Seward/Bear Creek Flood Service Area

HAZARD MITIGATION PLAN

A Service Area of the Kenai Peninsula Borough

June 2013

(Originally published July 2005)

Seward Bear Creek Flood Service Area

2013 Local Hazard Mitigation Plan (LHMP) Update

Executive Summary

The Seward Bear Creek Flood Service Area (SBCFSA) 2013 Local Hazard Mitigation Plan (LHMP) supplements the Kenai Peninsula Borough's Multi-Jurisdictional All-Hazard Mitigation Plan. This plan's "All Hazards" approach enables the participating communities to fully integrate essential emergency planning activities.

The SBCFSA's LHMP is a joint planning effort by the SBCFSA, City of Seward, and the Kenai Peninsula Borough. This HMP is intended to serve the SBCFSA's citizens and decision makers to implement actions that would reduce or eliminate future and potentially damaging natural hazard event impacts to their critical facilities, residential structures, and population.

This HMP was drafted and adopted to fulfill requirements mandated by the Disaster Mitigation Act of 2000, under Public Law 106-390, amending the Robert T. Stafford Disaster Relief and Emergency Assistance Act, and Title 42 of the United States Code (5121 et seq.).

Local governments are required to have a FEMA approved, local government adopted natural hazard mitigation plan for FEMA grant programs' eligibility.

The methodology used for developing the SBCFSA Local Hazard Mitigation Plan consisted of the following tasks:

- Plan development, review, and maintenance
- Public and agency coordination and involvement
- Critical facility inventory development
- Hazard impact area identification and description
- Population risk assessment and critical facility vulnerability identification
- Mitigation strategy development identifying, selecting, prioritizing, and implementing mitigation actions
- Local HMP adoption following a public hearing
- Periodic evaluation, review, and update

The HMP is divided into nine sections: Introduction, Community Description, Planning Process, HMP Adoption, Hazard Profiles, Vulnerability Analysis, Mitigation Strategy, and Reference List, with applicable supporting appendices.

The SBCFSA is at risk from eight identified natural hazards: earthquakes, erosion, flood, ground failure, severe weather, tsunamis, volcanic activity, and wildland fire. The primary threat to the SBCFSA is from severe weather and storm events. The Planning Team identified mitigation measures that span a broad spectrum of activities for all potential hazard impacts. They include:

- Promote recognizing and mitigating all natural hazards that affect the SBCFSA.
- Reduce loss and damage possibility from all natural hazards that affect the area.
- Cross reference mitigation goals and actions with other partners' planning mechanisms and projects.
- Reduce structural vulnerability to earthquake, erosion, flood, ground failure, severe weather, tsunami, volcano, and wildland fire damages.

- Maintaining city monitoring and warning systems, e.g. the City's tsunami warning and early alert broadcasting siren systems.

The plan will be monitored, reviewed, and evaluated annually; and updated every five years. It will also be reviewed and updated as appropriate, such as when new funding sources become available, or after a disaster occurs that significantly affects the SBCFSA.

This plan serves as guide for citizens and policy makers in SBCFSA in order to mitigate potential natural hazard disaster damages. The purpose of the HMP is to ensure public awareness and involvement, and maintenance of hazard mitigation initiatives to best protect and mitigate damages from natural hazard events. Periodic review of this plan is necessary in order to continually evaluate its effectiveness and to make the most efficient use of mitigation resources as they become available.

The 2013 SBCFSA Local Hazard Mitigation Plan developed initiatives will be incorporated into existing SBCFSA, City, Tribal, and Borough planning initiatives such as their respective Comprehensive, Capital Improvement, Emergency Response, and Transportation Plans as appropriate.

This document was prepared under a grant from the Federal Emergency Management Agency (FEMA)'s Grant Programs Directorate, U.S. Department of Homeland Security and the Alaska Division of Homeland Security and Emergency Management. Points of view or opinions expressed in this document are those of the authors and do not necessarily represent the official position or policies of FEMA's Grant Programs Directorate, the U.S. Department of Homeland Security or the State of Alaska

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Acronyms/Abbreviations

°F	Degrees Fahrenheit
AAG	Adaptation Advisory Group
ACCIMP	Alaska Climate Change Impact Mitigation Program
ACIAC	Alaska Climate Impact Assessment Commission
ACWF	Alaska Clean Water Fund
ADWF	Alaska Drinking Water Fund
AEA	Alaska Energy Authority
AEEE	Alternative Energy And Energy Efficiency
AFG	Assistance to Firefighters Grant
AHFC	Alaska Housing Finance Corporation
AICC	Alaska Interagency Coordination Center
AK	Alaska
ANTHC	Alaska Native Tribal Health Consortium
APA	American Planning Association
ARC	American Red Cross
ARRC	Alaska Railroad Corporation
AVCP	Alaska Village Council Of Presidents
AVEC	Alaska Village Electric Cooperative
AVHRR	Advanced Very High Resolution Radiometers
AVTEC	Alaska Vocational Technical Center
BFE	Base Flood Elevation
CAT (or CT)	Computerized Axial Tomography
CCP	Citizen Corps Program
CDBG	Community Development Block Grant
Census	US Census
CFP	Community Forestry Program
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
City	City of Seward
CReSIS	Center of Remote Sensing Of Ice Sheets
CVRF	Coastal Villages Regional Fund
CWSRF	Clean Water State Revolving Fund
DCCED	Department of Commerce, Community, And Economic Development
DCRA	Division of Community And Regional Affairs
DEC	Department of Environmental Conservation
DEED	Alaska Department of Education And Early Development
Denali	Denali Commission
DGGS	Division of Geological And Geophysical Survey
DHS	US Department of Homeland Security
DHS&EM	Division of Homeland Security And Emergency Management
DHHS	Department of Health and Human Services
DMA 2000	Disaster Mitigation Act of 2000
DMVA	Department of Military and Veterans Affairs
DNR	Department of Natural Resources

DOE	Department of Energy
DOF	Division of Forestry
DOI	Division of Insurance
DOL	Department of Labor
DOT/PF	Department of Transportation And Public Facilities
DSS	Division of Senior Services
EDA	Economic Development Administration
EDI	Economic Development Initiative
EMPG	Emergency Management Performance Grant
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
EWP	Emergency Watershed Protection Program
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FP&S	Fire Prevention and Safety
ft	Feet
FY	Fiscal Year
g	Gravity
GBS	General Building Stock
ghg	Greenhouse Gas
GI	Geophysical Institute
GIS	Geospatial Information System
Hazus	Hazards United States – Multi-Hazards
HEC-GeoRAS	USACE's Hydrologic Engineering Center's GIS Tools for Support of HEC-RAS using ArcGIS
HEC-RAS	USACE's Hydrologic Engineering Center's River Analysis System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HSGP	Homeland Security Grant Program
HUD	Department of Housing and Urban Development
IBHS	Institute for Business And Home Safety
IPCC	Intergovernmental Panel on Climate Change
IRS	Internal Revenue Service
KPB	Kenai Peninsula Borough
Kts	Knots
kW	Kilowatt
LEG	Legislative Grant
LKEDC	Lower Kuskokwim Economic Development Council, Inc.
M	Magnitude
MGL	Municipal Matching Grants and Loans
MMI	Modified Mercalli Intensity
Mtns	Mountains
MP	Mile Post

mph	Miles Per Hour
msl	Mean Sea Level
NASA	National Aeronautics and Space Administration
NCA	National Climate Assessment
NFIP	National Flood Insurance Program
NHC	Northwest Hydraulic Consultants
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRF	National Response Framework
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
PCIH	Primary Care in Hospitals
PDM	Pre-Disaster Mitigation
PGA	Peak Ground Acceleration
Ph	Phase
PNP	Private Non-Profit
PWS	Prince William Sound
RAS	River Analysis System
RCASP	Remote Community Alert Systems
RD	US Division of Rural Development
RL	Repetitive Loss
RFA	Rural Fire Assistance Grant
RFC	Repetitive Flood Claim
RPSU	Rural Power System Upgrade
SAFER	Staffing for Adequate Fire and Emergency Response
SBCFSA	Seward Bear Creek Flood Service Area
SBA	US Small Business Administration
SHMP	Alaska State Hazard Mitigation Plan
SHSP	State Homeland Security Program
SLA	State Legislative Action
SLR	Sea Level Rise
SMIC	Seward Marine Industrial Center
SNAP	Scenarios Network for Alaska & Arctic Planning
Snd	Sound
SOA	State of Alaska
Sq.	Square
Stafford Act	Robert T. Stafford Disaster Relief and Emergency Assistance Act
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, and Environmental
UAF	University of Alaska Fairbanks
UDF	User-Defined Facilities
UNEP	United Nations Environmental Programme
URS	URS Corporation
US or U.S.	United States
USACE	US Army Corps of Engineers

USC	US Code
USDA	US Department of Agriculture
USFS	US Forest Service
USGS	US Geological Survey
VFA	Volunteer Fire Assistance Grant
VSW	Village Safe Water
WARN	Warning, Alert, and Response Network
WC/ATWC	West Coast and Alaska Tsunami Warning Center
WHIP	Wildlife Habitat Incentives Program
WRCC	Western Regional Climate Center
Wrn	Western

This section provides a brief introduction to hazard mitigation planning, the grants associated with these requirements, and a description of this Hazard Mitigation Plan (HMP).

1.1 HAZARD MITIGATION PLANNING

In recent years, local hazard mitigation planning has been driven by a new Federal law. On October 30, 2000, Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) (P.L. 106-390) which amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) (Title 42 of the United States Code [USC] 5121 et seq.) by repealing the act's previous mitigation planning section (409) and replacing it with a new mitigation planning section (322). This new section emphasized the need for State, Tribal, and local entities to closely coordinate mitigation planning and implementation efforts. In addition, it provided the legal basis for the Federal Emergency Management Agency's (FEMA) mitigation plan requirements for mitigation grant assistance.

To implement these planning requirements, FEMA published an Interim Final Rule in the Federal Register on February 26, 2002 (FEMA 2002a), 44 CFR Part 201 with subsequent updates. The planning requirements for local entities are described in detail in Section 2 and are identified in their appropriate sections throughout this HMP.

FEMA's October 31, 2007, July 2008, and October 2012 changes to 44 CFR Part 201 combined and expanded flood mitigation planning requirements with local hazard mitigation plans (44 CFR §201.6). Furthermore, all hazard mitigation assistance program planning requirements were combined eliminating duplicated mitigation plan requirements. This change also required participating National Flood Insurance Program (NFIP) communities' risk assessments and mitigation strategies to identify and address repetitively flood damaged properties. Local hazard mitigation plans now qualify communities for several Federal Hazard Mitigation Assistance (HMA) grant programs.

This HMP complies with Title 44 CFR current as of September 28, 2012 and applicable guidance documents.

1.2 GRANT PROGRAMS WITH MITIGATION PLAN REQUIREMENTS

FEMA HMA grant programs provide funding to States, Tribes, and local entities that have a FEMA-approved State, Tribal, or Local Mitigation Plan. Two of the grants are authorized under the Stafford Act and DMA 2000, while the remaining three are authorized under the National Flood Insurance Act and the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act. The Hazard Mitigation Grant Program (HMGP) is a competitive, disaster funded, grant program. Whereas the other Unified Mitigation Assistance Programs: Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance (FMA), Repetitive Flood Claims (RFC), and Severe Repetitive Loss (SRL) programs although competitive, rely on specific pre-disaster grant funding sources, sharing several common elements.

> *"Hazard mitigation is any sustained action taken to reduce or eliminate long-term risk to people and property from natural hazards and their effects. This definition distinguishes actions that have a long-term impact from those that are more closely associated with immediate preparedness, response, and recovery activities. Hazard mitigation is the only phase of emergency management specifically dedicated to breaking the cycle of damage,*

reconstruction, and repeated damage. As such, States, Territories, Indian Tribal governments, and communities are encouraged to take advantage of funding provided by HMA programs in both the pre- and post-disaster timeframes.

Together, these programs provide significant opportunities to reduce or eliminate potential losses to State, Tribal, and local assets through hazard mitigation planning and project grant funding. Each HMA program was authorized by separate legislative action, and as such, each program differs slightly in scope and intent.

The Hazard Mitigation Grant Program (HMGP) may provide funds to States, Territories, Indian Tribal governments, local governments, and eligible private non-profits (PNPs) following a Presidential major disaster declaration. The Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance (FMA), Repetitive Flood Claims (RFC), and Severe Repetitive Loss Pilot (SRL) programs may provide funds annually to States, Territories, Indian Tribal governments, and local governments. While the statutory origins of the programs differ, all share the common goal of reducing the risk of loss of life and property due to natural hazards" (FEMA 2010).

1.2.1 Hazard Mitigation Assistance (HMA) Unified Programs

HMA grant program activities include:

Table 1-1 HMA Eligible Activities

Activities	HMGP	PDM	FMA	RFC	SRL
1. Mitigation Projects	√	√	√	√	√
Property Acquisition and Structure Demolition	√	√	√	√	√
Property Acquisition and Structure Relocation	√	√	√	√	√
Structure Elevation	√	√	√	√	√
Mitigation Reconstruction					√
Dry Floodproofing of Historic Residential Structures	√	√	√	√	√
Dry Floodproofing of Non-Residential Structures	√	√	√	√	
Minor Localized Flood Reduction Projects	√	√	√	√	√
Structural Retrofitting of Existing Buildings	√	√			
Non-Structural Retrofitting of Existing Buildings and Facilities	√	√			
Safe Room Construction	√	√			
Infrastructure Retrofit	√	√			
Soil Stabilization	√	√			
Wildfire Mitigation	√	√			
Post-Disaster Code Enforcement	√				
5% Initiative Projects	√				
2. Hazard Mitigation Planning	√	√	√		
3. Management Costs	√	√	√	√	√

(FEMA 2012)

The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster.

Projects must provide a long-term solution to a problem, for example, elevation of a home to reduce the risk of flood damages as opposed to buying sandbags and pumps to fight the flood. In addition, a project's potential savings must be more than the cost of implementing the project. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. The amount of funding available for the HMGP under a particular disaster declaration is limited. FEMA may provide a State or Tribe with up to 20 percent of the total aggregate disaster damage costs to fund HMGP project or planning grants. Fiscal Year (FY) 2006 provided approximately $232 million, FY 2007 was $316 million, FY 2008 was $1.246 billion, FY 2009 was $359 million, and FY 2010 was $23 million. The cost-share for these grants is 75 percent Federal/25 percent non-Federal. Communities that fulfill "Impoverished Community" criteria and receive FEMA Regional Administrator approval may be funded at 90 percent Federal/10 percent non-Federal.

The PDM grant program provides funds to States, Tribes, and local entities, including universities, for hazard mitigation planning and mitigation project implementation prior to a disaster event. PDM grants are awarded on a nationally competitive basis. Like HMGP funding, a PDM project's potential savings must be more than the cost of implementing the project. In addition, funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. The total amount of PDM funding available is appropriated by Congress on an annual basis. In FY 2008, PDM program funding totaled approximately $114 million, FY 2009 was $90 million, and FY 2010 was $100 million. The cost-share for these grants is 75 percent Federal/25 percent non-Federal.

The goal of the FMA grant program is to reduce or eliminate flood insurance claims under the NFIP. Particular emphasis for this program is placed on mitigating repetitive loss (RL) properties. The primary source of funding for this program is the National Flood Insurance Fund. Grant funding is available for two types of grants that focus on – project implementation and planning to identify flood threats and mitigation initiatives.

The Seward Bear Creek Flood Service Area (SBCFSA) currently participates as a Special Flood Service Area participant within the Kenai Peninsula Borough (KPB) and the City of Seward's NFIP and is therefore eligible for National Flood Insurance Act Grant Program Grants.

Project grants, which use the majority of the program's total funding, are awarded to States, Tribes, and local entities to apply mitigation measures to reduce flood losses to properties insured under the NFIP.

FMA provides funding to reduce or eliminate the long-term risk of flood damage to residential and non-residential structures insured under the NFIP.

HMP Description

The HMP consists of the following sections and appendices.

Introduction

Section 1 defines what a hazard mitigation plan is, delineates federal requirements and authorities, and introduces the Hazard Mitigation Assistance program listing the various grant programs and their historical funding levels.

Community Description

Section 2 provides a general history and background of the Seward Bear Creek Flood Service Area (SBCFSA), including historical trends for population and the demographic and economic conditions that have shaped the area.

Planning Process

Section 3 describes the HMP Update's planning process, identifies the Planning Team Members, the meetings held as part of the planning process, and the key stakeholders within the SBCFSA and the surrounding area. This section documents public outreach activities (support documents are located in Appendix F); the review and incorporation of relevant plans, reports, and other appropriate information; and actions the SBCFSA plans to implement to assure continued public participation; and their methods and schedule for keeping the plan current.

This section also describes the Planning Team's formal plan maintenance process to ensure that the HMP remains an active and applicable document throughout its 5-year lifecycle. The process includes monitoring, evaluating (Appendix H – Maintenance Documents), updating the HMP; and implementation initiatives.

Plan Adoption

Section 4 describes the community's HMP adoption process (supporting documents are located in Appendix E).

Hazard Analysis

Section 5 describes the process through which the Planning Team identified, screened, and selected the hazards to be profiled in this version of the HMP. The hazard analysis includes the nature, previous occurrences (history), location, extent, impact, and probability of future events for each hazard, considering potential impacts of climate change on hazard occurrence and severity, when possible and relevant. In addition, historical and hazard location figures are included.

Vulnerability Analysis

Section 6 identifies the SBCFSA's potentially vulnerable assets—people, residential and non-residential buildings, dwelling units (where available), critical facilities, and critical infrastructure. The resulting information identifies the full range of hazards that the SBCFSA could face and potential social impacts, damages, and economic losses. Land use, development trends, as well as potential climate change impacts, are also discussed.

Mitigation Strategy

Section 7 defines the mitigation strategy which provides a blueprint for reducing the potential losses identified in the vulnerability analysis. This section lists the community's governmental authorities, policies, programs and resources.

The Planning Team developed a list of mitigation goals and potential actions to address the risks facing the SBCFSA. Mitigation actions include preventive actions, property protection techniques, natural resource protection strategies, climate change adaptation initiatives, structural projects, emergency services, and public information and awareness activities. Mitigation strategies were developed to address NFIP insured properties (if applicable) while encouraging participation with the NFIP and the reduction of flood damage to flood-prone structures.

References

Section 8 lists the reference materials used to prepare this HMP.

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This section describes the location, geography, history and demographics of the Seward Bear Creek Flood Service Area (SBCFSA).

2.1 LOCATION, GEOGRAPHY, AND HISTORY

The SBCFSA covers multiple watersheds and includes the Communities of Bear Creek and Lowell Point, and the City of Seward. All communities are located in the Seward Recording District.

The following excerpts are provided by the Alaska Department of Community, Commerce, and Economic Development (DCCED), Division of Community and Regional Affairs (DCRA).

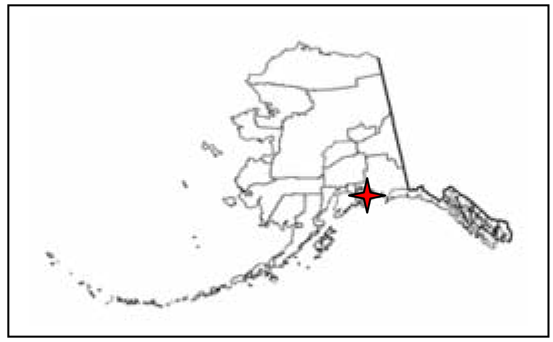

Figure 2-1 SBCFSA Location Map

> *"Bear Creek is on the east coast of the Kenai Peninsula, northeast of Seward, between Mile 3 and 7 of the Seward Highway. It lies approximately 120 highway miles south of Anchorage. It lies at approximately 60.211280 North Latitude and -149.308700 West Longitude. (Sec. 5, T001N, R001E, Seward Meridian.)*
>
> *Seward is situated on Resurrection Bay on the east coast of the Kenai Peninsula, 125 highway miles south of Anchorage. It lies at the foot of Mount Marathon and is the gateway to the Kenai Fjords National Park. Bear Creek and Lowell Point are adjacent to Seward. It lies at approximately 60.104170 North Latitude and -149.442220 West Longitude. (Sec. 10, T001S, R001W, Seward Meridian.) The area encompasses 14.4 sq. miles of land and 7.1 sq. miles of water.*
>
> *Lowell Point is 2 miles south of the Seward Highway terminus. It is situated on the northwest side of Resurrection Bay, at the foot of Bear Mountain, 125 highway miles south of Anchorage. It lies at approximately 60.071430 North Latitude and -149.434360 West Longitude. (Sec. 22, T001S, R001W, Seward Meridian.)" (DCCED/DCRA 2012).*

The SBCFSA's temperatures range from an average winter low of 23.2 degrees Fahrenheit (°F) to an average summer (July-August) high of 62.3 °F. The area receives approximately 68.12 inches of precipitation and 83.1 inches of snow (Western Regional Climate Center [WRCC] 2012).

D. H. Sleem is credited with first annotating the Bear Creek area on his Central Alaska Map which he developed to depict travel routes and the railroad railway from Seward to Fairbanks in 1910. His map was created from "U.S. Government and R.R. Surveys, reliable prospectors and personal reconnaissance…" (Rumsey 2012).

The following is a brief sketch of the area's history (DCRA):

1792	Alexander Baranof discovered Resurrection Bay when he sought a safe harbor. His discovery occurred on the Russian's Resurrection Sunday.
1867	American settlers began arriving shortly after Alaska's purchase from Russia. Community named after William Seward.

1890s	First settled by Captain Frank Lowell and his family.
1903	John and Frank Ballaine and others began constructing the railroad and other infrastructure.
1912	Seward was incorporated as a City.
1923	Railroad completed to the interior of Alaska
1964	Good Friday earthquake and tsunamis destroyed the harbor area, railroad terminal, and other coastal infrastructure which severely impacted Seward's economy.

2.2 DEMOGRAPHICS

Historically, demographic information is not available for the SBCFSA as a single population area. Therefore, this section of the LHMP looks at the individual population areas that are within the SBCFSA and that are considered and documented by the US Census (Census). Seward is one of the Kenai Peninsula Borough's six incorporated cities, whereas Bear Creek and Lowell Point both became Census Designated Places (CDPs) as of the 2000 Census in an attempt to more accurately capture population areas within the Borough. The populations of the City of Seward, Bear Creek, and Lowell Point may not account for every individual within the SBCFSA but it should provide an accurate demographics estimate. The 2010 Census indicates that the SBCFSA focused population areas contains approximately 4,790 residents.

City of Seward

The 2010 census recorded a total population of 2,693 residents in Seward city. Roughly 38 percent of the population is between 25 and 49 years of age.

Seward residents are predominately white (68.5 percent), with a mixed ethnic population approximately consisting of 16.7 percent American Indian and Alaska Native , 3.1 percent African American, 2.4 percent Asian, 0.6 percent Native Hawaiian and Pacific Islander, and the remaining 8.7 % identifying themselves as "Other" or having diverse cultural heritages. The male and female composition is approximately 61.9 and 38.0 percent, respectively. The 2010 census revealed that there are 1,124 housing units, having a median value of approximately $192,000; of these, 928 are occupied, of which 459 are "owner-occupied". The average owner-occupied household has approximately 2.3 individuals. The most recent 2012 (July) Alaska Department of Labor estimates the population of Seward city as 2,754. (2010 Census, 2012 DCRA)

Bear Creek Census Designated Place

The 2010 census recorded a total population of 1,956 residents in Bear Creek Census Designated Place (CDP). Roughly 36 percent of the population of Bear Creek CDP is between the ages of 25 and 49.

Bear Creek CDP residents are predominately white (80.9 percent), with a mixed ethnic population approximately consisting of 10.7 percent American Indian and Alaska Native, 1.6 percent Asian, 0.6 percent African American, 0.2 percent Native Hawaiian and Pacific Islander, and the remaining 6.0 % identifying themselves as "Other" or as having diverse cultural heritages. The male and female composition is approximately 53.7 and 46.3 percent, respectively. The 2010 Census revealed that there are 727 housing units with a median value of approximately $186,200; of these, 665 are occupied, of which 541 are "owner-occupied". The average owner-occupied household has approximately 3 individuals. The most recent 2012 Alaska Department of Labor estimates the population of Bear Creek CDP as 1,997. (2010 Census, 2012 DCRA)

Lowell Point Census Designated Place

The 2010 census recorded a total population of 80 residents in Lowell Point Census Designated Place (CDP). Roughly 41 percent of the population of Lowell Point CDP is between the ages of 25 and 49.

Lowell Point CDP residents are predominately white (96.2 percent), with the remaining 3.8 percent identifying themselves as American Indian and Alaska Native. The male and female composition is approximately 73.7 and 26.3 percent, respectively. The 2010 census revealed that there are 71 housing units. However, this Census year lacked specific housing value data. Therefore, we reference the 2000 Census data which lists the median value at approximately $130,800. Of these, the 2012 Census indicates there are 36 occupied, of which 26 are "owner-occupied". The average owner-occupied household has approximately three individuals. The most recent 2012 Alaska Department of Labor (July) estimates the population of Lowell Point CDP as 59. (2010 Census, 2012 DCRA)

Figure 2-2 illustrates the recent historic population for the three population centers. Population data was not available for Bear Creek and Lowell Point before 2000, as that was the first year they were recognized as CDPs for the 2000 US Census. US Census data for the three population centers were formerly combined with the Kenai Peninsula Borough's Census data. (DCRA 2012)

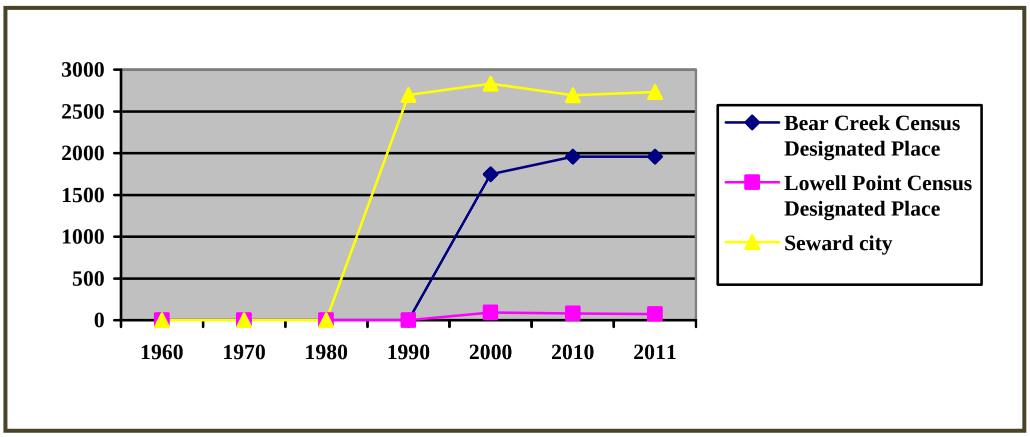

Figure 2-2 Seward Bear Creek Flood Service Area Historic Population

2.3 ECONOMY

There are diverse employment opportunities within the SBCFSA, with most residents working in the City of Seward. Established government provides the majority of the employment opportunities such as at the City, State, and Federal agencies. The Alaska Railroad, Kenai

Peninsula School District, Providence Seward Medical Center, State prison, and the University of Alaska Fairbanks Marine Sciences are all major employers. In addition, industries such as seafood processing, commercial and sport fishing, tourism, transportation, ship services and repairs, oil and gas, and local businesses also provide substantial employment opportunities (DCRA 2012, KPB 2005). The Port of Seward acts as an important economic generator for the City of Seward, KPB's Eastern Peninsula Region, as well as connecting to the Alaska railroad terminus. The port serves an important export function for Seward and the State, for example, servicing Usibelli Coal Mine coal shipments, cruise ships, ferries, barges, and ocean freighters.

According to the 2007-2011 American Community Survey, 1,134 Seward residents were listed as employed, almost a quarter of which were employed by the public sector. The same survey listed 968 Bear Creek residents as employed, with 14.0 percent of workers being employed by the public sector; and the US Census' 2007-2011 American Community Survey listed 33 residents of Lowell Point as being employed.

Bear Creek area median household income was $78,420 and per capita income was $22,988. Approximately 4.4 percent of Bear Creek residents were reported as having incomes below the poverty level. (2010 Census)

Similar data was not available from the US Census for Lowell Point.

The unemployment rates for Seward was 5.2 percent; and 5.2 percent for Bear Creek. However, these rates included part-time and seasonal jobs, and practical unemployment or underemployment are likely to be significantly higher. (2010 Census)

Figure 2-3 depicts an aerial photograph of the SBCFSA produced for the 2005 and 2010 Flood Hazard Mitigation Plans (FHMP) which is available on the KPB HMP website (KPB 2011).

