disproportionately affect children, to the greatest extent practicable and permitted by law. This analysis typically builds off of the EJ analysis. It includes a determination of whether the identified adverse environmental or human health impacts anticipated from the project would disproportionately affect children.

3.4.4 Protected Tribal Resources

The Executive Memorandum on Government-to-Government Relations with Native American Tribal Governments of 1994, the Department of Defense American Indian and Alaska Native Policy of 1998, and the Department of the Army Memorandum on American Indian and Alaska Native Policy of 2012 require that the USACE assess the impact that Federal projects may have on protected tribal resources and assure that the rights and concerns of Federally-recognized Tribes are considered during the development of such projects. Protected Tribal Resources are defined by the Department of the Army as those natural resources and properties of traditional or customary religious or cultural importance, either on or off Tribal lands, retained by, or reserved by or for Federally-recognized Tribes through treaties, statutes, judicial decisions or executive orders. The Federal government’s trust responsibility, deriving from the Federal Trust Doctrine and other sources, for these Protected Tribal Resources is independent of their association with Tribal lands.

3.5 Debris Maintenance and Flooding at Outfall

The outfall conditions at the end of the tunnel cause flooding and major maintenance costs for the Department of Public Works of the City of Seward. Each year approximately 25,000 cubic yards of rock and other debris are carried through the tunnel by stream flow. One flood event in the fall of 2012 generated an estimated

120,000 cubic yards of debris (the City of Seward, pers. comm.). During major flooding, the deposition of large quantities of debris effectively forms an alluvial fan at the outfall, which brings debris and floodwaters into contact with adjacent buildings and infrastructure. The adjacent fisheries dock and Alaska SeaLife Center dock have experienced increased dredging needs due to infilling from the sediment. The City of Seward uses heavy equipment to push the material into the bay or remove it from the site during the actual flooding event, putting equipment operators and other personnel at extreme risk (Figure 8 and Figure 9). Removal of this material is not desirable as the State of Alaska charges a royalty on the material if it is removed from the outfall area. Sediment discharged from the tunnel has buried the Lowell Point Road Bridge, which has required both repair and replacement as a direct result of the debris-laden floodwaters and the activity of flood fighting in this area. Damage has happened even without the flood volumes that are of greatest concern for property damage and loss of life.

Figure 9. Heavy Equipment Removing Sediment from Tunnel Outfall during 2012 Flood

In October 2006, a typhoon remnant resulted in 9 to 15 inches of rain in Seward for over 48 hours. The resultant outflow from the tunnel placed 15 feet of debris atop the Lowell Creek Bridge. Lowell Point residents had to rely on water transportation to get into town for three days while city workers hurried to clear the bridge. Water from the falls joined with tidal water to flood the adjacent shellfish hatchery with water and bury it in the gravel. The City of Seward sewage treatment facility was flooded, and the freshwater pump house belonging to the Alaska SeaLife Center was destroyed. City utility lines were also damaged (Seward/Bear Creek Flood Service Area 2013).

On July 29, 2009, storm-driven tides and heavy rain wreaked havoc on the city waterfront. Lowell Point Road was closed due to gravel overwhelming the Lowell Creek Bridge and water running across the approaches (Figure 10).

Figure 10. Lowell Creek Bridge during 2009 Flood

Over 8 inches of rain in September 2012 also caused high flows, again impacting the Lowell Creek Bridge and adjacent facilities with debris and high water (Figure 11).

Figure 11. Tunnel Outlet Area during 2012 Flood

3.5.1 Surge Release Flooding

During the October 1986 flood, five other Seward area streams had landslide debris blockages that resulted in surge releases when the blockages were breached. Such surge releases may be an order of magnitude above non-surge effected flood flows in terms of water and debris volume and associated consequences. Investigations by the USGS following the 1986 flood concluded, based on the geomorphology of Lowell Creek, that there was a high potential for similar landslide induced surge release flooding on Lowell Creek. Such a surge release would expose the flood diversion structure to elevated stream flows and debris loads, increasing the chance of an overflow with or without a tunnel blockage. A PMF compounded with a surge release event is estimated to be capable of producing stream flow of up to 19,000 cfs, far exceeding the capacity of the existing system.

3.5.2 Alluvial Fan Flooding

A majority of Seward is located upon the broad alluvial fan formed at the mouth of Lowell Canyon. Alluvial fans are depositional landforms located at the base of mountain ranges where a steep mountain stream emerges onto lesser valley slopes. They are usually conical or fan-shaped in plan view. The most recent flow path of Lowell Creek before construction of the diversion dam was down Jefferson Street through the middle of town (Figure 11). Hydrologically, flooding on alluvial fans is characterized within two generally defined areas. The upper area of the alluvial fan contains a section where the flow path can generally be determined with some degree of certainty. This area is subject to erosion and deposition, but a relatively stable flow path remains during floods. Downstream from this area, alluvial fan flooding is characterized by flow path uncertainty so considerable that this uncertainty cannot be set aside in a realistic assessment of flood risk or the reliable mitigation of the hazard. Flood flows will include floating debris, suspended sediment, and a portion of the Lowell Creek bedload in addition to debris and sediment that is entrained downstream from the diversion dam, such as material from damaged houses swept away from people’s yards and driveways.

PLATE NO. 2
MOUTH OF LOWELL CREEK, FLUME, AND SEWARD TOWNSITE, AUGUST 1936.

Figure 12. Oblique Aerial View of Seward (1936), Looking Downstream from Mt. Marathon

3.5.3 Tunnel Maintenance and Repair Needs

Since completion of the original project in 1940, repairs have been made to the tunnel because of damage from regular wear or high flow events. Repairs have been conducted both by USACE and the City of Seward. The first major repair of the tunnel took place in 1945. Tunnel repairs were made in 1968, 1980, 1984, 1988, 1991, 2003, and 2017. The tunnel continues to deteriorate due to continual wear and periodic high flow events. Repair and maintenance can only be done during the winter low-flow periods. While winter construction does make the work more complicated, it is the difficulty of dealing with occasional higher than normal flows and the short duration of the low-flow season that limits what can be accomplished in any given construction season. A large scour hole in the tunnel floor that reached bedrock and was approximately 30 ft long (Figure 13) was repaired in 2017, but all the recommended repairs to the tunnel could not be completed during the 2017 construction season. A summary of repair activities and costs since the original construction was completed is presented in Table 3.

Figure 13. Large Scour Hole in Floor of Tunnel Repaired During 2017 Repairs

Table 3. Lowell Creek Flood Diversion System Repair Activities and Costs

Date	**Party**	**Repair**	**Cost**	**Cost in 2017 Dollars (a)**
Annual	USACE/City	Annual Tunnel Inspection Trip and Report	$10,000/year	$10,000/year
1945	USACE/City	Rails welded to steel channel cross-ties and finished with concrete to complete the project.	Unknown	
Up to 1978	USACE	PL 84-99 authorized repairs performed to replace loose rails on the floor and tunnel walls. Rails welded to sole plates, and concrete lining between the floor rails was replaced.	$ 447,000 (b)	$1,713,000
1980	City	All loose rails were removed from the tunnel by the City of Seward.	Unknown	
1984	City	Loose rails removed and replaced, concrete placed between invert rails, the cover of Anvil Top placed over concrete between invert rails, sidewall rails repaired at the tunnel entrance. All protective rails in the middle third of the tunnel and the outfall plume section were removed due to degraded conditions. New concrete was not placed in this area due to a lack of funding and the end of the low flow period.	$1,700,000 (includes $1,500,000 for construction, $226,600 for design, and $20,000 for engineering during construction)	$4,236,000
1988	USACE	Alaska District performs emergency repairs under PL 84-99. Available funding was spent filling one large hole in the tunnel floor and a few other adjacent holes rather than all of the recommended repairs due to the lack of funding, and the end of the low flow period prevented any other work from being done.	$512,000	$1,179,000
1991	USACE	Alaska District performs repairs under PL 84-99. Repairs included filling invert holes with concrete and installing silica fume concrete over the invert.	$421,000	$870,000
2003	USACE	The Alaska District performs one-time emergency repairs as authorized by Section 510 of WRDA 2000. Repairs included the replacement of ten rails in the ogee section, and the entire invert was	$ 1,935,000	$3,022,000

		brought up to the original finish grade with 10,000 psi silica fume concrete.		
2017	USACE	Repairs included removing loose concrete between the rails at the intake transition and tunnel entrance and replacing with 10,000 psi silica fume concrete, filling a large gouge in the tunnel sidewall and hole in the adjacent floor, and extending steel rail wall armoring by approximately 30 feet.	$3,170,000	$3,170,000
Total	**USACE/City**	**Total without annual inspection expense.**	**N/A**	**$14,190,000**

(a) Costs adjusted to 2017 dollars using EM 1110-2-1304 Amendment 9 (30 Sep 2016), using the Yearly Cost Indexes by CWBS Feature Code. The Feature Code used was 09, Channels, and Canals.
(b) Detailed annual project cost information is not available before 1978. The costs shown for this repair are all the funds expended by the USACE prior to 1978.

3.6 Environmental Resources Not Considered in Detail

Initial evaluation of the effects of the proposed project indicated that there would likely be little to no effect on several resources. This analysis also considers the No-Action alternative, where the proposed project is not implemented. These resources are identified and discussed in Table 4.

Table 4. Environmental Resources Not Considered in Detail

Resource	Authority	Technically Important	Reason for Dismissal
Climate	National Environmental Policy Act of 1970; EC 1165-2-211	Promotes enhancement of the environment by evaluating the effects of government actions on a full suite of resource categories. Incorporates the physical effects of projected sea-level rise in planning, engineering, designing, constructing, operating, and maintaining USACE projects.	Short- and long-term greenhouse gas emissions resulting from the implementation of this project would be negligible. The Hydraulics and Structural Design appendix of this Integrated Feasibility Report contains sea level rise planning and design analysis regarding this project.
Geology/Topography	National Environmental Policy Act of 1970.	Promotes enhancement of the environment by evaluating the effects of government actions on a full suite of resource categories.	Implementation of USACE's project would not affect the geology or topography of the immediate region.
Seismicity	National Environmental Policy Act of 1970	Promotes enhancement of the environment by evaluating the effects of government actions on a full suite of resource categories.	Implementation of USACE's project would not affect the seismicity of the region.

Air Quality	Clean Air Act of 1963, as amended; National Environmental Policy Act of 1970.	Designed to control air pollution from listed criteria pollutants on a national level; promotes the enhancement of the environment by evaluating the effects of government actions on a full suite of resource categories.	Clean Air Act conformity determination requirements do not apply to USACE's project at this time.
Hazardous, Toxic, and Radioactive Waste	USACE Regulation 1165-2-132, HTRW guidance for Civil Works projects; 18 AAC75 (ADEC)	USACE defines the roles and responsibilities of HTRW sites. ADEC provides regulations for the management of such sites.	According to the ADEC Contaminated Sites database, no HTRW sites occur within or adjacent to all portions of USACE's project footprint.
Currents/Tides/Circulation/Surface Water Stream Flow	National Environmental Policy Act of 1970.	Promotes enhancement of the environment by evaluating the effects of government actions on a full suite of resource categories.	Implementation of USACE's project would not impact tidal regimes or nearshore currents. Also, the surface flows of Lowell Creek would still be directed through Bear Mountain and would discharge to Resurrection Bay.
Biological Resources			
Fish and Essential Fish Habitat	Magnuson Stevens Fishery Management and Conservation Act of 1976, as amended.	Resurrection Bay and the majority of its constituent freshwater streams are designated as Essential Fish Habitat. Section 305(b)(2) of the Magnuson Stevens Act requires Federal action agencies to consult with National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service on all actions, or proposed actions, authorized, funded, or undertaken by the agency that may adversely affect Essential Fish Habitat.	Lowell Creek does not support populations of freshwater fish, and its outfall flume and subsequent waterfall are barriers to anadromy. No portion of the proposed project's footprint would extend into the waters of Resurrection Bay. There would be no impacts on Essential Fish Habitat.

Marine Mammals	Marine Mammal Protection Act of 1972; Endangered Species Act of 1973, as amended.	The waters of Resurrection Bay provide a habitat to various marine mammals. The harassment of marine mammals is not permitted by law.	Law and policy support the conservation and protection of marine mammals. Federal actions are required to comply with Federal laws regarding the conservation of such resources. There are no elements of USACE's project that might impact marine mammals.
Threatened and Endangered Species	Endangered Species Act of 1973, as amended; Marine Mammal Protection Act of 1972.	All marine mammals are protected under the Marine Mammal Protection Act. Of these marine mammals, select populations may be designated as threatened or endangered under the Endangered Species Act.	Law and policy support the conservation and protection of threatened or endangered species. Federal actions are required to comply with Federal laws regarding the conservation of such resources. There are no threatened or endangered species that would be affected by the implementation of USACE's project, as proposed.
Invasive Species	National Environmental Policy Act of 1970; E.O. 13751: Safeguarding the Nation from the impacts of invasive species; E.O. 13112: Invasive Species	The inadvertent introduction of novel species can be ecologically damaging.	Because of USACE's project's type and specific location, the inadvertent release of novel species capable of becoming invasive is so low as to be discounted.

3.7 Relevant Resources

This section contains a description of relevant resources that could be impacted by USACE's proposed project. The resources described in this section are recognized by laws, executive orders, regulations, and other standards of national, state, or regional agencies and organizations; technical or scientific agencies, groups, or individuals; and the general public (Table 5).

Table 5. Relevant Resources

Resource	Authority	Technically Important	Publically Important
		Non-Biological Resources	
Aesthetics	National Historic Preservation Act	Alterations to the project's existing state may deter from its historical significance.	Conservation of historically relevant viewshed is important to the public.
Water Quality	Section 401 of the Clean Water Act of 1972, as amended; Magnusson Stevens Fishery Conservation and Management Act of 1976, as amended.	The nearshore waters of Resurrection Bay are important habitat for fish and wildlife. All waters of Resurrection Bay are designated as Essential Fish Habitat	Law and policy require that Federal actions adhere to water quality protection laws.
Sediments	Clean Water Act of 1972 as amended, Section 404(b)(1)	In-water placement of sediments or "fill" must comply with Section 404(b)(1) guidelines	Law and policy require that Federal actions adhere to water quality protection laws. USACE's proposed project does not affect the final fate of bedload sediments, and any "fill" associated with the project would be those materials utilized in the construction and/or maintenance of the diversion dam structure and are evaluated in Appendix A 404(b)(1) Evaluation.
Noise	Noise Pollution and Abatement Act of 1972	Designed to protect human health by minimizing annoyance of noise to the general public.	Ambient natural sounds in Lowell Canyon and Resurrection Bay are an effective attenuator of most noise; however, anthropogenic noise levels will increase during the construction period of this project.

Existing Infrastructure and Facilities	National Environmental Policy Act of 1970	Promotes enhancement of the environment by evaluating the effects of government actions on a full suite of resource categories.	Lowell Creek, at flood stage, has affected public infrastructure in Seward on multiple occasions.
Cultural Resources	National Historic Preservation Act of 1966; National Environmental Policy Act of 1970.	Alterations to the existing tunnel and dam may impact the historical significance of the structure.	Law and policy require that Federal actions are considerate of the protection and enhancement of cultural resources.
Environmental Justice	Executive Order 12898, 1994. Federal actions to address environmental justice in minority populations and low-income populations.	Identifies impacts to minority or low-income populations	Executive Orders and policy support that no group of people, because of their socioeconomic or racial or ethnic composition, should be disproportionately negatively affected by the execution and/or operation of Federal, state, local, or tribal programs or policies.
Biological Resources			
Terrestrial Habitat	National Environmental Policy Act of 1970	Promotes enhancement of the environment by evaluating the effects of government actions on a full suite of resource categories.	Law and policy require that Federal actions adhere to land and water quality protection laws.
Birds	Fish and Wildlife Coordination Act of 1934, as amended; Migratory Bird Treaty Act of 1918.	Resurrection Bay and its surrounding upland habitats are important foraging nesting areas for marine and terrestrial birds.	Law and policy recognize that migratory birds transcend geopolitical borders and that the protection of their nesting, foraging, and resting habitats are important for the long-term conservation of avian resources.

4. FUTURE WITHOUT PROJECT (FWOP) CONDITIONS

This section provides an analysis of conditions that are expected to persist in Seward, Alaska, in the absence of flood risk management improvements at Lowell Creek. The purpose of this section is to estimate the economic costs of those conditions. The expected without- project conditions form the basis of evaluation against which with-project conditions are compared. For this analysis, the Federal Fiscal Year 2020 (FY20) discount rate of 2.75 percent was used.

4.1 Physical Environment (future projection, climate change)

Bear Mountain, on which the project area is located, borders the City of Seward with the local hospital and low-income housing about 800 feet from the dam and spillway. It is unlikely that the fundamental nature of the area will change over the planning period of analysis.

Short observational records in Alaska make it difficult to separate climate change from natural multi-decadal variability. There are also quality problems, especially for measurements of precipitation and discharge. While there is evidence of a statewide average temperature increase of approximately 3 degrees Fahrenheit over the last 60 years, there are few spatially coherent trends in precipitation in Alaska. Thus, an increase or decrease in precipitation and resulting changes in stream discharge for this study area are considered unlikely.

4.2 Biological Resources

Under the FWOP, the primary inherent risk to the biological environment is encapsulated in the likelihood of inadvertent release of environmentally persistent contaminants through recurring flood damage to the residential and commercial properties of Seward. Many of the buildings in the estimated flood failure path of Lowell Creek (Figure 13), both commercial and private, incorporate a form of the above-ground heating oil storage system. These systems would be destroyed and their contents released to the environment if floods similar to those of the historical record were to occur. Underground storage tanks in the flood failure path would also be susceptible to damage and inadvertent discharge. Water could displace fuels or oils in the tanks or dislodge, puncture, and transport the tanks themselves. Similarly, industrial and household solvents, fuels, detergents, lubricants, heavy metals, pesticides, and various other anthropogenic compounds could be released to the environment during or following catastrophic flood events.

Some anthropogenic compounds are capable of disrupting natural functions in other mammals, fish, and birds leading to reproductive failure, disfigurement, anticoagulation, and etcetera. Still, more household anthropogenic compounds may bioaccumulate as they move through the food chain, often resulting in adverse health effects to higher-order species. Humans, too, are not so separated from the effects of persistent environmental compounds; a whole suite of household chemicals are known to be carcinogenic in humans. The inadvertent release of such compounds represents a risk to both the biological and human environments of Seward and the greater Resurrection Bay biome.