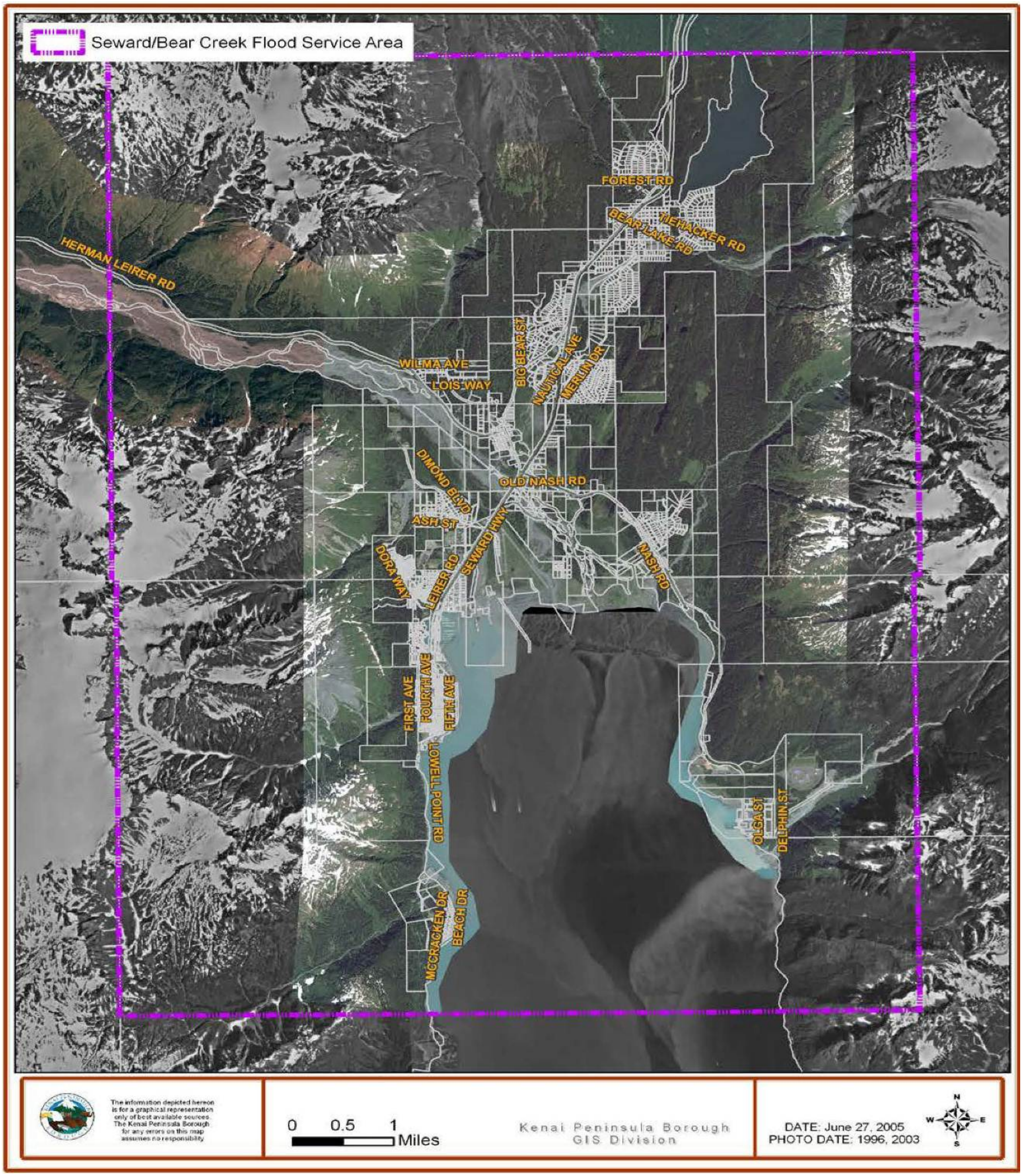

Figure 2-3 Aerial Photograph of the SBCFSA (KPB 2010).

This section provides an overview of the HMP's update process; identifies the Planning Team Members and key stakeholders; documents public outreach efforts; and summarizes the review and incorporation of existing plans, studies, and reports used to develop this HMP. Outreach support documents and meeting information regarding the Planning Team and public outreach efforts are provided in Appendix F.

The requirements for the planning process, as stipulated in DMA 2000 and its implementing regulations are described below.

DMA 2000 Requirements
1. REGULATION CHECKLIST
Local Planning Process §201.6(b): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: Element §201.6(b)(1): An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval; §201.6(b)(2): An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and nonprofit interests to be involved in the planning process; and §201.6(b)(3): Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information. §201.6(c)(1): [The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved. §201.6(c)(4)(i): The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle. §201.6(c)(4)(iii): The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.
ELEMENT A. Planning Process
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1)) A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2)) A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1)) A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3)) A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii)) A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle?) (Requirement §201.6(c)(4)(i))
Does the updated plan document how the planning team reviewed and analyzed each section of the plan and whether each section was revised as part of the update process? (Not applicable until 2013 update).
Source: FEMA, October 2011.

3.1 PLANNING PROCESS OVERVIEW

The SBCFSA provided funding and project oversight to URS Corporation to facilitate and guide Planning Team development and HMP update process.

The planning process began with Dan Mahalak, KPB Donald Gilman River Center, coordinating a local Planning Team kick-off meeting on September 19, 2012 in the City of Seward. The Planning Team identified applicable SBCFSA resources and capabilities during the meeting. URS explained how the HMP differed from current emergency plans. The Planning Team then discussed the FSA's rolls such as: acting as an advocate for the planning process, assisting with gathering information, and supporting public participation opportunities. There was also a brief discussion about hazards that affect the community such as earthquake, erosion, flood impacts with sediment deposition, tsunami, severe weather, and wildland fire impacts, which are increasing in intensity.

The Planning Team further discussed the hazard mitigation planning process, asking participants to help identify hazards that affect the City, to identify impacts to residential and critical facilities, and for assisting the Planning Team with identifying and prioritizing mitigation actions for potential future mitigation project funding

In summary, the following five-step process took place from September 2012 through June 2013.

1. Organize resources: Members of the Planning Team identified resources, including staff, agencies, and local community members, who could provide technical expertise and historical information needed in the development of the hazard mitigation plan.
2. Monitor, evaluate, and update the plan: The Planning Team developed a process to monitor the HMP's Mitigation Strategy to ensure it was used as intended while fulfilling community needs. The team then developed a process to evaluate the plan to compare how their decisions affected hazard impacts. They then outlined a method to share their successes with community members to encourage support for mitigation activities and to provide data for incorporating mitigation actions into existing planning mechanisms and to provide data for the plans five year update.
3. Assess risks: The Planning Team identified the hazards specific to SBCFSA, and with the assistance of a hazard mitigation planning consultant (URS), developed the risk assessment for the SBCFSA identified hazards. The Planning Team reviewed the risk assessment, including the vulnerability analysis, prior to and during the development of the mitigation strategy.
4. Assess capabilities: The Planning Team reviewed current administrative and technical, legal and regulatory, and fiscal capabilities to determine whether existing provisions and requirements adequately address relevant hazards.
5. Develop a mitigation strategy: After reviewing the risks posed by each hazard, the Planning Team developed a comprehensive range of potential mitigation goals and actions. Subsequently, the Planning Team identified and prioritized the actions for implementation.

3.2 HAZARD MITIGATION PLANNING TEAM

Table 3-1 lists the SBCFSA Planning Team members.

Table 3-1 Hazard Mitigation Planning Team

Name	Title	Organization	Key Input
Dan Mahalak	Seward Bear Creek Flood Service Area (SBCFSA) Water Resource Manager	Kenai Peninsula Borough (KPB)	Planning Team Lead, project management, and guidance
SBCFSA Board	SBCFSA Board Members-at-Large	SBCFSA	Plan review, implementation, and coordination
Bill Williamson	SBCFSA Chairman	SBCFSA	Plan review, implementation, and coordination
Randy Stauffer	SBCFSA Vice Chairman	SBCFSA	Plan review, implementation, and coordination
Stephanie Presley	SBCFSA Coordinator	SBCFSA	Plan review and coordination
Jim Hunt	Seward, City Manager	City of Seward (Seward)	Plan review
Ron Long	Director, Seward Community Development	Seward	Plan review, coordination, and implementation
Donna Glenz	Planner	Seward	Plan coordination and implementation
WC Casey	Director, Public Works	Seward	Project status determination
David Squires	Fire Chief	Seward	Hazard coordination
Scott Walden	Director, Emergency Management	KPB	Plan review and incorporation into KPB MHMP, hazard coordination, project coordination
Jon Czarnezki	Resource Planner	KPB	Plan review and coordination
Max Best	Director, Borough Planning	KPB	Plan review and coordination
Marcus Mueller	Land Management Officer	KPB	Plan review and coordination
Dan Bevington	Floodplain Administrator	KPB	Plan review and coordination, flood hazard review
Chris Clough	Manager, KPB Geographic Information System Development	KPB	GIS data sharing
Scott Simmons	Emergency Management, Hazard Mitigation, and Climate Change Planner	URS Corporation, Alaska	Project Lead, plan activity coordination, data acquisition, HMP development, and project reporting
Rich Chamberlain, GISP	GIS Practice Leader, Senior Staff GIS Specialist, Risk Assessment, Hazard United States (Hazus) Modeler	URS Corporation, Colorado	Hazus scenario, infrastructure vulnerability analysis, and population risk assessment
Kimberley Pirri, PE, CFM	Senior Water Resources Engineer, Hazus Development	URS Corporation, Colorado	Hazus scenario, infrastructure vulnerability analysis, and population risk assessment
Jon Philipsborn, MPA	Sustainability, Hazard Mitigation, Climate Change Adaptation Planner	URS Corporation, Georgia	Climate change adaptation and HMP development
Shane Parson, PhD, CFM	Risk Assessment, Hazus Modeler	URS Corporation, Maryland	Hazus scenario, infrastructure vulnerability analysis, and population risk assessment

3.3 PUBLIC INVOLVEMENT & OPPORTUNITY FOR INTERESTED PARTIES TO PARTICIPATE

Table 3-2 lists the community's public involvement initiatives focused to encourage participation and insight for the HMP development activities.

Table 3-2 Public Involvement Mechanisms

Mechanism	Description
Pre-Award Public Notice	Pre-award public meeting actions, i.e. intended purpose of applying for HMGP, intended outcome if awarded
Post-Award Public Notice	Post-award actions, i.e. SBCFSA board actions to accept grant funds and ordinance process to accept/appropriations.
Newsletter #1 Distribution (October 2012)	In October 2012, the jurisdiction distributed a newsletter describing the upcoming planning activity. The newsletter encouraged the whole community to provide hazard and critical facility information. It was posted at City Hall and Offices, Harbor Masters Office, Library, bulletin boards, shopping centers, and the SBCFSA and KPB websites to enable the widest dissemination.
Newsletter #2 Distribution (April, 2013)	In April 2013, the jurisdiction distributed a second newsletter describing the HMPs availability and present potential HMP projects for review. The newsletter encouraged the whole community to provide comments or input. It was posted at City Hall and Offices, Harbor Masters Office, Library, bulletin boards, shopping centers, and the SBCFSA and KPB websites to enable the widest dissemination.
Website HMP Update Process Notice	KPB public process is specifically described in Code, which also should be exercised / documented in this chart. For example, posted in local media sources or public places of interest (post office) five working days prior to public meeting.

On September 19, 2012, the SBCFSA Chairman introduced the hazard mitigation planning project during their Bi-Monthly Board Meeting. URS extended an invitation to all individuals and entities identified on the project mailing list via a project newsletter describing the planning process and announcing the upcoming public meeting. The newsletter was distributed to relevant academia, nonprofits, and local, state, and federal agencies and placed on the SBCFSA, City of Seward, and KPB websites.

During the meeting, the Planning Team led the attending public through a hazard identification and screening exercise. The attendees identified eight hazards: earthquake, erosion, flood, ground failure (avalanche, landslide, and subsidence), tsunami/seiche, volcano, severe weather, and wildland fire, all of which have historically or could potentially impact the SBCFSA. The Planning Team also discussed climate change and the potential effects to existing hazards that impact the SBCFSA, resulting from changes in precipitation, temperature, and sea level rise. In addition, the Planning Team also discussed the relevance of land use change and development in relation to future risk and hazard mitigation.

Following the hazard screening process, the Planning Team led the attendees through the process for identifying critical facilities in the community. URS also described the specific information needed from the Planning Team and public to complete the risk assessment including the location, value, and resident population, and worker/visitor population for critical facilities in the SBCFSA.

A risk assessment was completed after the community asset data was collected by the Planning Team over the fall and winter of 2012/2013, which identified the assets that are exposed and vulnerable to specified hazards.

A Planning Team meeting was held on March 13, 2012 to review and prioritize the mitigation actions identified based on the results of the risk assessment. A second newsletter was prepared and delivered in April 2012 describing the process to date, presenting the prioritized mitigation actions, and announcing the availability of the draft HMP for public review and comment.

The Planning Team provided SBCFSA residents and stakeholders the opportunity to address hazards and issues pertinent to their respective infrastructure and/or needs. These opportunities provided opportunities for the Planning Team to modify the mitigation strategy to better target stakeholder specific actions for reducing damages and losses.

The Planning Team held a special meeting on April 1, 2013 to review the draft HMP for accuracy – ensuring it meets the SBCFSA's needs. The meeting was productive with the Team highlighting several minor corrections or refinements. Changes were specifically targeted to plan hazard impacts, community vulnerability analysis, and the mitigation strategy.

3.4 INCORPORATING EXISTING PLANS AND OTHER RELEVANT INFORMATION

During the planning process, the Planning Team reviewed and incorporated information from existing plans, studies, reports, and technical reports into the HMP. Table 3-3 lists resources available from various sources and websites; which were reviewed, and referenced throughout this HMP update. A comprehensive reference list is provided in Section 8.

Table 3-3 Documents Reviewed

Existing plans, studies, reports, ordinances, etc.	Contents Summary (How will this information improve mitigation planning?)	Update Inclusion Yes / No
Seward/Bear Creek Flood Service Area, Flood Hazard Mitigation Plan, May 2010;	Provided detailed historical flood hazard assessment, watershed, and mitigation initiative development background data.	Yes
City of Seward 2020 Comprehensive Plan, Volume I, (CP 2005)	Plan identifies the goals, objectives, and implementation action items, updated and developed for each comprehensive plan element. The plan defined the City's: economic development, land use, housing, transportation, port and harbor development, recreation, public facilities and services, natural hazards, and quality of life.	Yes
Kenai Peninsula Borough Comprehensive Plan (CP 2005)	Plan details KPB's existing conditions, and identified goals, objectives, and implementation actions. The plan was relevant to current and future land use, transportation, and hazard impacts.	Yes
Earthquakes in Alaska, USGS Open-File Report 95-624, by Peter Haeussler and George Plafker	Defined the location's earthquake threat potential.	Yes
The USACE, Alaska Baseline	Defined the State's erosion threats, lists threatened	Yes

Table 3-3 Documents Reviewed

Existing plans, studies, reports, ordinances, etc.	Contents Summary (How will this information improve mitigation planning?)	Update Inclusion Yes / No
Erosion Assessment, Study Findings and Technical Report	communities, and the various erosion categories.	
The USACE, Alaska Baseline Erosion Assessment, Erosion Information Paper, Seward, Alaska, July 17 2008	Described the City's "Monitor Conditions" erosion classification and threat.	Yes
Kenai Peninsula Borough Situations and Prospects, Economic Trends for Year Ending December 31, 2006	Provided information for key industries, listed significant hazard events, and described the areas geologic hazards and areas for concern. (Note: This plan is no longer maintained).	Yes
State of Alaska, Department of Commerce, Community and Economic Development Community Profile	Provided historical and demographic information.	Yes
Kenai Peninsula Borough Multi-Jurisdictional, All-Hazard Mitigation Plan.	Provided Borough specific information pertinent to updating Appendix I, 2010 SBCFSA Flood Hazard Mitigation Plan to convert into a SBCFSA All-Hazard Mitigation Plan.	Yes
State of Alaska Hazard Mitigation Plan (SHMP), 2010	Defined statewide hazards and their potential locational impacts.	Yes
Hydrology for Floodplain Insurance Restudy of City of Seward, Kenai Peninsula Borough, Alaska - EMS-2001-CO-0067, Task Order #28	Defined the SBCFSA's infrastructure and residential property locations in relation to the area's watersheds.	Yes

3.5 PLAN MAINTENANCE

This section describes a formal plan maintenance process to ensure that the HMP remains an active and applicable document. It includes an explanation of how the SBCFSA's Planning Team intends to organize their efforts to ensure that improvements and revisions to the HMP occur in a well-managed, efficient, and coordinated manner.

The following three process steps are addressed in detail here:

1. Implementing the HMP
2. Continued public involvement
3. Monitoring, reviewing, evaluating, and updating the HMP

3.5.1 Incorporating Into Existing Planning Mechanisms

The requirements for implementation through existing planning mechanisms, as stipulated in the DMA 2000 and its implementing regulations, are described below.

DMA 2000 Requirements
1. REGULATION CHECKLIST
Incorporation into Existing Planning Mechanisms §201.6(b)(3): Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.
ELEMENT A Planning Process (Continued)
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports and technical information?
Source: FEMA, October 2011.

Once the HMP is community adopted and receives FEMA's final approval, each Planning Team Member will ensure that the HMP, in particular each Mitigation Action Project, is incorporated into existing planning mechanisms. Each member of the Planning Team will achieve this incorporation by undertaking the following activities.

- Conduct a review of the community-specific regulatory tools to assess the integration of the mitigation strategy. These regulatory tools are identified in the following capability assessment section.
- Work with pertinent community departments and State and Federal agencies to increase awareness of the HMP and provide assistance in integrating the mitigation strategy (including the Mitigation Action Plan) into relevant planning mechanisms. Implementation of these requirements may require updating or amending specific planning mechanisms.

3.5.2 Continued Public Involvement

The requirements for continued public involvement, as stipulated in the DMA 2000 and its implementing regulations are described below.

DMA 2000 Requirements
1. REGULATION CHECKLIST
Continued Public Involvement §201.6(c)(4)(iii): The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.
ELEMENT A Planning Process (Continued)
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))
Source: FEMA, October 2011.

The SBCFSA is dedicated to involving the public directly in the continual reshaping and updating of the HMP. A paper copy of the HMP and any proposed changes will be available at the SBCFSA, City of Seward, and the Qutekcak Tribal Office. An address and phone number of the Planning Team Leader to whom people can direct their comments or concerns will also be available at these locations.

The SBCFSA will continue to identify opportunities to raise community awareness about the HMP and the hazards that affect the area. This effort could include attendance and provision of materials at SBCFSA-selected events, outreach programs, public meetings, and through mailouts. Any public comments received regarding the HMP will be collected by the Planning Team Leader, included in the annual report, and considered during future HMP updates.

3.5.3 Monitoring, Reviewing, Evaluating, and Updating the HMP

The requirements for monitoring, reviewing, evaluating, and updating the HMP, as stipulated in the DMA 2000 and its implementing regulations are described below.

DMA 2000 Requirements
Monitoring, Evaluating and Updating the Plan §201.6(c)(4)(i): The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.
1. REGULATION CHECKLIST
ELEMENT A. Planning Process (Continued)
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle?)
Source: FEMA, October 2011.

This section provides an explanation of how the SBCFSA's Planning Team intends to organize their efforts to ensure that improvements and revisions to the HMP occur in a well-managed, efficient, and coordinated manner.

The following three process steps are addressed in detail here:

1. Review and revise the HMP to reflect development changes, project implementation progress, project priority changes, and resubmit.
2. HMP resubmittal at the end of the plan's five year life cycle for Borough review and approval.
3. Continued mitigation initiative implementation.

3.5.3.1 Monitoring the HMP

The HMP was prepared as a collaborative effort. To maintain momentum and build upon previous hazard mitigation planning efforts and successes, the City will continue to use the Planning Team to monitor, evaluate, and update the HMP. SBCFSA, KPB and City of Seward will be responsible for implementing the Mitigation Action Plan. However, the Borough has ultimate responsibility for regulatory compliance and borough-wide project prioritization.

The SBCFSA Board will designate the SBCFSA hazard mitigation Planning Team Leader as the primary point of contact and will coordinate local efforts to monitor, evaluate, and revise the HMP for submittal to KPB Emergency Management during the KPB Multi-Jurisdictional HMP five year update process.

Each member of the Planning Team will conduct an annual review during the anniversary week of the plan's official FEMA approval date to monitor the progress in implementing the HMP, particularly the Mitigation Action Plan. As shown in Appendix H, the Annual Review Questionnaire will provide the basis for possible changes in the HMP Mitigation Action Plan by refocusing on new or more threatening hazards, adjusting to changes to or increases in resource allocations, and engaging additional support for the HMP implementation. The Planning Team

Leader will initiate the annual review two months prior to the scheduled planning meeting date to ensure that all data is assembled for discussion with the Planning Team. The findings from these reviews will be presented at the annual Planning Team Meeting. Each review, as shown on the Annual Review Worksheet, will include an evaluation of the following:

- Participation of authorities and others in the HMP implementation
- Notable changes in the risk of natural or human-caused hazards
- Impacts of land development activities and related programs on hazard mitigation
- Progress made with the Mitigation Action Plan (identify problems and suggest improvements as necessary)
- The adequacy of local resources for implementation of the HMP

The SBCFSA's 2005 and 2010 Flood Hazard Mitigation Plans (FHMP) were originally formulated to fulfill NFIP requirements which sought to maintain momentum and build upon previous hazard mitigation initiatives and successes. The FHMP sought to track identified mitigation opportunities and initiatives while determining whether identified actions were effectively implemented.

The SBCFSA hazard mitigation Planning Team Leader, (or designee), was identified as the primary point of contact who would coordinate local efforts to monitor and evaluate the HMP.

3.5.3.2 Reviewing the HMP

The Planning Team did not perform an annual FHMP review. However, the SBCFSA provided substantial knowledge and insight with historical flood impacts, implemented mitigation measures, and proposed regulatory successes and/or failures.

It was a primary consideration to convert the existing 2010 Flood Hazard Mitigation Plan into a FEMA approvable All-Hazard Mitigation Plan. Table 3-6 delineates Planning Team identified HMP components that need to be addressed to reflect an all-hazard approach. The Team determined how community changes, construction and infrastructure conditions, climate changes, and population increases or decreases have influenced hazard risks and/or vulnerabilities.

The HMP is coordinated with the KPB Multi-Jurisdictional HMP to assure compliance with KPB objectives and requirements.

The current update process brought together new and existing stakeholders to review the existing FHMP to determine what was accomplished versus what was intended for accomplishment. Discussions resulted in refinement within Table 3-4, which guided the HMP review and update process.

Table 3-4 HMP Review and Update Process

2010 FHMP Section	2010 FHMP Items to be Updated	2010 FHMP Identified items for Deletion	Newly Identified Items to be Added for HMP Compliance
Planning Process	• Planning process • Planning team membership • Mitigation resource list • Public outreach initiatives	N/A	• Update planning Process to included "HMP review and update" processes
Risk Assessment	• Hazard profile history • Asset inventory • Vulnerability analysis & summaries	N/A	• Identify new hazards for All-Hazard Compliance • Identify repetitive loss properties as appropriate • Develop asset inventory • Determine infrastructure vulnerabilities • Develop floodplain assessment for each water shed
Mitigation Strategy	• Mitigation actions status • Mitigation action implementation	Implemented & non-relevant mitigation actions	• Identify existing (2010) mitigation plan actions' status • Identify new mitigation actions for newly identified hazard implementation • Develop capability assessment
Plan Maintenance	Plan maintenance process	N/A	Refine plan maintenance process and responsibilities

Each Planning Team Member reviewed the FHMP's project list and annotated their respective status. Their status will be further defined in Section 7, The Hazard Mitigation Strategy.

Table 3-5 identifies the planning categories which need updating.

Table 3-5 2010 HMP Status Determination

(Did we do what we said we'd do?)

2010 Flood HMP Section	2010 Activity Commitment	Status: F: Fulfilled NF: Not Fulfilled	New Action Commitment
Planning Process	Hold Planning Team meetings	NF	Planning Team will continue meetings and strive to integrate HMP initiatives into other SBCFSA plans, ordinances, and resolutions.
Risk Assessment	Identified flood risk assessment goals and objectives	NF	• Define goals and objectives as action items • Locate scientific information to augment these data. • Filled data gaps with HMGP funded floodplain assessment and climate change scenario future development analysis
Mitigation Strategy	Implement mitigation actions	F	• Determined 2010 identified mitigation actions' status • Developed follow-up action plan

Table 3-5 2010 HMP Status Determination

(Did we do what we said we'd do?)

2010 Flood HMP Section	2010 Activity Commitment	Status: F: Fulfilled NF: Not Fulfilled	New Action Commitment
Continued Public Involvement	Continue public involvement	F	• Defined public involvement process • Determined whether mitigation specific information was provided at outreach activities. (Activities may have included fairs, festivals, and public meetings)
Plan Maintenance	Only identified that preliminary DFIRM's would be released for public in June 2010	NF	• Conduct plan maintenance meetings to review HMP annually • Update plan at 5 year intervals • Implement FEMA plan improvement suggestions

The 44 CFR requires communities to schedule planning team meetings and teleconferences to review, discuss, and determine mitigation implementation accomplishments as well as data relevance for HMP inclusion. Meeting minutes are included in Appendix C, Community Involvement.

Table 3-6 lists relevant meeting information for the 2012 LHMP update which focused on changing the Flood Hazard Mitigation Plan into an all-hazard local hazard mitigation plan that would enable the SBCFSA to qualify for mitigation grant program funding.

Table 3-6 HMP Update - Planning Team Meeting Summary

Meeting Date/Method	Meeting Attendees	Meeting Summary
9/19/2012/ In-person	Dan Mahalak, PM, Randy Stauffer, SBCFSA Vice Chairman, Scott Walden, KPB EM, Donna Glenz, Seward Planner, David Squires, Seward Fire Chief	Kick-Off Meeting, Introduced project and initiatives.
3/15/2013/ Teleconference	Dan Mahalak, Water Resource Manager; Randy Stauffer, SBCFSA Vice Chairman; Stephanie Presley, SBCFSA Coordinator; Donna Glenz, City of Seward Planner; Dan Bevington, KPB Floodplain Administrator; Brenda Ahlberg, KPB Capital Projects; Marcus Mueller, KPB Land Management Officer; Scott Simmons, Project Manager, URS Alaska; Richard Chamberlain, GIS, Hazus, URS Colorado, Kimberly Pirri, PE, Hazus, URS Colorado, Jon Philipsborn, Climate Change and Sustainability, URS Georgia, and Shane Parson, PhD., Hazus, URS Maryland.	Teleconference to review, consider, and ultimately select potential mitigation projects for inclusion to the Hazard Mitigation Plan Update.
4/01/2013	SBCFSA Board Members	Review Mitigation Strategy and Mitigation Action Plan (MAP)
4/03-17/2013	SBCFSA Board, City of Seward, KPB	Review Draft HMP

3.5.3.3 Evaluating the HMP

The 2012 LHMP development and update provides the Annual Review Questionnaire (Appendix F). This form will provide the basis for future HMP evaluations by guiding the Planning Team with identifying new or more threatening hazards, adjusting to changes to or increases in resource allocations, and garnering additional support for HMP implementation.

The Planning Team Leader will initiate the annual review two months prior to the scheduled planning meeting date to ensure that all data is assembled for discussion with the Planning Team. The findings from these reviews will be presented at the annual Planning Team Meeting. Each review, as shown on the Annual Review Worksheet, will include an evaluation of the following:

- Participation of authorities and others in the HMP implementation
- Notable changes in the risk of natural or human-caused hazards
- Impacts of land development activities and related programs on hazard mitigation
- Progress made with the Mitigation Action Plan (identify problems and suggest improvements as necessary)
- The adequacy of local resources for implementation of the HMP

3.5.3.4 Updating the HMP

In addition to the annual review, the Planning Team will update the HMP every five years.

DMA 2000 Requirements
Reviewing, Evaluating, and Implementing the Plan §201.6(d)(3): A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit if for approval within 5 years in order to continue to be eligible for mitigation project grant funding.
ELEMENT D. Planning Process (Continued) *Update activities not applicable to the plan version*
D1. Was the Plan revised to reflect changes in development? (Requirement §201.6(d)(3))
D2. Was the Plan revised to reflect progress in local mitigation effort? (Requirement §201.6(d)(3))
D3. Was the Plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))
Source: FEMA, October 2011.

The SBCFSA will annually review the HMP as described in Section 3.5.3 and update the HMP every five years (or when significant changes are made) by having the identified Planning Team review all Annual Review Questionnaires (Appendix F) to determine the success of implementing the HMP's Mitigation Action Plan.

As shown in Appendix H, the Annual Review Questionnaire will enable the Team to identify possible changes in the HMP Mitigation Action Plan by refocusing on new or more threatening hazards, resource availability, and acquiring stakeholder support for the HMP project implementation.