4.3 Cultural Resources

Under FWOP conditions, the Lowell Creek Diversion Tunnel (SEW-00011) would likely continue to incur damage and repair from flood events. These events may lead to repair modifications, which would eventually result in the historic property losing its historical significance to the community and state. If a surge event occurs and the diversion dam is breached, the damage could also occur to historic properties downstream of the existing flood control.

4.4 Environmental Justice and Protection of Children

Directly downstream of the current infrastructure is an assisted living home that cares for elderly individuals, as well as the Providence Seward Medical Center, which is the primary care facility for the City of Seward. Under FWOP conditions, the USACE has determined that an overtopping of the diversion dam would have adverse impacts on these vulnerable groups downriver and any possible unknown disabled persons who may be residing within the immediate floodplain. During normal operations, it would be unlikely to have any impact on these populations.

4.5 Protected Tribal Resources

The USACE did not identify any Protected Tribal Resources within the project area, and as such, no Protected Tribal Resources will be impacted under FWOP conditions, under normal operations, or from a surge event.

4.6 Economic Conditions

The State of Alaska Department of Labor and Workforce Development projects the Kenai Peninsula Borough as a whole to gain several thousand residents over the next 30 years (Table 6). The degree to which this increase occurs, specifically in the greater Seward area, is dependent upon several factors. The city’s relative proximity to Anchorage, access to marine recreation, and rural lifestyle while maintaining common services and conveniences make it an attractive location for some future development. However, a significantly large increase in development and population is not expected.

Table 6. State of Alaska Population Projections for the Kenai Peninsula Borough

Year	Population	Increase
2017	58,024	N/A
2020	58,696	672
2025	60,412	1,716
2030	61,702	1,290
2035	62,586	884
2040	63,147	561
2045	63,472	325

Because of this relatively stable environment, the prevailing economic and political conditions are not expected to change significantly throughout the analysis.

4.7 Planned Development

The area downgradient of the diversion dam is well developed already, but significant additional development is not expected.

4.8 Future Without Project Scenarios

Under FWOP Conditions, flows that can exceed the capacity of the existing flood diversion system will continue to threaten to overtop the diversion dam and cause structural damages and loss of life in Seward. Surge release floods from the failure of temporary landslide debris blockages will continue to compound this threat. Flood water arrival with little to no warning will continue to make an effective evacuation of the population at risk very difficult. Attempts to mobilize threatened residents could result in greater life loss due to the short time window increasing the chance of getting caught in the flood. Given that the assisted living center and community hospital are directly downstream and close to the current structure, a large proportion of the threatened population are either over 65 or under medical care, and thus vertical evacuation would also remain difficult. Due to the nature of alluvial fan flooding, once exiting Lowell Creek Canyon, flood water flow paths will be uncertain, further complicating any potential mitigation and evacuation efforts. Floodwaters will include floating debris, suspended sediment, and a portion of the Lowell Creek bedload in addition to debris and sediment that is entrained downstream from the diversion dam. Flood flows will breach Seward from west to east isolating portions of town. Frequent repairs will continue to be required to keep the existing flood diversion system operational. The City of Seward will continue to expend effort and funds to manage the excessive amounts of sediment deposited at the tunnel outlet, and nearby facilities will continue to experience elevated operational costs due to the sediment deposition and induced localized flooding. Summer tourism is anticipated to remain strong in Seward, putting additional people at risk if a flood occurred then. Also, many tourism services would be interrupted, and local businesses would suffer losses if a flood occurred during the summer.

[redacted]

[redacted]

[redacted]

[redacted]

The natural condition of Lowell Creek during peak flow is to transport and deposit large volumes of sediment and to meander about these depositions en route to Resurrection Bay. This condition precludes large-scale development within the lower watershed due to the possibility of flood damage. Lowell Creek's current system modifies Lowell Creek so that surface flows and loose sediments are intercepted and diverted for concentrated placement in Resurrection Bay, away from existing downstream infrastructure.

Conceivably, with the increasing infrastructure situated in the historic lower watershed, there will continue to exist an enhanced likelihood of environmental impact through the inadvertent release of environmental contaminants resulting from catastrophic flooding as a result of FWOP conditions. Petroleum products such as fuels and lubricants, and common household and industrial chemicals are now ubiquitous within Lowell Creek's historic channel. The absolute failure of Lowell Creek's current condition would result in a return to its historical and natural condition, which would predictably destroy infrastructure and expose potential contaminants to the environment. Typically, petroleum, its byproducts, and other industrial compounds persist in the environment longer than the effects witnessed at initial exposure. Despite differing levels of innate toxicity, some compounds impair surface water quality, migrate throughout the groundwater table, bioaccumulate in living organisms, and interrupt and affect a whole suite of human and animal endocrine functions.

4.9 Summary of Without Project Condition

Under the FWOP conditions, Lowell Creek will continue to threaten Seward with periodic flooding. The debris would continue to aggregate at the outfall area requiring flood-fighting efforts and bringing potential damages to Seward, Lowell Point, the Alaska SeaLife Center, and the surrounding area. The bridge would likely incur future damage, and replacement and the city's sewage treatment facility would remain threatened. The threat of tunnel blockage would persist, potentially leading to an inflow of water and debris into downtown Seward resulting in structural damages estimated at $150M [redacted].

5. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS*

5.1 Plan Formulation Rationale

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 one or more study objectives. A management measure (measures) can be an activity or structural feature or element that can be implemented at a specific geographic location to address one or more planning objectives. An activity is defined as a non-structural action such as proposed operational changes to improve navigation efficiency. A structural activity requires construction or assembly, typically within the project area or site.

During the planning charrette meeting conducted in Seward on 25-26 October 2016, participants developed descriptions of existing conditions and FWOP conditions. Then management measures were identified, screened, and used to develop alternative plans. Participation was facilitated through a combination of small and large group interactive exercises.

It was noted early in the study that life safety risk is inherent in any flood diversion system. A hybrid risk assessment methodology was incorporated into the study to address the life safety risks of the existing project and quantify reductions in risk attributable to potential alternatives.

5.2 Management Measures

During the planning charrette, several measures were identified using the criteria presented in Section 2.7, "National Evaluation Criteria" and discussed below in Section 5.2.1, "Criteria and Metrics." The project delivery team evaluated the structural and non-structural measures discussed in Section 5.2.2, "Initial Measures Eliminated." These measures were combined to form the alternatives outlined in Section 5.3, “Measures Carried Forward.”

5.2.1 Criteria and Metrics

Alternative plans were formulated to address study objectives and adhere to study constraints. As part of Federal guidelines for water resources projects, there are general feasibility criteria that must be met. According to the USACE Engineering Regulation (ER) 1105-2-100 for planning, USACE projects must be analyzed with regard to the following four criteria:

- Completeness is the extent to which alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities.
- Effectiveness is the extent to which alternative plans contribute to achieving the planning objectives.
- Efficiency is the extent to which an alternative plan is the most cost-effective means of achieving the objectives.
- Acceptability is the extent to which alternative plans are acceptable in terms of applicable laws, regulations, and public policies. Mitigation of adverse effects shall be an integral component of each alternative plan.

In addition, the team used specific screening criteria, which included evaluating the reduction to total life safety risk under each alternative. Each measure was evaluated against the general metric of whether the design would address the major mechanisms causing total life loss within the Seward area. Specific engineering design criteria used to develop the measures is presented in Appendix C: Hydraulics and Hydrology

5.2.2 Initial Measures Eliminated

A total of 22 structural measures and 8 non-structural measures initially identified during the charrette meeting were eliminated and not carried forward for further consideration. Some measures were screened during the charrette taking into account the experience of the charrette attendees as discussed in. After the charrette, the Project Delivery Team (PDT) evaluated the measures further with input from all disciplines to determine what each measure would or would not contribute to potential solutions. Similar measures were grouped together and described as one resulting in the 9 structural and 5 non-structural measures presented in Table 7.

These initial measures were screened based on the effectiveness, constructability, and affordability considering the reduction of damages by either preventing the flow of water through Seward from the structure and/or reducing the build-up of debris at the tunnel outlet. Each of these factors were evaluated considering varying flows and recurrence intervals. In addition, the team evaluated the situation with and without the occurrence of the tunnel being blocked by landslide or debris, since locals and team members noted there was a chance of an upstream landslide creating a temporary dam and releasing a surge when the dam burst. This condition was also factored into the screening of alternatives. Averting the flow through Seward is essential in preventing economic damages and critical to reducing the life safety risk. Inhibiting the build-up of debris at the outlet would reduce economic damages in other areas than the water flow from the structure. The measures and rationale for the decisions for elimination during this study are presented in Table 7.

Table 7. Measures Eliminated

Measures	Addresses	Elimination Rationale
Structural		
Alter Jefferson Street/Structures (4 similar measure combined)	Lowell Creek Flooding	Effectiveness low. Altering Jefferson Street has been attempted in the past, and before the current system, a channel down Jefferson Street was the primary means of flood control. However, as happened with the previous channel, one large event could fill the channel and cause massive flooding. Ineffective because the flow slows down and drops its sediment load, thus clogging the channel or pipe.
Pipe to covey flow (2 similar measures combined)	Lowell Creek Flooding	Effectiveness low. A pipe to convey flow would be ineffective in conveying the amount of flow that can occur during larger events. The existing storm sewer has shown that such a measure would not resolve the issue.
Upstream alterations, retention or rack/slit dam (8 similar measures combined)	Lowell Creek Surge/ Outlet Debris Flooding	Effectiveness and constructability low. Although the team did carry forward an upstream retention dam for NED analysis (Alt 5), the measures involving upstream alterations, in general, would only transfer the risks further up the drainage to a more difficult area to access and perform maintenance and debris removal. These alterations would also be more difficult to construct and would not provide a permanent, effective solution.
Lowell Point Road (3 similar measures combined)	Outlet Debris Flooding	Effectiveness low. Measures that alter Lowell Point Road would not be effective as they do not address the primary risk driver of surge flow and the associated debris with such flows that could overtop the dam.

		These measures also do nothing to address flows, not associated with a surge.
Hopper/conveyance at the tunnel outlet	Outlet Debris Flooding	Effectiveness low. The team considered placing a hopper with a conveyance system to move debris from the outfall. The flows and debris from any but the smallest events would likely destroy such a structure and/or require significant maintenance; thus, it would not be effective in addressing any of the issues.
Lower tunnel outlet to grade	Outlet Debris Flooding	Effectiveness low. Lowering the tunnel outlet to grade would do nothing to prevent flows or debris from filling the area and damaging or destroying the bridge. Such a measure would still leave Lowell Point cut off during flood events, flood the area and threaten critical infrastructure.
Raise existing dam	Lowell Creek Flooding	Effectiveness and affordability low. Raising the existing dam would not increase the flow in the tunnel as the tunnel only has a limited capacity. It may provide a small amount of extra time before the dam overtopped, but would not prevent it or reduce flows into Seward.
Upstream river training	Lowell Creek Surge	Effectiveness low. Dependent on location, very difficult to maintain due to debris.
Flood control wall near Alaska SeaLife Center	Outlet Debris Flooding	Effectiveness and completeness low. Remnants of an old flood control wall can be seen near the Alaska SeaLife Center as the flow enters Resurrection Bay, and this shows that a sea wall would only provide a temporary solution for small events. Such a measure would not address larger flow events, debris, or surge.

Non-structural		
Dredging outfall	Outlet Debris Flooding	Effectiveness low. The outfall can be dredged to remove debris; however, the event of record in 1986 deposited an estimated 120,000 cubic yards of debris. This indicates that such measures would be ineffective at larger flow events and, if attempted during any event, would be dangerous and impossible for most events.
Relocation from floodplain (2 similar measures combined)	Lowell Creek Flooding	Affordability and acceptability low. Relocating Seward, or even critical portions of it, would only transfer the risk. The area is on an alluvial fan, and no location in the vicinity is out of the floodplain.
Monitoring/Technology (3 similar measures combined)	Outlet Debris Flooding/ Lowell Creek Flooding	Effectiveness low. Events occur with such suddenness that any efforts at monitoring would be of limited benefit. The terrain lends itself to flashy flows, and in the event debris blocks the tunnel, only a very short time would elapse before flow went over the spillway and into downtown Seward.
Emergency pumping	Lowell Creek Flooding	Effectiveness, completeness, and constructability low. Emergency pumping would be completely overwhelmed in almost any appreciable event. In addition to the volume of flow, debris is deposited of such size and volumes that it could easily cause damage or destruction of the pumps. The sudden large flows and carried debris would challenge the pump system design and capacity with no backup if it failed.
Debris repurposing	Outlet Debris Flooding	Effectiveness and completeness low. Debris repurposing could only occur after an event, and this would do nothing to address the issues of flow, debris, and surge in the area.

5.3 Measures Carried Forward

Of the measures initially identified, eight structural and two non-structural measures were considered viable and contribute to the resolution of problems identified at the site. Measures that were carried forward in the analysis and combined to form the alternatives evaluated during feasibility are shown in Table 8.

Table 8. Measures Carried Forward

Structural Measures	**Non-structural Measures**
Additional tunnel	Selective Tree Removal
Tunnel Outfall Design Options (Separable Element Evaluation)	Early warning system and evacuation plan
Additional diversion dam	
Refurbish existing tunnel	
Enlarge existing tunnel	
Upstream retention basin	
Low flow Diversion	
Protect Tunnel Inlet from Landslide	

5.4 Alternatives Considered

The PDT combined various measures carried forward (see Table 8) into an array of alternative plans with associated concept drawings based on design standards and other engineering considerations. These alternative plans were formulated to address study objectives and adhere to study constraints. Each alternative plan was developed considering the four National Evaluation Criteria explained in Section 2.7, “National Evaluation Criteria”: completeness, efficiency, effectiveness, and acceptability, as well as a total life safety risk.

A total of 5 alternatives, including No Action, were formulated for further consideration. However, since two of the alternatives, Alternative 3 and 4, have to consider two tunnel diameters (18 ft and 24 ft) as Alternatives “3A and 4A” and “3B and 4B”, one could argue that there are actually seven alternatives listed below:

- Alternative 1: No Action
- Alternative 2: Improve Existing Flood Diversion System.
- Alternative 3: Enlarge Current Flood Diversion System to Convey Larger Flow considering two tunnel diameter options below:
  (A) 18 ft Tunnel
  (B) 24 ft Tunnel

- Alternative 4: Construct New Flood Diversion System considering two tunnel diameter options below:
  (A) 18 ft Tunnel
  (B) 24 ft Tunnel
- Alternative 5: Construct Debris Retention Basin.

Each of the alternatives listed above that includes a tunnel in the design to transmit the flow from Lowell Creek drainage (Alternatives 2, 3A, 3B, 4A, and 4B), also requires an outfall to transmit this discharge from the tunnel to the ocean. The outfall design options were evaluated as a consistent measure with the proposed outfall design applied to each alternative that has an outfall (Alternatives 2, 3, and 4).

5.4.1 Separable Element Evaluation - Tunnel Outfall Design Options

A new outfall design is a structural measure applicable to all structural alternatives, except Alternative 5. The outfall is considered a separable element because a different benefit stream accrued to it than the rest of the project. The tunnel and upstream features directly benefited the structures in downtown Seward from inundation resulting from an overtopping of the dam due to tunnel failure, etc. The outfall feature decreased the City of Seward’s annual Operation and Maintenance (O&M) cost and had a minor effect on the inundation of structures in the area of the SeaLife Center.

The existing project functions without an extended outfall; however, an extended outfall provides operational efficiencies that should be justified based on the standalone, separable benefit to the project. The outfall is a measure with a relatively consistent design and providing a benefit that can be applied to each alternative for plan selection purposes.

Figure 16. Existing Lowell Creek Tunnel Outfall. Google Earth image 29 June 2019.

The existing tunnel discharge point is west of Lowell Point Road and requires the City of Seward to remove the sediment that rapidly accumulates during storm events. Such emergency actions must be taken to maintain road access to Lowell Point, south of the tunnel outfall, to reduce damage to the bridge and road, and to reduce the risk of flooding and associated damages to nearby infrastructure. The City of Seward spends an annual average of $556,000 on routine and emergency actions associated with the discharge from the Lowell Creek tunnel.

Various outfall design lengths were considered during the study. The team qualitatively compared to effectiveness, benefits, and the rough-order-magnitude (ROM) cost. The outfall effectiveness is based on the ability to convey the anticipated flow to a discharge point. The basic design would be similar for all the lengths evaluated. All the extended outfalls consist of pre-cast concrete, open-channel flumes placed on drilled piers as described in Appendix C and Section 7, “Tentatively Selected Plan” below. The construction costs increase as the outfall structure gets longer. Given the consistent design, the discharge point is the main consideration for the effectiveness evaluation for each outfall option.

The outfall evaluation consisted of five general outfall options with varying discharge points, associated benefits, ROM construction, and maintenance costs as listed below:

- Limited outfall length similar to the current outfall that discharges east of Lowell Point Road between the mountain and the road

- 100-ft long extended outfall that discharges west of the current Lowell Point Road alignment between the mountain and the road. This option includes a cost to realign the road and bridge to a higher elevation on the mountain side to get above the discharge point
- 150-ft long extended outfall that extends over Lowell Point Road that discharges on the existing fluvial fan in relatively shallow water
- 500-ft long extended outfall that extends over Lowell Point Road that discharges into deeper water
- 750-ft long extended outfall that extends over Lowell Point Road that discharges into even deeper water

Each outfall option was compared for benefits or negative impacts to:

- Threat of Lowell Point Road closure and maintenance of access to Lowell Point to the south, especially during storm events
- Threat of flooding over the road caused by sediments and debris accumulating and blocking flow under the Lowell Point Road bridge
- Emergency action costs and safety concerns during storm events to maintain the road access and flooding associated with accumulating sediment east and west of the road
- Dredge maintenance costs to manage accumulated sediment

The PDT examined five different lengths for a project outfall. It was determined that a 150 ft outfall would provide adequate sedimentation control for the project (Table 9).