In the fourth year following adoption of the HMP, the Planning Team will undertake the following activities:

- Request grant assistance for DHS&EM to update the HMP (this can take up to one year to obtain and one year to update the plan).
- Ensure that each authority administering a mitigation project will submit a Progress Report (Appendix H) to the Planning Team.
- Develop a chart to identify those HMP sections that need improvement, the section and page number of their location within the HMP, and describe the proposed changes.
- Thoroughly analyze and update the natural hazard risks.
  - Determine the current status of the mitigation projects.
  - Identify the proposed Mitigation Plan Actions (projects) that were completed, deleted, or delayed. Each action should include a description of whether the project should remain on the list, be deleted because the action is no longer feasible, or include delay reasons.
  - Describe how each action's priority status has changed since the HMP was originally developed and subsequently approved by FEMA and promulgated by the State.
  - Determine whether or not the project has helped achieve the appropriate goals identified in the plan.
  - Describe whether the community has experienced any barriers preventing them from implementing their mitigation actions (projects) such as financial, legal, and/or political restrictions and stating appropriate strategies to overcome them.
  - Update ongoing processes, and change the proposed implementation date/duration timeline for delayed actions the SBCFSA still desires to implement.
  - Prepare a new Mitigation Action Plan Matrix for the SBCFSA.
- Prepare a new draft updated HMP.
- Submit the updated HMP to the Borough for pre-adoption review and approval.

The Planning Team reviewed a wide range of reports, studies, and other research documents to determine appropriateness and incorporation into the updated HMP. Table 3-5 lists those documents and their inclusion status.

Formal State and FEMA HMP Review

Completed Hazard Mitigation Plans do not qualify the SBCFSA for mitigation grant program eligibility until they have been reviewed and adopted by the Borough, and received State and FEMA final approval.

The SBCFSA will submit the draft HMP to the Kenai Peninsula Borough (KPB) for initial review and preliminary approval. Once any corrections are made, the Borough will adopt the plan into its Multi-Jurisdictional HMP. The Borough will send the complete Multi-Jurisdictional HMP to the State and FEMA for their respective review and conditional approval.

Once the plan has fulfilled all FEMA criteria, the Borough will pass an HMP Adoption Resolution. KPB will then forward all incorporated plans to FEMA during their scheduled update process.

4.1 ADOPTION BY LOCAL GOVERNING BODIES AND SUPPORTING DOCUMENTATION

The requirements for the adoption of this HMP by the local governing body, as stipulated in the DMA 2000 and its implementing regulations are described below.

DMA 2000 Requirements
Local Plan Adoption §201.6(c)(5): [The plan shall include…] Documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County commissioner, Tribal Council). For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.
1. REGULATION CHECKLIST ELEMENT E. Plan Adoption
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval??) (Requirement §201.6(c)(5))
Source: FEMA, October 2011.

The Seward Bear Creek Flood Service Area (SBCFSA) is the Special Service Area represented in this HMP and meets the requirements of Section 409 of the Stafford Act and Section 322 of DMA 2000, and 44 CFR §201.6(c)(5).

The local governing body of the SBCFSA approved the HMP by vote on , 2013 and submitted the final draft HMP to the Borough for Adoption and subsequent inclusion within the Borough's Multi-Jurisdictional All-Hazard Mitigation Plan.

A scanned copy of the vote record and the Borough's formal adoption are included in Appendix E.

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This section identifies and profiles the hazards that could affect the SBCFSA.

5.1 OVERVIEW OF A HAZARD ANALYSIS

A hazard analysis includes the identification, screening, and profiling of each hazard. Hazard identification is the process of recognizing the natural events that threaten an area. Natural hazards result from unexpected or uncontrollable natural events of sufficient magnitude. Human, Technological, and Terrorism related hazards are beyond the scope of this plan. Even though a particular hazard may not have occurred in recent history in the study area, all natural hazards that may potentially affect the study area are considered; the hazards that are unlikely to occur or for which the risk of damage is accepted as being very low, are eliminated from consideration.

Hazard profiling is accomplished by describing hazards in terms of their nature, history, magnitude, frequency, location, extent, and probability. This information is identified through collecting historical and anecdotal information, reviewing existing plans and studies, and preparing study area hazard maps. Hazard maps are used to determine the geographic extent of each hazard and to define the approximate boundaries of the at-risk areas. In addition, this HMP incorporates future climate change scenarios and projections to consider future hazard risks in the analysis.

DMA 2000 Requirements
Identifying Hazards §201.6(c)(2)(i): The risk assessment shall include a] description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events. §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.
1. REGULATION CHECKLIST
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction? B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods?
Source: FEMA, October 2011.

5.2 HAZARD IDENTIFICATION AND SCREENING

The requirements for hazard identification, as stipulated in DMA 2000 and its implementing regulations are described below.

For the first step of the hazard analysis, on September 19, 2012 the Planning Team reviewed eight possible hazards that could affect the SBCFSA. The Planning Team then evaluated and screened the comprehensive list of potential hazards based on a range of factors, including prior knowledge or perception of threat, the relative risk presented by each hazard, the ability to mitigate the hazard, and the known or expected availability of information on the hazard (see Table 5-1). The

Planning Team determined that all eight hazards pose a threat to the SBCFSA: earthquake, erosion, flood, ground failure, tsunami/seiche, volcano, severe weather, and wildland/urban interface fire.

Table 5-1 Identification and Screening of Hazards

Hazard Type	Should It Be Profiled?	Explanation
Earthquake (EQ)	Yes	Periodic, unpredictable occurrences. The SBCFSA experienced no damage from the 11/2003 Denali Earthquake; but experienced severe structural and extensive infrastructure damage from the 1964 Good Friday Earthquake and its aftershocks, tsunamis, seiches, and flooding.
Erosion	Yes	The SBCFSA experiences storm surge, coastal ice run-up, and coastal wind erosion along the shoreline adjacent to Resurrection Bay and riverine erosion along the area's river, stream, and creek embankments from high water flow, riverine ice flows, wind, and surface runoff.
Flood	Yes	Snowmelt run-off and rainfall flooding occurs during spring thaw and the fall rainy season. Events occur from soil saturation. Several minor flood events cause damage. Severe damages occur from major floods.
Ground Failure (Avalanche, Landslide/Debris Flow, Permafrost, Subsidence)	Yes	Ground Failure occurs throughout Alaska resulting from avalanches, landslides, land subsidence, and permafrost. These hazards periodically cause houses to shift due to ground sinking and upheaval. The SBCFSA has erosion damage along the area's extensive river, stream, and creek system's embankments. The SBCFSA has also indicated that avalanches and landslides periodically occur in known locations.
Tsunami & Seiche	Yes	This hazard has historically destroyed SBCFSA infrastructure.
Volcano	Yes	Volcanic eruptions occur within and adjacent to KPB sending volcanic debris throughout the borough and adversely impacting the SBCFSA.
Weather, Severe (Wind, rain, snow, cold, etc.)	Yes	Annual weather patterns, severe cold, heavy rain, freezing rain, snow accumulations, storm surge, and wind, are the predominate threats. Intense wind and heavy rain are the primary impacts to the community. Severe weather events cause fuel price increases and frozen pipes. Heavy snow loads potentially damage house roofs. Winds potentially remove or damages roofs and moves houses off their foundations.
Wildland/Urban Interface Fire	Yes	The SBCFSA and the surrounding mountainous area becomes very dry in summer months with weather and human caused incidents igniting dry vegetation (e.g., lightning, camp fires, and trash burning).

5.3 HAZARD PROFILE

The requirements for hazard profiles, as stipulated in DMA 2000 and its implementing regulations are described below.

DMA 2000 Requirements
Profiling Hazards **Requirement §201.6(c)(2)(i):** [The risk assessment shall include a] description of the location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
1. REGULATION CHECKLIST
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction? (Requirement §201.6(c)(2)(i)) B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction?
Source: FEMA, October 2011.

The specific hazards selected by the Planning Team for profiling have been examined in a methodical manner based on the following factors:

- Nature (Type)
- History (Previous Occurrences)
- Location
- Extent (to include magnitude and severity)
- Impact (Section 5 provides general impacts associated with each hazard. Section 6 provides detailed impacts to the SBCFSA's residents and critical facilities).
- Future event probability

NFIP insured Repetitive Loss Structures (RLS) are addressed in Section 6.0, Vulnerability Analysis.

Each hazard is assigned a rating based on the following criteria for probability (Table 5-2) and magnitude/severity (Table 5-3). Probability is determined based on historic events, using the criteria identified in Table 5-2, to provide the likelihood of a future event.

Table 5-2 Hazard Probability Criteria

Probability	Criteria
4 - Highly Likely	• Event is probable within the calendar year. • Event has up to 1 in 1 year chance of occurring (1/1=100 percent). • History of events is greater than 33 percent likely per year. • Event is ***"Highly Likely"*** to occur.
3 - Likely	• Event is probable within the next three years. • Event has up to 1 in 3 years chance of occurring (1/3=33 percent). • History of events is greater than 20 per cent but less than or equal to 33 percent likely per year. • Event is ***"Likely"*** to occur.
2 - Possible	• Event is probable within the next five years. • Event has up to 1 in 5 years chance of occurring (1/5=20 percent). • History of events is greater than 10 percent but less than or equal to 20 percent likely per year. • Event could ***"Possibly"*** occur.
1 - Unlikely	• Event is possible within the next ten years. • Event has up to 1 in 10 years chance of occurring (1/10=10 percent). • History of events is less than or equal to 10 percent likely per year. • Event is ***"Unlikely"*** but is possible to occur.

Similar to estimating probability; magnitude, and severity are determined based on historic events using the criteria identified below.

Table 5-3 Hazard Magnitude/Severity Criteria

Magnitude / Severity	Criteria
4 - Catastrophic	• Multiple deaths. • Complete shutdown of facilities for 30 or more days. • More than 50 percent of property is severely damaged.
3 - Critical	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least two weeks. • More than 25 percent of property is severely damaged.
2 - Limited	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than one week. • More than 10 percent of property is severely damaged.
1 - Negligible	• Injuries and/or illnesses are treatable with first-aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property is severely damaged.

The hazards profiled for the SBCFSA are presented throughout Section 5.3. The presentation order does not signify their importance or risk level.

5.3.1 Earthquake

5.3.1.1 Nature

An earthquake is a sudden motion or trembling caused by a release of strain accumulated within or along the edge of the earth's tectonic plates. The effects of an earthquake can be felt far beyond the site of its occurrence. Earthquakes usually occur without warning and after only a few seconds can cause massive damage and extensive casualties. The most common effect of earthquakes is ground motion, or the vibration or shaking of the ground during an earthquake.

Ground motion generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. An earthquake causes waves in the earth's interior (i.e., seismic waves) and along the earth's surface (i.e., surface waves). Two kinds of seismic waves occur: P (primary) waves are longitudinal or compressional waves similar in character to sound waves that cause back and forth oscillation along the direction of travel (vertical motion), and S (secondary) waves, also known as shear waves, are slower than P waves and cause structures to vibrate from side to side (horizontal motion). There are also two types of surface waves: Raleigh waves and Love waves. These waves travel more slowly and typically are significantly less damaging than seismic waves.

In addition to ground motion, several secondary natural hazards can occur from earthquakes such as:

- **Surface Faulting** is the differential movement of two sides of a fault at the earth's surface. Displacement along faults, both in terms of length and width, varies but can be significant (e.g., up to 20 feet [ft]), as can the length of the surface rupture (e.g., up to 200 miles). Surface faulting can cause severe damage to linear structures, including railways, highways, pipelines, and tunnels.
- **Liquefaction** occurs when seismic waves pass through saturated granular soil, distorting its granular structure, and causing some of the empty spaces between granules to collapse. Pore water pressure may also increase sufficiently to cause the soil to behave like a fluid for a brief period and cause deformations. Liquefaction causes lateral spreads (horizontal movements of commonly 10 to 15 ft, but up to 100 ft), flow failures (massive flows of soil, typically hundreds of ft, but up to 12 miles), and loss of bearing strength (soil deformations causing structures to settle or tip). Liquefaction can cause severe damage to property.
- **Landslides, Avalanches, and Debris Flows** occur as a result of horizontal seismic inertia forces induced in the slopes by the ground shaking. The most common earthquake-induced landslides include shallow, disrupted landslides such as avalanches, rock falls, rockslides, and soil slides. Avalanches and debris flows are created when snow and surface soils on steep slopes become totally saturated with water. Once the soil liquefies, it loses the ability to hold together and can flow downhill at very high speeds, taking vegetation and/or structures with it. Slide risks increase after an earthquake during a wet winter.

The severity of an earthquake can be expressed in terms of intensity and magnitude.

- Intensity is based on the damage and observed effects on people and the natural and built environment. It varies on the location with respect to the earthquake epicenter, which is the point on the earth's surface that is directly above where the earthquake occurred. The severity of intensity generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. The scale most often used in the U.S. to measure intensity is the Modified Mercalli Intensity (MMI) Scale. As shown in Table 4-4, the MMI Scale consists of 12 increasing intensity levels that range from imperceptible to catastrophic destruction. Peak ground acceleration (PGA) is also used to measure earthquake intensity by quantifying how hard the earth shakes in a given location. PGA can be measured as acceleration due to gravity (g) (see Table 5-4) (MMI 2012).

- Magnitude (M) is the measure of the earthquake strength. It is related to the amount of seismic energy released at the earthquake's hypocenter, the actual location of the energy released inside the earth. It is based on the amplitude of the earthquake waves recorded on instruments, known as the Richter magnitude test scales, which have a common calibration (see Table 5-4).

Table 5-4 Comparisons: Magnitude, Intensity, Ground-Shaking

Magnitude	Intensity	PGA (% *g*)	Perceived Shaking
0 – 4.3	I	<0.17	Not Felt
	II-III	0.17 – 1.4	Weak
4.3 – 4.8	IV	1.4 – 3.9	Light
	V	3.9 – 9.2	Moderate
4.8 – 6.2	VI	9.2 – 18	Strong
	VII	18 – 34	Very Strong
6.2 – 7.3	VIII	34 – 65	Severe
	IX	65 – 124	Violent
	X	124 +	Extreme
7.3 – 8.9	XI		
	XII		

(MMI 2012)

5.3.1.2 History

There have been over 3,671 earthquakes within 100 miles of the SBCFSA since 1973. The Planning Team determined that the SBCFSA has a minimal concern for earthquake damages from earthquakes below M 5.0 as they inflict minimal damage to the community or its infrastructure. They concluded that the SBCFSA needs to be most concerned with earthquakes with a magnitude > M 5.0.

Table 5-5 lists 27 historical earthquakes that exceeded M 5.0 from 1983 to present located within 100 miles of the SBCFSA.

Table 5-5 Historical Earthquakes for SBCFSA
(Highlight is earthquake of record)

Year	Month	Day	Time	Latitude	Longitude	Depth (Miles)	Magnitude	Distance (miles)
2011	6	16	5:02:24 AM	60.76	-151.08	36.04	5	71.46
2009	8	19	2:52:48 PM	61.23	-150.86	41.01	5.1	87.61
2006	7	27	8:52:48 AM	61.16	-149.68	14.29	5	66.49
2004	12	21	7:26:24 AM	60.54	-147.6	18.02	5.1	62.76
2004	3	5	9:36:00 AM	60.5	-151.64	37.90	5	82.02
2002	2	6	6:00:00 PM	61.17	-149.73	21.75	5.3	67.73
2002	2	6	7:12:00 PM	61.18	-149.73	22.37	5	68.35
2002	2	25	7:55:12 AM	60.56	-147.15	1.24	5	77.67

Table 5-5 Historical Earthquakes for SBCFSA

(Highlight is earthquake of record)

Year	Month	Day	Time	Latitude	Longitude	Depth (Miles)	Magnitude	Distance (miles)
2002	8	6	12:28:48 AM	61.42	-150.35	34.18	5	90.10
2000	3	16	7:12:00 PM	61.4	-149.89	24.23	5	84.51
1999	4	18	1:55:12 AM	60.39	-151.85	45.36	5.3	88.23
1999	7	22	4:19:12 AM	61.3	-149.38	27.96	5.3	75.19
1997	12	5	1:26:24 PM	60.9	-149.19	22.37	5.1	47.22
1997	5	13	7:55:12 AM	61.05	-150.77	36.04	5	76.43
1995	5	24	10:04:48 PM	61.01	-150.12	25.48	5.6	61.52
1994	4	25	10:04:48 PM	60.9	-151.14	41.63	5.4	78.29
1993	5	18	11:31:12 PM	61.03	-149.95	31.69	5.2	60.89
1992	6	9	7:55:12 AM	61.33	-150.07	22.99	5.1	81.40
1991	4	26	10:04:48 PM	61.25	-150.15	23.61	5.2	77.05
1991	12	7	2:52:48 AM	60.95	-150.34	31.07	5.1	62.14
1987	4	18	9:21:36 PM	61.37	-150.66	42.25	5.7	92.58
1983	7	12	9:36:00 AM	61.03	-147.29	22.99	6.4	88.86
1983	9	7	3:36:00 AM	60.98	-147.5	27.96	6.2	80.78
1983	9	7	12:00:00 PM	60.99	-147.52	28.58	5	81.40
1980	8	1	4:48:00 PM	59.62	-148.94	16.16	5.7	42.87
1979	11	14	7:12:00 PM	61.38	-150.09	35.42	5.1	85.13
1973	8	31	9:36:00 PM	61.1	-147.41	30.45	5.1	88.86

(USGS 2012)

The average magnitude of the SBCFSA's earthquakes is M 3.05. The largest recorded earthquakes within 100 miles of the SBCFSA measured M 6.4 and 6.2 occurring on July 12, 1983 and September 7, 1983 respectively. These earthquakes were felt throughout the area causing minor damages to critical facilities, residences, non-residential buildings, and infrastructure.

Planning Team members stated that SBCFSA experienced moderate ground shaking from the November 3, 2002 M 7.9 Denali Fault earthquake whose epicenter occurred over 200 miles away. No significant damage occurred from this event. North America's strongest recorded earthquake occurred on March 27, 1964 in Prince William Sound, measuring M 9.2. This was a devastating earthquake event (with aftershocks) that caused underwater landslides which in-turn generated a massive local tsunami that ruptured fuel storage tanks which collapsed and quickly caught fire, sank moored ships, and destroyed railroad docks, train cars (rolling stock), and the Seward Highway bridges. There were 11 deaths in the City of Seward. The Resurrection Bay area received $14.6 million (of the total disaster's $84 million) in damages. .

5.3.1.3 Location, Extent, Impact, and Probability of Future Events

Location

Historical events have demonstrated that the entire geographic area of Alaska, and thus the SBCFSA, is prone to earthquake effects. The 1964 Great Alaskan Earthquake caused extensive devastation in Seward. This single event required the City to rebuild while reconsidering building and infrastructure locations.

Figure 5-1 displays Alaska's active and potentially active fault locations.

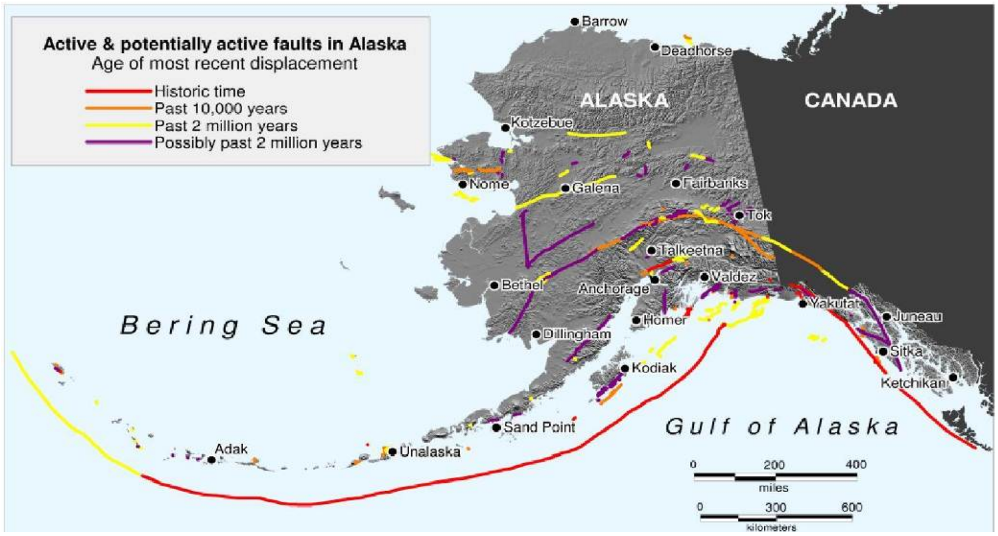


Figure 5-1 Active and Potentially Active Faults in Alaska

The Department of Geological and Geophysical Survey (DGGS) Neotectonic Map of Alaska depicts Alaska's known earthquake fault locations. DGGS states,

> *"The Neotectonic Map of Alaska is the most comprehensive overview of Alaskan Neotectonics published to date; however, users of this map should be aware of the fact the map represents the author's understanding of Alaskan Neotectonics at the time of publication. Since publication of the Neotectonic map, our understanding of Alaskan Neotectonics has changed and earthquakes have continued to occur. For example, M7.9 Denali fault earthquake ruptured three faults, including the Susitna Glacier fault, which was previously undiscovered..."* (DGGS 2009).

As depicted in the Neotectonic Map of Alaska (Figure 5-2), the most prominent fault in close proximity to the SBCFSA is the Aleutian Mega-Thrust Fault (approximately 140 miles to the southwest). There are numerous smaller known faults within 100 miles of the SBCFSA. Many are complex fault areas. The SBCFSA can therefore expect to be impacted by significant future earthquake events (DGGS 2009).

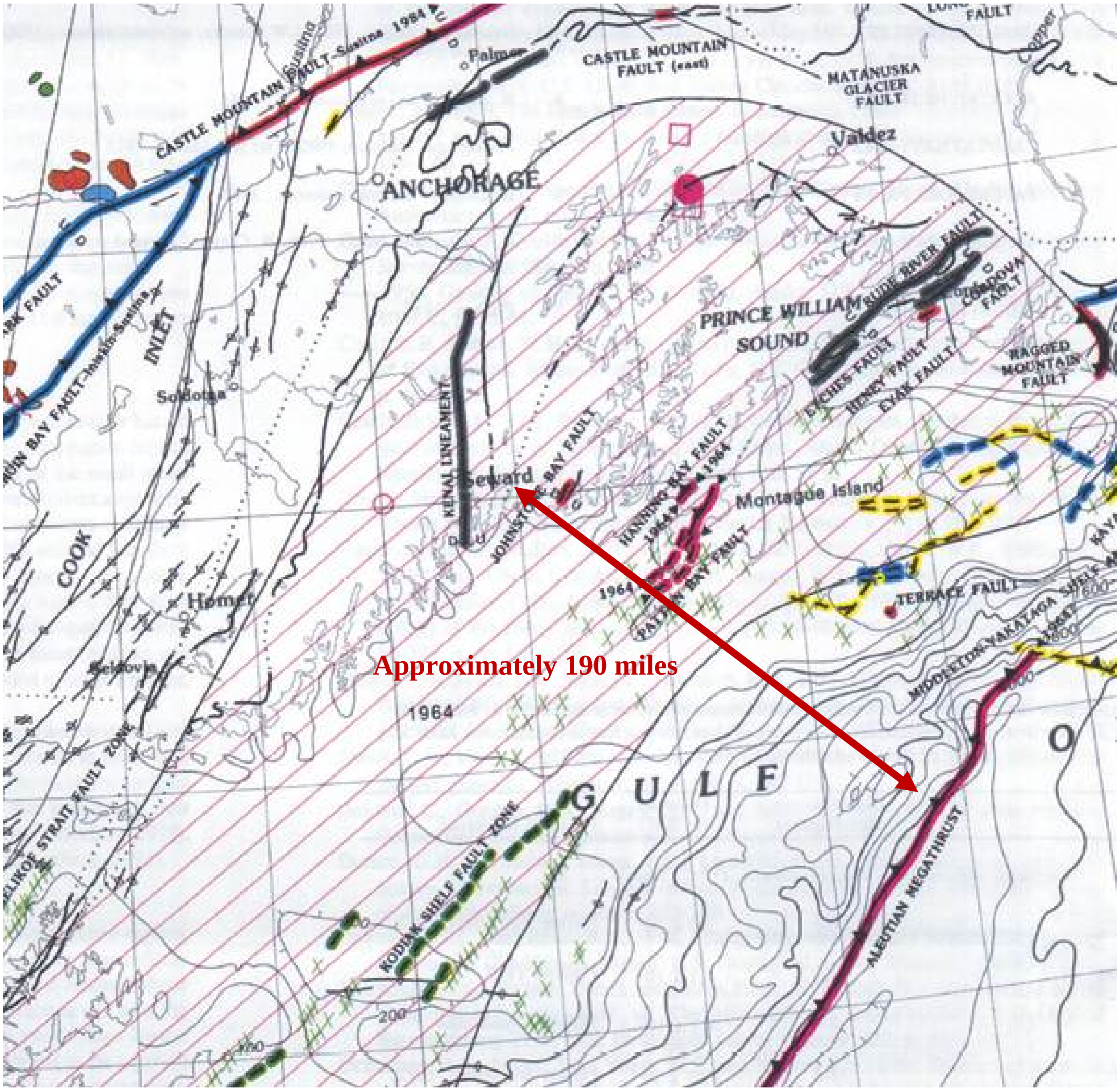


Figure 5-2 "Neotechtonic Map of Alaska" Image – SBCFSA Area (DGGS 2009)

Of the 3,671 recorded earthquakes since 1973, 31 exceeded M 5.0. Two occurred with a magnitude of 6.2 and 6.4 (USGS 2009) and with epicenters approximately 82.87 and 91.85 air miles north-east respectively from the SBCFSA.

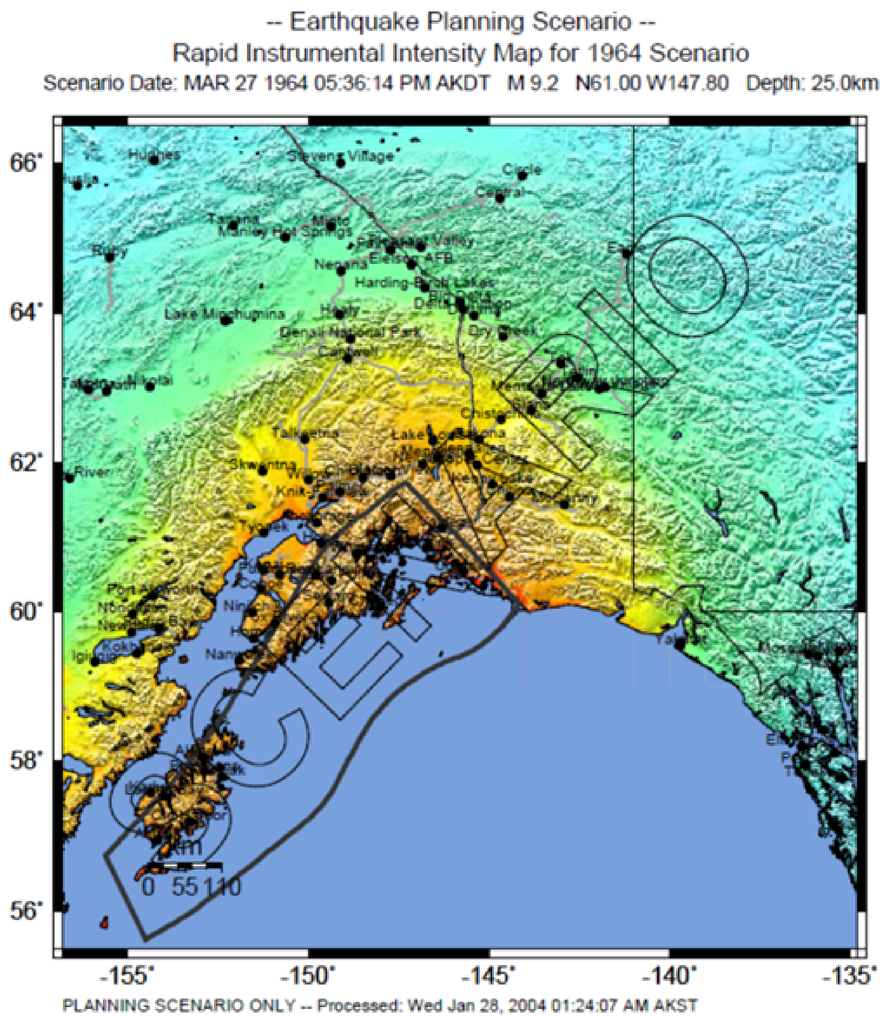
Extent

Earthquakes felt in the SBCFSA area have exceeded M 5.0 in the past 36 years, and damage has been reported throughout the project area.

Based on historic earthquake events and the criteria identified in Table 5-5, the magnitude and severity of earthquake impacts in the SBCFSA are considered "Catastrophic" with potential of multiple deaths and injuries, the potential for critical facilities to be shut down for 30 days or more, more than 50 percent of property or critical infrastructure being severely damaged, and with significant permanent damage to transportation, infrastructure, or the economy.

Impact

The SBCFSA is located in an area that is very seismically active, and the effects of earthquakes centered elsewhere are expected to be felt in the SBCFSA with significant shaking based on past events (Figure 5-3).