The cost for a 100 ft outfall is higher than a 150 ft outfall due to the need to realign the road in order to have the discharge on the east side of the road and bridge. Without the realignment of the road, this option would leave Lowell Point vulnerable to being cut off during flood events, and fail to protect the road and bridge during storm events. In addition, the city personnel would continue to be put in harm’s way during flood-fighting activities (See Figure 9 and Figure 10). With the road alignment, city personnel could perform maintenance activity when site conditions are safer. However, since the sediment would be deposited on land or very shallow water at higher tides, flood fighting would still be needed to reduce flooding impacts to nearby structures.

Table 9. Outfall Evaluation Summary

Outfall Length	Discharge Point	ROM Construction Cost	Maintenance Costs	Benefit Comments
Limited	Base of mountain west of road	$4,000,000	$566,000/year	Sediment would continue to be deposited in the current location damaging or destroying the bridge during events and threatening community infrastructure
100-ft	West of road	$14,200,000	$566,000/year	Would require realignment of the road to prevent damage to the bridge
150-ft	Fluvial fan west of road	$13,900,000	$566,000/year	Would eliminate flood-fighting during events and damage to the bridge. More frequent dredging than longer options, but similar effort compared to the shorter outfall.
500-ft	Deep water west of road	$36,900,000	$744,000/year	Sediment would be deposited into the Bay, but periodic dredging would be required approximately every 5 years
750-ft	Deep Water in Resurrection Bay	~$56,000,000	No dredging	Sediment deposited directly into deep water. No dredging would be required.

A 150 ft outfall would reach over Lowell Point Road, eliminating the need to realign the road while still protecting it from sediment deposition. This option discharges the sediment on the alluvial fan at approximately +22 ft Mean Lower Low Water (MLLW). Although higher tides should inundate these sediments, such a discharge point will require periodic dredging to maintain the fluvial fan. The quantity and cost would be similar or same as the current maintenance cost and that of a 100 ft outfall; however, this activity would be safer for city personnel because this maintenance activity can be scheduled when site conditions (e.g., wave height) are safe, with limited, if any, need to conduct maintenance activities during flood events to reduce debris and flooding impacts to nearby structures.

A 500 ft outfall option would discharge sediments into the waters of Resurrection Bay at an approximate depth of -36.5 ft MLLW. These sediments would accumulate and require periodic dredging approximately every five years—the cost of offshore dredging results in a higher average annual cost. However, as with the 150 ft outfall, this dredging activity should be safer since it can be scheduled when conditions are favorable.

A 750 ft outfall discharges sediments into deeper water on a relatively steep slope (1.5H1V) at approximately -179 ft MLLWand would require no periodic dredging. However, the cost of construction and the depth of construction led the PDT to the determination that an outfall of this length would not be feasible.

The PDT concluded that the 150 ft outfall with an estimated construction cost of $14M provides optimal benefits to the community, including an added benefit of safer maintenance dredging. Due to the conceptual nature of this outfall analysis, an environmental analysis was not carried out on all the options; however, an environmental analysis was carried out on the optimal (150 ft) option as it is included in all structural alternatives except for Alternative 5.

5.4.2 Descriptions of Alternative Plans

5.4.2.1 Alternative 1: No Action

If no action is taken to improve the Lowell Creek Flood Diversion System, flows threatening to exceed the capacity of the existing flood diversion system will continue to threaten to overtop the diversion dam and cause structural damages and risk life loss in Seward. Surge release floods from the failure of temporary landslide debris blockages will continue to compound this threat. Flood water arrival with little to no warning will continue to make an effective evacuation of the population at risk very difficult. Once exiting Lowell Creek Canyon, flood water flow paths will be uncertain, further complicating any potential mitigation and evacuation efforts. Flood flows will breach the only road providing access to Seward. Frequent repairs will continue to be required to keep the existing flood diversion system operational. The City of Seward will continue to expend effort and funds to manage the excessive amounts of sediment deposited at the tunnel, often under hazardous conditions, and nearby facilities will continue to experience elevated operational costs due to the sediment deposition and induced localized flooding. Due to summer tourism in Seward, additional people will be at risk if a flood were to occur during the tourist season.

5.4.2.2 Alternative 2: Improve Existing Flood Diversion System.

Structural components of this alternative (Figure 16) would include refurbishing the existing tunnel, extending the outfall 150 ft to go over the road, protecting the tunnel inlet from landslide with a canopy, and improving the low flow diversion system. Non-structural components would include tree removal and implementation of an early warning system and evacuation plan. The effectiveness of the early warning system will depend on the nature of flood and/or surge events, which could overtop the existing dam over a short time period. However, including such a system is a relatively low cost, and the PDT decided it has the potential to prove effective at providing an early warning to a significant portion of the at-risk Seward population.

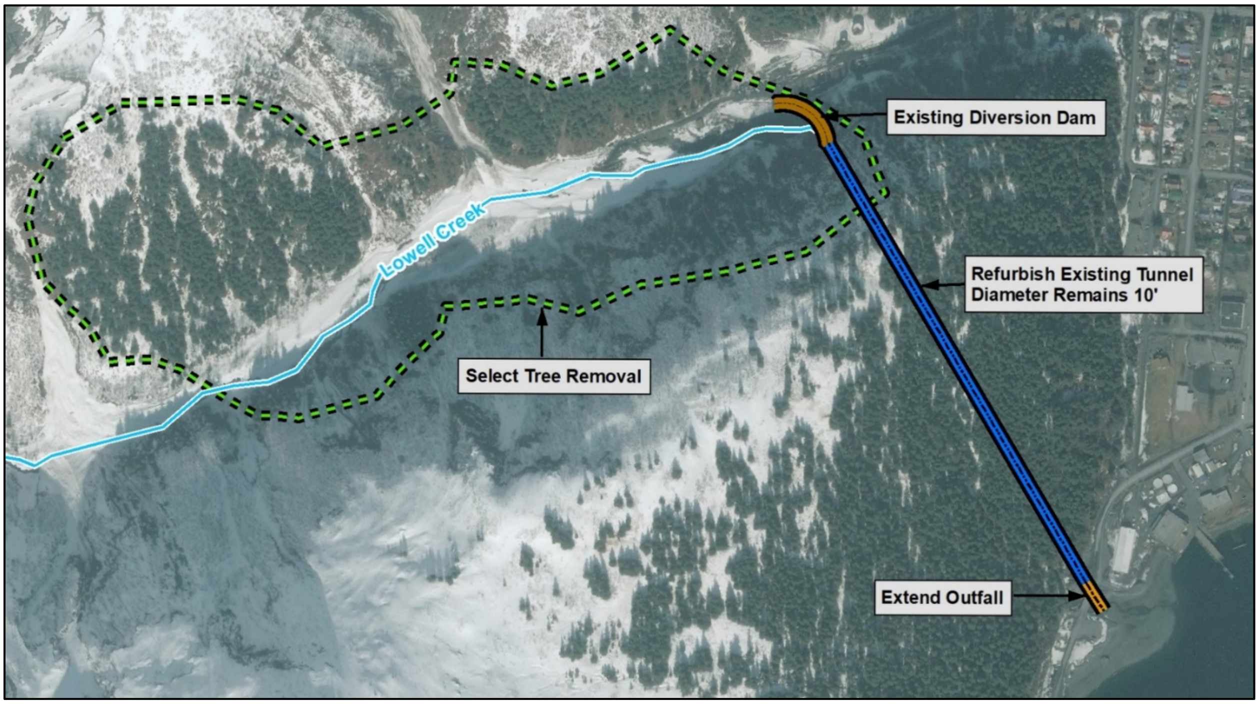

Figure 17. Alternative 2: Improve Existing Diversion System

5.4.2.3 Alternative 3A and 3B: Enlarge Current Flood Diversion System to Convey Larger Flow

Alternative 3 includes enlarging the current flood diversion system to convey larger flows. Two options, “A” and “B,” were developed with the only difference the existing tunnel diameter would be enlarged to either 18 ft (Alternative 3A, Figure 18) or 24 ft (Alternative 3B), respectively. The flow capacities for these smaller and larger tunnel diameters would range from 8,500 cfs to 19,000 cfs, as discussed in Appendix C: Hydraulics and Hydrology and Section 4.2, “Biological Resources.”

The other components are consistent with each option and are listed below:

Structural components:

- Extending the outfall 150 ft to go over the road
- Protecting the tunnel inlet from landslide with a canopy
- Improving the low flow diversion system

Non-Structural Components:

- Tree removal
- Implementation of an early warning system and evacuation plan

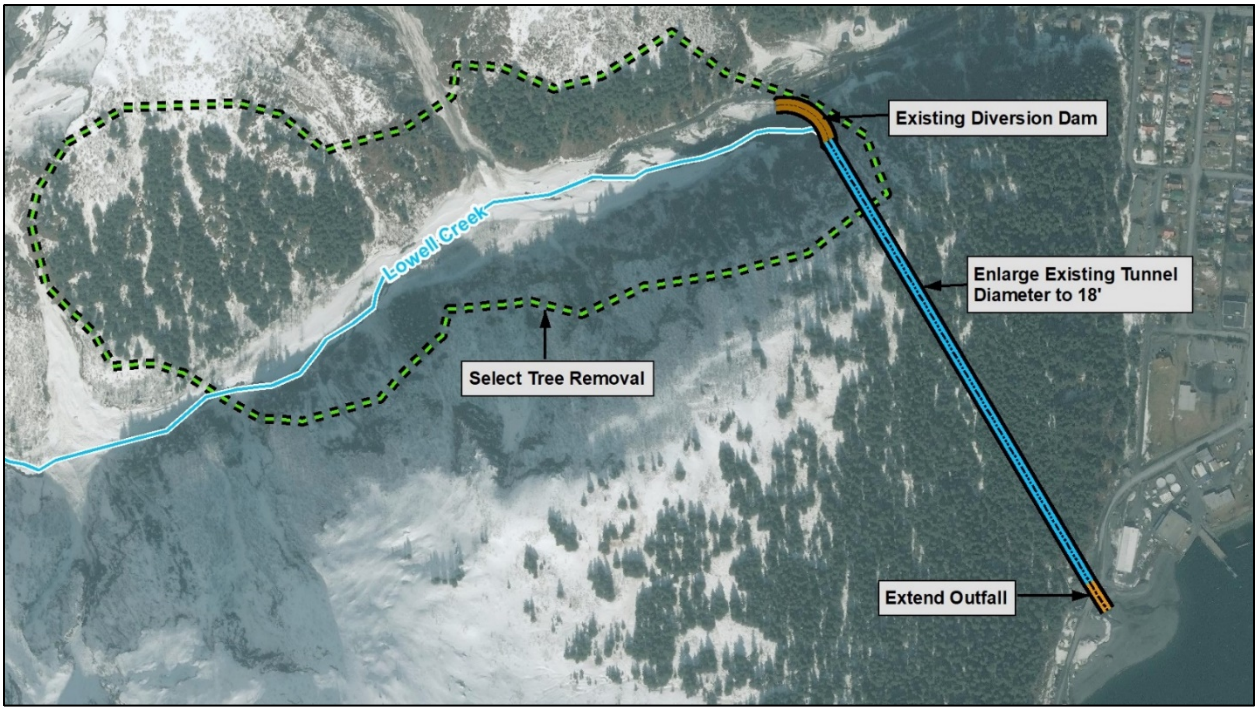

Figure 18. Alternative 3A, Enlarge Current System to Convey Larger Flow with 18 ft Diameter Tunnel (Alternative 3B includes a 24 ft diameter tunnel)

5.4.2.4 Alternative 4A and 4B: Construct New Flood Diversion System.

Alternative 4 includes a new tunnel upstream from the existing tunnel and refurbishing the existing tunnel (Figure 19). Two options, "A" and "B," were developed with the only difference the new tunnel diameter would be either 18 ft (Alternative 4A) or 24 ft, (Alternative 4B), respectively. The existing tunnel refurbishment would maintain the tunnel diameter at 10 ft. The flow capacities for these smaller and larger tunnel diameters would range from 8,500 cfs to 19,000 cfs, and the existing tunnel capacity is estimated at 2,800 cfs, as discussed in Appendix C: Hydraulics and Hydrology and Section 4.2, "Biological Resources."

The other components are consistent with each option and are listed below:

Structural components:
- Extending the outfall 150 ft to go over the road
- Protecting the tunnel inlet from landslide with a canopy
- Improving the low flow diversion system

Non-Structural Components:
- Tree removal
- Implementation of an early warning system and evacuation plan

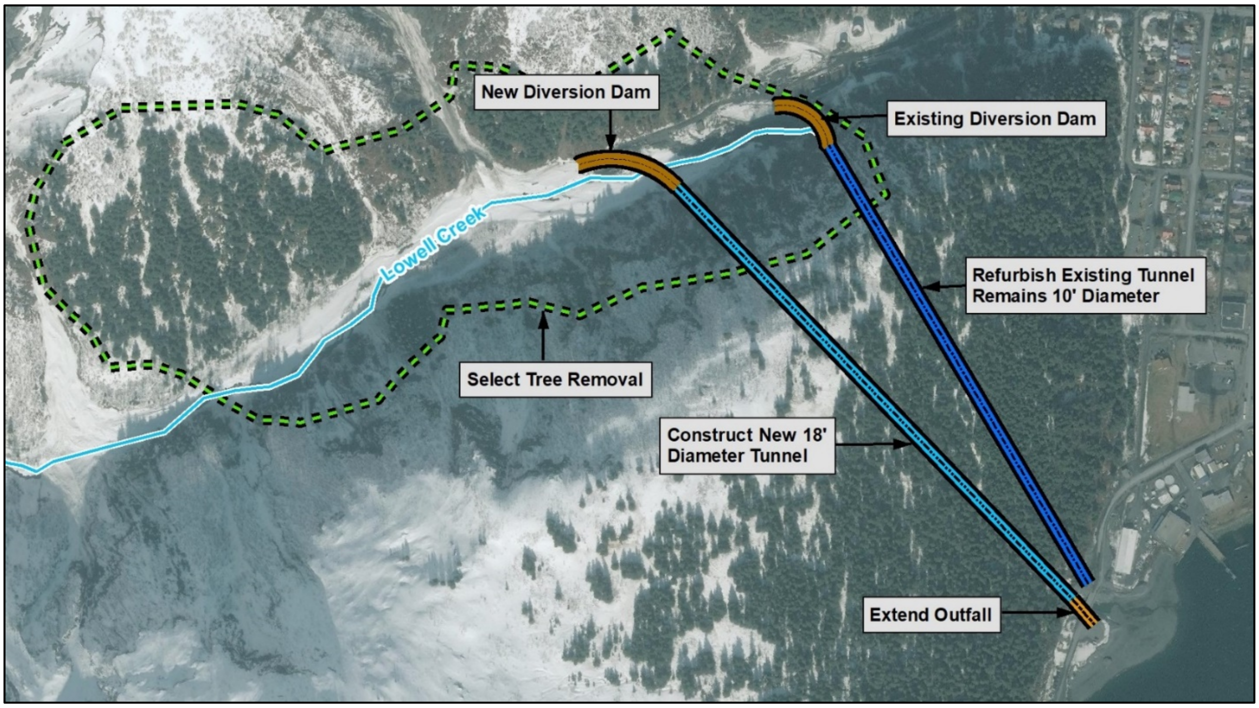

Figure 19. Alternative 4: Construct New Flood Diversion System (Alternative 4A is portrayed with 18 ft tunnel)

5.4.2.5 Alternative 5: Construct Debris Retention Basin.

Alternative 5 includes a roller-compacted concrete structure constructed approximately 700 feet upstream of the existing tunnel entrance to intercept debris before it passes through the tunnel (Figure 20). The structure is designed to create a 25,000 cubic yard detention volume where debris, mostly sand and gravel with cobbles and some boulders, can accumulate and be hauled out after rain events. The structure is approximately 200 feet in length, with a crest approximately 15 feet above the canyon floor. The upstream embankment face would be constructed at a 1H:1V slope, and the downstream face would be constructed at a 2H:1V slope, similar to the existing diversion dam.

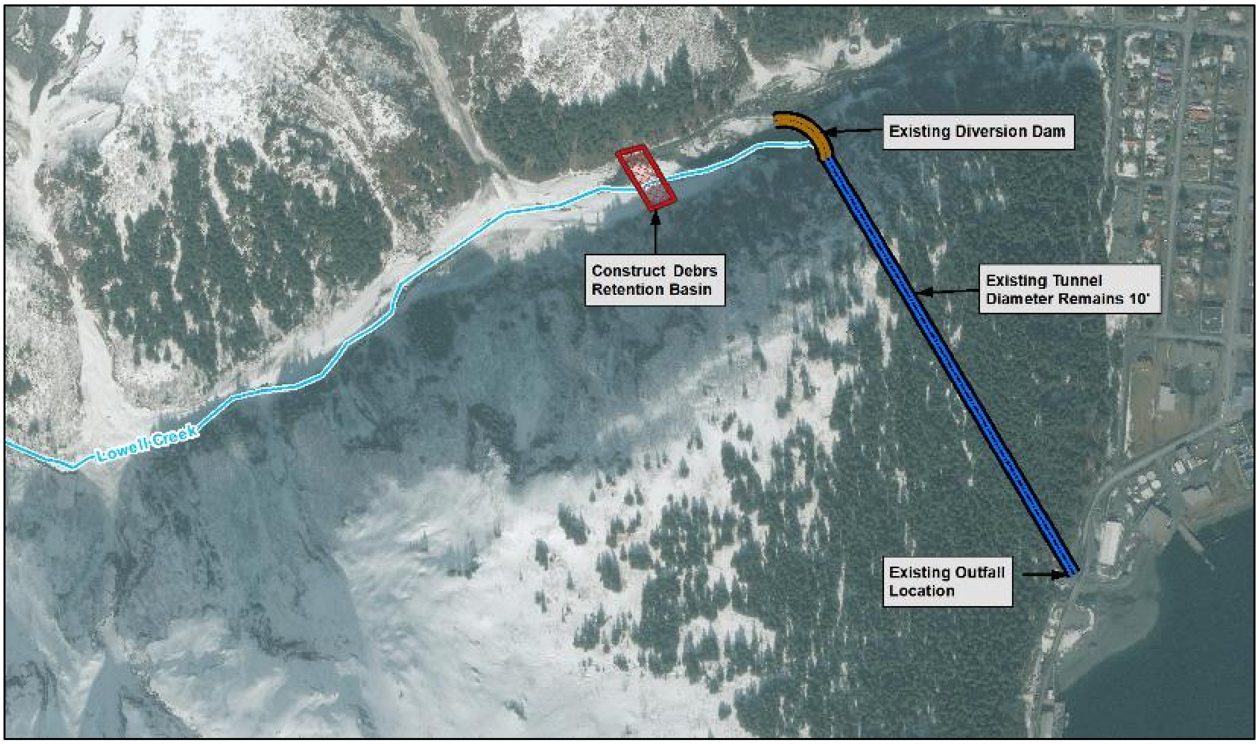

Figure 20. Construct Debris Retention Basin

5.5 Alternatives Eliminated from Detailed Analysis

No alternatives carried forward following the charrette were initially eliminated before detailed analysis.

5.6 Alternatives Carried Forward

The following alternatives were carried forward for detailed analysis:

- Alternative 2: Improve Existing Flood Diversion System
- Alternative 3A and 3B: Enlarge Current Diversion System to Convey Larger Flow
  (A) 18 ft Tunnel
  (B) 24 ft Tunnel
- Alternative 4A and 4B: Construct New Flood Diversion System
  (A) 18 ft Tunnel
  (B) 24 ft Tunnel
- Alternative 5: Construct Debris Retention Basin.

6. COMPARISON AND SELECTION OF PLANS*

6.1 With Project Conditions

The following section describes anticipated conditions at Lowell Creek and Seward, assuming that a project has been constructed. The anticipated changes in the size of the tunnel and the extension of the outfall are the basis for the economic analysis. A larger tunnel would conduct more flow, therefore, reducing the probability of flooding in the town. Extending the outfall would eliminate debris aggregation at the outfall and associated flooding. The NED benefits of a flood diversion project at Lowell Creek are expected to result from reduced flood damages and reduced need for flood fighting at the outfall. The damages and costs were calculated using FY19 price levels. Costs were annualized using the FY20 Federal discount rate of 2.75 percent and a period of analysis of 50 years with the year 2025 as the base year. The expected annual damage and benefit estimates were compared to the annual construction costs and the associated Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs for each of the project measures.

6.2 Alternative Plan Costs

Rough Order of Magnitude (ROM) costs were developed for the alternatives, including those to construct and maintain facilities. Appendix D details the procedures and assumptions used to calculate these estimates. Cost risk contingencies were included to account for uncertain items such as sediment characterization. Project costs were developed without escalation and are in 2020 dollars. The ROM costs for each alternative are displayed in Table 10.

Table 10. Summary of Alternative Costs

	Alternative 2	Alternative 3A	Alternative 3B	Alternative 4A	Alternative 4B	Alternative 5
Construct Additional Tunnel and Diversion Dam				$68,878,281	$91,727,936	
Enlarge Existing Tunnel to 18ft		$97,838,611				
Enlarge Existing Tunnel to 24ft			$211,155,185			
Refurbish Existing Tunnel	$12,454,786			$12,454,786	$12,454,786	
Extend Tunnel Outfall 150’ Over the Road	$12,349,634	$14,489,311	$33,494,923	$14,489,311	$33,494,923	
Tree Removal	$1,657,205	$1,657,205	$1,657,205	$1,657,205	$1,657,205	
Protect Tunnel Inlet from Landslide Blockage (canopy)	$5,918,756	$5,918,756	$5,918,756	$5,918,756	$5,918,756	
Implement Early Warning System and Evacuation Plan	$39,186	$39,186	$39,186	$39,186	$39,186	
Improve Low Flow Diversion System	$11,785,997	$11,785,997	$11,785,997			
Debris Basin						$15,800,000
Total (rounded)	**$53,100,000**	**$157,300,000**	**$314,800,000**	**$122,900,000**	**$172,600,000**	**$15,800,000**

6.2.1 Construction and Investment Costs

As with benefit cash flows, costs are compounded to a base year and amortized for comparison against average annual benefits. As such, the project first costs shown above and detailed in Appendix D differ slightly from those used in the benefit-cost analysis. Costs used in the benefit-cost analysis include the project's initial cost compounded to the base year using the FY20 discount rate, interest during construction, and operations and maintenance costs greater than the without-project condition. The construction of the project alternatives is expected to begin in the year 2023, during which time interest during construction (IDC) will be computed. It will continue for one year for every measure except for enlarging the existing flood diversion system (Alternative 3A and 3B). For this measure, seasonal peak flows cannot be diverted. Therefore construction activities are limited to the winter months; thus, construction must be prolonged over seven years. The costs used in the benefit-cost analysis are displayed in Table 11.

Table 11. Project Costs for Benefit-Cost Analysis

	Alternative 2	Alternative 3A	Alternative 3B	Alternative 4A	Alternative 4B	Alternative 5
	Improve Existing Flood Diversion System	Enlarge Existing Flood Diversion System – 18' Tunnel	Enlarge Existing Flood Diversion System – 24' Tunnel	Construct New Flood Diversion System – 18' Tunnel	Construct New Flood Diversion System – 24' Tunnel	Debris Retention Basin
Construction First Cost	$53,061,221	$157,282,815	$314,846,026	$122,928,162	$172,606,683	$15,800,000
Interest During Construction	$730,000	$13,587,000	$27,199,000	$1,690,000	$2,373,000	$436,000
Total Cost	$53,791,221	$170,869,815	$342,045,026	$124,618,162	$174,979,683	$16,236,000
Average Annual Construction	$1,992,476	$6,329,175	$12,669,662	$4,615,971	$6,481,408	$601,396
Average Annual OMRR&R	$916,000	$1,087,000	$1,216,000	$1,152,000	$1,290,000	$692,000
Total Average Annual Cost	$2,908,476	$7,416,175	$13,885,662	$5,767,971	$7,771,408	$1,293,396

6.2.2 Operations and Maintenance Costs

Operations and maintenance costs associated with the project fall into two main categories: Maintaining the system and debris removal. Maintaining the system would include repairs from damage caused during events and well as preventive maintenance. The estimated average annual cost of maintaining the system is approximately $744,000. Debris removal consists of removing debris periodically from the outfall area. This activity would incur an average annual cost of $556,000.

6.2.3 Total Average Annual Equivalent Costs

Average annual costs were developed by combining the initial construction costs with the annual Operations and Maintenance costs for each potential alternative using the FY20 Federal Discount Rate of 2.750 percent along with a period of analysis of 50 years (Table 11).

6.3 Project Benefits

Each alternative provides a certain amount of relief from existing and expected future inefficiencies. From a NED perspective, the differences between the FWOP conditions and those that will occur under the various With Project Conditions are benefits that accrue to the project and form the basis of the Tentatively Selected Plan (TSP). As mentioned at the outset, the NED policy exception waiver that has been approved for this study allows for plan justification under a Non-NED framework: Other Social Effects (OSE).

Economic benefits associated are associated with reduced flood damages. The primary flood damages avoided would be structural damages and damages to the associated contents of the structures, though there are some benefits from reduced vehicular damages. Average annual flood reduction damages would be about $899,000 (Table 12).

Table 12. Expected Annual Damages Reduced by Measure ($1,000's)

Plan	**Total Without Project**	**Total with Project**	**Damages Reduced**
Without Project	899.84		0.00
Improve Existing Flood Diversion System	899.84	899.84	0.00
Enlarge Existing Flood Diversion System	899.84	10.00	889.84
Construct New Flood Diversion System	899.84	10.00	889.84
Debris Retention Basin	899.84	899.84	0.00

6.4 National Economic Development (NED) Analysis

Net benefits and the benefit-cost ratio are determined using the average annual benefits and average annual costs for each alternative. Net benefits are determined by subtracting the average annual equivalent costs from the average annual benefits for each alternative; the benefit-cost ratio is determined by dividing average annual benefits by average annual costs. Benefits by category, project costs, and the benefit-cost ratio were calculated for each alternative (Table 13).

Table 13. NED Analysis Results (in dollars)

Damage Category	Alternative 2	Alternative 3A	Alternative 3B	Alternative 4A	Alternative 4B	Alternativ e 5
	Improve Existing Flood Diversion System	Enlarge Existing Flood Diversion System – 18' Tunnel	Enlarge Existing Flood Diversion System – 24' Tunnel	Construct New Flood Diversion System – 18' Tunnel	Construct New Flood Diversion System – 24' Tunnel	Debris Retention Basin
Structural	-	$399,066	$399,066	$399,066	$399,066	-
Contents	-	$436,424	$436,424	$436,424	$436,424	-
Vehicle	-	$36,843	$36,843	$36,843	$36,843	-
Debris Removal	-	$27,508	$27,508	$27,508	$27,508	-
Flood Fight Costs Avoided	$556,000	$556,000	$556,000	$556,000	$556,000	$556,000
Total Average Annual Benefits	$556,000	$1,455,840	$1,455,840	$1,455,840	$1,455,840	$556,000
Total Average Annual Cost	$2,908,476	$7,416,175	$13,885,662	$5,767,971	$7,771,408	$1,293,396
Net Benefits	($2,352,476)	($5,960,335)	($12,429,822)	($4,312,131)	($6,315,568)	($737,396)
BCR	0.19	0.20	0.10	0.25	0.19	0.43

No NED plan was identified. Since no alternative has positive net benefits, plan selection utilized CE/ICA. While these values represent NED benefits resulting from flood diversion at Lowell Creek, they do not represent the full scale of benefits that could be realized with the implementation of a project. The next section discusses the CE/ICA metric and summarizes the results.

6.5 Cost-Effectiveness and Incremental Cost Analysis (CE/ICA)

A plan justified solely by NED benefits could not be identified. Therefore, the team submitted a policy waiver to ASA(CW) to use CE/ICA for project justification. The CE/ICA effects are non-monetary outputs. The CE/ICA is utilized to inform decisions on sound investments by identifying options that yield maximum desired outputs for the least acceptable cost. These outputs are measured in total life risk, as exemplified by average annual life loss (AALL). This metric takes into account the hazard, which includes the frequency of the hydraulic scenario, and performance, which includes how well the diversion dam will perform during the hydraulic scenario. It is important to recall one of the primary planning objectives developed to address the flood risk problem at Seward to understand the basis of the outputs used in this CE/ICA:

> Reduce risk to public health, life, and safety from flooding of Lowell Creek to the City of Seward.

AALL directly affects the public health, life, and safety of Seward residents and a transient population (tourists) that can be especially vulnerable camped along the waterfront downgradient of the Lowell Creek Drainage. With reduced AALL, residents will experience increased safety and public health while seeing a decrease in life loss during flood events. The CE/ICA compares the AALL between proposed alternatives and the No Action plan. The Alaska District Hydraulics & Hydrology and Geotechnical Appendecies collaborated with Economics on the model development of the metric.

6.5.1 CE/ICA Results

The CE/ICA showed that only Alternatives 3A and 4A presented a substantial reduction in life loss from the existing conditions [redacted]

[redacted]

[redacted]

[redacted]

The existing AALL and the calculated reduction in AALL for each of the alternatives are portrayed in Table 16. It can be noted that Alternative 2 revealed no statistical difference from the existing conditions; this reflects that Alternative 2 is hydrologically identical to the existing system, only refurbishing the current system.

[redacted]

The CE/ICA results revealed two not cost-effective plans, one cost-effective plan, and two Best Buy plans other than the No Action plan (Table 17).

Table 17. CE/ICA Results

Alternative	Alt. Description	Average Annual Cost (1000s)	[redacted]	Cost-Effective
No Action	No Action Plan	$0	[redacted]	Best Buy
Alt 2	Improve Existing Tunnel	$2,908	[redacted]	Cost-Effective
Alt 3A	Enlarge Existing Tunnel 18’	$7,416	[redacted]	Non-Cost Effective
Alt 4A	Construct New Tunnel 18’	$5,758	[redacted]	Best Buy
Alt 3B	Enlarge Existing Tunnel 24'	$13,886	[redacted]	Non-Cost Effective
Alt 4B	Construct New Tunnel 24'	$7,771	[redacted]	Best Buy

The Incremental Cost Box Graph in Figure 21 displays the Best Buy plan comparisons resulting from the incremental cost analysis. As stated above, there are two Best Buy plans other than the No Action plan. The graph shows a great increase in cost per increment between Alternatives 4A and 4B explicitly.

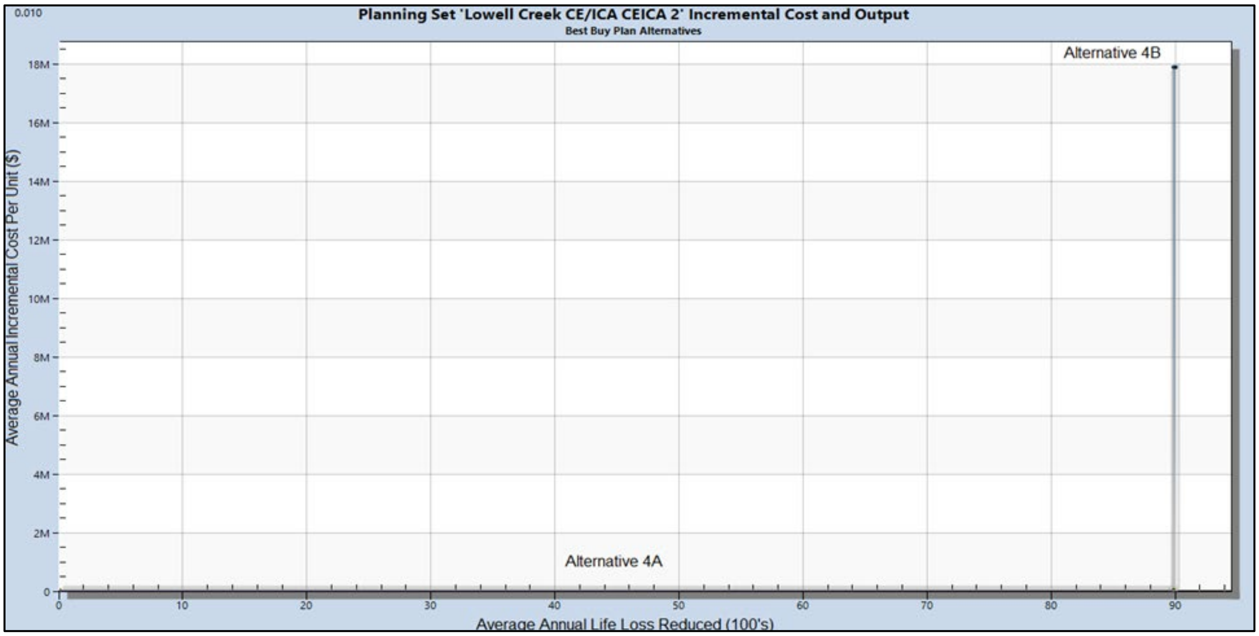

Figure 21. Average Annual Life Loss Reduced vs. Incremental Cost by Alternative

6.6 Risk and Sensitivity

Based on the information and inputs available at this point in the study, there is a high likelihood that the net benefits associated with the structural alternatives presented will remain negative. The cost estimates have been conservative, combined with the fact that the alternatives with the highest reduction in damages assume that nearly all damage in rare frequency events will be fully mitigated.

The exception is that the sedimentation issue that the study area experiences is currently underrepresented in the economic analysis. The remaining risks are that proper quantification of the sedimentation issue could lead to additional NED benefits. A sensitivity analysis could be performed using existing depth-damage relationships to determine what escalation of damages would have to occur to justify one of the alternatives that reduce structural damages.

An additional risk not quantified is the effect of climate change and relative sea-level change, which are currently not addressed by the hydraulic engineering team. Using future year hydraulics may show a significant increase in stages within the Lowell Creek watershed, and thereby increasing structural damages. However, the relative sea-level change (RSLC) trend in Seward is negative at -2.87 millimeters per year (NOAA 2020). As a result, there is little risk, if any, to the only project structure (outfall at elevation +58.99 ft MLLLW) that has the potential to be impacted by a change in sea level.

6.7 Plan Rationale

The NED analysis did not identify a plan with positive net benefits. Thus the team utilized CE/ICA with a metric of reduction in AALL to analyze the alternatives, which resulted in multiple Best Buy plans. However, only one plan (Alternative 4A) provided a substantial reduction of AALL overall flow frequencies and including surge at an incremental cost compared to other alternatives. Thus, Alternative 4A was selected as the TSP.

6.8 Summary of Accounts

The USACE planning guidance establishes four accounts to facilitate and display the effects of alternative plans. Plan formulation was performed for this study with a combined focus on CE/ICA benefits and NED benefits with consideration of all effects, beneficial or adverse, to each of the four evaluation accounts identified in the Principles and Guidelines. Plan selection was based on a weighting of the projected effects of each alternative on the four evaluation accounts. The PDT reviewed qualitative and quantitative information for major project effects and major potential effect categories.

6.8.1 National Economic Development

Consistent with the Implementation Guidance, to compare alternative plans, this study first conducted a NED analysis sufficient to determine that no NED Plan is attainable, then evaluated non-monetary benefits through a CE/ICA. The NED account shows changes in the economic value of the national output of goods and services. Previous sections discussed the NED analysis results with none of the alternative plans having positive net benefits to the Nation. The benefit-cost ratios for all alternatives range from 0.10 to 0.43. The smallest scale alternative upstream from the current system yielded the Benefit-Cost Ratio (BCR) of 0.43. As there is no NED plan because costs exceed benefits (less than 1.0 BCR), on the team supplemented the economic analysis with CE/ICA.

6.8.2 Regional Economic Development (RED)

Economic benefits that accrue to the region, but not necessarily the Nation, including increased income and employment associated with the construction of a project. The RED analysis includes the use of regional economic impact models to provide estimates of regional job creation, retention, and other economic measures such as sales or value-added.

The input-output macroeconomic model Regional Economic System (RECONS) can be used to address the impacts of the construction spending associated with the project alternatives.

6.8.3 Environmental Quality (EQ)

The Environmental Quality (EQ) displays the non-monetary effects of the alternatives on natural resources. The overarching effect of environmental quality by improving the Lowell Creek flood diversion system is the potential reduction of inadvertent release of environmentally persistent compounds. The release of such compounds might occur as a result of catastrophic flooding and the destruction of infrastructure and commercial and residential buildings. Impacts on EQ are described more fully in the EA sections of the draft feasibility report. Additional information is available in Section 8.0, "Environmental Consequences*."