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Figure 5-3 1964 Good Friday Earthquake Scenario (USGS 2013)

Impacts to future populations, residences, critical facilities, and infrastructure are anticipated to remain the same.

Probability of Future Events

The SBCFSA has an extensive record of significant earthquake activity resulting in damage, injuries, and death. While it is not possible to predict when an earthquake will occur, Figure 5-4 was generated using the United States Geological Survey (USGS) Earthquake Mapping model and indicates a 100-percent probability of an M 5.0 or greater earthquake occurring within 100 years and 100 miles of the SBCFSA. Therefore it is expected that an event is “Highly Likely”. An earthquake event is probable within the calendar year, with a 1 in 1 year chance of occurring (1/1= 100 percent). History of events is greater than 33 percent likely per year.

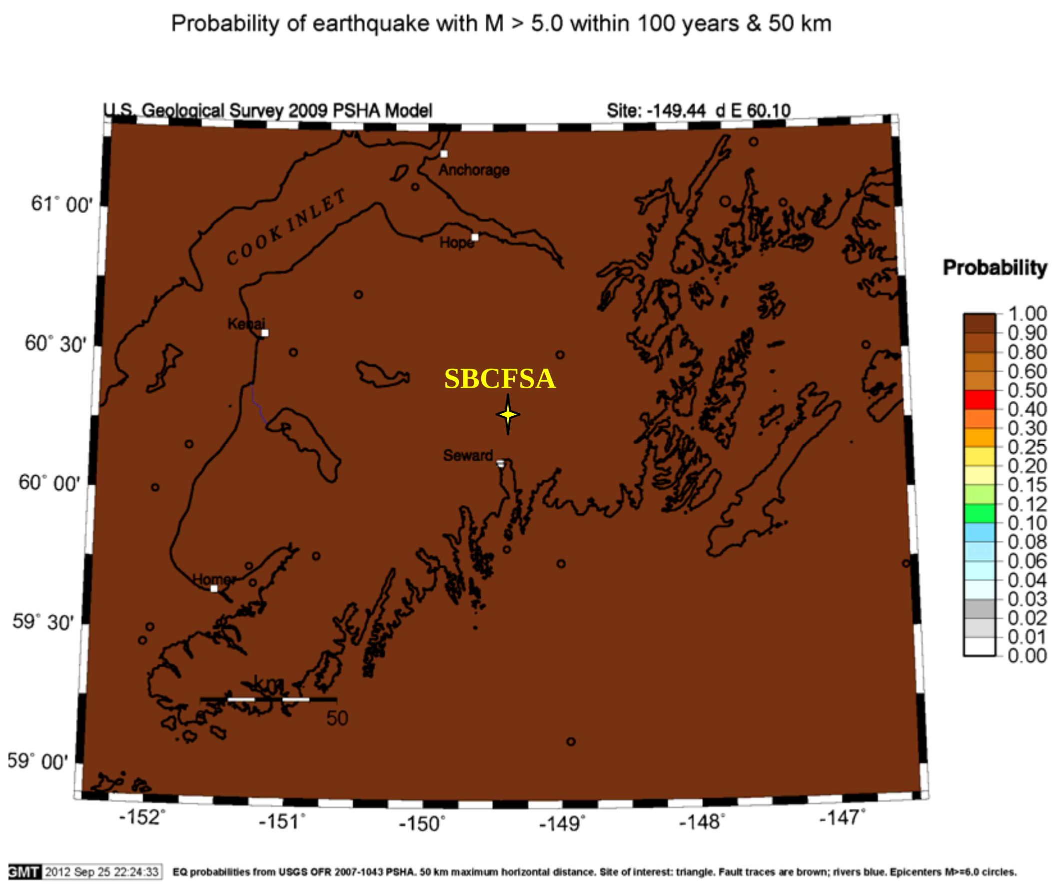


Figure 5-4 SBCFSA’s Earthquake Probability (USGS 2009)

The analysis of the earthquake hazard was conducted with the FEMA Hazus model (version 2.1). The 1964 Earthquake was modeled as worst-case scenario based on data provided by the USGS Shakemap program. See Appendix J, Section J.1 for more details on the Hazus earthquake modeling.

5.3.2 Erosion

5.3.2.1 Nature

Erosion rarely causes death or injury. However, erosion causes the destruction of property, development and infrastructure. Erosion is the wearing away, transportation, and movement of land. It is usually gradual but can occur rapidly as the result of floods, storms or other events, or slowly as the result of long-term environmental changes such as melting permafrost. Erosion is a natural process, but its effects can be exacerbated by human activity.

Coastal and riverine erosion are problems for communities where disappearing land threatens development and infrastructure. Riverine erosion is a major threat to the SBCFSA as it threatens SBCFSA residential structures and utilities.

Erosion is the wearing away of land resulting in embankment loss from natural processes or human activity or influences. It is measured as the rate of change in the position or horizontal displacement of a water-land interface over a period of time. Land loss is the most visible aspect of riverine erosion because of the dramatic change it causes.

Riverine erosion results from the force of flowing water and ice formations in and adjacent to river channels. This erosion affects the bed and banks of the channel and can alter or preclude any channel navigation or riverbank development. In less stable braided channel reaches, erosion, and material deposition are constant issues. In more stable meandering channels, erosion episodes may only occasionally occur.

Erosion rates may also change in different river systems due to climate change impacts. For example, increased precipitation or increased snow melt at certain times of the year could result in increased flood events or greater river flow-rates. These in-turn could have an impact on sediment supply within the river. All of these factors could contribute to greater erosion levels. In addition long-term human factors such as water table depletion or the construction of embankment protection structures could also have an impact on erosion levels.

Land surface erosion results from flowing water across road surfaces due to poor or improper drainage during rain and snowmelt run-off which typically result from fall and winter sea storms.

5.3.2.2 History

Several agencies such as the USACE, Alaska Railroad Corporation (ARRC), Alaska Department of Transportation and Public Facilities (DOT/PF), KPB, and the City of Seward have successfully implemented erosion control measures such as embankment armoring, groins, jetties, or revetments. However, several of these have failed for various reasons. It is imperative that more appropriate actions be taken to protect residential properties and essential infrastructure.

The USACE's Alaska Baseline Erosion Assessment, Erosion Information Paper – Seward, Alaska, July 17, 2008 defined the SBCFSA's erosion threat as:

> *"“Seward has continuous erosion associated with the glacially fed, swift-moving drainages from the mountains surrounding Resurrection Bay. The drainages carry glacial debris that is deposited in the streams and added to the alluvial fans at outlets (2005 Seward/Bear Creek Flood Service Area (SBCFSA) Flood Hazard Mitigation Plan). Glacial streams such as Lowell Creek, Spruce Creek, Fourth of July Creek, and Japanese (local: Japp) Creek erode avalanche and other debris in their courses. Channel migrations in alluvial fan areas, channel migrations in the wider floodplain drainages such as Resurrection River, and periodically heavy rainfall associated with storm events are other contributing factors to erosion…*

Residents in Lowell Point were isolated from Seward when an approximate 18-inch rainfall in 3 days during August 1986 eroded debris in Spruce Creek, washing out the bridge and a large portion of Lowell Point Road. A torrent of debris was sent down Spruce Creek when a 15-inch rainfall, combined with one of the highest tides of the year, resulted eroded Lowell Point Road and brought Spruce Creek closer to the sewage lagoon in October 2006. The Lowell Creek diversion tunnel outflow dumped a 25-foot high pile of debris and gravel on the Lowell Creek Bridge at Lowell Point Road, damaging the bridge and backing water into surrounding businesses and streets.

The alluvial fan area of Japanese Creek has seen increasing development in recent years and supports a number of schools, a military recreation center, several businesses, many private residences, the maximum-security Alaska Spring Creek Prison, several large commercial developments such as the Seward Marine Industrial Center Deep-Water Port Facility, and a future long term care center for the elderly. The city has diverted the river and constructed a levee along each side of the creek channel to protect these facilities. An interim Corps Flood Damage Reduction Reconnaissance Report stated the levees had reduced the active surface of the fan by 70 percent. The 2006 flood eroded the toe of a levee that had been constructed by the city along part of the channel to protect development; however damages have since been repaired" (USACE 2008).

5.3.2.3 Location, Extent, Impact, and Probability of Future Events

Location

The USACE 2008 SBCFSA erosion assessment provided comprehensive information describing the SBCFSA's erosion threat as well as photos depicting the deteriorating embankments which expose critical infrastructure.

Figures 5-5, 5-6, and 5-7 depict SBCFSA's erosion threatened areas.

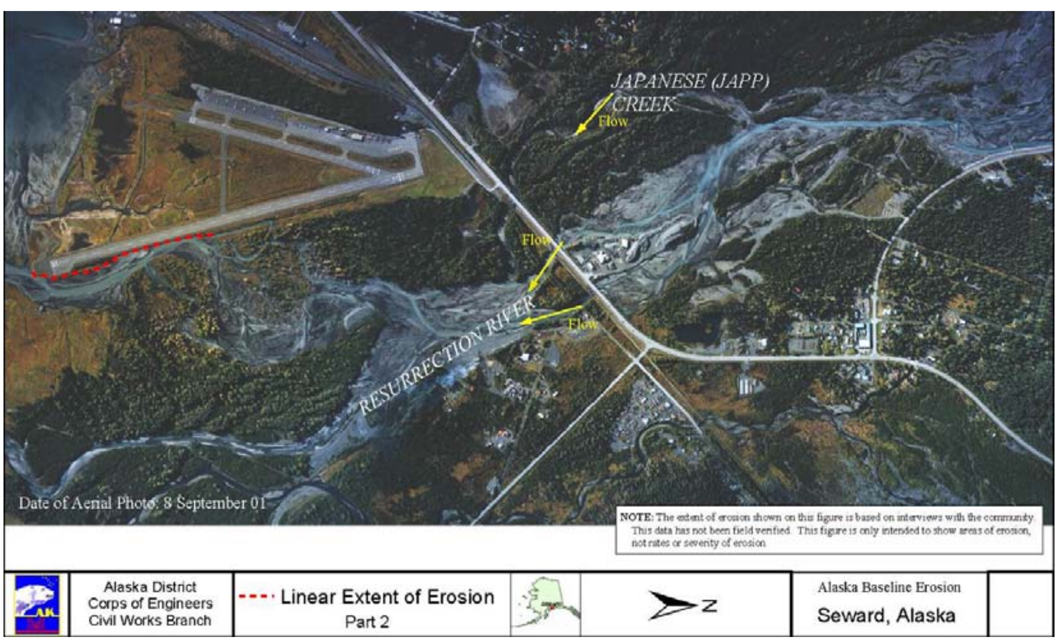


Figure 5-5 Seward Airport Erosion Map (USACE 2008)

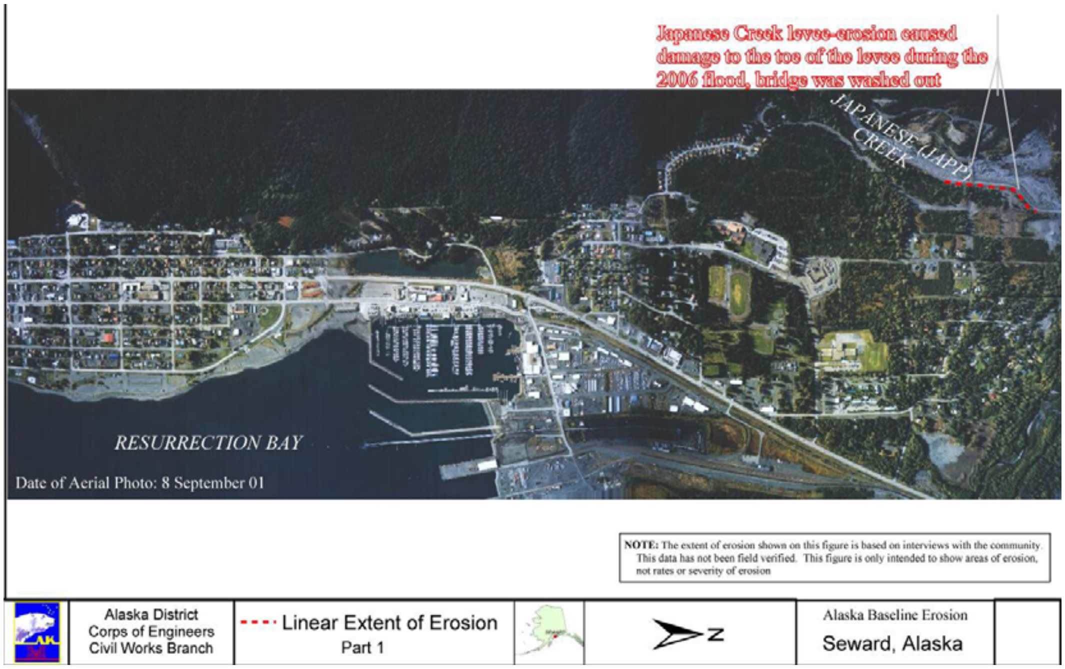


Figure 5-6 Japanese Creek Erosion Location Map (USACE 2008)

Figure 5-7 Seward Airport Erosion Map (USACE 2008)

Extent

A variety of natural and human-induced factors influence the erosion process within the community. River orientation and proximity to current forces can influence erosion rates.

Embankment composition also influences erosion rates, as sand and silt will erode easily, whereas boulders or large rocks are more erosion resistant. Other factors that may influence riverine erosion include:

- Embankment type
- Geomorphology
- Structure types along the embankment
- Embankment elevation
- Embankment exposure to wind and waves
- Infrastructure encroachment into the high hazard zone
- Proximity to erosion inducing riverine structures
- Coastal and riverine topography
- Development density

Climate change may also contribute to increasing riverine erosion. It is not expected that climate change will have much of a coastal erosion impact in the near future from sea level rise. Increased precipitation is projected, which could contribute to increased erosion. Similarly, projected temperature increases could contribute to seasonal snow and ice melt changes, and accelerate local glacier melt. This may result in additional run-off erosion from numerous glacially-fed streams.

See Appendix I for additional information on potential SBCFSA climate change effects.

Based on the SBCFSA's past erosion events, the USACE Erosion Assessment, and the criteria identified in Table 5-3, the magnitude and severity of erosion impacts in the SBCFSA are considered "Limited" with potential for critical facilities to be shut down for more than a week, and more than 10 percent of property or critical infrastructure being severely damaged.

Impact

Impacts from erosion include loss of land and any development on that land. Erosion can cause increased river delta sedimentation and hinder channel navigation – affecting marine transport. Other impacts include water quality reduction due to high sediment loads, native aquatic habitat losses, public utility damages (fuel headers and electric and water/wastewater utilities), and other economic impacts associated with the costs of trying to prevent or control erosion sites.

The USACE 2008 erosion assessment lists specific erosion areas (Figures 5-4, 5-5, and 5-6) and associated threats to the SBCFSA's, infrastructure:

> *"Lowell Point Road, the only road connection between Seward and Lowell Point, continues to be at risk from shoreline erosion and periodic erosion events associated with Spruce Creek and Lowell Creek. Sewer lines that follow the road and connect to the sewage lagoon south of the Spruce Creek Bridge are at risk if the eroding Spruce Creek channel moves closer. The levee at Japanese Creek and the airport runway are at risk during storm and flood events occur." (USACE 2008).*

Figure 5-8 depicts the SBCFSA's GIS based coastal and riverine erosion area proximity.

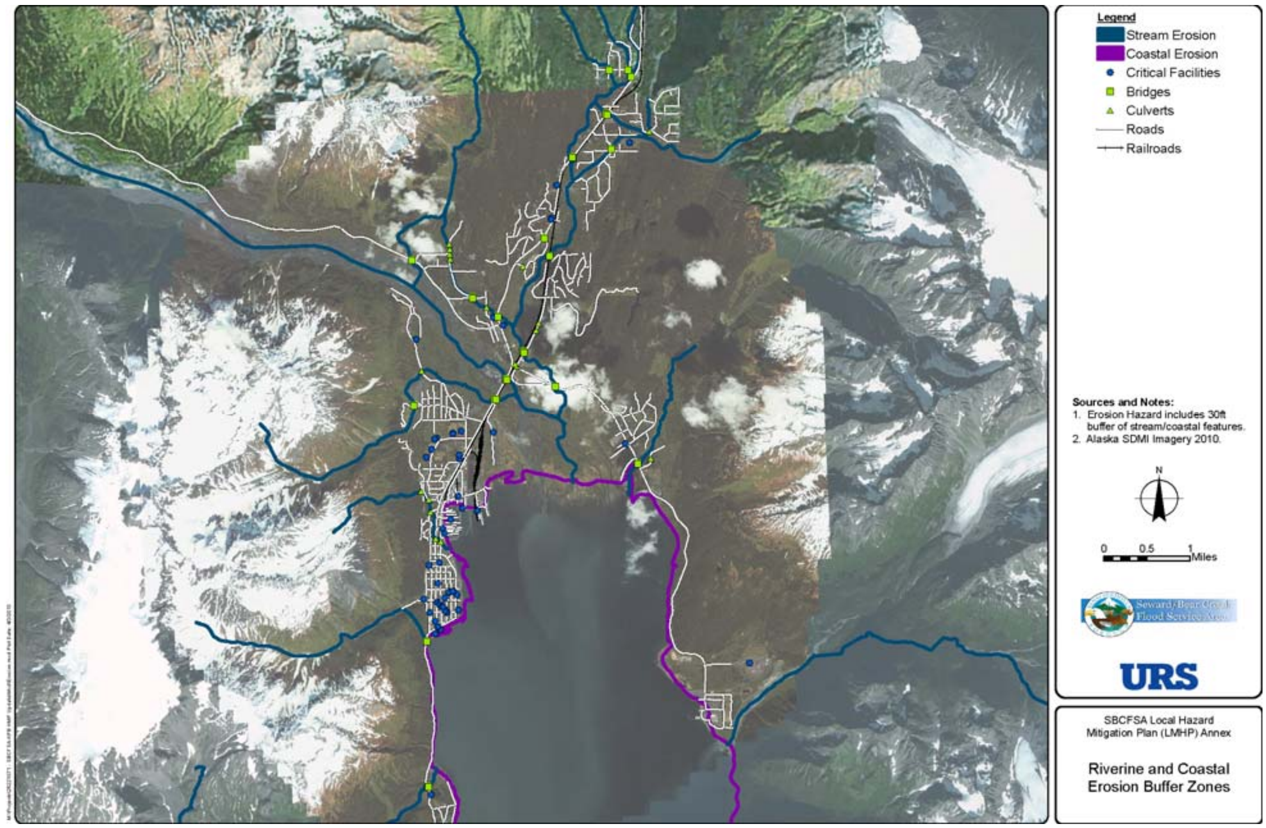


Figure 5-8 Coastal and Riverine Erosion Buffer Zone Map

Probability of Future Events

Based on historical impacts and future climate change projections, the USACE's erosion assessment, and the criteria identified in Table 5-2, it is "Likely" that erosion will occur in the next three years (event has up to 1 in 3 years chance of occurring) as the history of events is greater than 20 percent but less than or equal to 33 percent likely per year.

5.3.3 Flood

5.3.3.1 Nature

Flooding is the accumulation of water where usually none occurs or excess water overflows from a creek, stream, river, lake, reservoir, glacier, or coastal water body onto adjacent floodplains. Floodplains are lowlands adjacent to water bodies that are subject to recurring floods. Floods are natural events that are considered hazards only when people and property are affected.

A flood is the temporary inundation of water or mud on normally dry land. Heavy or prolonged rain, snowmelt, or dam collapse can cause inundation. Riverine and flash floods are the common flood event types affecting the SBCFSA.

Riverine flooding most frequently occurs in the late spring and fall, and is caused by storms that bring heavy rain and/or warm temperatures that produce rapid snowmelt on saturated or frozen ground. As storms move from the Pacific Ocean across the Alaska Coast, air rises and cools over the coastal ranges, and heavy rainfall develops over the high-elevation streams. As much as 15 inches of rain has fallen in the SBCFSA over a 24-hour period. Severe and prolonged storms can raise rivers and streams to their flood stages for 3 to 4 days or longer.

Flash floods typically originate from slow-moving storms that can generate immense rainfall volumes which rapidly raise water levels bursting levees and seeking new routes to lower ground. Flash floods quickly reach high velocities; often carrying debris. They can strike SBCFSA populated areas with little to no warning and may bring several feet of water. These events have moved small car-sized boulders, uprooted trees, destroyed structures and facilities, eroded roadways, swept away vehicles and created new water channels. The intensity of flash flooding is a function of rainfall intensity and duration, watershed steepness, stream gradients, watershed vegetation resistance, natural and artificial flood storage area capacities, and streambed and floodplain configuration. Urban areas are more vulnerable to flash flooding because of development, land clearing, drainage system construction, and open areas that allow water to move unobstructed; such as parking lots and ditches. Wildfires exacerbate flood and land slide conditions because wildfires alter soil conditions and remove essential landslide resistant vegetation.

Flood events not only impact communities with high water levels, or fast flowing waters, but sediment and debris transport also impacts infrastructure and limits river vessel access. Dredging may be the only option to maintain an infrastructure's viability and longevity.

Figure 5-9 Grouse Creek Debris Removal (URS 2012)

The four primary types of flooding that occur in the SBCFSA are rainfall-runoff, snowmelt, storm surge, and tsunami-seiche floods.

- **Rainfall-Runoff Flooding** occurs in late summer and early fall. The rainfall intensity, duration, distribution, and geomorphic characteristics of the watershed all play a role in determining the magnitude of the flood. Rainfall run-off flooding is the most common type of flood. This type of flood event generally results from weather systems that have associated prolonged rainfall.
- **Snowmelt Floods** typically occur from April through June. The depths of the snowpack and spring weather patterns influence the flooding magnitude.
- **Storm Surge,** or coastal floods, occurs when the sea is driven inland above the high-tide level onto land that is normally dry. Often, heavy surf conditions driven by high winds accompany a storm surge adding to the destructive-flooding water's force. The conditions that cause coastal floods also can cause significant shoreline erosion as the flood waters undercut roads and other structures. Storm surge is a leading cause of property damage in Alaska.

The meteorological parameters conducive to coastal flooding are low atmospheric pressure, strong winds (blowing directly onshore or along the shore with the shoreline to the right of the direction of the flow), and winds maintained from roughly the same direction over a long distance across the open ocean (fetch).

Communities that are situated on low-lying coastal lands with gradually sloping bathymetry near the shore and exposure to strong winds with a long fetch over the water are particularly susceptible to coastal flooding. Several locations along the Resurrection Bay (Lowell Point, City of Seward, and the SBCFSA) have experienced significant damage from coastal floods over the past several decades. Most coastal flooding occurs during the late summer or early fall season in these locations

- **Tsunami-Seiche** events are covered in Section 5.3.5.

Timing of Events

Many floods are predictable based on rainfall patterns. Most of the annual precipitation is received from April through October with August and September being the wettest. This rainfall leads to flooding in early/late summer and/or fall. Spring snowmelt increases runoff, which can cause flooding. It also breaks the winter ice cover, which causes localized stream and creek ice-jam floods.

5.3.3.2 History

The SBCFSA experiences severe damages from flooding caused by heavy rainfall, snowmelt, and spring run-off. Spring and fall season rain storms result in substantial run-off, subsequent debris accumulation and flooding, and significant damage throughout the service area. The airport, residential structures, businesses, and other community infrastructure have been damaged or destroyed by these events.

SBCFSA residences, which include those located in the City of Seward, are located on alluvial fan deposits which were developed from water run-off and debris transport from the surrounding watersheds. Seward has adopted the KPB Flood Insurance Rate Map.

According to the SBCFSA Planning Team, the area’s coastline is prone to severe storm surge and high winds that exacerbate rainfall flooding and erosion. The worst flooding events occur from complex storm events. The area has received extensive damaging flood impacts throughout its history. The Alaska State Legislature passed the 1977 Disaster Act which authorized the DHS&EM. DHS&EM then began tracking disaster damages which are reflected in the Disaster Cost Index from which the following is extracted:

> ***“13. Southcentral Alaska Rainstorm, July 22, 1981:*** *A torrential rainstorm resulted in widespread flooding, stream over flow and damage to bridges and culverts in South-central Alaska. This condition made travel hazardous throughout the region and in some cases roads were impassable to all traffic, including emergency vehicles. The Governor's Proclamation of a Disaster Emergency enabled DHS&EM to provide the affected communities with immediate recovery assistance, resulting in the restoration of the area's transportation system. No direct assistance was provided to individuals and families.*

56. Southcentral Alaska Flood (Major Disaster), October 12, 1986 FEMA declared (DR-0782) on October 27, 1986: *Record rainfall in South-central Alaska caused widespread flooding in Seward, Matanuska-Susitna Borough and Cordova. The President declared a Major disaster implementing all public and individual assistance programs, including [U.S. Small Business Administration] SBA disaster loans and disaster unemployment insurance benefits.*

100. Seward/Kenai Peninsula Borough, August 30, 1989: *This Declaration relates to the same storm and flooding incident that affected Anchorage. Primary area of damage was in the city of Seward. As in Anchorage, State disaster assistance was limited to public property damage, with SBA loans available for individuals and businesses.*

111. '89 Spring Floods Hazard Mitigation, April 14, 1990: *The Major Disaster Declaration by the President in response to statewide flooding in the Spring of 1989 authorized the commitment of federal funds to projects designed to mitigate flood damage in future years. Since the federal funding required a State matching share, the Governor declared a disaster to provide these funds and authorize their expenditure.*

124. Lowell Creek Tunnel, September 27, 1990: *A major rehabilitation of Lowell Creek Tunnel is required to insure continued protection of the City of Seward. This is a mitigation project.*

96-180 South-central Fall Floods declared September 21, 1995 by Governor Knowles then FEMA declared (DR-1072) on October 13, 1996: *On September 21, 1995, the Governor declared a disaster as a result of heavy rainfall in South-central Alaska an as a result the Kenai Peninsula Borough, Matanuska-Susitna Borough, and the Municipality of Anchorage were initially affected. On September 29, 1995, the Governor amended the original declaration to include Chugach, and the Copper River Regional Education Attendance areas, including the communities of Whittier and Cordova, and the Richardson, Copper River and Edgerton Highway areas which suffered severe damage to numerous personal residences, flooding, eroding of public roadways, destruction & significant damage to bridges, flood control dikes and levees, water and sewer facilities, power and harbor facilities. On October 13, 1995, the President declared this event as a major disaster (AK-1072-DR) under the Robert T. Stafford Disaster Relief and Emergency Assistance Act. Individual Assistance totaled $699K for 190 applicants. Public Assistance totaled $7.97 million for 21 applicants with 140 DSR's. Hazard Mitigation totaled $1.2 million. The total for this disaster is $10.5 million.*

03-202 Kenai Peninsula Borough Flooding (AK-DR-1445) Declared November 6, 2002 by Governor Knowles then FEMA Declared December 4, 2002. FEMA amended the Declaration to extend the incident period to December 20th: *Starting October 23, 2002 through November 12, 2002, heavy rains (from three inches to fifteen inches) caused widespread damage, school closures, road washouts and stranded residents & hunters throughout the Kenai Peninsula Borough, the Kodiak Borough and the Chignik Bay area, including Chignik Lake and Chignik Lagoon. The driving rain continued for an extended time frame with multiple storm fronts. Although damages were widespread, the Kenai Peninsula Borough received the most damages. Damages in the Kenai Peninsula Borough consisted of road washouts, culvert damages, bridge damage at several locations, and private home damages caused by overflowing rivers and streams. The Kodiak Borough damages included road washouts, culvert damages, river spike damage, and damages to a* *pier caused by sea surge. The Four Dam Pool Power Agency received damages to their facility. The Chignik Bay area, including Chignik Lake and Chignik Lagoon damage consisted of sea surge damage to docks and piers, damage a fuel of loading facility and dump truck, damage to a bridge in Chignik, and damage to the Department of Transportation-Chignik Lagoon Airport. The Kodiak Borough and Chignik Bay area also experienced private home damages. Federal Disaster Assistance for Individual Assistance, Debris Removal, Emergency Protective Measures and all categories of Permanent Work were provided under the Public Assistance Program. FEMA also authorized 404 Hazard Mitigation funding. Individual Assistance totaled $142K. Public Assistance totaled $16.6 million for 26 applicants with 118 PW's. Hazard Mitigation totaled $582K. The total for this disaster is $17.6 million.*

06-217 2006 South Central Storm (AK-06-217) declared March 13, 2006 by Governor Murkowski: *Beginning on February 5, 2006 and continuing through February 11, 2006, a series of strong winter storms with high winds, heavy snow, and freezing rain occurred in the City of Seward and surrounding areas of the Kenai Peninsula Borough in South Central Alaska, causing avalanches that severely damaged power lines and other infrastructures, blocked roads, and threatened further damages. As a result of the disaster, there was severe damage to power transmission and distribution lines supplying the City of Seward and surrounding areas; disruption of normal power supply requiring the prolonged use of emergency backup generators with extraordinary expensive operation costs; and damage and threat to public and private property as a result of power disruption. On March 13, 2006, a letter was submitted to request a federal time extension of 30 days. As of 3/20/06, the decision is pending. Decision made not to seek Federal assistance. Current estimated cost for repairs is $1,254,730; however, this does not include the ongoing cost of line repair. No federal declaration was sought; therefore, the State is limited to public assistance only (no HM or IA). As of 3/20/06, only the City of Seward and Sealife Center are applicants. Disaster administratively closed out and ltr to applicants on 6/29/07. (7 Nov 08 update)--Formal closeout letter to DMVA/DAS ws dated 6 Nov 08 (funds authorized = $1,465,321; funds expended =$1,306.509.72; funds lapsed to DFR = $158,811.28. (7Nov08, R.B.Stewart)*

07-221 2006 October Southern Alaska Storm (AK-07-221) declared October 14, 2006 by Governor Murkowski FEMA declared (DR-1669) on December 8, 2006: *Beginning on October 8, 2006 and continuing through October 13, 2006, a strong large area of low pressure that developed in the Northern Pacific and moved into the Southwest area of the state, produced hurricane force winds throughout much of the state and heavy rains in the Southcentral and Northern Gulf coast areas, which resulted in severe flooding and wind damage and threats to life in the Southern part of the state, to include the Kenai Peninsula Borough including the Cities of Seward and Seldovia, the Chugach Rural Education Area including the City of Cordova and the City of Valdez, and the Copper River Rural Education Area including the Richardson Highway to the Glennallen and highways and drainages in the McCarthy areas. Initial total damages are estimated at $557,415 with a public assistance estimate of $456,855. Federal declaration was made December 2006 including assistance for Public Assistance and Hazard Mitigation but not including Individual Assistance. Revised State of Alaska Cost estimates are $1,265,000 in Individual Assistance and $38,241,826 in Public Assistance for a total cost of $39,506,826. There is $26,825,918 available from the Federal Highway Administration leaving a requested amount of $13,948,999. A total of 10 individuals or households applied for assistance through the State's IA Temporary*

Housing program. Six eligible applicants received a total of $93,611.21 for home replacement, major repair and mitigation, and/or for temporary housing accommodations. Each TH applicant involved extensive case management. The temporary housing program closed 3/10/2008.