6.8.4 Other Social Effects (OSE)

The Other Social Effects (OSE) account includes impacts on life safety, vulnerable populations, local economic vitality, and community optimism. Impacts on these topics are a natural outcome of civil works projects and are most commonly qualitatively discussed in the OSE account. Life loss modeling software such as HEC-FIA and HEC-LifeSim can quantify the loss of life for a given alternative to determine if life safety risk decreases or is induced as a result of Federal investment. [redacted]

6.8.5 Four Accounts Evaluation Summary

Based on this analysis of the four accounts, each alternative has positive effects for the EQ, RED, and OSE accounts and no positive BCR for the NED account. A summary of the four accounts for the alternatives is shown in Table 18.

Table 18. Four Accounts Summary

Alternative	Net Annual Benefits & BCR*	EQ	RED	OSE
2	($2,352,000) 0.19	Positive	Increased employment and income for the community	Beneficial
3A	($5,960,000) 0.20	Positive	Increased employment and income for the community	Beneficial
3B	($12,430,000) 0.10	Positive	Increased employment and income for the community	Beneficial
4A	($4,312,000) 0.25	Positive	Increased employment and income for the community	Beneficial
4B	($6,316,000) 0.19	Positive	Increased employment and income for the community	Beneficial
5	(737,000) 0.43	Positive	Increased employment and income for the community	Beneficial

7. TENTATIVELY SELECTED PLAN

7.1 Description of the Tentatively Selected Plan

To reduce the risk at Lowell Creek to below the tolerable risk guidelines set by USACE, the TSP, Alternative 4A, includes the construction of a dam upstream of the existing dam to divert all of the Lowell Creek flow into a new 18-ft diameter tunnel which conveys this flow to the outfall that discharges on to the existing Lowell Creek alluvial fan (Figure 22). A canopy will be constructed over the new tunnel entrance to prevent blockage from a landslide, and a 150 ft outfall that conveys the Lowell Creek flow over Lowell Point Road on to the alluvial fan. The new 18-foot tunnel would reduce risks (see Table 16) associated with flows up to 8,400 cfs (PMF).

The existing diversion dam and tunnel will remain, but their purpose is to provide additional capacity if the new diversion dam is overtopped, or if the Lowell Creek flow needs to be diverted to facilitate maintenance activities associated with the new diversion system. The existing 10-ft diameter tunnel will be refurbished so it can continue to serve its purpose of conveying flow when needed in the future.

The TSP also incorporates the measure of removing some trees in the Lowell Creek Canyon area (Figure 22) that are large enough to get caught in the tunnel upstream of the dam and installing instrumentation. The select tree removal measure will be revisited during PED to verify the location, number, and size of the trees that are recommended for removal.

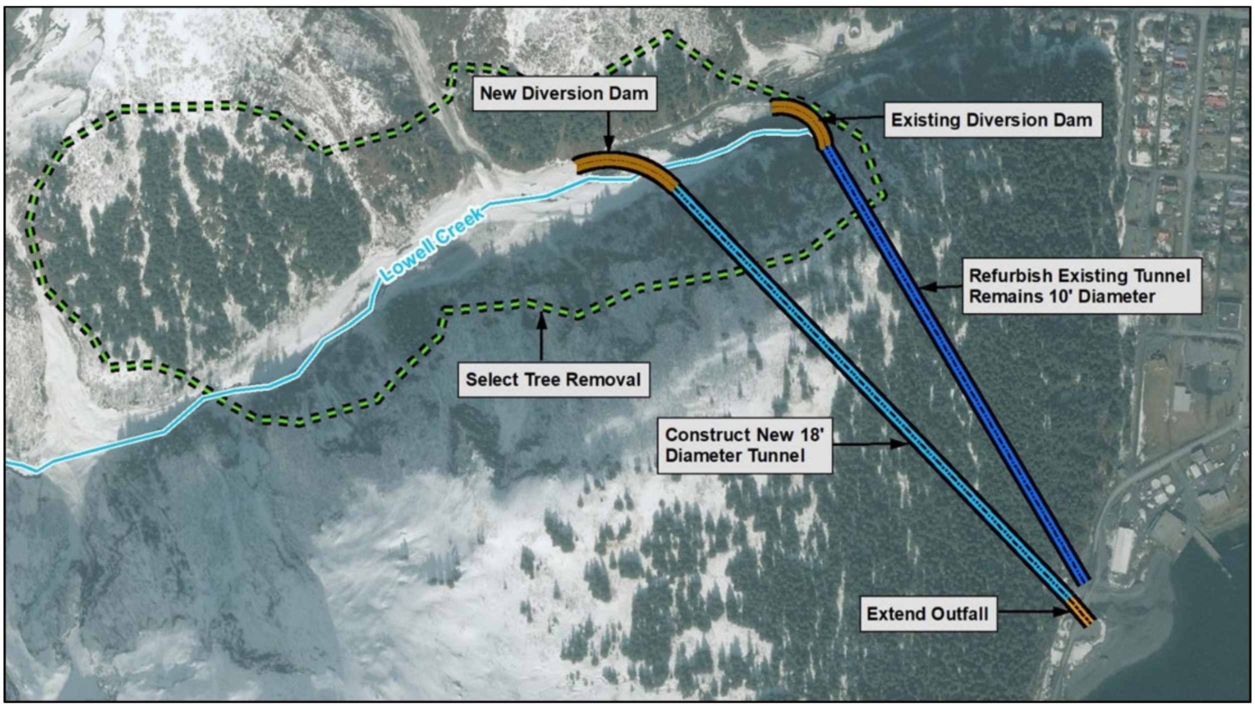

Figure 22. Tentatively Selected Plan for Lowell Creek Feasibility Study

7.2 Plan Components

The significant plan components for Alternative 4A include:

- New Diversion Dam
- New 18 ft in diameter tunnel
- Tunnel Inlet portal canopy over the new tunnel
- Extended 150 ft outfall for the new tunnel
- Refurbishment of the existing 10 ft diameter tunnel
- Select tree removal in Lowell Creek Canyon

Each component above is discussed in more detail in the sections below.

7.2.1 New Diversion Dam

The diversion dam, spillway, and intake transition designs are largely based on the existing dam configuration. Any new intake transition design will require physical modeling during PED to confirm performance. The diversion dam height above the adjacent streambed will be similar to that of the existing dam.

7.2.2 New 18 ft Diameter Tunnel

It is assumed that new tunnel construction will be by drill and blast methods and that a stabilizing shotcrete liner will be installed before forming and placing the concrete liner. Contact grouting will be accomplished after the concrete liner is placed to ensure full contact at the tunnel crown. A typical cross-section of the proposed tunnel, also referred to as the flume, is shown in Figure 23.

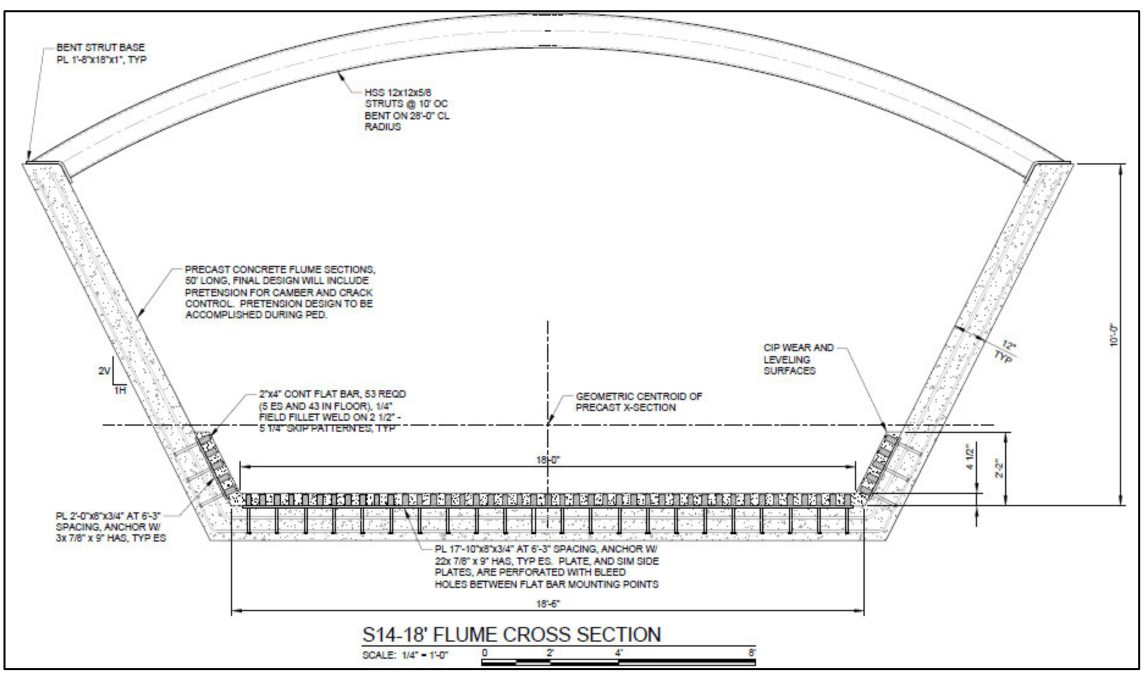

Figure 23. 18 Foot Flume Cross-section

7.2.3 Tunnel Inlet Portal Canopy

The tunnel inlet portal canopy is designed as a steel-frame structure with concrete footings tied into bedrock and a combination of site-cast and precast concrete decking. Design live load capacity was set at 600 pounds per square foot to provide substantial resistance to landslide-related loading. No composite action was assumed between the steel girders and the deck slabs; however, this could be incorporated during PED to either provide some cost reduction or increase the structure's load capacity. At this time, no architectural treatment has been included. However, it is assumed that a large structure of this type in a natural setting should consider aesthetics for the final design. The anticipated design of the tunnel inlet portal canopy is shown in Figure 24.

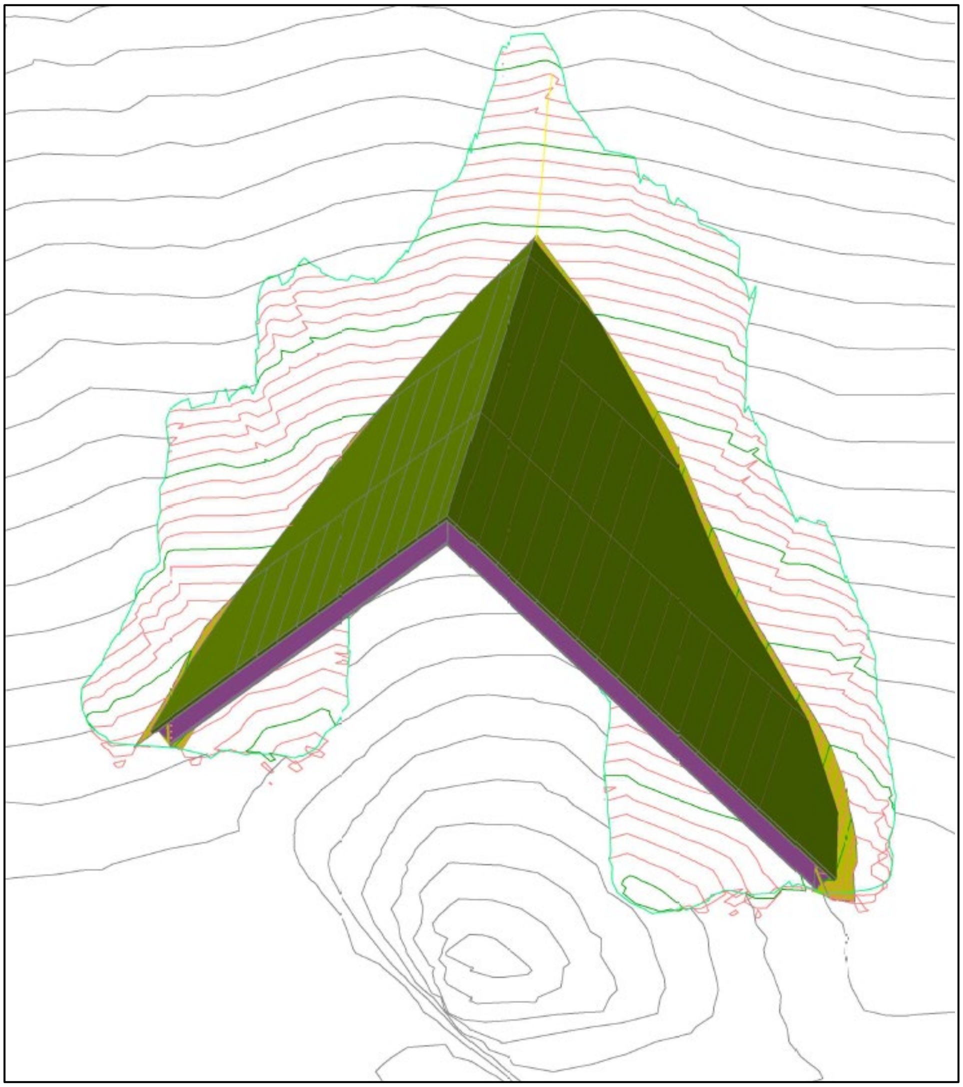

Figure 24. Entrance Portal Canopy Oblique View

7.2.4 Extended Outfall – 150 ft

The outfall is a pre-cast concrete open-channel flume placed on drilled piers with pier caps, similar to those typically used in bridge construction. Piers are concrete-filled steel pipes with a rebar cage. The pre-cast flume sections have bent tube-steel struts across the top of the walls to facilitate lifting and placing as well as reinforcing the sidewalls of the flume for lateral loads. Armoring is field-welded and encased in concrete to form a replaceable wear surface, which also will allow for a uniform slope. The system has been designed for a mounded gravel live load to prevent flume failure should a blockage occur. Seismic loads perpendicular to the length of the flume have been accounted for. However, further work must be done to account for seismic loads along the length of the flume. A rigid connection to the supporting rock where the flume is tied to Bear Mountain would prevent the piers from seeing lateral loads for seismic forces in this direction, which would make for a large load over a small area. For the 150' long outfall extension under consideration, these large forces may be manageable, but this further evaluation is needed during PED.

7.2.5 Select Tree Removal

This measure includes selective tree removal of those trees exhibiting a 48" or greater diameter at breast height or multiple trunks of 30" in diameter at breast height in a portion of the upper watershed. This measure has the objective of removing trees that are large enough to cause blockage in the tunnels if they fall and are swept into the tunnel(s) during a storm event. However, the select tree removal specifications will be re-evaluated during PED because the tree specifications reported here were developed for the existing 10-ft diameter tunnel, and the new 18 ft diameter tunnel may tolerate larger trees and still avoid blockage issues.

7.3 Construction of Tentative Selected Plan

Diversion Dam and Intake Transition

It is assumed that the diversion dam will be constructed of roller-compacted concrete; however, the intake transition will require formed and carefully controlled concrete screeding and finishing. The details of combining these construction methods will need to be further evaluated during design.

Tunnel

It is assumed that tunnel construction will be by drill and blast methods and that a stabilizing shotcrete liner will be installed prior to forming and placing the concrete liner. Contact grouting will be accomplished after the concrete liner is placed to ensure full contact at the tunnel crown.

Outfalls

Outfall construction will be similar to simple-span, pre-cast concrete bridge construction with land-based equipment being necessary to complete the structure. Multiple cranes may be necessary to lift the heavy flume elements into place. The proposed outfall design is shown in Figure 25.

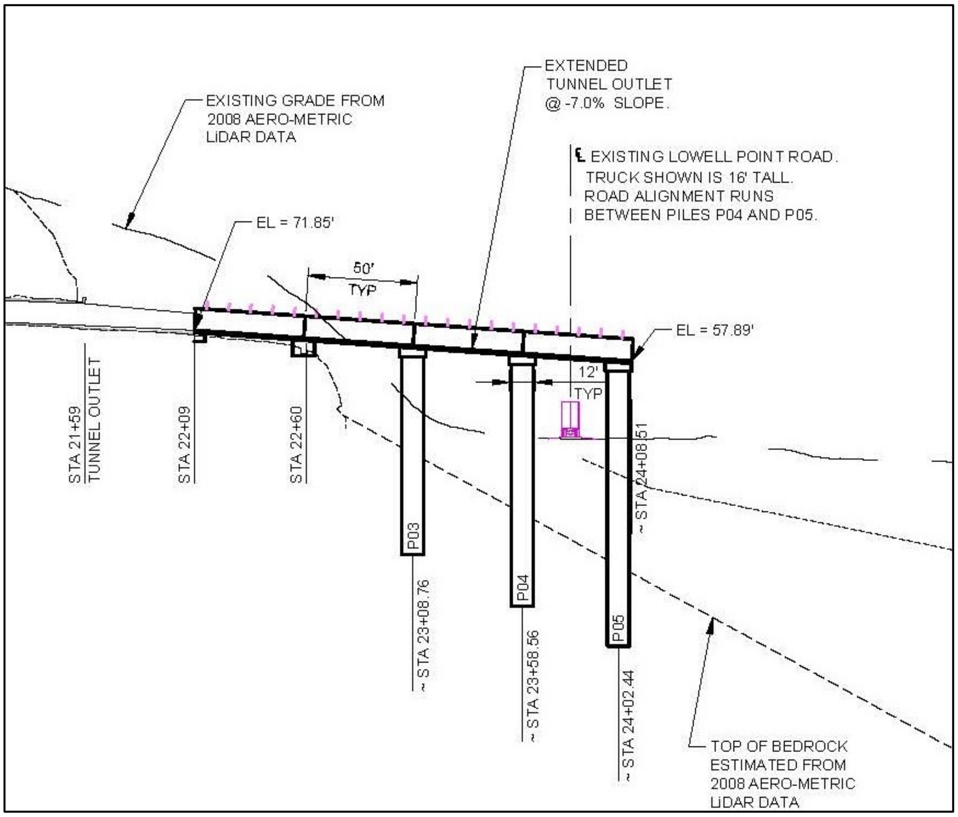

Figure 25. Proposed Design of Extended Outfall

Early Warning System

The early warning system consists of three continuously operating gages in the Lowell Creek Basin, a discharge gage to measure the quantity of water exiting the tunnel, and two Snow Telemetry (SNOTEL) sites within the basin to measure rainfall and snowpack accumulation.

Refurbishing Existing Tunnel

Repairs to the tunnel lining will be focused on the invert where water and debris have been flowing as well as completing contact grouting of the tunnel crown. Repairs would be cast in place concrete overlays controlled to maintain the design slope and grade of the tunnel invert. Successful repair operations in the past have employed establishing temporary grade control beams and a screed that produces the inverted profile by traversing the temporary rails. Concrete was delivered to the repair areas by winch operated carts.

7.4 Operation & Maintenance

The outfall of the project must be maintained to prevent material buildup that would jeopardize adjacent facilities or block the system. It is expected that the system will deposit approximately 25,000 cubic yards of material annually on to the alluvial fan. Over time, this material would accumulate, and sediment handling is expected to be similar to what has currently taken place with heavy equipment pushing and moving the sediment towards deep water. Annual costs for these efforts have been provided by the City of Seward and are estimated to be $556,000.

7.5 Integration of Environmental Operating Principles

The following environmental operating principles have been integrated into the planning process:

Foster sustainability as a way of life throughout the organization:

Proactively consider environmental consequences of all USACE activities and act accordingly: Environmental consequences were considered throughout the planning process, and every effort has been made to avoid, minimize, or mitigate anticipated impacts.

Create mutually supporting economic and environmentally sustainable solutions: No NED plan was identified for this project, but the NED policy exception waiver affords the PDT the flexibility to use CE/ICA in the absence of a NED plan. Alternative 4A is the Best Buy plan based on CE/ICA. This project was formulated in a way that makes it lasting, requiring limited maintenance and avoiding long term environmental impacts wherever possible.

Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE, which may impact human and natural environments: A full environmental assessment (EA) has been conducted as required by the National Environmental Policy Act. In addition, the principles of avoidance, minimization, and mitigation would be enacted to the extent possible.

Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs: For this study, extensive coordination has taken place to determine the impacts and subsequent mitigations actions regarding environmental impacts.

Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner: The USACE worked closely with the City of Seward throughout this study. The City of

Seward and other agencies that work at Seward is very knowledgeable about the environment surrounding Lowell Creek.

Employ an open, transparent process that respects the views of individuals and groups interested in the USACE activities: The USACE made every effort to be responsive to stakeholder concerns. Public input was solicited and used for both environmental and economic analysis purposes. Before this study started, a meeting took place for feedback from the City of Seward and stakeholders on what problems the community faces and the impacts on flooding with the existing conditions in the Seward area. The group defined objectives, opportunities, and constraints for this study and discussed alternative ideas. The team analyzed seven alternatives at Lowell Creek and used these as the final array to determine the Tentatively Selected Plan (TSP) (Sections 5.4 to 5.6).

7.6 Real Estate Considerations

Removal of selected trees upstream from the tunnel and the construction of the canopy for inlet protection from landslides will require easements. In addition, staging areas will be required at both ends of the tunnel for construction. The features, owners, acres, and the standard estate required for the TSP Lands, Easements, Rights of Way, Relocations, and Disposal Area (LERRD) are described in Table 19.

Table 19. Tentatively Selected Plan LERRD Requirements

Tract ID	Feature	Owner	Acres	Minimum Estate Required
1	Tree Removal	State of Alaska	45.51	Non-standard estate Permanent Easement
2	Tree Removal	NFS	16.74	Permanent Easement
3	Dam and Tunnel Canopy	NFS	25.32	Fee
4	Outfall and Staging	Federal Government	22.27	Public Domain
5	Outfall and Staging Area	NFS	0.20	Fee
		TOTAL ACRES	110.04	

The navigation servitude may only be exercised by the Federal Government for Congressionally authorized projects or measures that are related to navigation or pursuant to regulatory authorities to protect navigation. Navigation servitude is not being applied to this project. No known utilities or facilities are located in this area, and no relocations are required. Public Law 91-646 relocations (relocation of persons) are not anticipated, nor is any utility relocation anticipated. There are no other Federal Projects that would be affected by the project footprint. Further information about real estate requirements for the project is available in Appendix F.

7.7 Risk and Uncertainty

In any planning decision, it is important to take into account the risk and uncertainty that is invariably present. For this study, there are a few risk and uncertainty categories that were identified and evaluated during the planning process. The risk and uncertainty of items remaining for this project are summarized in Table 20.

Table 20. Risk and Uncertainty Summary

Assumption or Estimate	Risk Level	Risk Comment
Lack of Data	Medium	Assumptions made due to lack of gauged (rainfall/runoff) data
Bedrock Depth	Medium	The depth of bedrock has been assumed and will be further investigated during PED.
Sedimentation Quantity	Medium	The quantity of sedimentation is estimated based on estimates of deposition during historical events.
Weather Delays	Low	The project area is prone to extreme weather conditions that could impact data collections and construction.
Unanticipated cultural resources	Low	There is minimal risk of encountering unanticipated cultural resources.

7.8 Project Cost

7.8.1 Cost Sharing

According to the implementation guidance for Section 5032 of the Water Resources Development Act of 2007, the design and construction of the approved plan shall be accomplished at Federal expense with the non-Federal sponsor providing, at no cost to the Government, all needed lands, easements, and rights-of-way (Table 21). The project design and construction of the approved project will not be cost shared and are 100% Federal expense. The Sponsor will only be responsible for providing LERRDs for the project at no cost to the Government.

Table 21. Cost Share for TSP

Item	Total Cost	Federal Share	%	Non-Federal Share	%
Construction Estimate Total	$103,438,000	$103,438,000	100		
LERRD	$5,750	$0	$0	$5,750	100
Planning, Engineering & Design	$12,632,000	$12,632,000	100		
Construction Management	$6,859,000	$6,859,000	100		
TOTAL PROJECT COST	$122,929,000	$122,929,000	100		
FINAL COST ALLOCATION	**$122,929,000**	**$122,929,000**	100	**$5,750**	100

7.9 Project Schedule

The construction of the project alternatives is expected to begin in the year 2023. It will continue for one year for every alternative except Alternative 3A and 3B. For these alternatives, which include enlarging the existing flood diversion system, seasonal peak flows cannot be diverted. Therefore construction activities are limited to the winter months, and therefore construction must be prolonged over a period of 7 years.

Major construction features for Alternative 4A include a new 18ft diversion tunnel and dam, canopy, and extending the outfall. Project specifications would detail time restrictions for the contractor to conduct certain activities during specified time periods.

Construction sequencing would likely be similar to the following:

- Construction of canopy
- Drilling and construction of a tunnel
- Construction of diversion dam
- Extension of outfall construction.

For cost estimation purposes, the construction sequencing summarized directly above was developed utilizing the best construction sequencing scenario for cost-effective project implementation. The basis for the construction sequencing scenario is USACE's experience with previous projects constructed, including port construction projects in the region. However, there is inherent risk and uncertainty in project authorization and appropriation of funds by Congress, which can influence the TSP construction schedule and sequencing scenario developed during the feasibility study phase. Construction sequencing developed during the feasibility study may have to be revisited to inform appropriation decisions that may potentially be based on what project components or feature(s) have priority considering the associated benefits.

Priorities for TSP components are influenced by engineering and hydrology considerations, operation and management needs, as well as the benefits associated with the project components, and the priorities expressed by the non-Federal sponsor.

There is also a cost risk if construction sequencing for the entire TSP cannot be optimized due to inadequate funding.

Total project costs could increase due to, but not limited to:

- More contractor mobilizations would likely be required to complete the TSP.
- Potential efficiencies associated with optimized construction sequencing may not be realized if appropriations prevent the scheduling and construction of the entire TSP under one contract.

Environmental mitigatory measures developed for this project are summarized in Section 8.4, “Summary of Mitigation Measures.” Preconstruction bird surveys should be conducted as well as the implementation of USFWS bald and golden eagle nest site protocols.

8. ENVIRONMENTAL CONSEQUENCES*

Table 22. Environmental Consequences Summary

	Alternative 1: No Action	Alternative 2: Improve Existing + 150' Outfall Flume	Alternative 3 (a) and (b): Enlarge Existing + 150' Outfall Flume	Alternative 4 (a) and (b): Construct New +150' Outfall Flume	Alternative 5: Construct Debris Basin
Aesthetics	Aesthetics would be unaffected by Alternative 1.	The tunnel entrance would be covered by reinforced structure; original aspects of the project would be permanently altered.	The 150' outfall flume would be the most readily observed permanent effect to the existing aesthetic properties of the location. Similarly, enlargement of the diversion dam and tunnel system would be permanent.	The 150' outfall flume would be the most readily observed effect to the existing aesthetics. The existing diversion system would not be affected. A new, permanent alteration of the aesthetic baseline would occur as a result of the implementat-ion of a new, larger diversion system above the existing.	The aesthetic qualities of the upper watershed would be affected on a recurring annual basis as the debris basin was reestablish-ed. Dump truck traffic in Seward would increase during the wintertime as this effort was implement-ed.
Water Quality	Water quality may be negatively affected by debris, household, and industrial compounds as a result of catastrophic flooding through Seward.	The alternative would not affect baseline water quality conditions.	Alternatives would mimic existing conditions and would likely not affect baseline water quality conditions.	Alternatives would mimic existing conditions and would likely not affect baseline water quality conditions.	Increased turbidity in the vicinity of and downstream of active earthwork. Likely requires surface flow diversion for construction.

Noise	Ambient noise levels would likely not be impacted by the implementa-tion of Alternative 1.	Ambient noise levels would increase in proximity to areas of active construction but would not exceed those of a normal construction site.	Ambient noise levels would increase in proximity to areas of active construction but would not exceed those of a normal construction site.	Ambient noise levels would increase in proximity to areas of active construction but would not exceed those of a normal construction site.	Ambient noise levels would increase during periods of active work but would be limited to the upper portions of the Lowell Creek watershed.
Existing Infrastruc-ture and Facilities	Seward's infrastructure downstream of the existing diversion structure could be subject to catastrophic damage. Similarly, infrastructure located in proximity to the existing outfall structure may be subject to flood damage.	Seward's infrastructure downstream of the existing diversion structure could be subject to catastrophic damage. The risk of flood damage to infrastructure in proximity to the outfall would persist until the construction of the new outfall was complete.	Alternative 3 would carry the same risk as to the No Action Alternative until fully constructed.	Constructing a new, upstream diversion structure and tunnel would carry the same risk as to the No Action Alternative until the diversion and tunnel structure were capable of conveying surface flows.	Seward's infrastructure downstream of the existing diversion structure could be subject to catastrophic flooding damage if the tunnel were blocked.
Cultural Resources	Cultural resources would not be affected by the No Action Alternative.	Alterations to the existing structure would require reinitiation of Section 106 Consultation.	Alterations to the existing structure would require reinitiation of Section 106 Consultation.	Cultural resources would not be affected by the Construct New Alternative.	Cultural resources would not be affected by the Construct Debris Basin Alternative.
Environ-mental Justice	Catastrophic flooding would likely disproportion-ately affect members of the population who may be disabled or have hearing or vision	Catastrophic flooding would likely disproportion-ately affect members of the population who may be disabled or have hearing or vision impairment.	Protracted construction time may prolong the risk associated with catastrophic flooding.	The redundancy of two tunnels potentially eliminates disproportion-ate risk to members of the population who may be disabled or	The alternative would not reduce the risk of catastrophic flooding to members of the population who may be

	impairment.			have hearing or vision impairment.	disabled or have hearing or vision impairment.
Protected Tribal Resources	There would be no impact on any known Tribal Resource.	There would be no impact on any known Tribal Resource.	There would be no impact on any known Tribal Resource.	There would be no impact on any known Tribal Resource.	There would be no impact on any known Tribal Resource.
Biological Resources					
Terrestrial Habitat	Terrestrial habitat would not be affected by the no-action alternative	Terrestrial habitat in the area of the existing project would not be affected. Terrestrial habitat in the tree removal area may become successional.	Effects to terrestrial habitat in the area of the diversion and tunnel inlet would resemble the existing condition. Vegetation in the tree removal area may become successional. Terrestrial habitat in the vicinity of the outfall would resemble the existing baseline condition.	Effects to the terrestrial habitat in the area of the new diversion dam and tunnel inlet would strongly resemble the habitat at the existing diversion site. Vegetation in the tree removal area may become successional. Terrestrial habitat in the vicinity of the outfall would strongly resemble the existing baseline condition.	Effects to terrestrial habitat in the upper watershed would include an annual disturbance regime that does not currently exist.
Birds	Birds may be inadvertently impacted by exposure to household and industrial compounds released as a result of catastrophic flooding.	Birds would not be impacted directly. Indirect impacts from tree removal would be difficult to quantify. Birds may be dissuaded from foraging or nesting in close	Birds would not be impacted directly. Indirect impacts from tree removal would be difficult to quantify. Birds may be	Birds would not be impacted directly. Indirect impacts from tree removal would be difficult to quantify. Birds may be	Birds would not be impacted directly; indirect effects would be difficult to determine; birds may be dissuaded from forging

		proximity to active construction.	dissuaded from foraging or nesting in close proximity to active construction.	dissuaded from foraging or nesting in close proximity to active construction.	in the immediate area of active construction.

8.1 Physical Environment

Existing physical environmental conditions described in Section 3, “Baseline Conditions/Affected Environment*” that have been carried forward for analysis, are presented below.

8.1.1 Aesthetics

8.1.1.1 No Action Alternative

Implementation of the No Action Alternative would not affect the aesthetic characteristics of the existing project

8.1.1.2 Alternative 2: Improve Existing Flood Diversion System

Implementation of Alternative 2 would affect the aesthetic characteristics of the existing project by constructing a protective structure above the tunnel’s mouth to prevent landslides from blocking the tunnel. Improving the existing flood diversion system would have only a small physical effect, roughly the size of the tunnel entrance itself, on the existing aesthetic value of the system overall.

8.1.1.3 Alternative 3A and 3B: Enlarge Existing System + 150’ Outfall

Implementation of Alternatives 3A and 3B would affect the existing aesthetic characteristics at the diversion structure and tunnel entrance invert by replacing these structures. However, the structures would appear relatively similar to the existing but would be larger. Impacts on the aesthetic characteristics at the diversion dam and tunnel intake area would be the noticeable change in size to the existing structure regardless of whichever Alternative 3A or 3B were implemented. However, the replacement structure would be similar in appearance to the existing structure.

Aesthetic characteristics at the point of outfall would be modified by the implementation of Alternatives 3A and 3B. A 150-foot pile-supported elevated flume would follow the slope of the tunnel, span the existing roadway, and would change Lowell Creek’s depositional action to the seaward side of the road. The existing outfall would no longer discharge unless there as an overtopping event from the new diversion dam, or the creek flow was intentionally diverted for maintenance purposes. Despite such a change in appearance, likely, the new outfall would still represent a point of curiosity for tourists and locals alike because it will be even more prominent than the existing structure. In total, however, the Lowell Creek outfall structure represents a minuscule fraction of Resurrection Bay and its surrounding hillsides' viewshed. It would not be more than a minor impact on the aesthetic characteristics of the area.

8.1.1.4 Alternative 4A and 4B: Construct New Flood Diversion System, an 18 ft tunnel, b 24 ft tunnel + 150' Outfall (4A TSP Alternative)

Implementation of Alternatives 4A and 4B would not affect the aesthetic characteristics of the existing project. However, the creation of a new diversion dam and tunnel inlet system just upstream of the existing would permanently affect the aesthetic characteristics of upper Lowell Canyon. Although the effect on aesthetics would be permanent, the overall impact would not be remarkable as it would not be visible to the public in most situations. It would not detract from the overall viewshed of Resurrection Bay.

Impacts to aesthetic characteristics at the point of outfall are similar to those evaluated in Section 8.1.1.3, "Alternative 3A and 3B: Enlarge Existing System + 150' Outfall", with the exception that the elevated flume would exit Bear Mountain south of the existing outfall because it would be following the grade of a new tunnel. Despite such a change in appearance, likely, the new outfall would still represent a point of curiosity for tourists and locals alike because it will be even more prominent than the existing structure. In total, however, the Lowell Creek outfall structure represents a small fraction of Resurrection Bay and its surrounding hillsides' viewshed.

8.1.1.5 Alternative 5: Construct Upstream Sediment Basin

Implementation of Alternative 5 would not affect the aesthetic characteristics of the existing project. However, the construction and annual maintenance of the sediment basin would require an increased presence of heavy equipment not only in Lowell Canyon but along Seward's streets as the material was being excavated and transported to staging areas. Similarly, the sediment basin itself would be an alteration to the natural setting of upper Lowell Canyon.

Construction of Alternative 5 would occur during the period of lowest surface flow, which corresponds with the winter months in Seward. Aesthetic effects to the surrounding environment would be temporary in terms of construction and support equipment presence, and likely unremarkable within the canyon itself as it is not a heavily trafficked area or a point of particular interest. Also, the inherent danger of the system may serve as a deterrent to those who might seek to observe the project area.

8.1.2 Water Quality

8.1.2.1 *No Action Alternative*

Implementation of the No Action Alternative would likely have no discernable effect on existing water quality characteristics. However, the potential risk to water quality as a result of catastrophic flooding and damage to buildings and infrastructure resulting in the inadvertent release of environmentally persistent or fouling compounds is not reduced by the implementation of the No Action Alternative.

8.1.2.2 Alternative 2: Improve Existing Flood Diversion System

From a hydraulic perspective, the No Action Alternative and Alternative 2 are identical. Implementation of a reinforced structure at the entrance of the tunnel to protect it from rock slides would not affect water quality. However, Alternative 2 incorporates selective tree removal of those trees exhibiting a 48” or greater diameter at breast height or multiple trunks of 30” in diameter at breast height in a portion of the upper watershed, which may facilitate an increased degree of erosion compared to the No Action Alternative. Quantification of such an increase and its potential effect upon water quality would be difficult to characterize. During periods of high flow, the surface waters of Lowell Creek are typically saturated with suspended sediments, and the bed load quantity is only an approximation. As a result, the degree selective tree removal and potential subsequent elevated erosion would have on its baseline condition is unknown.

Alternative 2 would also incorporate improvements to the existing low-flow diversion system that helps to facilitate seasonal maintenance of the diversion dam, tunnel invert, tunnel, and existing outfall flume. Although maintenance efficiencies would be realized, there would be no overall impact on water quality.