07-223 2007 January Kenai Ice Jam Flood, AK-07-223, issued March 02, 2007 by Governor Sarah Palin: *Beginning on January 25 and continuing through February 4, 2007, Skilak glacier-dammed lake breached releasing a four-foot high surge of water into the Kenai River that ultimately dislodged river ice, moved the ice rafts downriver and created ice jams as various points along the river. These ice rafts, some up to 4 feet thick and weighing several tons destroyed or damaged public and private riverbank fishing platforms, stairs, and elevated walkways as they moved downriver. Where ice jams formed, the water and ice rafts overtopped the riverbanks (some up to 15 feet high) and flooded several public campgrounds, fishing parks, and residential homes from the community of Sterling to the City of Soldotna, within the Kenai Peninsula Borough. Approximately 150 homes and riverside businesses in the City of Soldotna and in the Big Eddy, Poacher's Cove, and River Quest portions of the Kenai Borough reported damage to their buildings, fishing structures, and/or docks; another 775 home properties within the borough were also impacted by floodwaters or ice. Some of the damaged fishing platforms were specially designed for handicap access. A voluntary evacuation program was instituted in several areas. Some roads were inundated and impassable due to high water. Ice jams also threatened the temporary highway bridge at Soldotna when the water level rose to 20 feet; however, the water dropped before damage could occur to the bridge or embankment. Preceding the flooding, the National Weather Service issued flood warnings, watches and advisories.*

Confirmed damages occurred along the Kenai River in the Kenai Peninsula Borough, especially in the area of the City of Soldotna. Public infrastructure, commercial property, and personal property damages were reported in the metropolitan areas and the borough. The Division of Homeland Security and Emergency Management (DHS&EM) has received local disaster declarations from the City of Soldotna through the Kenai Peninsula Borough, requesting State disaster assistance; and from the Kenai Peninsula Borough, dated Feb 13, 2007, expanding the event date through February 5 and expanding the impacted area to include from Skilak Lake to the mouth of the Kenai River into the Cook Inlet. Due to the severity of the initial damage reports, the Governor inspected the flooding damage on February 3, 2007.

09-230, 2009 Seward Storm Surge declared by Governor Parnell on December 31, 2009: *On December 1, 2009 the City of Seward experienced a winter storm event that caused damage to the shoreline and an important roadway within the community. High winds, 3 plus inches of rainfall, and a 12.6 foot tide, caused extensive damage to the wave barrier along Lowell Point Road, the Seward Greenbelt area and the seawall at the Alaska Sea Life Center" (DHS&EM 2011).*

FEMA 4094-DR Alaska – Severe Storm, Straight-line Winds, Flooding, and Landslides

Federal Declaration November 27, 2012.

On November 5, 2012, Governor Sean Parnell requested a major disaster declaration due to a severe storm, straight-line winds, flooding, and landslides during the period of September 15-30, 2012. The Governor requested a declaration for Individual Assistance for Alaska Gateway Regional Educational Attendance Area (REAA), Kenai Peninsula Borough, and Matanuska Susitna Borough and Public Assistance for five boroughs and REAAs and Hazard

Mitigation statewide. During the period of October 11-27, 2012, joint federal, state, and local government Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below. PDAs estimate damages immediately after an event and are considered, along with several other factors, in determining whether a disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that Federal assistance is necessary.1

On November 27, 2012, President Obama declared that a major disaster exists in the State of Alaska. This declaration made Public Assistance requested by the Governor available to state and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by severe storm, straight-line winds, flooding, and landslides in the Alaska Gateway REAA, Chugach REAA, Denali Borough, Kenai Peninsula Borough, and the Matanuska Susitna Borough. This declaration also made Hazard Mitigation Grant Program assistance requested by the Governor available for hazard mitigation measures for all boroughs and REAAs in the State of Alaska.

The USACE Floodplain Manager does not provide any significant information for the SBCFSA on their website. They only list limited information for the City of Seward:

The City of Seward is a home rule city with a population of 3,010 as of October 2011. There are multiple river systems and the Resurrection Bay Coastal Area. The City is an active NFIP participant with an official flood study available through the FEMA Flood Map Store.

- *NFIP status is through the Kenai Peninsula Borough.*
- *Published FIRMs show detailed flood information.*
- *FIRMs can be purchased from Federal Emergency Management Agency's (FEMA) Map Service Center at: https://msc.fema.gov/webapp/wcs/stores/servlet/CategoryDisplay?catalogId=10001&storeId=10001&categoryId=12001&langId=-1&userType=G&type=1&future=false*

The SBCFSA experienced a severe flood event during September 19 through 23, 2012 causing severe damages throughout the area. The Governor requested and received a Federal Disaster Declaration on October 2012.

The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) website explains that the:

"…[Alaska Pacific River Forecast Center] APRFC provides operational hydrologic services for three Weather Forecast Offices located in Anchorage, Fairbanks, and Juneau. Operational products generated by the APRFC include flood forecasts, general river forecasts, recreational forecasts, navigation forecasts, reservoir inflow forecasts, water supply outlooks, spring flood outlooks, and various types of flash flood guidance. APRFC also provide hydrologic development support for both the Alaska and Pacific Regions. This includes a variety of other services, such as developing and implementing new procedures, forecast techniques, computer systems, data handling techniques, and hydrologic-related hardware. The APRFC also provides hydrologic expertise on a wide range of hydrologic activities for NWS and other federal, state, and local agencies" (APRFC 2012).

The Seward Bear Creek Flood Service Area, Flood Hazard Mitigation Plan, A Service Area of the Kenai Peninsula Borough, May 2010 provides the concise flood history. URS performed a field floodplain analysis during the September 2012 flood event. This information is included within Table 5-6.

Table 5-6 Representative Sampling of Historic Flood Events

Date	Watershed	Description
1903-1966	Lowell Creek	Lowell Creek flooding began to be recorded almost as soon as settlers arrived to begin building the railroad.
		1903 and 1917 photographs it is evident that Lowell Creek regularly demolished the center of town with floodwaters.
		1918 Another flood occurred before this project could be started.
		1930's Lowell Creek was diverted through an elevated flume.
		1935 flood was estimated that 10,000 cubic yards was deposited in the flume in 11 hours.
		1937 it was determined that the cost of maintaining the deteriorating flume was prohibitive.
		1939 Congress allocated funds to the Army Corps of Engineers to build the Lowell Creek Diversion Tunnel and Dam: original cost of $143, 929.00.
		1966 Flooding and landslides partially blocked the Lowell Creek Diversion Tunnel and water levels behind the diversion tunnel dam came within 2 feet of overtopping the dam.
	Resurrection River	Flooding is recorded on the Resurrection River in 1946 when the first recorded flooding of the airport occurred, as well as in 1961 and 1962.
1986	Entire SBCFSA	Rainstorm dropped ~18 inches of rain on the Kenai Peninsula from October 9 – 11. Landslides, landslide-dam failure, and resultant floods, debris flows, alluvial fan aggradations and flooding in and around Seward. Damages: ~ $20 million.
1989	Entire SBCFSA	Heavy rains from August 25 – 27 Damages: over $1,000,000 to homes, roads, bridges, and infrastructure.
1993	Entire SBCFSA	Heavy rains on August 26 caused Salmon Creek, Clear Creek and the Resurrection River to flood. Damage: Three homes, one business, and the Alaska Rail Road tracks.
1995	Entire SBCFSA	Typhoon Oscar generated rain from September 19 with about 9 inches of rain within a 24 hour period. Damages: • State authorities closed the Seward Highway from flood near Milepost 3. • The Alaska Railroad removed debris accumulated at their Seward Highway Milepost 4.8 bridge and replaced damaged bridge infrastructure. • Additional damages: the airport, sewage treatment facility, roads, trails, railroad facilities, power transmission lines and damage to dikes and levees and the Lowell Creek diversion tunnel. • Estimated flood damage was 9.8 million dollars. • A South Central Fall Flood Hazard Mitigation Grant

Table 5-6 Representative Sampling of Historic Flood Events

Date	Watershed	Description
		Program (HMGP) was $1,185,588, for bridge repair mitigation and $731,658 for a comprehensive flood mitigation project on the lower Resurrection River.
2002	Entire SBCFSA	Heaviest rainfall and most severe flooding occurred October 22 – 24. Damages: • Salmon Creek flooding severely affected Marathon View II subdivision, Whites, Sawmill and Camelot. • Infrastructure damaged included roads, Lowell Creek diversion tunnel, and the small boat harbor.
2006	Entire SBCFSA	High tides, warm temperatures, and typhoon remnants caused 9 – 15 inches of rain to fall on the Seward area. Damages: • Heavy rain contributed to the Seward Highway overtopping at Mile 4. • The Lowell Creek diversion tunnel outflow dumped a 15 foot high pile of debris and gravel on the bridge, damaging the bridge and backing water up into surrounding businesses and streets. • Alaska Sea-Life Center and Institute of Marine Science (IMS) received extensive damage: pump house was completely destroyed, • Shell Fish factory was flooded with water and gravel. • Power and water lines in the area were damaged. • Timber Lane Bridge damaged in Old Mill Subdivision • Forest Lane Bridge over Sometimes Creek was destroyed and replaced with two large culverts. • The loss of the bridge caused residents of Lowell Point to be cut off by road. • Water taxi's had to be pressed into service to help Lowell Point residents get to jobs and stores. • Families were evacuated from their homes in the Exit Glacier Road area, Old Mill Subdivision and around the Resurrection River highway bridges. • Japanese Creek levee, Box Canyon levee and Kwechak Creek levee were all damaged in the flooding as was the airport. • The Seward Highway was blocked by flooding at milepost 3.5 • Nash Road was blocked by flood waters. Portions of the airport runways were flooded. • A federal disaster was declared for this flood event.
2007	Entire SBCFSA	Flood occurred after steady rain and high ground water conditions. Damages: • Water to rise in Salmon Creek, Clear Creek, Sometimes Creek, and Lost Creek. • Flooding threatened property and infrastructure in these areas including Salmon Creek Road, Nash Road, the Timber Lane Bridge, and the new bridge that had replaced the temporary culverts under Forest Road across Sometimes Creek. • The KPB Office of Emergency Management (OEM) instituted Emergency dredging and bank restoration on

Table 5-6 Representative Sampling of Historic Flood Events

Date	Watershed	Description
		Salmon Creek. • SBCFSA obtaining permits and private property owner waivers. • KPB appealed directly to Governor Palin, for DNR to allow a short-term limited area exemption from the material sale fee. • KPB contracted for emergency dredging and bank repair above and below Timber Lane Bridge. • SBCFSA contracted dredging and bank repair project extending further north on Lost Creek.
2009	Entire SBCFSA	Flooding on July 29 – heavy rains, 3.3 inches in 24 hours. Damages: ***City of Seward:*** • Lowell Point Road – closed at the bridge due to debris piled up on the roadway. • Several landslides on Lowell Point Road. Storm surge damaged Lowell Point Road and the small board harbor, waterfront adjacent to the Alaska Sea-life Center, IMS, and the Shell Fish factory. • Seward Airport runway 13/31 closed – water on the runway. • Dimond Boulevard closed – water across the road. ***Outside City Limits*** • Exit Glacier Road closed – water across the road and up to the bottom of Exit Glacier Bridge. • Box Canyon Creek landslides caused Surge release flooding threatened homes in the Old Exit Glacier Subdivision; levee needed emergency restoration. • Bear Creek Fire Department went door-to-door warning residents of flood threat. • Old Mill Subdivision reported – water across the road and the bridge at Sometimes Creek threatening to wash out. • Flooding was reported on low lying properties on Clear Creek. • Kwechak Creek Levee emergency repairs – damaged from surge release flooding. • Local and borough emergency declarations were made. Emergency crews worked during and after the flooding on Lowell Creek Bridge, Box Canyon Levee and Upper Kwechak Levee.
2012	Entire SBCFSA	Flooding on September 19 – 30, heavy rains, 9 inches in one 24 hour period.

(FEMA 2012, NWS 2011, USACE 2011, DHS&EM 2010)

Location

The September 21, 2012 Fall Rainstorm event caused severe flooding throughout the SBCFSA. The following figures (5-10, 5-11, and 5-12) depict how debris-laden streams can impact the community; creating debris removal challenges.

Figure 5-10 Lowell Creek Tunnel Debris Laden Outfall (URS 2012)

Figure 5-11 Lowell Creek Bridge During High Water Flow – 9/18/2012 (URS 2012)

Figure 5-12 Lowell Creek Bridge Covered - 9/20/2012 (URS 2012)

Figure 5-13 depicts Keen Eye Photography's aerial photo (provided by the SBCFSA) of the 2012 flood impacts adjacent to, and north of, the Nash Road/Seward Highway intersection.

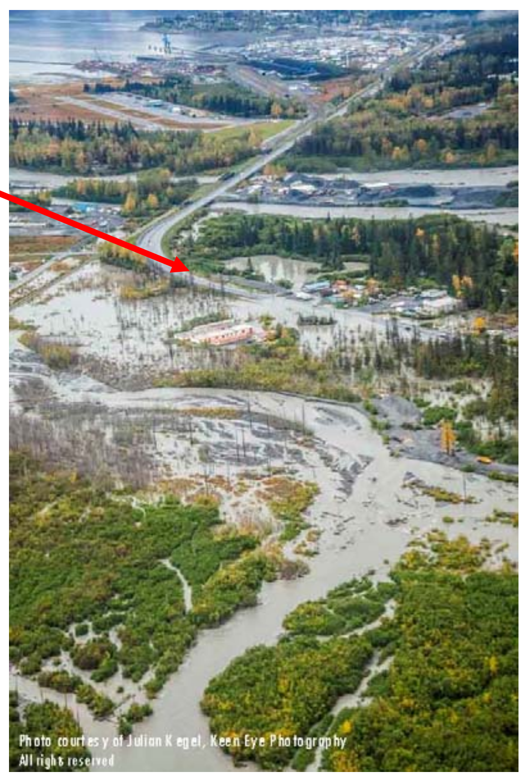


Figure 5-13 Seward Highway Flooding (SBCFSA 2012)

The USACE, Floodplain Management Flood Hazard Data report describes the location of their high water elevation (HWE) markers and flood gages:

> *"High Water Elevation (HWE) signs were placed at the water level of the 1964 flood, which represents the BFE. HWE #1 is on a utility pole approximately 150 yards shoreward and downstream of the elementary school. HWE #2 is on the streamward, upstream side of the preschool building. HWE #3 is on the streamward, upstream corner of the SBCFSA generator building. The 1985 flood depth was reported to be approximately 2 ft." (USACE 2011).*

Extent

Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence.

The following factors contribute to riverine flooding frequency and severity:

- Rainfall intensity and duration.
- Antecedent moisture conditions.
- Watershed conditions, including terrain steepness, soil types, amount, vegetation type, and development density.
- The attenuating feature existence in the watershed, including natural features such as swamps and lakes and human-built features such as dams.
- The flood control feature existence, such as levees and flood control channels.
- Flow velocity.
- Availability of sediment for transport, and the bed and embankment watercourse erodibility.
- SBCFSA location related to the base flood elevation as indicated with their certified high water mark.

The following factors contribute to the coastal flooding frequency and severity:

- Astronomical tides
- Storm surge - the rise in water from wind stress and low atmospheric pressure
- Waves
- Peak still-water elevation

The SBCFSA population and infrastructure receives repetitive and destructive flood impacts from several watersheds. Figure 5-14 depicts the SBCFSA watersheds. The City of Seward and the surrounding area's road system is lightly depicted demonstrating the potential impact on the City and the roadways from uncontrolled flood events.

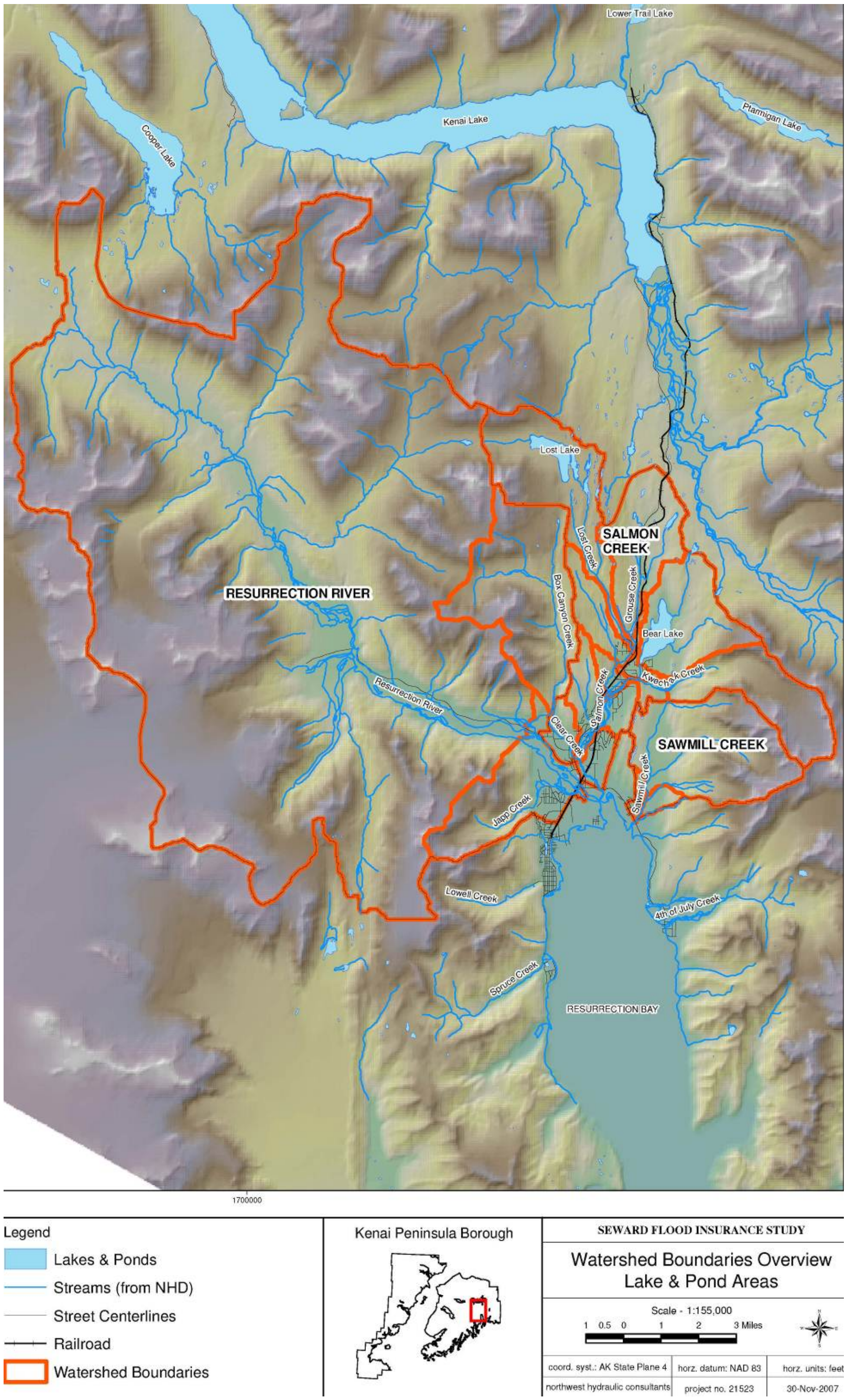


Figure 5-14 SBCFSA Watershed Boundaries (FEMA 2007)

Based on the extensive history of previous occurrence impacts and their widespread impact areas, FEMA's Flood Insurance Studies, Flood Insurance Rate Maps, URS Hazus modeling, and criteria in Table 5-2.

The threat extent is classified as "Limited" where injuries or illnesses do not result in permanent disability, complete shutdown of critical facilities could last for more than one week, and more than ten percent of property is severely damaged.

Impact

Nationwide, floods result in more deaths than any other natural hazard. Physical damage from floods includes the following:

- Structure flood inundation, causing water damage to structural elements and contents.
- Erosion or scouring of stream banks, roadway embankments, foundations, footings for bridge piers, and other features.
- Damage to structures, roads, bridges, culverts, and other features from high-velocity flow and debris carried by floodwaters. Such debris may also accumulate on bridge piers and in culverts, increasing loads on these features or causing overtopping or backwater damages.
- Sewage and hazardous or toxic materials release as wastewater treatment plants or sewage lagoons are inundated, storage tanks are damaged, and pipelines are severed.

Floods also result in economic losses through business and government facility closure, communications, utility (such as water and sewer), and transportation services disruptions. Floods result in excessive expenditures for emergency response, and generally disrupt the normal function of a community. The 2007 KPB Economic Development Plan states, the SBCFSA's economic losses for real property ($315,610,200) and personal property ($24,226,960) for the service area could total approximately $339,837,130.

Impacts and problems also related to flooding are deposition and stream bank erosion (erosion is discussed in detail in Section 5.3.2). Deposition is the accumulation of soil, silt, and other particles on a river bottom or delta. Deposition leads to the destruction of fish habitat, presents daily challenges and access to residential areas. Deposition also reduces channel capacity, resulting in increased flooding or bank erosion (BKP 1988).

The impacts of climate change on the Kenai Peninsula area will affect future flood event recurrence probability, as well as future flood event severity, in the SBCFSA. Precipitation and temperature both have an impact on flooding, especially in glacially-fed watershed systems, such as those in the SBCFSA, where glacial melt and high altitude snowmelt influence seasonal flooding. Therefore, predicted changes in precipitation and temperature will influence probability and severity of flooding. Based on future climate change scenarios, the SBCFSA is projected to experience an increase in total annual precipitation, and also an increase in the average annual temperature. Both of these impacts will have an effect on the frequency and severity of flood events within the SBCFSA and surrounding areas. Additional information related to climate change analysis is discussed in Appendix I.

The analysis of both riverine and coastal flood hazards for current conditions and future conditions due to climate change was conducted using the FEMA Hazus model (version 2.1). Coastal flood analysis was completed based on the velocity flood zones shown on the KPB FEMA FIRMs. Riverine flood analysis was completed for the 10-, 50-, 100-, and 500-year flood events on each of the streams affecting the SBCFSA for both current and future climate change conditions. See Appendix J, Section J.2 for more details on the flood hazard modeling, and Appendix I for additional information on the climate change scenarios used for the modeling.

Probability of Future Events

Climate change impacts to the Kenai Peninsula area will affect the future flood event recurrence probability, as well as future flood event severity for the SBCFSA. Precipitation and temperature both impact flood severity, especially in glacially fed watershed systems, such as those in the SBCFSA, where glacial melt and high altitude snowmelt influence seasonal flooding. Therefore, predicted changes in precipitation and temperature will influence probability and severity of flooding.

Similarly, sea level rise and accompanying storm surge changes resulting from climate change would potentially exacerbate coastal flooding impacts.

Based on previous occurrences, USACE Floodplain Manager's area threat assessment, and criteria in Table 5-2, it is "Highly Likely" a damaging flood will occur in the SBCFSA, as there is a 1 in 1 year chance of occurring (1/1=100 percent) based on a history of events demonstrating a greater than 33-percent recurrence per year.

However, based on Hazus analysis, future climate change influenced weather patterns could potentially increase the 100-year flood recurrence probability to a more frequent 50-year event equivalent by the year 2050.

5.3.4 Ground Failure (Avalanche, Landslide, Permafrost, Subsidence, Unstable Soils)

5.3.4.1 Nature

Ground failure describes gravitational soil movement. Soil movement influences can include rain snow and/or water saturation, seismic activity, melting permafrost, river or coastal embankment undercutting, or a combination of conditions on steep slopes.

Ground failures include dislodgment and fall of a mass of soil or rocks along a sloped surface, or for the dislodged mass itself. The term is used for varying phenomena, including mudflows, mudslides, debris flows, rock falls, rockslides, debris avalanches, debris slides, and slump-earth flows. The susceptibility of hillside and mountainous areas to landslides depends on variations in geology, topography, vegetation, and weather. Landslides may also be triggered or exacerbated by indiscriminate development of sloping ground, or the creation of cut-and-fill slopes in areas of unstable or inadequately stable geologic conditions.

Additionally, ground failure events often occur with other natural hazards, thereby exacerbating conditions, such as:

- Avalanches, the damage amount directly relates to the slide size, avalanche type, the material composition and consistency, the flow's force and velocity, and the avalanche path.
- Earthquake ground movement can trigger events ranging from rock falls and topples to massive slides.
- Intense or prolonged precipitation that causes flooding can also saturate slopes and cause failures leading to landslides.
- Wildfires can remove vegetation from hillsides significantly increasing runoff and landslide potential.

Development, construction, and other human activities can also provoke ground failure events. Increased runoff, excavation in hillsides, shocks and vibrations from construction, non-engineered fill places excess load to the top of slopes, and changes in vegetation from fire, timber harvesting and land clearing have all led to landslide events. Broken underground water mains can also saturate soil and destabilize slopes, initiating slides. Something as simple as a blocked culvert can increase and alter water flow, thereby increasing the potential for a landslide event in an area with high natural risk. Weathering and decomposition of geologic material, and alterations in flow of surface or ground water can further increase the potential for landslides.

The USGS identifies nine landslide types, distinguished by material type and movement mechanism including:

- **Complex** is any combination of landslide types.
- **Cornice Collapse** is an overhanging snow mass formed by wind blowing snow over a ridge crest or the sides of a gully. The cornice can break off and trigger bigger snow avalanches when it hits the wind-loaded snow pillow.
- **Debris Flows** arise from saturated material that generally moves rapidly down a slope. A debris flow usually mobilizes from other types of landslide on a steep slope, then flows through confined channels, liquefying and gaining speed. Debris flows can travel at speeds of more than 35 miles-per-hour (mph) for several miles. Other types of flows include debris avalanches, mudflows, creeps, earth flows, debris flows, and lahars.
- **Falls** are the free-fall movement of rocks and boulders detached from steep slopes or cliffs.
- **Ice Fall Avalanches** result from the sudden fall of broken glacier ice down a steep slope. They can be unpredictable as it is hard to know when ice falls are imminent. Despite common belief, they are unrelated to temperature, time of day or other typical avalanche factors.
- **Lateral Spreads** are a type of landslide generally occurs on gentle slope or flat terrain. Lateral spreads are characterized by liquefaction of fine-grained soils. The event is typically triggered by an earthquake or human-caused rapid ground motion.
- **Slab Avalanches** are the most dangerous types of avalanches. They happen when a mass of cohesive snow breaks away and travels down the mountainside. Slab avalanches occur

as a result of the presence of structural weaknesses within interfacing layers of the snowpack.

- **Slides,** the more accurate and restrictive use of the term landslide, refers to a mass movement of material, originating from a discrete weakness area that slides from stable underlying material. A *rotational slide* occurs when there is movement along a concave surface; a *translational slide* originates from movement along a flat surface.
- **Topples** are rocks and boulders that rotate forward and may become falls.