As with the No Action Alternative, the potential risk to water quality as a result of catastrophic flooding and damage to downstream buildings and infrastructure resulting in the inadvertent release of environmentally persistent or fouling compounds is not reduced by the implementation of Alternative 2.

8.1.2.3 Alternative 3A and 3A: Enlarge Existing System + 150’ Outfall

Implementation of Alternative 3A and 3B entails the enlargement of the existing system in the form of an 18 foot or 24-foot diameter horseshoe tunnel and their supporting structures. Implementation of Alternatives 3A and 3B would replace the tunnel’s intake transition and diversion dam, selectively remove trees in portions of the upper watershed, and would incorporate an extended 150-foot outfall flume.

Effects on water quality as a result of replacing the existing diversion dam and tunnel intake transition would be unlikely because construction would have to be performed during the period of lowest surface flow, typically the winter months when precipitation falls as snow. Similar to the system’s existing maintenance protocol, Lowell Creek’s surface water flows would be diverted around the active construction and into the storm sewer or through a segmented pipe running through the tunnel itself. Surface waters would not have the opportunity to interact with concrete or construction-related materials or surfaces until they were cured. Some residual construction-related dust would be expected to be scoured by surface waters once the construction diversion was removed, but this would not be expected to affect surface water quality more than just temporarily and for a very short duration.

Alternatives 3A and 3B would likely employ the most common methodology for tunnel creation, the drill and blast method, which is comprised of drilling blast holes and filling them with explosives; detonating the blast, followed by ventilation to clear blast fumes; removal of the blasted rock; scaling the crown and walls to remove loose rock; installing supports, and advancement of all utilities and machinery to support subsequent blasts. Enlarging the existing tunnel to a diameter of either 18 or 24 feet represents a multiple-year effort to accomplish, with those years being curtailed into the season of the lowest surface water flows. Despite the multiple-year effort required, effects on water quality would be not be expected because of the same reasons for the replacement of the intake transition and diversion dam. Surface flows would be diverted around the active construction area and would not be allowed to flow through the tunnel until construction crews and support equipment had been removed. Some residual construction-related dust would be expected to be scoured by surface waters once the construction diversion was removed, but this would not be expected to affect surface water quality or turbidity more than just temporarily and for a very short duration. Debris and rubble generated by the tunnel expansion process, likely through drilling and blasting, would not come into contact with surface flows and would be trucked away for either on-land disposal or beneficial use as road base or fill for another project. The duration of construction efforts, in terms of year or seasons, is the primary difference between the 18 or 24-foot tunnels. Otherwise, the overall effect upon water quality is the same.

Alternatives 3A and 3B would incorporate a 150-foot concrete outfall flume at the point where the tunnel exited Bear Mountain so that sediment deposition in proximity to the Lowell Point Bridge would occur on its downstream side rather than the existing upstream side. Implementation of the extended outfall flume would not extend into the intertidal waters of Resurrection Bay and would not affect those existing water quality characteristics. Like the construction of the tunnel intake transition, diversion dam, and tunnel itself, construction of the outfall flume would occur during the period of lowest surface water flows.

Alternatives 3A and 3B incorporate selective tree removal of those trees exhibiting a 48” or greater diameter at breast height in a portion of the upper watershed, which may facilitate an increased degree of erosion compared to the No Action Alternative. Quantification of such an increase and its potential effect upon water quality would be difficult to characterize. During periods of high flow, the surface waters of Lowell Creek are typically saturated with suspended sediments. Thus, to what degree selective tree removal and potential subsequent elevated erosion would have on its baseline condition is unknown.

8.1.2.4 Alternative 4A and 4B: Construct New Flood Diversion System, an 18 ft Tunnel, b 24 ft Tunnel + 150' Outfall (4A TSP Alternative)

Construction of a new flood diversion dam and tunnel intake transition would occur upstream of the existing project and would be limited to the periods of lowest surface flows. Any surface water flows would be diverted around the active construction area and would be allowed to return to the main channel downstream and diverted through the existing tunnel as would normally happen. The effects on water quality as a result of the construction of these elements would not be expected.

Construction of the tunnel, regardless of the diameter, could theoretically occur year-round if conducted from the downstream side because it would not be subject to surface flows during the high flow period. Alternative 4A and 4B would likely employ the most common methodology for tunnel creation, the drill and blast method, which is comprised of drilling blast holes and filling them with explosives; detonating the blast, followed by ventilation to clear blast fumes; removal of the blasted rock; scaling the crown and walls to remove loose rock; installing supports, and advancement of all utilities and machinery to support subsequent blasts. Debris and rubble generated by the tunnel expansion process, likely through drilling and blasting, would not come into contact with surface flows and would be trucked away for either on-land disposal or beneficial use as road base or fill for another project.

Alternative 4A and 4B would incorporate a 150-foot concrete outfall flume at the point where the tunnel exited Bear Mountain so that sediment deposition in proximity to the Lowell Point Bridge would occur on its downstream side rather than the existing upstream side. Implementation of the extended outfall flume would not extend into the intertidal waters of Resurrection Bay and would not affect those existing water quality characteristics. Like the construction of the tunnel intake transition, diversion dam, and tunnel itself, construction of the outfall flume would occur during the period of lowest surface water flows.

Alternative 4A and 4B would incorporate selective tree removal of those trees exhibiting a 48" or greater diameter at breast height in a portion of the upper watershed, which may facilitate an increased degree of erosion compared to the No Action Alternative. Quantification of such an increase and its potential effect upon water quality would be difficult to characterize. During periods of high flow, the surface waters of Lowell Creek are typically saturated with suspended sediments, and the bed load quantity is only an approximation, so to what degree selective tree removal and potential subsequent elevated erosion would have on its baseline condition is unknown.

8.1.2.5 Alternative 5: Construct Upstream Sediment Basin

Alternative 5 would construct a catchment basin for bedload material above the existing diversion dam and the tunnel entrance. Like Alternatives 3A, 3B, 4A, and 4B, the basin would only be able to be constructed and/or maintained during the period of lowest surface flows. The catchment basin would be capable of storing approximately 25,000 cubic yards of material, the approximate annual depositional volume generated by Lowell Creek. Surface waters would be diverted around areas of active excavation and would likely not come into contact with newly exposed sediments until the excavation was complete.

The catchment basin would require annual maintenance to perform as envisioned. Excavated sediments would be trucked via dump truck to material staging areas before utilization in other projects such as road base or general fill. Assuming the standard dump truck has an operating volume of 16 cubic yards, approximately 1,560 individual trips would be required to meet project assumptions of 25,000 cubic yards. Sediment composition in Lowell Canyon above the existing diversion is generally a heterogeneous mix of boulders, cobbles, and gravels, which would preclude vehicle operations if a road were not installed.

The amount of ground disturbance required to construct the catchment basin could affect water quality by temporarily increasing turbidity levels once surface flows and bedload were to interact with those disturbed areas. However, the signature of such an impact would likely be muted by Lowell Creek’s natural tendency to mobilize large quantities of bedload and fine sediments during precipitation events. Overall, any increase in turbidity would be temporary. The increased turbidity of Lowell Creek’s surface waters flowing into Resurrection Bay would cause a visible plume of suspended sediments. It would temporarily affect water quality until they settled out of suspension or came into equilibrium with the background levels of the Bay. Normally, because many of the streams that feed into Resurrection Bay are glacial, following precipitation events, the waters of Resurrection Bay can be occluded by elevated fine particulate (glacial dust) suspended sediments for hours to days before returning to pre-precipitation values. It would be difficult to attribute elevated turbidity levels as a result of the implementation of Alternative 5 to the overall turbidity values observed in Resurrection Bay following even a normal precipitation event.

8.1.3 Noise

8.1.3.1 No Action Alternative

Ambient noise levels would not be affected by the implementation of the No Action Alternative. Other than the existing heavy equipment operations at the outfall area where sediments accrete, and recurring maintenance to the structure, there would be no other anthropogenic influence upon the existing ambient noise climate in the vicinity of the existing project.

8.1.3.2 Alternative 2: Improve Existing Flood Diversion System

Implementation of Alternative 2 would have only highly localized impacts upon ambient noise levels. The majority of work would occur at the existing tunnel’s entrance and would likely incorporate the operation of heavy equipment. However, given the naturally attenuating attributes of the existing environment, it is likely that the short-lived construction noise generated by the project would only be perceived by those at the project site. The nearest residential structure to the existing diversion dam is approximately 300 meters downstream around a slight bend in the canyon at the canyon mouth.

8.1.3.3 Alternative 3A and 3B: Enlarge Existing System + 150' Outfall

Except for duration, implementation of Alternatives 3A and 3B would likely have similar impacts to the ambient noise levels as Alternative 2 concerning the construction of the diversion dam and tunnel entrance invert and who may be able to perceive it.

Drilling and blasting would also likely have a minimal impact on ambient noise levels. Drilling by itself does not constitute more than average construction site noise. Blasting, however, would be confined so that explosive charges were stemmed from an inert material that directs the force of the explosion towards the rock, thereby reducing the potential for rapidly expanding gasses escaping the borehole and generating a high energy sound pressure wave. Also, as the drilling and blasting cycles moved into Bear Mountain, the capacity for perception of such noise is similarly reduced.

Construction of the 150-foot elevated outfall flume would generate increased construction-related noises in the vicinity of the existing outfall. Pile driving the support piers for the extended flume likely represents the greatest potential for impacts to ambient noise levels. However, because of its location immediately adjacent to Resurrection Bay, construction related noises would be subject to the attenuating effects of the ambient wind, wave action, and nearby boat and automobile traffic noises. Effects on the ambient noise levels as a result of the construction of the elevated outfall would be temporary and likely heavily attenuated by natural noise sources.

8.1.3.4 Alternative 4A and 4B: Construct New Flood Diversion System, an 18 ft tunnel, b 24 ft tunnel + 150' Outfall (4A TSP Alternative)

Implementation of Alternatives 4A and 4B would likely have similar impacts upon the ambient noise levels as Alternatives 2, 3A, and 3B concerning the construction of the diversion dam and tunnel entrance invert and who may be able to perceive it.

Drilling and blasting required to implement Alternatives 4A and 4B would result in the same impacts on ambient noise levels as Alternatives 3A and 3B, as evaluated above.

Construction of the 150-foot elevated outfall flume under Alternative 4A and 4B would have the same overall impact on ambient noise levels as evaluated in Alternatives 3A and 3B above.

8.1.3.5 Alternative 5: Construct Upstream Sediment Basin

The implementation and maintenance of a sediment basin in the upper Lowell Creek watershed above the diversion dam structure would require annually recurring impacts on the area's ambient noise levels from the operation of heavy equipment. Sounds associated with the excavation of sediments in the upper watershed would not likely be perceived by anyone not present or in very close proximity to the active site.

A secondary source of noise associated with Alternative 5 would be traffic to and from the site by dump trucks and other heavy equipment, which would have to utilize surface streets through Seward to move sediments to staging areas. Increased traffic associated with Alternative 5 would impact ambient noise levels. Still, it would likely not exceed any threshold for disturbance because the sounds of traffic are generally associated with being part of the ambient noise profile.

8.1.4 Existing Infrastructure and Facilities

8.1.4.1 No Action Alternative

Implementation of the No Action Alternative does not decrease the inherent risk posed by catastrophic flooding and damage from debris to infrastructure and facilities resources downstream of the existing diversion structure. [redacted]

8.1.4.2 Alternative 2: Improve Existing Flood Diversion System

Implementation of Alternative 2, like the No Action Alternative, does not reduce the inherent risk posed by catastrophic flooding and damage from debris to infrastructure and facilities resources downstream of the existing diversion structure.

8.1.4.3 Alternative 3A and 3B: Enlarge Existing System + 150' Outfall

Implementation of Alternative 3A and 3B would reduce but not eliminate the inherent risk posed by catastrophic flooding and damage from debris to infrastructure and facilities resources downstream of the existing diversion structure. Construction would take multiple years because it would have to occur during the lowest surface flow periods. Also, there would be no redundant flood diversion capacity during periods of construction.

8.1.4.4 Alternative 4A and 4B: Construct New Flood Diversion System, an 18 ft Tunnel, b 24 ft Tunnel + 150' Outfall (4A TSP Alternative)

Alternatives 4A and 4B eliminate the inherent risk posed by catastrophic flooding and damage from debris to infrastructure and facilities resources downstream of the existing diversion structure to the maximum extent practicable. Although construction would be expected to take multiple years, the existing diversion structure would ensure redundancy during that period, and throughout the life of the project as additional functional overflow capacity.

8.1.4.5 Alternative 5: Construct Upstream Sediment Basin

Implementation of Alternative 5 does not reduce the inherent risk posed by catastrophic flooding to infrastructure resources downstream of the existing diversion structure. Implementation of Alternative 5 would transfer debris management activities from below the point of the outfall to above the diversion structure and assumes an average annual rate of bedload migration by Lowell Creek.

8.1.5 Cultural Resources

8.1.5.1 No Action Alternative

The No Action Alternative would have no significant impacts on known cultural resources. The Lowell Creek Diversion Tunnel will continue to receive repairs and maintenance, which will not impact the structure's listing on the National Register of Historic Places in the foreseeable future.

8.1.5.2 Alternative 2: Improve Existing Flood Diversion System

Alternative 2 would involve significant modifications to the Lowell Creek Diversion Tunnel (SEW-00011), which would have an adverse impact on the historic property. USACE would work with the SHPO and the City of Seward to determine the appropriate course of mitigation.

8.1.5.3 Alternative 3A and 3B: Enlarge Existing System + 150' Outfall

Alternative 3 would involve significant modifications to the Lowell Creek Diversion Tunnel (SEW-00011), which would have an adverse impact on the historic property. USACE would work with the SHPO and the City of Seward to determine the appropriate course of mitigation.

8.1.5.4 Alternative 4A and 4B: Construct New Flood Diversion System, an 18 ft tunnel, 4B 24 ft tunnel + 150' Outfall (4A TSP Alternative)

Alternative 4 would have no impact on historic properties in the area. Furthermore, Alternative 4 would both protect the existing Lowell Creek Diversion Tunnel (SEW-00011), and its use as a back-up in the occurrence of a surge event also protects its significance.

8.1.5.5 Alternative 5: Construct Upstream Sediment Basin

Alternative 5 would have no impact on historic properties in the area. This project would be upriver of the project and would not impact the structure or its significance.

8.1.6 Environmental Justice

8.1.6.1 No Action Alternative

The No Action Alternative may have an adverse impact on any vulnerable disabled populations downriver during a surge event, and may also impact persons with handicaps who could not exit the impact area quick enough to escape a surge event. A 2018 survey of health needs in Seward identified that 66% of surveyed population are overweight or obese, and 21% of the surveyed population had a chronic disease within the population (SCHNA 2018).

8.1.6.2 Alternative 2: Improve Existing Flood Diversion System

The Alternative 2 proposal would not have any adverse impact on minority or vulnerable disabled populations as the alternative seeks to develop infrastructure to protect portions of the city with these populations.

8.1.6.3 Alternative 3A and 3B: Enlarge Existing System + 150’ Outfall

The Alternative 3 proposal would not have any adverse impact on minority or vulnerable disabled populations as the alternative seeks to develop infrastructure to protect portions of the city with these populations.

8.1.6.4 Alternative 4A and 4B: Construct New Flood Diversion System, an 18 ft tunnel, 4B 24 ft tunnel + 150’ Outfall (4A TSP Alternative)

The Alternative 4 proposal would not have any adverse impact on minority or vulnerable disabled populations as the alternative seeks to develop infrastructure to protect portions of the city with these populations.

8.1.6.5 Alternative 5: Construct Upstream Sediment Basin

The Alternative 5 proposal would not have any adverse impact on minority or vulnerable disabled populations as the alternative seeks to develop infrastructure to protect portions of the city with these populations.

8.1.7 Protected Tribal Resources

8.1.7.1 No Action Alternative

Under the No Action Alternative, no known Tribal Resources would be adversely affected by the existing structures and methods of handling the Lowell Creek.

8.1.7.1.1 Alternative 2: Improve Existing Flood Diversion System

The Alternative 2 design would not impact any known Tribal Resources in the project area or the vicinity.

8.1.7.1.2 Alternative 3A and 3B: Enlarge Existing System + 150' Outfall

The Alternative 3 design would not impact any known Tribal Resources in the project area or the vicinity.

8.1.7.1.3 Alternative 4A and 4B: Construct New Flood Diversion System, an 18 ft tunnel, 4B 24 ft tunnel + 150' Outfall (4A TSP Alternative)

The Alternative 4 design would not impact any known Tribal Resources in the project area or the vicinity.

8.1.7.1.4 Alternative 5: Construct Upstream Sediment Basin

The Alternative 5 design would not impact any known Tribal Resources in the project area or the vicinity.

8.2 Biological Resources

8.2.1 Terrestrial Habitat

8.2.1.1 No Action Alternative

Implementation of the No Action Alternative would not affect terrestrial habitat in Lowell Canyon or at the point of the outfall.

8.2.1.2 Alternative 2: Improve Existing Flood Diversion System

Implementation of Alternative 2 would not affect terrestrial habitat in locations of the existing project. However, Alternative 2 would affect terrestrial habitat in the upper Lowell Creek watershed by selectively removing trees with a single trunk diameter at breast height that was 48" or larger, or multiple trunked trees where those trunk diameters at breast height exceeded 30". Currently, USACE does not know what percentage of trees in Lowell Creek's upper watershed meet this criterion. However, because the area designated for selective tree removal is known to be sparsely vegetated, USACE does not expect that many trees would meet its criteria. Yet, the effect of selectively removing large trees is generally cascading. It leads to the succession of understory vegetation until smaller trees become large enough to crowd out light to the understory, which results in the subsequent reduction of the understory vegetation. The selective removal of larger trees in a portion of Lowell Creek's upper watershed would affect highly localized vegetation successional events in the short term. However, long-term effects associated with selective tree removal would be negated by natural processes.

Effects on terrestrial habitat resulting from the installation of a protective structure above the existing tunnel entrance and invert would be difficult to detect because the original habitat attributes are already disturbed by the existing diversion system, and the footprint of the protective structure is roughly the size of the tunnel entrance.