In Alaska, earthquakes, seasonally frozen ground, and permafrost are often agents of ground failure. Permafrost is defined as soil, sand, gravel, or bedrock that has remained below 32°F for two or more years. Permafrost can exist as massive ice wedges and lenses in poorly drained soils or as relatively dry matrix in well-drained gravel or bedrock. During the summer, the surficial soil material thaws to a depth of a few feet, but the underlying frozen materials prevent drainage. The surficial material that is subject to annual freezing and thawing is referred to as the “active layer”. Except for a few areas in the high alpine areas, the Seward area is free from permafrost (KPB, 2008).

- **Permafrost melting (or degradation)** occurs naturally as a result of climate change, although this is usually a very gradual process spread out over many years. In more northern parts of Alaska, where permafrost is more prevalent, the current increased rate of climate change is causing permafrost to melt leading to problems with the subsidence of land beneath infrastructure including roads, pipelines, and buildings. Thermokarst is the process by which characteristic land forms result from the melting of ice-rich permafrost. As a result of thermokarst, subsidence often creates depressions that fill with melt water, producing water bodies referred to as thermokarst lakes or thaw lakes.

Human induced ground warming can often degrade permafrost much faster than natural degradation caused by a warming climate. Permafrost degradation can be caused by constructing warm structures on the ground surface allowing heat transfer to the underlying ground. Under this scenario, improperly designed and constructed structures can settle as the ground subsides, resulting in loss of the structure or expensive repairs. Permafrost is also degraded by damaging the insulating vegetative ground cover, allowing the summer thaw to extend deeper into the soil causing subsidence of ice-rich permafrost, often leading to creation of thermokarst water bodies. Evidence of this type of degradation can be seen where thermokarst water bodies are abundant in the ruts of an old trail used by heavy equipment (cat trails) or where roads or railroads constructed by clearing and grubbing have settled unevenly. (Subsidence, liquefaction, and surface faulting are described in Section 5.3.1.1).

Seasonal freezing can cause frost heaves and frost jacking. Frost heaves occur when ice forms in the ground and separates sediment pores, causing ground displacement. Frost jacking causes unheated structures to move upwards. Permafrost is frozen ground in which a naturally occurring temperature below 32ºF has existed for two or more years. Permafrost can form a stable foundation if kept frozen but when thawed; the soil weakens and can fail. Approximately 85 percent of Alaska is underlain by continuous or discontinuous permafrost (DHS&EM 2010).

Indicators of a possible ground failure include:

- Springs, seeps, or wet ground that is not typically wet
- New cracks or bulges in the ground or pavement
- Soil subsiding from a foundation
- Secondary structures (decks, patios) tilting or moving away from main structures
- Broken water line or other underground utility
- Leaning structures that were previously straight
- Offset fence lines
- Sunken or dropped-down road beds
- Rapid increase in stream levels, sometimes with increased turbidity
- Rapid decrease in stream levels even though it is raining or has recently stopped and
- Sticking doors and windows, visible spaces indicating frames out of plumb

The State of Alaska 2010 State Hazard Mitigation Plan provides additional ground failure information defining mass movement types, topographic and geologic factors which influence ground failure which pertain to SBCFSA.

5.3.4.2 History

There are few written records defining ground failure impacts however, the 2005 City of Seward Comprehensive Plan provides some insight into this hazard's threat potential:

> ***3.8.3 Steep Slopes, Avalanche and Landslide Areas***
>
> *Steep slopes, which may be susceptible to avalanches and landslides, occur on the edge of town west of First Avenue, on the west side of Resurrection Bay along Lowell Point Road, the eastern section of Nash Road as it goes up the hill toward the Fourth of July Creek area. Based on recent experience in towns like Cordova which has experienced damage from avalanches, the potential for avalanche/landslide hazards to develop in areas of steep slopes should be analyzed.*
>
> ***3.8.4 Saturated Soils***
>
> *Areas where soils are saturated with water or where the groundwater is high can create problems with foundations, water damage to structures, and cause on-site sewage disposals to malfunction. These areas are often found adjacent to rivers, lakes, and coastal areas and are classified as wetlands by the USACE. Areas classified as wetlands may be subject to development restrictions.*
>
> *The major categories of wetland types that have been mapped for the Seward area by the National Wetlands Inventory (NWI) include estuarine, bogs and muskegs (formally palustrine) and riverine areas. Areas that have been identified as seasonally or temporarily flooded have also been mapped. These areas have certain functions and values with regard to habitat, flood and erosion mitigation, and human use other than development. The functions and values have both practical and regulatory implications for use and management of public and private lands, including the following:*

- *Estuarine and riverine areas are likely to be considered for a variety of functions by state and federal regulatory agencies, which require permits for development in these areas.*
- *Areas of high habitat function and value support species of recreational and commercial importance to Seward (such as salmon); development impacts to these areas will be scrutinized by permitting agencies. Development of public lands with habitat value should be carefully evaluated.*
- *Areas of high function and value for flood and erosion protection help mitigate potential property damage from these hazards; their development, however, can increase damage to other properties, and require carefully evaluation.*

Summary of Planning Issues and Trends

- *Because of the limited amount of land in the city and because of the desirability of waterfront property, pressure to use the waterfront for higher density development continues. The high seismic risk calls for continued restriction by zoning and implementation of safety codes that promote low density development.*
- *Tsunamis readiness is compromised by not having local, continuous 24-hour earthquake monitoring.*
- *The following flood dangers exist:*
  - *The Lowell Creek Diversion Tunnel could in times of high water clog up or collapse, resulting in flooding of several Lowell Canyon homes and the hospital.*
  - *The stream at Lowell Point being susceptible to landslides can lead to road closures and flooding.*
  - *The dike next to the water tank could breach from high velocities of Japanese Creek, flooding Seward Resort and Forest Acres.*
  - *Resurrection River channel problems can lead to airport erosion and potential flood problems for roads and structures in the industrial ar*ea as occurred in the 1995 flood.
  - *Mile Two streams can clog up and flood roads, damaging them.*
  - *Potential for a flash flood from the breaching of the dike at Fourth of July Creek could endanger lives at Spring Creek Correctional Center and/or community security.*
  - *Some subdivisions, because of the way buildings are sited and spaced, are vulnerable to flooding.*
- *Construction has begun on steep slopes and cliff areas without a good analysis of the stability of soils and of the potential for avalanche and landslide hazards.*
- *Problems with foundations, water damage to structures, and possible malfunction of on-site sewage disposals due to saturated soils are ongoing home owner problems.*

5.3.4.3 Location, Extent, Impact, and Probability of Future Events

Location

The SBCFSA stated the surround area does not possess permafrost which is validated by the City of Seward's Comprehensive Plan which describes their potential ground failure locations but no permafrost concerns:

> *"Steep slopes, which may be susceptible to avalanches and landslides, occur on the edge of town west of First Avenue, on the west side of Resurrection Bay along Lowell Point Road, the eastern section of Nash Road as it goes up the hill toward the Fourth of July Creek area" (Seward 2005)*

According to Permafrost Zones map (Figure 5-15) developed for the National Snow and Ice Data Center/World Data Center for Glaciology (NSIDC 2002), along with the SBCFSA's Comprehensive Plan, and comments received from the Planning Team, the SBCFSA has substantiated that no permafrost laden soils exist within the SBCFSA.

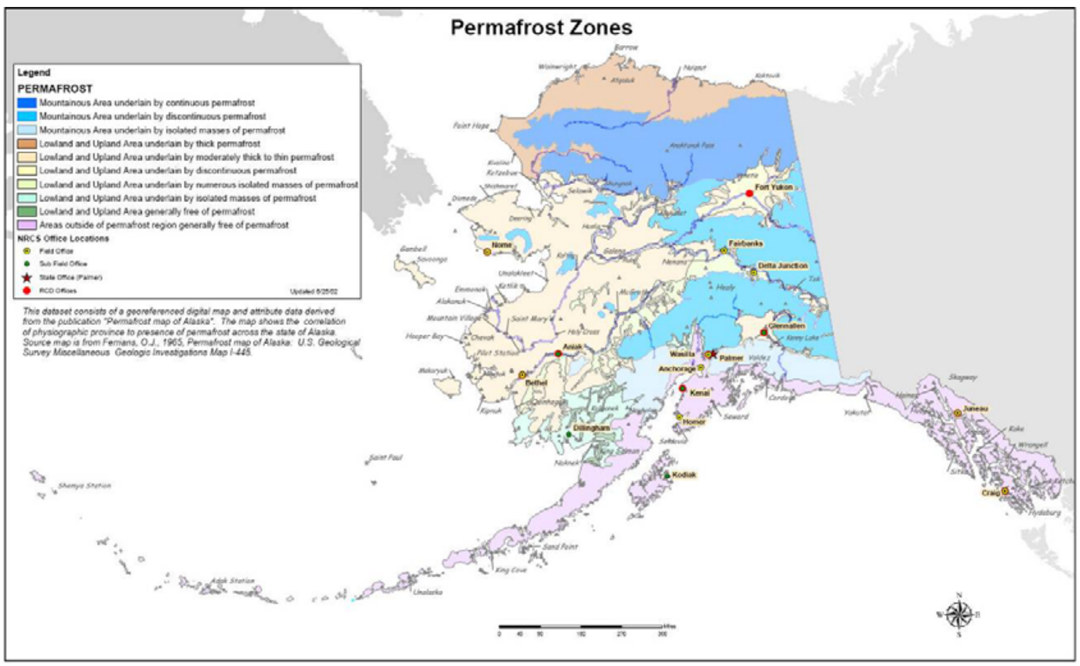


Figure 5-15 Permafrost Map of Alaska (NSIDC 2002)

Figure 5-16 depicts slope angle degrees as an indicator of snow avalanche or landslide potential.

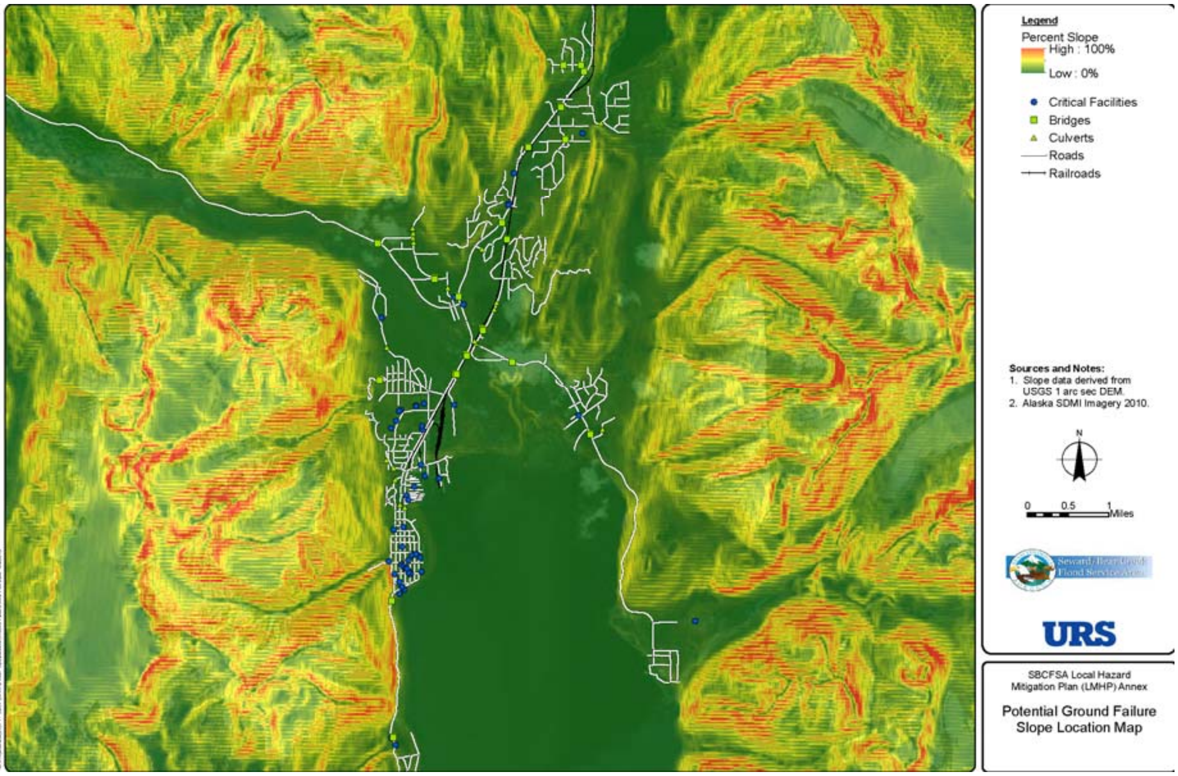


Figure 5-16 **SBCFSA Slope Failure Potential** (URS 2012)

Extent

The damage magnitude for ground failure could range from minor with some repairs required and little to no damage to transportation, infrastructure, or the economy; to major damage if a critical facility (such as the airport) were damaged and transportation was effected.

Based on research and the Planning Team's knowledge of past ground failure and permafrost degradation events and the criteria identified in Table 5-3, the extent of ground failure impacts in the SBCFSA are considered "Negligible" impacts would occur mainly from avalanches or landslides resulting from water saturated soils with little to no warning. This hazard could potentially cause injuries or death, however, neither would shut-down critical facilities nor cause major service interruptions for much more than 24 hours; less than 10 percent of property would be damaged by ground failure events; and minor quality of life would be lost.

Impact

Not all ground failure events pose a sudden and catastrophic hazard. For example, permafrost does not pose a threat to the SBCFSA. Impacts associated with SBCFSA associated ground failure events include damages to infrastructure, buildings, and transportation interruptions from avalanches, landslides, and surface subsidence. To avoid costly damage to these facilities, careful planning and location and facility construction design is warranted.

The Planning Team stated that the Lowell Point Road, the Seward Highway at mile 21, and the airport runway may be susceptible to avalanche, landslide, or subsidence from some form of ground failure impacts.

Probability of Future Events

There are few written records defining ground failure impacts for the SBCFSA, the Planning Team states that they have experienced significant avalanches and minor landslides which disrupt transportation for short durations.

The Planning Team further stated the probability for ground failure recurring follows the criteria in Table 5-2, the probability of future damage resulting from ground failure is probable within the next three years. Events are “Likely” to occur (event has up to 1 in 3 years chance of occurring) as the history of events is greater than 20 percent but less than 33percent likely per year (SBCFSA 2012).

As discussed in Appendix I, future climate change scenarios project both an increase in total annual precipitation, as well as an increase in average annual temperature within the SBCFSA and surrounding areas. As a result, there is an increasing likelihood that local and regional glacier melt rate – already well documented (e.g., NPS, Tuttle 2011), as well as snow and ice melt in high altitudes, will accelerate. This could potentially impact the occurrence of future avalanches and other landslide-type events in the SBCFSA.

Appendix I further discusses climate change scenarios and potential resulting impact considerations.

5.3.5 Tsunami and Seiche

5.3.5.1 Nature

A tsunami is a series of waves generated in a body of water by an impulsive disturbance along the seafloor that vertically displaces the water. A seiche is an oscillating wave occurring within a partially or totally enclosed water body.

Subduction zone earthquakes at plate boundaries often cause tsunamis. However, submarine landslides, submarine volcanic eruptions, and the collapses of volcanic edifices can also generate tsunamis. A single tsunami may involve a series of waves, known as a train, of varying heights. In open water, tsunamis exhibit long wave periods (up to several hours) and wavelengths that can extend up to several hundred miles, unlike typical wind-generated swells on the ocean, which might have a period of about 10 seconds and a wavelength of 300 feet.

The actual height of a tsunami wave in open water is generally only 1 to 3 feet and is often practically unnoticeable to people on ships. The energy of a tsunami passes through the entire water column to the seabed. Tsunami waves may travel across the ocean at speeds up to 700 miles per hour (mph). As the wave approaches land, the sea shallows and the wave no longer travels as quickly, so the wave begins to “pile up” as the wave-front becomes steeper and taller, and less distance occurs between crests. Therefore, the wave can increase to a height of 90 feet or more as it approaches the coastline and compresses.

Tsunamis not only affect beaches that are open to the ocean, but also bay mouths, tidal flats, and the shores of large coastal rivers. Tsunami waves can also diffract around land masses and islands. Since tsunamis are not symmetrical, the waves may be much stronger in one direction than another, depending on the nature of the source and the surrounding geography. However, tsunamis do propagate outward from their source, so coasts in the shadow of affected land masses are usually fairly safe.

Local tsunamis and seiches may be generated from earthquakes, underwater landslides, atmospheric disturbances, or avalanches and last from a few minutes to a few hours. Initial waves typically occur quite soon after onslaught, with very little advance warning. They occur more in Alaska than any other part of the US.

Seiches occur within an enclosed water body such as a lake, harbor, cove or bay. They are locally event generated waves characterized as a "bathtub effect" where successive water waves move back and forth within the enclosed area until the energy is fully spent causing repeated impacts and damages.

5.3.5.2 History

The SBCFSA has received prior tsunami impacts. Most notable are the catastrophic 1964, Good Friday Earthquake induced distant and locally generated tsunamis. Tsunamis affecting the SBCFSA occur infrequently. The SBCFSA 2010 FHMP states,

> *"Alaska has the greatest tsunami potential in the entire United States. Historic tsunamis generated by earthquakes on the Alaska-Aleutian subduction zone have resulted in widespread damage and loss of life along the Alaskan Pacific coast and other places located at exposed locations around the Pacific Ocean. Large seismic events occurring in the vicinity of the Alaska Peninsula, Aleutian Islands, and Gulf of Alaska have a very high potential for generating both local and Pacific-wide tsunamis[within Resurrection Bay]…*
>
> *In 1964 south central Alaska experienced the strongest earthquake ever recorded in North America, its strength estimated at 9.1 on the Richter Scale. The resulting tsunami in Resurrection Bay inundated and destroyed 300 feet by 3500 feet of the Seward waterfront including the San Juan Army and railroad docks, the tracks leading to the dock, the oil tank farms, fish processors, warehouses and the small boat harbor. The economic loss, particularly to Seward's port facilities resulted in the destruction of 90% of Seward's economy…*
>
> *… Seward's mayor at that time knew firsthand of the disastrous effects of tsunamis, because he lived through the 1964 tsunamis as a young boy. During the Great Alaskan Earthquake, a section of Seward's waterfront slid into the bay triggering a series of tsunamis that inundated the community a mere 20 minutes later. Twelve people were killed and the destruction was extensive — 14 million dollars (in 1964 dollars)" (SBCFSA 2010).*

5.3.5.3 Location, Extent, Impact, and Probability of Future Events

Location

The State of Alaska, the University of Alaska Fairbanks, Geophysical Institute (UAF/GI), and the West Coast/Alaska Tsunami Warning Center (WC/ATWC) indicate the SBCFSA has a significant tsunami impact threat.

An excerpt from the Report of Investigations 2010-1, Tsunami Inundation Maps of Seward and Northern Resurrection Bay, Alaska, by E.N. Suleimani et al. states:

> *"At the time of the 1964 earthquake, the economy of Seward was based on shipping, and was heavily dependent on the city's railroad, harbor, and port operations. Seward was severely impacted by the 1964 earthquake and tsunami waves. The loss of harbor*

facilities from the earthquake and resultant offshore slope failures near the Seward waterfront devastated the economic base of the town (Lemke, 1967)…

Seward is built mostly on the alluvial fan of Lowell Creek. Lowell Point, Tonsina Point, and the area at the mouth of Fourth of July Creek (fi g. 4) are also alluvial fans that extend into the bay as fan deltas (Lemke, 1967). The entire head of Resurrection Bay is a fjord-head delta, formed by Resurrection River. Haeussler and others (2007) use the term 'bathtub' to describe a fl at depression in the middle of the bay extending north to south (fi g. 4). The deepest part of the bathtub is approximately 300 m below sea level. Prior to the 1964 earthquake, the average offshore slopes in the vicinity of Seward ranged from 10 to 20 degrees, decreasing to 5 degrees at the depth of about 200 m (Lemke, 1967). Today, that same area has an average slope of about 25 degrees (Lee and others, 2006). A natural barrier formed by Caines Head and a glacial sill divide the bay into two deep basins, separated by a narrow 'neck' with maximum depth above the sill at 195 m. This sill inhibits sediment transport by tidal currents to the southern part of the bay (Haeussler and others, 2007)" (UAF/GI 2010)

Figure 5-17 depicts aerial photos of the 1964 tsunami inundation line against historical as well as current day infrastructure.

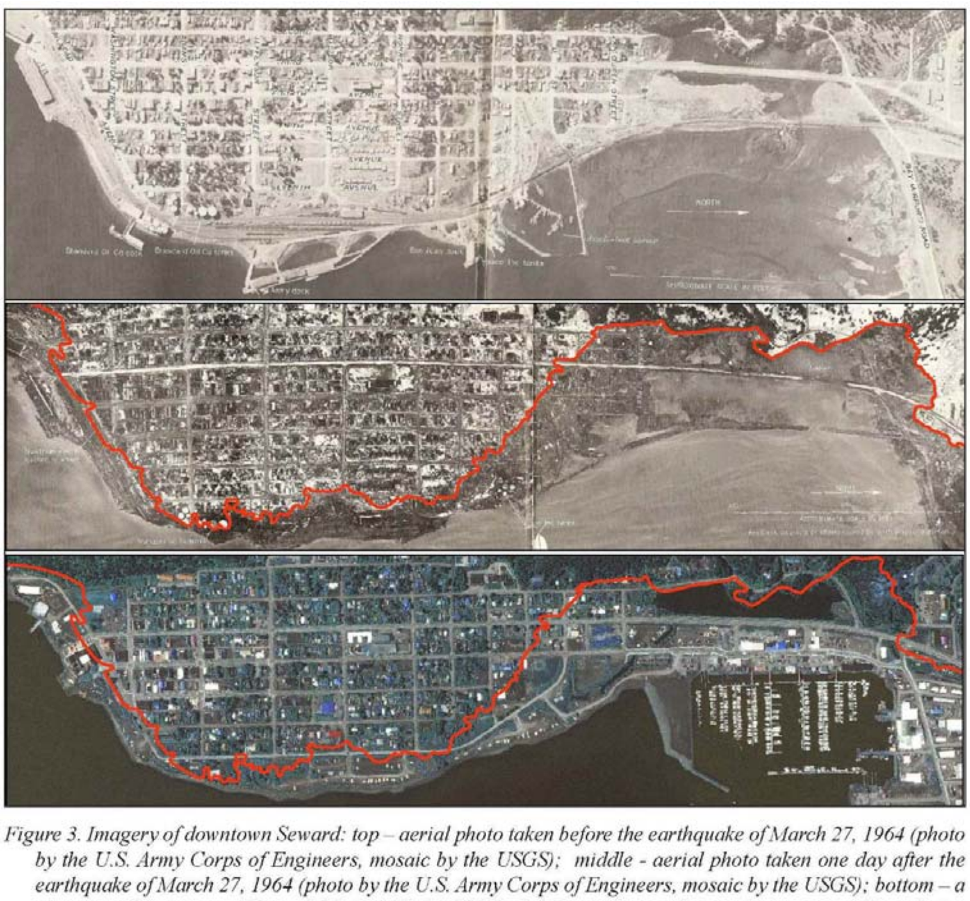


Figure 3. Imagery of downtown Seward: top – aerial photo taken before the earthquake of March 27, 1964 (photo by the U.S. Army Corps of Engineers, mosaic by the USGS); middle - aerial photo taken one day after the earthquake of March 27, 1964 (photo by the U.S. Army Corps of Engineers, mosaic by the USGS); bottom – a recent satellite image of Seward (Digital Globe, 2005). Red line indicates the maximum extent of inundation caused by the 1964 tsunami waves.

Figure 5-17 Historical vs. Present Day Tsunami Inundation Potential (UAF/GI 2010)

Extent

Based on historic earthquake events, WC/ATWC information, and the criteria identified in Table 5-3, the magnitude and severity of earthquake impacts in the City are considered "Catastrophic" with multiple injuries, the potential for critical facilities to be shut down for more than a month, more than 50% of property is severely damaged, and significant damage to transportation, infrastructure, or the economy.

Impact

The UAF GI indicates there is a high likelihood of the SBCFSA, specifically the City of Seward and Lowell Point with receiving future tsunami impacts. The most damaging impacts are anticipated from locally generated tsunamis occurring from accumulated glacial silt and debris situated throughout Resurrection Bay's numerous outflow and alluvial fan locations. The UAF/GI Report defines the 1964 tsunami impacts.

> *"The Mw9.2 Alaska earthquake of March 27, 1964, at Seward was characterized by strong ground motion that lasted 3–4 minutes. During the shaking, a section of the waterfront slid into the bay, taking with it docks and other harbor facilities. At the same time, fuel tanks fractured and oil ignited. Both local, landslide-generated waves and distant, tectonically generated waves inundated the Seward shoreline and caused tremendous damage (Lemke, 1967). Damage from the strong ground motion alone was minor compared to tsunami-related destruction. As a result of regional tectonic deformation, the Resurrection Bay area subsided about 3.5 feet (1.1 m), which resulted in low-lying coastal areas being inundated at high tide. Thirteen people were killed and five injured in Seward as a combined result of the earthquake and tsunami waves. Eighty-six houses were totally destroyed and 269 were heavily damaged. According to Lemke (1967), the total cost to repair public and private facilities was estimated at $22 million ($153 million in 2009 dollars)" (UAF/GI 2010).*

Probability of Future Events

The SBCFSA has a significant tsunami impact history. While it is not possible to predict when a tsunami will occur, WC/ATWC's (Paul Whitmore' personal) comments, tsunami forecast modeling, and Table 5-2 indicates a distant source tsunami as well as a locally-generated tsunami are "Highly Likely" to occur, but the recurrence interval is unknown. Too many factors determine when the next event will occur, as supported by known bathymetric conditions within Resurrection Bay.

5.3.6 Volcanic Hazards

5.3.6.1 Nature

Alaska is home to 41 historically active volcanoes stretching across the entire southern portion of the state from the Wrangell Mountains to the far western Aleutian Islands. "Historically active" refers to actual eruptions that have occurred during Alaskan historic time, in general the time-period in which written records have been kept; from about 1760. Alaska averages 1-2 eruptions per year. In 1912, the largest eruption of the 20th century occurred at Novarupta and Mount Katmai, located in what is now Katmai National Park and Preserve on the Alaska Peninsula (AVO 2011, USGS 2002).

A volcano is a vent or opening in the earth's crust from which molten lava (magma), pyroclastic materials, and volcanic gases are expelled onto the surface. Volcanoes and other volcanic phenomena can unleash cataclysmic destructive power greater than nuclear bombs, and can pose serious hazards if they occur in populated and/or cultivated regions.

There are four general volcano types:

- Lava domes are formed when lava erupts and accumulates near the vent.
- Cinder cones are shaped and formed by cinders, ash, and other fragmented material accumulations that originate from an eruption.
- Shield volcanoes are broad, gently sloping volcanic cones with a flat dome shape that usually encompass several tens or hundreds of square miles, built from overlapping and inter-fingering basaltic lava flows.
- Composite or stratovolcanoes are typically steep-sided, large dimensional symmetrical cones built from alternating lava, volcanic ash, cinder, and block layers. Most composite volcanoes have a crater at the summit containing a central vent or a clustered group of vents.

Along with the different volcano types there are different eruption classifications. Eruption types are a major determinant of the physical impacts an event will create, and the particular hazards it poses. Six main types of volcano hazards exist including:

- Volcanic gases are made up of water vapor (steam), carbon dioxide, ammonia, as well as sulfur, chlorine, fluorine, and boron compounds, and several other compounds. Wind is the primary source of dispersion for volcanic gases. Life, health, and property can be endangered from volcanic gases within about 6 miles of a volcano. Acids, ammonia, and other compounds present in volcanic gases can damage eyes and respiratory systems of people and animals, and heavier-than-air gases, such as carbon dioxide, can accumulate in closed depressions and suffocate people or animals.
- Lahars are usually created by shield volcanoes and stratovolcanoes and can easily grow to more than 10 times their initial size. They are formed when loose masses of unconsolidated, wet debris become mobilized. Eruptions may trigger one or more lahars directly by quickly melting snow and ice on a volcano or ejecting water from a crater lake. More often, lahars are formed by intense rainfall during or after an eruption since rainwater can easily erode loose volcanic rock and soil on hillsides and in river valleys. As a lahar moves farther away from a volcano, it will eventually begin to lose its heavy load of sediment and decrease in size.
- Landslides are common on stratovolcanoes because their massive cones typically rise thousands of feet above the surrounding terrain, and are often weakened by the very process that created the mountain – the rise and eruption of molten rock (magma). If the moving rock debris is large enough and contains a large content of water and soil material, the landslide may transform into a lahar and flow down valley more than 50 miles from the volcano.

- Lava flows are streams of molten rock that erupt from a vent and move downslope. Lava flows destroy everything in their path; however, deaths caused directly by lava flows are uncommon because most move slowly enough that people can move out of way easily, and flows usually do not travel far from the source vent. Lava flows can bury homes and agricultural land under tens of feet of hardened rock, obscuring landmarks and property lines in a vast, new, hummocky landscape.
- Pyroclastic flows are dense mixtures of hot, dry rock fragments and gases that can reach 50 mph. Most pyroclastic flows include a ground flow composed of coarse fragments and an ash cloud that can travel by wind. Escape from a pyroclastic flow is unlikely because of the speed at which they can move.
- Tephra is a term describing any size of volcanic rock or lava that is expelled from a volcano during an eruption. Large fragments generally fall back close to the erupting vent, while smaller fragment particles can be carried hundreds to thousands of miles away from the source by wind. Ash clouds are common adaptations of tephra.