8.2.1.3 Alternative 3A and 3B: Enlarge Existing System + 150' Outfall

Implementation of Alternatives 3A and 3B would result in the same effects to terrestrial habitat in the upper watershed as Alternative 2.

The effects on terrestrial habitat within the footprint of Alternative 3's new diversion dam would most closely resemble the site's existing conditions due to the site's existing poor habitat quality attributes. The area identified for the new diversion dam is relatively devoid of vegetation, highly disturbed, and consists almost entirely of boulders, cobbles, and gravels. Furthermore, an improved road already services the structure to a point just upstream of the outer edge of the existing diversion structure.

Effects on terrestrial habitat as a result of enlarging the existing tunnel system, for both Alternatives 3A and 3B would be similar. They would closely resemble the existing site's baseline conditions and would not affect the site's existing poor habitat quality attributes. Drilling and blasting and the subsequent extraction of blasted materials would require the operation of heavy machinery in the vicinity of the existing, heavily disturbed tunnel entrance area. The area above the tunnel is heavily scoured multiple times a year by Lowell Creek's bedload, which precludes the establishment of any vegetation.

Effects to terrestrial habitat as a result of implementing a 150-foot elevated outfall flume at the point where the tunnel exits Bear Mountain would likely be similar to the existing baseline condition because of the site's existing poor habitat quality attributes. Lowell Creek's bedload and hydraulic action continuously scour the area from the existing point of the outfall to the surface waters of Resurrection Bay, as evident in Figure 9 and Figure 10. The site is entirely devoid of vegetation and is comprised entirely of bedload sediments. Additional impacts to terrestrial habitat as a result of the implementation of a 150' elevated outfall flume include those to the alluvial accretion of bedload sediments beyond the existing Lowell Point Bridge. However, these impacts would likely be indiscernible from the existing condition at the site.

8.2.1.4 Alternative 4A and 4B: Construct New Flood Diversion System, an 18 ft tunnel, b 24 ft tunnel + 150' Outfall (4A TSP Alternative)

Implementation of Alternatives 4A and 4B would result in the same effects to terrestrial habitat in the upper watershed as Alternative 2.

The effects on terrestrial habitat within the footprint of Alternative 4's new diversion dam would be similar to those observed by the presence of the existing structure due to the site's existing poor habitat quality attributes. The area identified for the new diversion dam is highly disturbed by bedload scour, devoid of vegetation, and consists almost entirely of boulders, cobbles, and gravels. An improved road extending from the existing structure to the site of the new structure would be required to service and construct the diversion system. The effects on terrestrial habitat by the emplacement of this road extension would resemble the existing condition because of the high degree of scouring by bedload the area currently receives. However, once operational, the in-channel area between the new structure and existing structure would be subject to far less scour and would likely experience some degree of natural vegetation establishment.

Effects on terrestrial habitat as a result of drilling and blasting to create a new tunnel system, for both Alternatives 4A and 4B would be similar. Effects to terrestrial habitat from drilling and blasting and the subsequent extraction of blasted materials for the creation of a new tunnel would resemble those for Alternatives 3A and 3B except for the required removal of a small portion of hillside habitats at the entrance and exit points of the newly created tunnel. However, the areas of sparsely vegetated hillside habitats that would be affected represent a small fraction of the overall undisturbed surrounding areas. Despite their permanence, effects to terrestrial habitat as a result of creating new tunnel entrance and exit points would not be expected to affect the area's overall habitat continuity and complexity.

The effects on terrestrial habitat as a result of implementing a 150-foot elevated outfall flume would be the same as those evaluated under Alternatives 3A and 3B.

8.2.1.5 Alternative 5: Construct Upstream Sediment Basin

Effects on terrestrial habitat as a result of the construction of an upstream sediment basin would be relegated to those heavily disturbed in-channel surface areas required for the emplacement of a service road and in the area of sediment excavation. These areas would be subject to annual disturbance by heavy equipment and anthropogenic presence as a requirement of the maintenance of the sediment basin. However, because this area is entirely located within the bankfull limits of Lowell Creek, it would also be subject to bedload scour and sediment accretion, which would preclude vegetation establishment.

Although the implementation of Alternative 5 would add an annual disturbance regime to the terrestrial habitat between the existing diversion structure and the upstream sediment basin, it would likely only be temporary and short-lived in the context of Lowell Creek's existing capacity for habitat disturbance within its channel.

8.2.2 Birds

8.2.2.1 No Action Alternative

Implementation of the No Action Alternative would have no effect upon birds.

8.2.2.2 Alternative 2: Improve Existing Flood Diversion System

Implementation of the protective structure above the tunnel entrance and invert would not affect birds because the construction of that element would occur during the period of lowest surface flows (winter) and would therefore not coincide with migratory or resident bird's breeding and nesting season (late spring and summer). Also, the existing project site is highly disturbed and provides poor habitat for birds during the nesting and breeding season.

Selective removal of trees in the upper watershed that meets USACE's criteria for removal may indirectly affect birds by reducing the overall quantity of nesting, foraging, roosting, and breeding habitat in a small area of Lowell Creek's upper watershed. Similarly, eagles typically prefer mature trees for nesting and the rearing of their young. Therefore, selective removal of larger trees may disproportionately affect the quality and quantity of eagle nesting habitat in a small portion of the upper watershed of Lowell Creek. However, direct effects to migratory and resident birds would be avoided by conducting selective removal efforts during the non-breeding/nesting months. The USACE would also conduct eagle nest surveys within the upper watershed area identified for selective tree removal to determine whether any of its criteria trees supported eagle nests. Criteria trees that supported eagle nests would be left standing.

Construction actions associated with the implementation of Alternative 2 may inadvertently pose a nuisance attraction for some birds that may be attracted to anthropogenic activity and unsecured trash. As such, construction activities would maintain to refuse discipline in an attempt to deter nuisance attraction.

8.2.2.3 Alternative 3A and 3B: Enlarge Existing System + 150' Outfall

Implementation of elements of Alternatives 3A and 3B would not affect resident or migratory birds because they would not occur during the breeding and nesting season and would not be affecting preferential breeding, foraging, roosting, or nesting habitat. These elements include:

- Construction of the new diversion dam
- Construction of the protective structure above the tunnel entrance
- Construction of the tunnel, to include all drilling, blasting, and excavation
- Construction of the 150-foot elevated outfall flume

The effects upon resident and migratory birds as a result of selective tree removal actions for Alternatives 3A and 3B are the same as those of Alternative 2.

8.2.2.4 Alternative 4A and 4B: Construct New Flood Diversion System, an 18 ft tunnel, b 24 ft tunnel + 150' Outfall (4A TSP Alternative)

Implementation of elements of Alternatives 4A and 4B would not affect resident or migratory birds because they would not occur during the breeding and nesting season and would not be affecting preferential breeding, foraging, roosting, or nesting habitat. These elements include:

- Construction of the new diversion dam
- Construction of the protective structure above the tunnel entrance
- Construction of the tunnel, to include all drilling, blasting, and excavation.
- Construction of the 150-foot elevated outfall flume

The effects upon resident and migratory birds as a result of selective tree removal actions for Alternatives 4A and 4B are the same as those of Alternative 2.

8.2.2.5 Alternative 5: Construct Upstream Sediment Basin

Implementation of Alternative 5 would not affect resident or migratory birds because all construction work would be completed outside of the breeding/nesting window. Furthermore, the construction of Alternative 5 would not affect preferential breeding, foraging, roosting, or nesting habitat within the Lowell Creek channel.

8.3 Unavoidable Adverse Impacts

As currently proposed, the Preferred Alternative, Alternative 4A, would not have any unavoidable adverse impacts to any of the aforementioned resource categories, whether dismissed or analyzed in depth.

8.4 Summary of Mitigation Measures

The USACE would conduct eagle nest surveys in the portion of Lowell Creek’s watershed identified for selective tree removal. Large trees that met the USACE’s removal criteria that supported eagle nests would be left standing.

Best Management Practices (BMPs) would be required for construction activities and construction lay down or staging areas that included standard practice protocols for the storage of petroleum, oils, and lubricants, refueling procedures, and a spill response plan.

There is no Clean Water Act compensatory mitigation requirement for the implementation of the Preferred Alternative, Alternative 4A.

8.5 Cumulative Effects

“Cumulative effects” are the impacts on the environment that result from the incremental impact of the action when added to past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

- There are no other Federal projects planned for the Lowell Creek watershed.
- The continued accretion of bedload sediments at the point of outfall poses a flooding risk to the infrastructure and resources of south Seward.

9. PUBLIC AND AGENCY INVOLVEMENT

9.1 Public/Scoping Meetings

The Lowell Creek Flood Diversion Planning Charrette was conducted on October 25-26, 2016. The planning charrette was required as part of the planning process to initiate the feasibility study. The charrette involved Project Delivery Team (PDT) members and the USACE planning Vertical Team including Alaska District (POA), Pacific of Ocean Division (POD), and Headquarters, U.S. Army Corps of Engineers (HQUSACE). Representatives from the City of Seward were present. Other agencies present included the State of Alaska (Department of Transportation and Public Facilities, Department of Natural Resources, and Department of Fish and Game), NMFS, USFWS, the Seward Bear Creek Flood Service Area, Federal Emergency Management Agency (FEMA), and the Kenai Peninsula Borough. The planning charrette plays a key role in enlisting the buy-in during the initial stages of project development from all parties involved with the project.

Outcomes of the charrette included reaching a consensus on the problem statement and objectives of the proposed project. It also included a discussion of the considerations and constraints for engineering, economics, environmental, and planning. It also articulated the important historical, social, and political factors involved in the project. Existing data and current work was presented by the USACE (Hydraulics & Hydrology Branch), and a local perspective was presented by the City Manager of Seward.

9.2 Government to Government Consultation (if applicable)

No government to government consultation was required or took place for this study.

9.3 Federal and State Agency Coordination

In-person meetings were held between biologists from the Environmental Resources Section and biologists with the National Marine Fisheries Service (Protected Resource Division and Habitat Division), U.S. Fish and Wildlife Service (Project Planning and Marine Mammal Management Divisions), and the Alaska Department of Fish and Game (Marine Mammals, Sport Fish, Commercial Fish, and Habitat Divisions).

The USACE formally requested coordination with USFWS under the precepts of the Fish and Wildlife Coordination Act. USFWS provided a response letter stating, “The Service has reviewed the project and has no objections at this time. Due to limited expected impacts on trust resources, we will not pursue further investigation or a report under the Fish and Wildlife Coordination Act Report.”

The USACE initiated coordination with the NMFS early in the project planning phase with regard to potential impacts to threatened or endangered marine mammals and those marine mammals not covered by the Endangered Species Act and Essential Fish Habitat. Since the initiation, it has been determined that USACE's project will not affect resources under the regulatory purview of NMFS.

The USACE has conducted and produced a Survey Report and a Finding of Effect letter under the NHPA, which was submitted to the SHPO and received concurrence based on the TSP.

The USACE coordinated via telephone with the Alaska Department of Fish and Game regarding selective tree removal and appropriate coordination actions prior to entering State Lands.

9.4 Status of Environmental Compliance

The compliance status with relevant Federal and State regulations and with relevant Executive Orders is summarized in Table 23.

Table 23. Environmental Compliance

Federal Statutory Authority	Compliance Status	Compliance Date/Comment
Clean Air Act	FC	This project is not reasonably expected to impact air quality negatively, nor is it in a non-attainment area.
Clean Water Act	PC	Upon receipt of 401 certifications. 404(b)(1) analysis is being developed for ADEC review.
Coastal Zone Management Act	N/A	The State of Alaska withdrew from the voluntary National Coastal Zone Management Program on 1 July 2011. Therefore, within the State of Alaska, Federal agencies are not required to ensure their activities are consistent with an approved State coastal management plan.
Endangered Species Act	FC	The project, as proposed, would not affect threatened or endangered species or their designated critical habitat.
Marine Mammal Protection Act	FC	The project, as proposed, would not affect marine mammals.
Magnuson-Stevens Fishery Conservation and Management Act	FC	The project, as proposed, does not affect Essential Fish Habitat.
Fish and Wildlife Coordination Act (FWCA)	FC	Coordination complete. Due to limited expected impacts on trust resources, USFWS will not pursue further investigation under the FWCA. Official correspondence was received on 21 January 2020.
Marine Protection, Research, and Sanctuaries Act	FC	The project, as proposed, does not affect ocean waters outside of the territorial sea.
Migratory Bird Treaty Act (MBTA)	FC	The project does not seek to take avian species covered under the MBTA.
National Historic Preservation Act	FC	Alterations to the existing tunnel would require coordination with SHPO.
Executive Order 11990: Protection of Wetlands	FC	Lowell Creek is not included in the National Wetlands Inventory. Impacts on the waters are being considered in a 404(b)(1) that is currently being prepared.
Executive Order 12898: Environmental Justice	FC	The project does not disproportionately affect underserved communities.
Executive Order 13045: Protection of Children from	FC	The project does not disproportionately affect the health or well-being of children.

Environmental Health Risks and Safety Risks		
Executive Order 13186 Protection of Migratory Birds	FC	The project would not impact migratory birds.

Note: FC=Fully Compliant/PC= Partial Compliant

9.5 Views of the Sponsor

The non-Federal sponsor for this study, the City of Seward, Alaska, is supportive of the TSP and passed a resolution expressing their support, which is included in Appendix G.

10. PREPARERS OF THE ENVIRONMENTAL ASSESSMENT

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11. CONCLUSIONS & RECOMMENDATIONS

11.1 Conclusions

The alternatives carried forward were evaluated using the NED analysis (Section 6.4, “National Economic Development (NED) Analysis”) and CE/ICA for OSE (Section 6.5, “Cost-Effectiveness and Incremental Cost Analysis (CE/ICA)”), in this case, reduction in total life safety risk. No NED plan was identified. The CE/ICA identified three Best Buy plans (No Action and Alternatives 4A and 4B), and one Cost-Effective plan (Alternative 2). Although Alternative 2 is a cost-effective plan, it is essentially identical to the No Action plan hydrologically. It would provide no perceivable NED benefits other than possible protection of the road and bridge from debris. Alternative 4B, while a Best Buy plan, is more expensive than Alternative 4A and provides little additional benefits. Alternative 4A was ultimately identified as the TSP because it is the Best Buy plan, which has optimized by combining various measures to minimize project cost and still meet the identified objectives and avoid identified constraints.

The TSP is to construct a new flood diversion system upstream from the current system. The benefits of the proposed flood diversion system will result from savings in damages avoided and reduced flood-fighting efforts. [redacted] The TSP would have the capability to transport much higher flows than the current system and retain the current system to divert flows during maintenance or in the unlikely event that a flow overtopped the new system.

Ongoing coordination with Federal and State resource agencies shall seek to ensure that all practical means to avoid or minimize adverse environmental effects will be analyzed and incorporated into the TSP.

While the incorporation of reasonable and prudent measures will likely be required by the coordinating environmental agencies to mitigate potential short-term environmental impacts, over the longer term, the project will reduce the potential for flooding in Seward. Reduced flooding would result in a reduction in the potential for the inadvertent release of petroleum, oils, and lubricants, and other locally persistent contaminants, into the environment. Over the long-term, this potential reduction in the introduction of environmental contaminants could outweigh the short-term impacts of project construction.

The TSP has an estimated project first cost of approximately $122.9M (FY20 dollars). This plan maximizes total net benefits and has a Benefit-to-Cost Ratio (BCR) of 0.25. The TSP is supported by the City of Seward, which is the non-Federal sponsor.

The proposed construction of the TSP, as discussed in this document, would have short-term environmental impacts during construction that would be largely minimized by pre-construction nesting bird surveys. In the long-term, impacts would be negligible, as discussed in this report. This assessment supports the conclusion that the proposed project does not constitute a major Federal action, significantly affecting the quality of the human environment. Therefore, a Finding of No Significant Impact (FONSI) has been prepared. The Alaska District Office of Counsel has reviewed this document and has issued a certification of legal sufficiency.

11.2 Recommendations

The Alaska District recommends that the selected flood risk management plan at Seward, Alaska, be constructed generally in accordance with the TSP herein, and with such modifications thereof as in the discretion of the Director of Civil Works may be advisable at an estimated project first cost with the contingency of $122,900,000.

Federal implementation of the recommended project would be subject to the NFS 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, including but not limited to:

a. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefor, to meet any of the non-Federal obligations for the project unless the Federal agency providing the funds verifies in writing that the funds are authorized to be used to carry out the project;

b. Not less than once each year, inform affected interests of the extent of protection afforded by the flood risk management features;

c. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

d. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project partnership agreement, and to implement such plan not later than one year after completion of construction of the flood risk management features;

e. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or take other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

f. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the flood risk management features afford, hinder operation and maintenance of the project, or interfere with the project's proper function;

g. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

h. Comply with all 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. 4601-4655), and the Uniform Regulations contained in 49 Code of Federal Regulations (CFR) Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; Flood Risk Management Improvements Feasibility Study, Seward, Alaska Page 54 and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

i. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a *manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;*

j. *Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;*

k. *Hold and save the United States free from all damages arising from the design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;*

l. *Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20;*

m. *Comply with all the requirements of applicable Federal laws and implementing regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, as amended (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; the Age Discrimination Act of 1975 (42 U.S.C. 6102); the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and Army Regulation 600-7 issued pursuant thereto; and 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (labor standards originally enacted as the Davis-Bacon Act, the Contract Work Hours and Safety Standards Act, and the Copeland Anti-Kick Act);*

n. *Perform, or ensure the performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific Flood Risk Management Improvements Feasibility Study, Seward, Alaska Page 55 written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;*

o. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

p. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA;

q. Provide, during the design and implementation phase, a percentage of all costs that exceed $100,000 for data recovery activities associated with historic preservation for the project as follows: 35 percent of such costs that are attributable to the flood risk management features and 50 percent of such costs that are attributable to the recreation features; and

r. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

The recommendations for implementation of flood risk management on Lowell Creek at Seward, Alaska, reflect the policies governing the formulation of individual projects and the information available at this time. They do not necessarily reflect the program and budgeting priorities inherent in the local and State programs or the formulation of a national civil works water resources program. Consequently, the recommendations may be changed at higher review levels of the executive branch outside Alaska before they are used to support funding.

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DAMON A. DELAROSA Date
Colonel, U.S. Army
Commanding

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