Ash fall poses a significant volcanic hazard to the Kenai Peninsula Borough because, unlike other secondary eruption effects such as lahars and lava flows, ash fall can travel thousands of miles from the eruption site.

Volcanic ash consists of tiny jagged particles of rock and natural glass blasted into the air by a volcano. Ash can threaten the health of people, livestock, and wildlife. Ash imparts catastrophic damage to flying jet aircraft, operating electronics and machinery, and interrupts power generation and telecommunications. Wind can carry ash thousands of miles, affecting far greater areas and many more people than other volcano hazards. Even after a series of ash-producing eruptions has ended, wind and human activity can stir up fallen ash for months or years, presenting a long-term health and economic risk. Special concern is extended to aircraft because volcanic ash completely destroys aircraft engines.

Ash clouds have caused catastrophic aircraft engine failure, most notably in 1989 when KLM Flight 867, a 747 jetliner, flew into an ash cloud from Mt. Redoubt's eruption and subsequently experienced flameout of all four engines. The jetliner fell 13,000 feet before the flight crew was able to restart the engines and land the plane safely in Anchorage. The significant trans-Pacific and intrastate air traffic traveling directly over or near Alaska's volcanoes, has necessitated developing strong communication and warning links between the Alaska Volcano Observatory (AVO), other government agencies with responsibility for aviation management, and the airline and air cargo industry (AVO 2011, USGS 2002).

Table 5-7 provides the AVO's identified volcano list.

Table 5-7 Identified Volcanos

Volcano Names			
Adagdak	Akutan	Alagogshak	Amak
Amchixtam Chaxsxii	Amukta	Andrew Bay volcano	Aniakchak
Atka	Augustine	Basalt of Gertrude Creek	Behm Canal-Rudyerd Bay
Black Peak	Blue Mtn	Bobrof	Bogoslof
Buldir	Buzzard Creek	Camille Cone	Capital
Carlisle	Chagulak	Chiginagak	Churchill, Mt
Cleveland	Cone 3110	Cone 3601	Dana

Table 5-7 Identified Volcanos

Volcano Names			
Davidof	Denison	Devils Desk	Double Glacierv
Douglas	Drum	Duncan Canal	Dutton
Edgecumbe	Emmons Lake Volcanic Center	Espenberg	Fisher
Folsoms Bluff	Fourpeaked	Frosty	Gareloi
Gas Rocks, the	Gilbert	Gordon	Gosling Cone
Great Sitkin	Griggs	Hayes	Herbert
Iliamna	Imuruk Lake	Ingakslugwat Hills	Ingrisarak Mtn
Iron Trig cone	Isanotski	Iskut-Unuk River cones	Jarvis
Jumbo Dome	Kagamil	Kaguyak	Kanaga
Kasatochi	Katmai	Kejulik	Kialagvik
Kiska	Klawasi Group	Knob 1000	Kochilagok Hill
Koniuji	Kookooligit Mountains	Korovin	Koyuk-Buckland volcanics
Kukak	Kupreanof	Little Sitkin	Lone basalt
Lost Jim Cone	Mageik	Makushin	Martin
Moffett	Monogenetic QT vents of WWVF	Morzhovoi	Nelson Island
Novarupta	Nunivak Island	Nushkolik Mountain volcanic field	Okmok
Pavlof	Pavlof Sister	Prindle Volcano	Rainbow River cone
Recheshnoi	Redoubt	Roundtop	Sanford
Seguam	Segula	Semisopochnoi	Sergief
Shishaldin	Skookum Creek	Snowy	Spurr
St. George volcanic field	St. Michael	St. Paul Island	Steller
Stepovak Bay 1	Stepovak Bay 2	Stepovak Bay 3	Stepovak Bay 4
Submarine 001	Submarine 002	Submarine 003	Submarine 004
Submarine 005	Submarine 006	Suemez Island	Table Top Mtn
Takawangha	Tana (east)	Tanada Peak	Tanaga
Tlevak Strait	Togiak volcanics	Trader Mtn	Trident
Ugashik-Peulik	Ukinrek Maars	Uliaga	Ungulungwak Hill-Ingrichuak Hill
Unimak 5270	Unnamed (near Ukinrek Maars)	Veniaminof	Vsevidof
Westdahl	Wide Bay cone	Wrangell	Yantarni
Yunaska			

5.3.6.2 History

The AVO, and its constituent organizations (USGS, DNR, and UAF), has volcano hazard identification and assessment responsibility for Alaska's active volcanic centers. The AVO monitors active volcanoes several times each day using Advanced Very High Resolution Radiometers (AVHRR) and satellite imagery. Figure 5-18 delineates the AVO's monitoring program.

DHS&EM's Disaster Cost Index records the following volcanic eruption disaster events:

103. Mt. Redoubt Volcano, December 20, 1989 *When Mt. Redoubt erupted in December 1989, posing a threat to the Kenai Peninsula Borough, Mat-Su Borough, and the Municipality of Anchorage, and interrupting air travel, the Governor declared a Disaster Emergency. The Declaration provided funding to upgrade and operate a 24-hr. monitoring and warning capability.*

104. KPB-Mt. Redoubt, January 11, 1990 *The Kenai Peninsula Borough, most directly affected by Mt. Redoubt, experienced extraordinary costs in upgrading air quality in schools and other public facilities throughout successive volcanic eruptions. The Borough also sustained costs of maintaining 24-hr. operations during critical periods. The Governor's declaration of Disaster Emergency supported these activities.*

161. Mt. Spurr, September 21, 1992 *Frequent eruptions and the possibility of further eruptions has caused health hazards and property damage within the local governments of the Municipality of Anchorage, Kenai Peninsula Borough and Mat-Su Borough. These eruptions caused physical damage to observation and warning equipment. Funds to replace equipment for AVO.*

Alaska's volcanoes have very diverse eruption histories spanning thousands of years. Activity spanning such an extensive timeline is nearly impossible to define. However modern science has enabled the AVO with determining fairly recent historical eruption dates. Table 5-8 lists the AVO's identified volcano's historical eruption dates with explanatory symbols to designate the data's accuracy.

Table 5-8 Volcano Eruption Dates

Named Volcanoes and Their Respective Eruption Dates				
Amak	**Fisher**	**Kagamil**	**Pavlof**	**Trident**
✳1700	✳1830	✳1929	✳1762	✳1913
✳1796	**Gareloi**	**Kanaga**	✳1790	✳1949
Amukta	✳1760	✳1763	❗1892	**Vsevidof**
✳1770	❗1873	❗1942	**Pavlof Sister**	✳1830
Augustine	**Great Sitkin**	**Kasatochi**	✳1762	**Westdahl**
✳1902	✳1760	✳1760	**Seguam**	✳1979
Chiginagak	✳1784	**Kukak**	❗1786	**Wrangell**
✳1929	**Iliamna**	✳1889	**Semisopochnoi**	✳1784
Cleveland	✳1741	**Makushin**	❗1873	✳1819
✳1774	✳1768	❗1769	**Shishaldin**	✳1884
❗1828	✳1778	✳1796	✳1901	
❗1893	✳1779	✳1865	✳1925	
✳1897	✳1843	**Okmok**	**Tanaga**	
✳1938	**Little Sitkin**	❗1938	✳1763	
✳1975	✳1776			

Key:
❗Eruption
✳Questionable eruption
ℹNon-eruptive activity

5.3.6.3 Location, Extent, Impact, and Probability of Future Events

Location

Figure 5-18 depicts active and inactive volcanoes throughout Alaska.

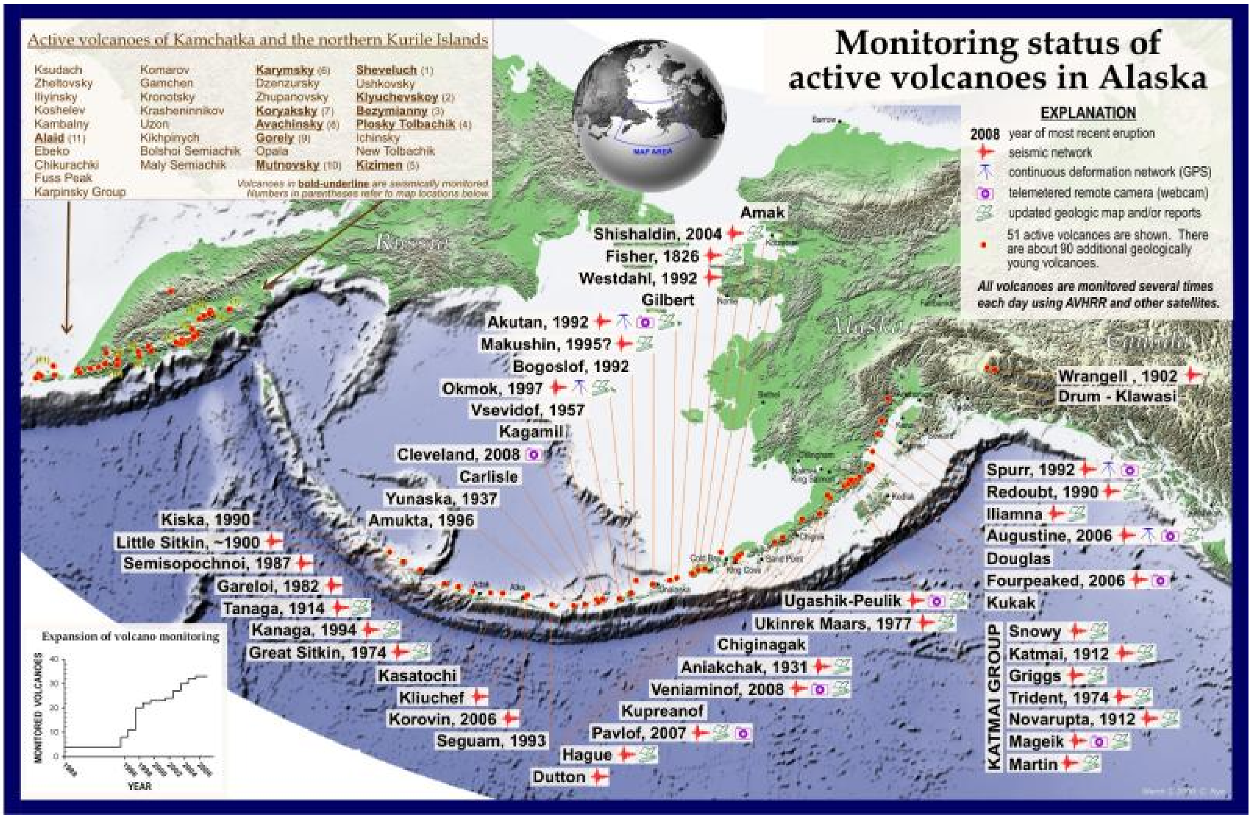


Figure 5-18 AVO's Volcano Monitoring Status Map (AVO 2008)

The AVO publishes individual hazard assessments for each active volcano in Alaska. Table 5-9 lists a representative sample of their preliminary reports and hazard assessments.

Table 5-9 Published Volcano Hazard Assessments

Volcano Names			
Akutan Volcano	Great Sitkin Volcano	Makushin Volcano	Mount Spurr Volcano
Aniakcahak Volcano	Hayes Volcano	Okmok Volcano	Tanaga Island Volcanic Cluster
Augustine Volcano	Iliamna Volcano	Pavlof Volcano	
Emmons Lake Volcanic Center	Kanaga Volcano	Redoubt Volcano	
Gareloi Volcano	Katmai Volcanic Cluster	Shishaldin Volcano	

Each report contains a description of the eruptive history of the volcano, the hazards they pose, and the likely effects of future eruptions to populations, facilities, and ecosystems.

Figure 5-19 depicts those volcanoes closest to the Kenai Peninsula Borough which are the most likely to impact the SBCFSA.

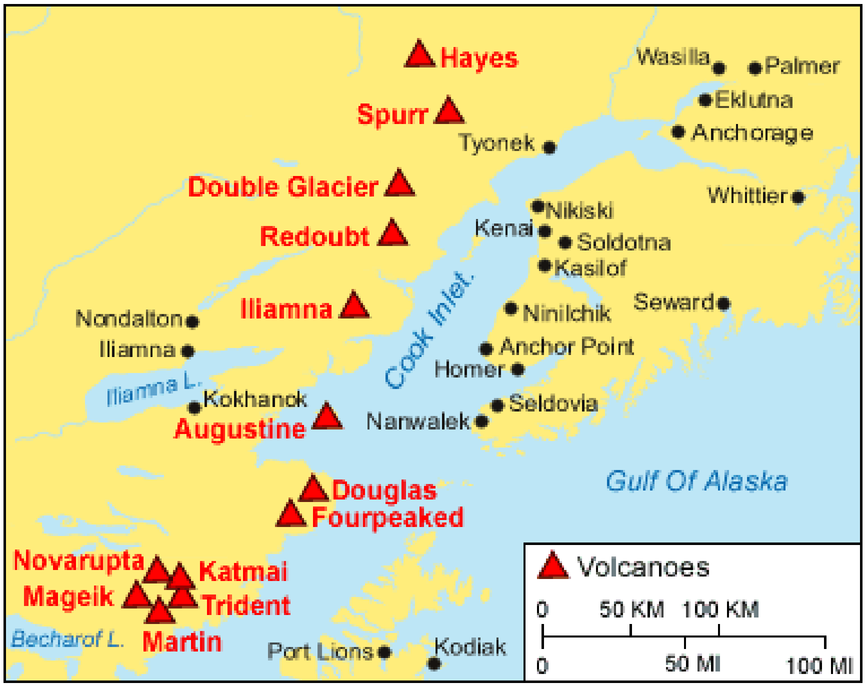


Figure 5-19 KPB's most threatening volcanoes (AVO 2012)

Alaska contains 80+ volcanic centers and is at continual risk for volcanic eruptions. Most of Alaska's volcanoes are far from settlements that could be affected by lahars, pyroclastic flows and clouds, and lava flows; however ash clouds and ash fall have historically caused significant impact to human populations.

> *"When volcanoes erupt explosively, high-speed flows of hot ash (pyroclastic flows) and landslides can devastate areas 10 or more miles away, and huge mudflows of volcanic ash and debris (lahars) can inundate valleys more than 50 miles downstream. . . Explosive eruptions can also produce large earthquakes. . . the greatest hazard posed by eruptions of most Alaskan volcanoes is airborne dust and ash; even minor amounts of ash can cause the engines of jet aircraft to suddenly fail in flight" (USGS 1998)*

Although the SBCFSA is far from any active volcanoes, many of the volcanoes in Alaska are capable of producing eruptions that can affect the area. The SBCFSA need only be concerned with significant volcanic ash falls. A large ash plume has the capability of shutting down air, and potentially, ferry and barge operations because tephra is damaging to all engine types.

USGS Bulletin 1028-N explains that Mount Katmai's eruption on June 5, 1912 was up to that point "the greatest volcanic catastrophe in the recorded history of Alaska. More than six cubic miles of ash and pumice were blown into the air from Mount Katmai and the adjacent vents in the Valley of Ten Thousand Smokes." The eruption lasted for 3 days. The USGS Fact Sheet 075-98, Version 1.0 states,

> *"The ash cloud, now thousands of miles across, shrouded southern Alaska and western Canada, and sulfurous ash was falling on Vancouver, British Columbia;*

and Seattle, Washington. The next day the cloud passed over Virginia, and by June 17th it reached Algeria in Africa."

Figure 5-20 shows the extent of four ash cloud impact areas. The 1912 Katmai ash cloud is gray; the Augustine (blue plume), Redoubt (orange plume), and Spurr (yellow plume) were each dwarfed by the Katmai event. "Volcanologist's discovered that [this] 1912 [Katmai] eruption was actually from Novarupta, not Mount Katmai" (USGS 1998).

Figure 5-20 1912 Katmai Volcano Impact (USGS 1998)

- Archaeological evidence suggests that an eruption of Aniakchak volcano 3,500 years ago spread ash over much of Bristol Bay and generated a tsunami which washed up onto the tundra around Nushagak Bay. Within the past 10,000 years, Aniakchak volcano has significantly erupted on at least 40 occasions.
- The 1989-90 eruption of Mt. Redoubt seriously affected the population commerce, and oil production and transportation throughout the Cook Inlet region.

"Redoubt Volcano is a strato-volcano located within a few hundred kilometers of more than half of the population of Alaska. This volcano has erupted explosively at least six times since historical observations began in 1778. The most recent

eruption occurred in 1989-90 and similar eruptions can be expected in the future. The early part of the 1989-90 eruption was characterized by explosive emission of substantial volumes of volcanic ash to altitudes greater than 12 kilometers above sea level and widespread flooding of the Drift River valley. Later, the eruption became less violent, as developing lava domes collapsed, forming short-lived pyroclastic flows associated with low-level ash emission. Clouds of volcanic ash had significant effects on air travel as they drifted across Alaska, over Canada, and over parts of the conterminous United States causing damage to jet aircraft, as far away as Texas. Total estimated economic costs are $160 million, making the eruption of Redoubt the second most costly in U.S. history" (USGS 1998).

- Mt. Spurr's 1992 eruption brought business to a halt and forced a 20 hour Anchorage International Airport closure. Communities 400 miles away reported light ash dustings.

  "Eruptions from Crater Peak on June 27, August 18, and September 16–17, 1992, produced ash clouds (fig. 11) that reached altitudes of 13 to 15 kilometers [8-9 miles] above sea level. These ash clouds drifted in a variety of directions and were tracked in satellite images for thousands of kilometers beyond the volcano (Schneider and others, 1995). One ash cloud that drifted southeastward over western Canada and over parts of the conterminous United States and eventually out across the Atlantic Ocean (fig. 12) significantly disrupted air travel over these regions but caused no direct damage to flying aircraft" (USGS 2002)

  In 1992, another eruption series occurred, resulting in three separate eruption events. The first, in June, dusted Denali National Park and Manley Hot Springs with 2 mm of ash – a relatively minor event. In August, the mountain again erupted, covering Anchorage with ash, bringing business to a halt and forcing officials to close Anchorage International Airport for 20 hours. St. Augustine's 1986 eruption caused similar air traffic disruption.

- Small ash clouds from the 2001 eruption of Mt. Cleveland were noted by USGS to have reached Fairbanks. These clouds dissipated somewhere along the line between Cleveland and Fairbanks. A full plume, visible on satellite imagery, was noted in a line from Cleveland to Nunivak Island.

- The January 10, 2004 eruption of Augustine volcano resulted in a National Weather Service urgent notification of ash fall. No measurable ash was recorded.

Figure 5-21 displays the air travel routes in the North Pacific, Russia, and Alaska and the active volcanoes which could easily disrupt air travel during significant volcanic eruptions with ash fall events.

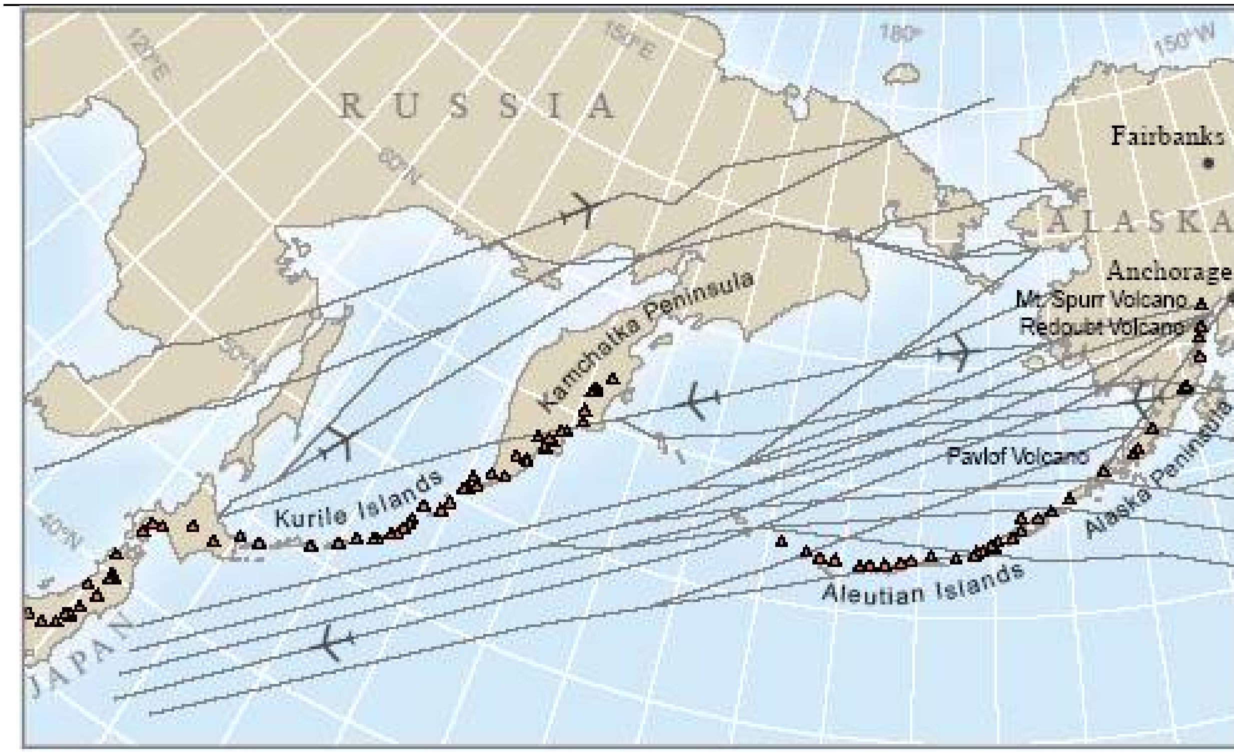


Figure 5-21 North Pacific Air Travel Routes (USGS 2001)

Eruptions, explosive and otherwise, of the Augustine Volcano occur every five to ten years. Plumes from at least one Augustine eruption have been caught on camera.

Extent

Volcanic effects include severe blast, turbulent ash and gas clouds, lightning discharge, volcanic mudflows, pyroclastic flows, corrosive rain, flash flood, outburst floods, earthquakes, and tsunamis. Some of these activities include ash fallout in various communities, air traffic, road transportation, and maritime activity disruptions.

SBCFSA might receive some ash fall during a massive volcanic eruption. A tsunami is possible if the eruption included a massive, high speed pyroclastic flow into the Pacific Ocean or Prince William Sound. However, SBCFSA has only a minimal tsunami impact threat from volcanic activity. A much more likely impact would be prolonged traffic disruptions (air, land, or rail) preventing essential community resupply e.g. food and medicine delivery, and medivac service capabilities to full service hospitals.

A massive eruption anywhere on earth, such as Tambora in 1815, could severely affect the global climate; radically changing SBCFSA's (and everyone else's) risk from weather events for weeks, months, or years.

Based on historic volcanic activity impacts and the criteria identified in Table 5-3, the magnitude and severity of impacts in the SBCFSA are considered "limited" with minor injuries, the potential for critical facilities to be shut down for more than a week, more than 10% of property or critical infrastructure being severely damaged, and limited permanent damage to transportation, infrastructure, or the economy.

Impact

An ash fall event like the one experienced at Kodiak Island in 1902 would undoubtedly be devastating to the SBCFSA by straining its resources; especially if other hub communities are also significantly affected by a volcanic eruption.

An eruption of significant size in southcentral Alaska will certainly affect air, land, and rail routes, which in turn affects the entire state. Humans would likely experience respiratory problems from airborne ash, personal injury, and potential residential displacement or lack of shelter with general property damage (electronics and unprotected machinery), structural damage from ash loading, state/regional transportation interruptions, loss of commerce, as well as water supply contamination.

These impacts can range from inconvenience – a few days with no transportation capability; to disastrous – heavy, debilitating ash fall throughout the state, forcing the SBCFSA to be completely self-sufficient.

Probability of Future Events

Geologists can make general forecasts of long-term activity associated with individual volcanoes by carefully analyzing past activity, but these are on the order of trends and likelihood, rather than specific events or timelines. Short-range forecasts are often possible with greater accuracy. Several signs of increasing activity can indicate that an eruption will follow within weeks or months. Magma moving upward into a volcano often causes a significant increase in small, localized earthquakes, and measurable carbon dioxide and compounds of sulfur and chlorine emissions increases. Shifts in magma depth and location can cause ground level elevation changes that can be detected through ground instrumentation or remote sensing.

Based on the criteria identified in Table 5-2 and information presented in the SHMP, it is “Likely” for a volcanic eruption to occur within the next three years. Event has up to 1 in 3 years chance of occurring (1/3=33 percent). History of events is greater than 20percent but less than or equal to 33 percent likely per year. Vulnerability depends on the type of activity and current weather, especially wind patterns.

5.3.7 Weather (Severe)

5.3.7.1 Nature

Severe weather occur throughout Alaska with extremes experienced by the SBCFSA that includes thunderstorms, lightning, hail, heavy and drifting snow, freezing rain/ice storm, extreme cold, and high winds. The SBCFSA experiences periodic severe weather events such as the following:

- **Heavy Rain** occurs rather frequently over the coastal areas along the Bering Sea and the Gulf of Alaska. Heavy rain is a severe threat to the SBCFSA as it usually results in dangerous flooding.
- **Heavy Snow** generally means snowfall accumulating to four inches or more in depth in 12 hours or less or six inches or more in depth in 24 hours or less.

- **Drifting Snow** is the uneven distribution of snowfall and snow depth caused by strong surface winds. Drifting snow may occur during or after a snowfall.
- **Freezing Rain and Ice Storms** occur when rain or drizzle freezes on surfaces, accumulating 12 inches in less than 24 hours. Ice accumulations can damage trees, utility poles, and communication towers which disrupts transportation, power, and communications.
- **Extreme Cold** is the definition of extreme cold varies according to the normal climate of a region. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme". In Alaska, extreme cold usually involves temperatures between -20 to -50°F. Excessive cold may accompany winter storms, be left in their wake, or can occur without storm activity. Extreme cold accompanied by wind exacerbates exposure injuries such as frostbite and hypothermia.
- **High Winds** occur in Alaska when there are winter low-pressure systems in the North Pacific Ocean and the Gulf of Alaska. Alaska's high wind can equal hurricane force but fall under a different classification because they are not cyclonic nor possess other hurricane characteristics. In Alaska, high winds (winds in excess of 60 mph) occur rather frequently over the coastal areas along the Bering Sea and the Gulf of Alaska. High winds are a severe threat to Quinhagak.

  Strong winds occasionally occur over the interior due to strong pressure differences, especially where influenced by mountainous terrain, but the windiest places in Alaska are generally along the coastlines.

  (NWS 2011)
- **Winter Storms** include a variety of phenomena described above and as previously stated may include several components; wind, snow, and ice storms. Ice storms, which include freezing rain, sleet, and hail, can be the most devastating of winter weather phenomena and are often the cause of automobile accidents, power outages, and personal injury. Ice storms result in the accumulation of ice from freezing rain, which coats every surface it falls on with a glaze of ice. Freezing rain is most commonly found in a narrow band on the cold side of a warm front, where surface temperatures are at or just below freezing temperatures. Typically, ice crystals high in the atmosphere grow by collecting water vapor molecules, which are sometimes supplied by evaporating cloud droplets. As the crystals fall, they encounter a layer of warm air where they particles melt and collapse into raindrops. As the raindrops approach the ground, they encounter a layer of cold air and cool to temperatures below freezing. However, since the cold layer is so shallow, the drops themselves do not freeze, but rather, are supercooled, that is, in liquid state at below-freezing temperature. These supercooled raindrops freeze on contact when they strike the ground or other cold surfaces.

  Snowstorms happen when a mass of very cold air moves away from the polar region. As the mass collides with a warm air mass, the warm air rises quickly and the cold air cuts underneath it. This causes a huge cloud bank to form and as the ice crystals within the cloud collide, snow is formed. Snow will only fall from the cloud if the temperature of the air between the bottom of the cloud and the ground is below 40 degrees Fahrenheit. A higher temperature will cause the snowflakes to melt as they fall through the air, turning them into rain or sleet. Similar to ice storms, the effects from a snowstorm can disturb a community for weeks or even months. The combination of heavy snowfall, high winds and cold temperatures pose potential danger by causing prolonged power outages, automobile accidents and transportation delays, creating dangerous walkways, and through direct damage to buildings, pipes, livestock, crops and other vegetation. Buildings and trees can also collapse under the weight of heavy snow.

Winter storm floods are discussed in Section 5.3.3.

5.3.7.2 History

The SBCFSA is continually impacted by severe weather either as severe rain or snow. Severe rain accumulation results typically result in a Governor's Disaster declaration. DHS&EM's Disaster Cost Index records the following severe weather disaster events which affected the area:

83. Omega Block Disaster, January 28, 1989 & FEMA declared (DR-00826) on May 10, 1989: *The Governor declared a statewide disaster to provide emergency relief to communities suffering adverse effects of a record breaking cold spell, with temperatures as low as -85 degrees. The State conducted a wide variety of emergency actions, which included: emergency repairs to maintain & prevent damage to water, sewer & electrical systems, emergency resupply of essential fuels & food, & DOT/PF support in maintaining access to isolated communities.*

112. Snow & Ice Removal, 1990: *Because of record snowfalls in Southcentral Alaska, the Legislature appropriated a special grant to local governments affected in order to supplement normal snow and ice removal budgets. The Legislature directed that funds be managed by the Division of Homeland Security and Emergency Management. No Disaster Declaration occurred.*

119. Hazard Mitigation Cold Weather, 1990: *The Presidential Declaration of Major Disaster for the Omega Block cold spell of January and February 1989 authorized federal funds for mitigation of cold weather damage in future events. The Governor's declaration of disaster provided the State matching funds required for obtaining and using this federal money.*

(New numbering system began in 1995 to begin with event year)

00-191 Central Gulf Coast Storm declared February 4, 2000 by Governor Murkowski Murkowski then FEMA declared (DR-1316) on February 17, 2000: *On Feb 4 2000, the Governor declared a disaster due to high impact weather events throughout an extensive area of the state. The State began responding to the incident since the beginning of December 21, 1999. The declaration was expanded on February 8 to include City of Whittier, City of Valdez, Kenai Peninsula Borough, Matanuska-Susitna Borough and the Municipality of Anchorage. On February 17, 2000, President Bill Clinton determined the event disaster warranted a major disaster declaration under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, P.L. 93-288 as amended ("the Stafford Act). On March 17, 2000, the Governor again expanded the disaster area and declared that a condition of disaster exists in Aleutians East, Bristol Bay, Denali, Fairbanks North Star, Kodiak Island, and Lake and Peninsula Boroughs and the census areas of Dillingham, Bethel, Wade Hampton, and Southeast Fairbanks, which is of sufficient severity and magnitude to warrant a disaster declaration. Effective* *on April 4, 2000, Amendment No. 2 to the Notice of a Major Disaster Declaration, the Director of FEMA included the expanded area in the presidential declaration. Public Assistance, for 64 applicants with 251 PW's, totaled $12.8 million. Hazard Mitigation totaled $2 million. The total for this disaster is $15.66 million.*

03-204 Southcentral Windstorm (AK-DR-1461) Declared March 28, 2003 by Governor Murkowski then FEMA declared April 26, 2003: *A major windstorm with sustained and severe winds that exceeded 100 mph occurred between March 6 and March 14, 2003. The windstorm affected the Matanuska-Susitna Borough, the Municipality of Anchorage, and the Kenai Peninsula Borough. Severe damage occurred to numerous personal residences and local businesses; extensive damage occurred to public facilities (i.e. schools, libraries, community centers, airports, buildings and utilities) in the Matanuska-Susitna Borough, Municipality of Anchorage and the Kenai Peninsula Borough. Although damages were widespread, Anchorage facilities received the most damages. Federal Disaster Assistance for Debris Removal, Emergency Protective Measures and all Permanent Work categories were approved under the Public Assistance Program. FEMA also authorized 404 Mitigation funding and individual assistance under the Individual and Household Program. Individual Assistance totaled $48K. Public Assistance totaled $2.5 million for 24 potential applicants with 87 PW's. Hazard Mitigation totaled $532K. The total for this disaster is $3.47 million. (closeout data: $2.8 million total paid out (includes $220,000 mitigation and $47,600 State IA///posted 7/29/08 rbs).*

06-217 2006 South Central Storm (AK-06-217) declared March 13, 2006 by Governor Murkowski: *Beginning on February 5, 2006 and continuing through February 11, 2006, a series of strong winter storms with high winds, heavy snow, and freezing rain occurred in the City of Seward and surrounding areas of the Kenai Peninsula Borough in South Central Alaska, causing avalanches that severely damaged power lines and other infrastructures, blocked roads, and threatened further damages. As a result of the disaster, there was severe damage to power transmission and distribution lines supplying the City of Seward and surrounding areas; disruption of normal power supply requiring the prolonged use of emergency backup generators with extraordinary expensive operation costs; and damage and threat to public and private property as a result of power disruption. On March 13, 2006, a letter was submitted to request a federal time extension of 30 days. As of 3/20/06, the decision is pending. Decision made not to seek Federal assistance. Current estimated cost for repairs is $1,254,730; however, this does not include the ongoing cost of line repair. No federal declaration was sought; therefore, the State is limited to public assistance only (no HM or IA). As of 3/20/06, only the City of Seward and Sealife Center are applicants. Disaster administratively closed out and letter sent to applicants on 6/29/07. (7 Nov 08 update)--Formal closeout letter to DMVA/DAS was dated 6 Nov 08 (funds authorized = $1,465,321; funds expended =$1,306.509.72; funds lapsed to DFR = $158,811.28. (7Nov08, R.B.Stewart)*

07-221 2006 October Southern Alaska Storm (AK-07-221) declared October 14, 2006 by Governor Murkowski FEMA declared (DR-1669) on December 8, 2006. *Beginning on October 8, 2006 and continuing through October 13, 2006, a strong large area of low pressure that developed in the Northern Pacific and moved into the Southwest area of the state, produced hurricane force winds throughout much of the state and heavy rains in the Southcentral and Northern Gulf coast areas, which resulted in severe flooding and wind damage and threats to life in the Southern part of the state, to include the Kenai Peninsula Borough including the Cities of Seward and Seldovia, the Chugach Rural*

Education Area including the City of Cordova and the City of Valdez, and the Copper River Rural Education Area including the Richardson Highway to the Glenallen and highways and drainages in the McCarthy areas. Initial total damages are estimated at $557,415 with a public assistance estimate of $456,855. Federal declaration was made December 2006 including assistance for Public Assistance and Hazard Mitigation but not including Individual Assistance. Revised State of Alaska Cost estimates are $1,265,000 in Individual Assistance and $38,241,826 in Public Assistance for a total cost of $39,506,826. There is $26,825,918 available from the Federal Highway Administration leaving a requested amount of $13,948,999. A total of 10 individuals or households applied for assistance through the State's IA Temporary Housing program. Six eligible applicants received a total of $93,611.21 for home replacement, major repair and mitigation, and/or for temporary housing accommodations. Each TH applicant involved extensive case management. The temporary housing program closed 3/10/2008.

09-230, 2009 Seward Storm Surge declared by Governor Parnell on December 31, 2009. *On December 1, 2009 the City of Seward experienced a winter storm event that caused damage to the shoreline and an important roadway within the community. High winds, 3 plus inches of rainfall, and a 12.6 foot tide, caused extensive damage to the wave barrier along Lowell Point Road, the Seward Greenbelt area and the seawall at the Alaska Sea Life Center.*

12-237, 2011 Kenai Peninsula Windstorm declared by Governor Parnell on December 12, 2011 then FEMA declared February 2, 2012 (DR-4054). *On November 1, 12, and 15, 2011, a series of major windstorms caused widespread power outages threatening life and property. Power was disrupted to 17,300 homes and businesses. Local utilities, Homer Electric Association (HEA) and Chugach Electric employed several work crews to restore power to the area. Public Infrastructure, commercial property, and personal property damages were reported in the metropolitan areas and throughout the borough. DHS&EM received local declarations from the Kenai Peninsula Borough (KPB) requesting state disaster assistance to cover immediate response, public and individual costs and from the City of Seward through the KPB requesting State assistance.*

The Western Regional Climate Center (WRCC) provides weather data throughout the Pacific Northwest. The WRCC's SBCFSA's daily comparative average and extreme data are as follows:

Figure 5-22 provides average and extreme temperature data. As indicated on the graph, October 1986 had a maximum rainfall event with 15.05 inches. Other high accumulation year information for 2006, 2009, and 2012 were not available.

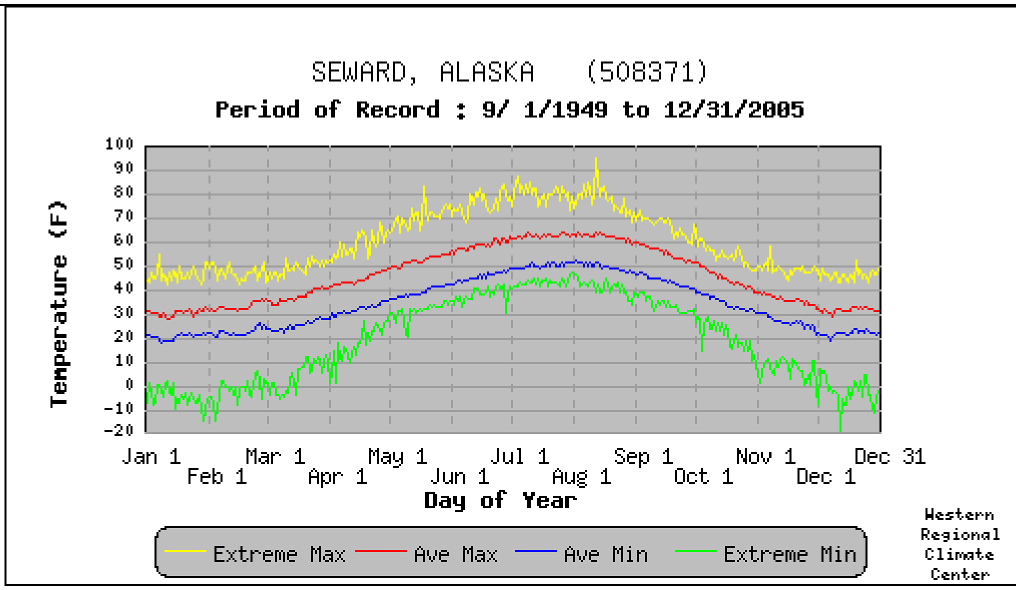


Figure 5-22 SBCFSA's Temperature Extremes (WRCC 2012)

Figure 5-23 displays the areas daily precipitation extremes.

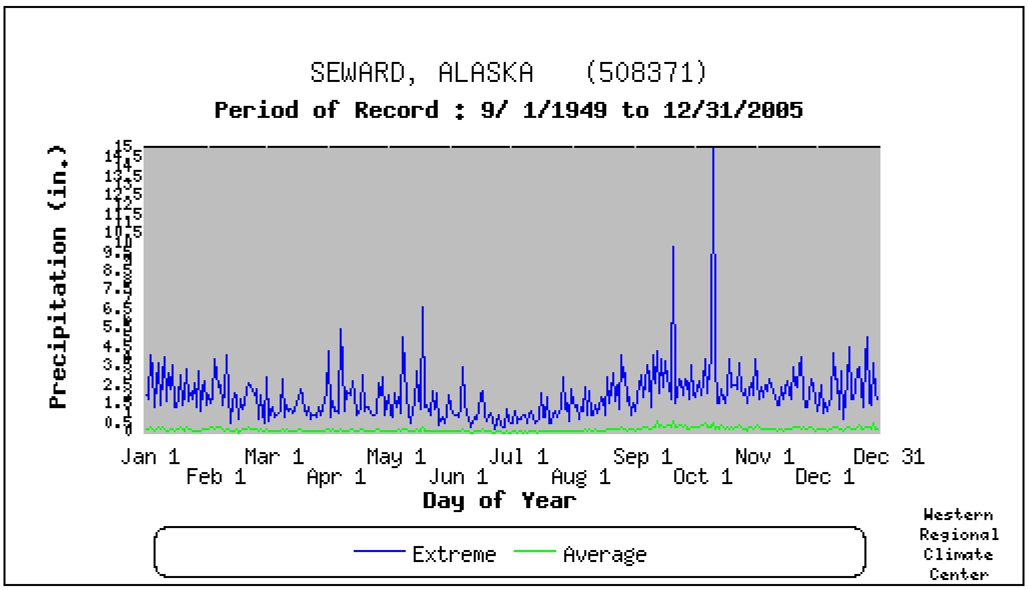


Figure 5-23 SBCFSA's Precipitation Extremes (NWS 2012)

Figure 5-24 displays the areas daily snowfall extremes.

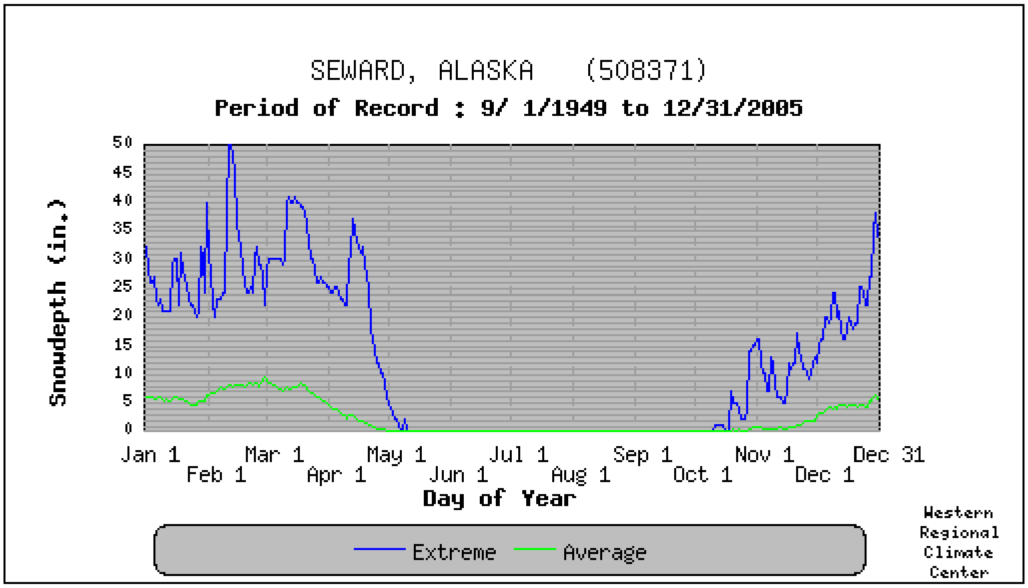


Figure 5-24 SSBCFSA's Snowfall Extremes (WRCC 2012)

5.3.7.3 *Location, Extent, Impact, and Probability of Future Events*

The City is continually impacted by severe weather as depicted in the University of Alaska Fairbanks' (UAF), Scenarios Network for Alaska & Arctic Planning (SNAP) provides the following (Figures 5-25 and 5-26) historical precipitation and temperature weather data:

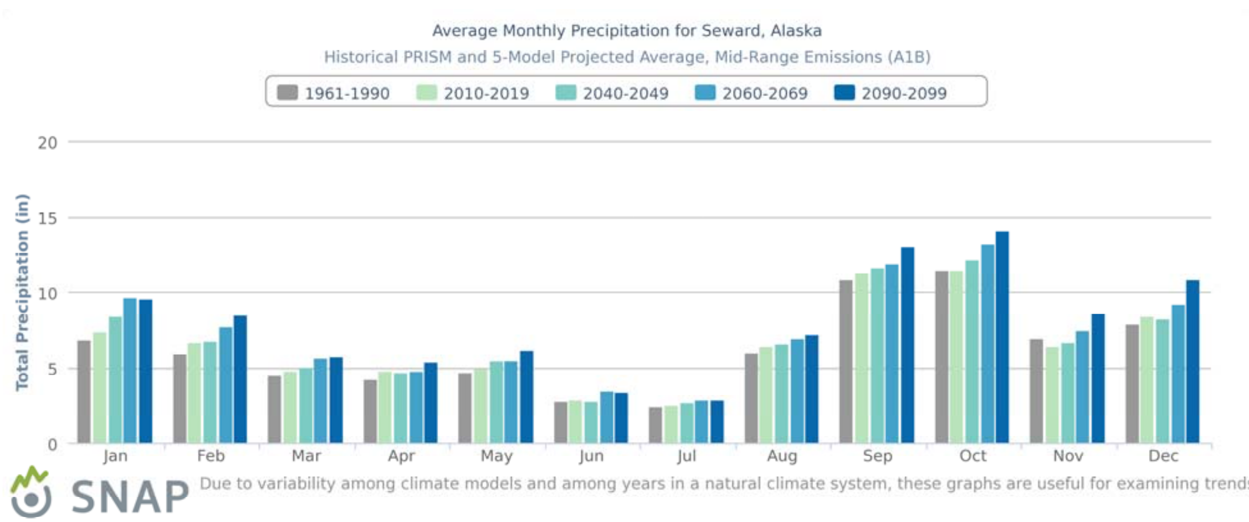


Figure 5-25 Historic and Predicted Precipitation (UAF 2012b)

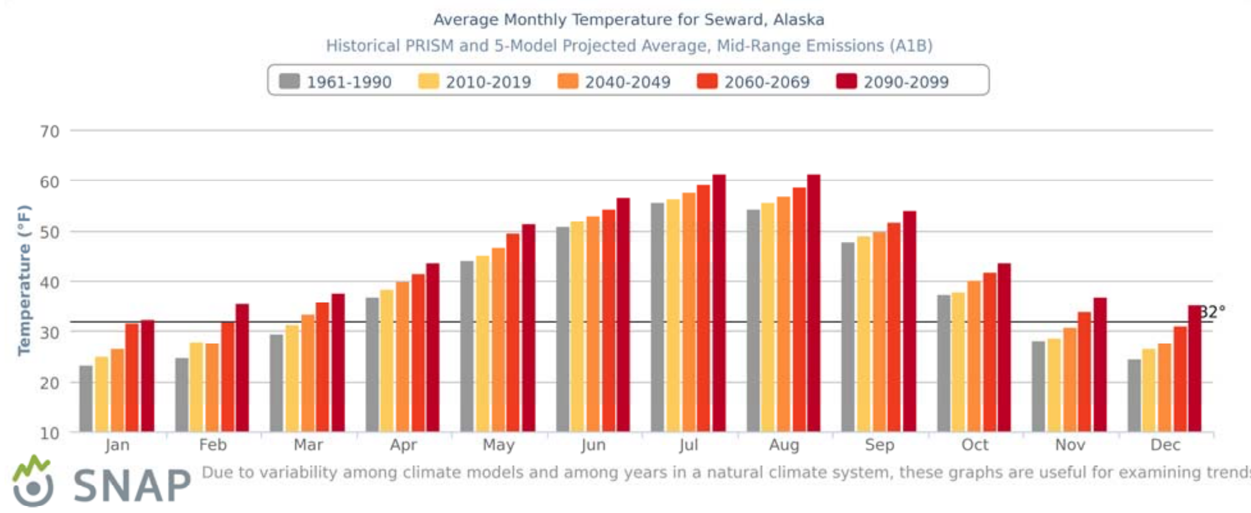


Figure 5-26 Historic and Predicted Temperature (UAF 2012b)

Table 5-10 provides a sample list of 29 major storm events the National Weather Service identified for SBCFSA's Weather Zone. Each weather event may not have specifically impacted the SBCFSA but they are listed due to their close proximity to listed communities or by location within the identified zone.

Table 5-10 Severe Weather Events

Location	Date	Event Type and Magnitude
Seward	10/9/2006	Flood, High Wind: 73.6 mph (64 kts.) Damages: $500K A strong storm in the north Pacific moved into the eastern Bering Sea Monday October 8th. This storm produced strong wind along and in advance of a strong weather front associated with the storm. Strong northwest wind occurred around the west side of this storm in the Eastern Aleutians. This storm had a strong tropical connection that pushed copious amounts of rain into the Prince William Sound area, Cook Inlet, the Susitna Valley, and the Copper River Basin. Along with the extremely heavy rainfall, very warm air resulted in excessive snow melt that contributed to the flooding. Flooding along the Richardson Highway resulted in road wash outs through Keystone Canyon and also in the Copper River Basin at Squirrel Creek and at the Tonsina Lodge. Flooding also occurred in Cordova and Seward resulting in road wash outs in both those communities.
Western (Wrn) Prince William Sound (PWS) & Kenai Mountains (Mtns)	12/22-27/2006	Blizzard A strong low in the northern Gulf of Alaska produced strong north to east wind and areas of snow over the south central region of the state and northern Prince William Sound. This storm produced heavy snow in the northern sound and moderate snow fall across the Kenai Peninsula into the Susitna Valley.
Wrn PWS Snd & Kenai Mtns	1/3/2007	Blizzard A storm moved toward Prince William Sound generating strong wind and snow in the western Sound.
Wrn PWS Snd & Kenai Mtns	1/14/2007	Blizzard, Wind Gusts: 40 mph (34.7 kts.) A low pressure system moved into Prince William Sound bringing snow to the eastern Kenai Peninsula. A moderately

Table 5-10 Severe Weather Events

Location	Date	Event Type and Magnitude
		strong pressure gradient on the west side of the low caused gusty winds especially in and below mountain passes. Gusts to 40 mph reduced visibility to a quarter mile at times along the eastern Kenai Peninsula.
Wrn PWS Snd & Kenai Mtns	1/16/2007	Blizzard A strong low in the Gulf of Alaska produced snow and strong wind in Portage Valley resulting in a blizzard.
Wrn PWS Snd & Kenai Mtns	3/6/2007	Blizzard A strong low moved into Prince William Sound producing strong wind and snow resulting in a Blizzard. A volunteer weather spotter report wind gusting to near 80 mph.
Wrn PWS Snd & Kenai Mtns	3/20-23/2007	Blizzard An intense storm moved into the southwest Gulf of Alaska Tuesday March 20th. Strong channelled wind along with moderate snow fall in Portage Valley produced a blizzard in the valley.
Wrn PWS Snd & Kenai Mtns	4/7/2007	High Wind: 78 mph (68 kts.) An intense area of low pressure over western Alaska combined with rapidly rising pressure in the eastern Gulf of Alaska produced the typically high wind through Portage Valley and along Turnagain Arm.
Moose Pass	6/21/2007	Hail: 0.75 inches Severe thunderstorms developed on the interior Kenai Peninsula. Spotter reports were of hail 1/2 to 3/4 inch and heavy rain with these Thunderstorms.
Wrn PWS Snd & Kenai Mtns	10/25/2007	High Wind: 84 mph (73 kts.) A 996MB Low was centered near the southern tip of the Kenai Peninsula. This storm generated gale force winds across the northern gulf of Alaska and warning level winds over portions of the northern gulf coast through Portage pass and along Turnagain Arm. Rain and winds began across the area on the morning of October 25th. The Portage ASOS recorded periods of heavy rain and winds gusting in the upper teens to upper 20's during the morning hours...with gusts reaching into the upper 40's by afternoon. Winds and rain continued across the zone with gusts increasing through late afternoon. At 5:53 PM, a peak wind of 73KT registered on the ASOS. Winds gradually diminished thereafter.
Wrn PWS Snd & Kenai Mtns	11/8/2007	High Wind: 75.9 mph (66 kts.) A strong low in the Bering Sea and the associated front produced strong wind through the mountain gaps of the Kenai Peninsula. The peak gusts were 85 mph along the hillside and 76 mph in Portage Valley.
Wrn PWS Snd & Kenai Mtns	11/20-22/2007	High Wind: 89.7 mph (78 kts.) A very strong 966MB surface low moved into the western Gulf of Alaska and positioned itself just to the west of Kodiak Island. The surface gradients were oriented in a Northwest to Southeast manner which provided maximum funneling of winds through the Chugach Mountains of western Prince William Sound. The typical gap win through Portage Pass produce gusts to 90 mph in Portage Valley. High winds were generated in conjunction with the strong surface low and channeled terrain of western Prince William sound for the community of Whittier and in Portage Valley. Winds first reached 75 mph at 219 PM in Portage Valley and

Table 5-10 Severe Weather Events

Location	Date	Event Type and Magnitude
		frequently gusted to 75 mph or greater through 1 AM November 21st. Whittier reported wind gusts to 72 mph during this storm.
Wrn PWS Snd & Kenai Mtns	12/4/2007	Blizzard A storm in the Gulf of Alaska brought snow and wind to Northern Prince William Sound in Thompson Pass to Keystone Canyon and in Portage Valley. Heavy snow fell across the region with 17 inches of snow reported in Thompson Pass.
Wrn PWS Snd & Kenai Mtns	12/24/2007	Blizzard A strong storm moved across Kodiak Island December 24th to the northern Gulf of Alaska. Snow fell in advance of the low across Kodiak island spreading to the southern Kenai Peninsula. Strong wind associated with this storm combined with the snow to produce blizzard conditions across lake Iliamna followed by blizzard conditions across Kodiak island. Heavy snow fell over the southern Kenai Peninsula to Portage pass. The strong wind hit those areas producing blizzard conditions in the pass and along Turnagain Arm.
Wrn PWS Snd & Kenai Mtns	2/16/2008	Blizzard A weather system and associated front moved onshore from the Gulf of Alaska toward Seward, bringing high winds and blizzard conditions to the Eastern Kenai Peninsula and Western Prince William Sound.
Wrn PWS Snd & Kenai Mtns	1/14/2009	High Wind: 85 mph (74 kts.) A series of intense tropically connected storms moved into the eastern Bering Sea beginning January 13th. The storms pushed the warm tropical air over the existing deep arctic air that had been over Alaska since the end of December 2008. High wind, snow, and freezing rain occurred throughout the south central and southwest regions of Alaska while strong north wind and snow produced blizzard conditions in the Pribilof Islands. Wind at higher elevations of the Chugach Mountains exceeded 120 mph. The upper hillside of the Anchorage area had several spotter reports of wind around 110 mph and wind reached 50 mph in east Anchorage. Freezing rain created chaos across the south central region on the 14th and 15th resulting in many vehicles sliding off the road and numerous roll over accidents. Windows were blown out of a local McDonald's and some vehicles. The rapid warming combined with heavy rain resulted in localized flooding in the Anchorage area, Valdez and Girdwood.
Wrn PWS Snd & Kenai Mtns	1/16/2009	High Wind: 64 mph (64 kts.) Damages, $2K A series of intense tropically connected storms moved into the eastern Bering Sea beginning January 13th. The storms pushed the warm tropical air over the existing deep arctic air that had been over Alaska since the end of December 2008. High wind, snow, and freezing rain occurred throughout the south central and southwest regions of Alaska while strong north wind and snow produced blizzard conditions in the Pribilof Islands. Wind at higher elevations of the Chugach Mountains exceeded 120 mph. The upper hillside of the Anchorage area had several spotter reports of wind around 110 mph and wind reached 50 mph in east Anchorage. Freezing rain created chaos across the south central region on the 14th and 15th resulting in many vehicles sliding off the road and numerous rollover accidents. Windows were blown out of a local McDonald's and some vehicles. The rapid warming combined with heavy rain resulted in localized flooding in the Anchorage area, Valdez and

Table 5-10 Severe Weather Events

Location	Date	Event Type and Magnitude
		Girdwood.
Wrn PWS Snd & Kenai Mtns	3/16/2009	Blizzard Strong north wind and snow produced blizzard conditions in Turnagain Pass to Seward.
Wrn PWS Snd & Kenai Mtns	3/25/2009	Blizzard A strong low south of the Alaska Peninsula produced strong wind and snow across the eastern Aleutians, Alaska Peninsula, Bristol Bay area and Kuskokwim Delta. The front associated with this storm created high wind and dumped around 2 feet of snow through Portage Valley into Turnagain Pass that resulted in a blizzard.
Wrn PWS Snd & Kenai Mtns	3/28/2009	Blizzard An intense storm moved into the Eastern Bering Sea Saturday. This storm packed high wind and snow as it moved across the Alaska Peninsula to the Bering Sea coast. Strong wind peaked at 100 KT at Saint George in the midst of the Blizzard on the 28th. The strong wind moved into south central Alaska Saturday night and Sunday along with moderate to heavy snow fall. Whittier reported 2 to 2.5 feet of snow with this event. Portage Valley experienced high wind and heavy snow resulting in a white out blizzard.
Wrn PWS Snd & Kenai Mtns	4/9/2009	Blizzard A storm moved from the north Pacific across the Aleutians to south of the Pribilof Islands to southwest of Kodiak Island. Blizzard conditions occurred in the western Aleutians on the 8th then in the Pribilof Islands on the 9th. The front associated with this storm produced snow in the Portage Valley area along with strong wind that resulted in a blizzard.
Wrn PWS Snd & Kenai Mtns	7/21/2009	High Wind: 71.3 mph (62 kts.) An unseasonably intense 974 MB storm for July moved into the Bristol Bay area on the 21st of July. The associated front pushed across south central Alaska producing strong wind across the Chugach Mountains through Portage Pass.
Seward, Lowell Point	7/30/2009	Flood, Heavy Rain, Damages: $50K A tropically connected storm resulted in heavy rain over the Kenai Peninsula that produced flooding in the Seward area. The approach to the bridge to Lowell Point washed out and a land slide at a tunnel at mile 11 shut down the Alaska Railroad. River gages in Seward exceeded flood stage.
Wrn PWS Snd & Kenai Mtns, Lowell Point	11/29-30/2009	Blizzard, High Wind: 89.7 mph (78 kts.) Damages: $50K A major Bering sea storm and the associated front that extended to the Gulf of Alaska produced high winds across the Aleutians and blizzard conditions from the Pribilof Islands to the Bering Sea coast and high wind heavy snow and blizzard conditions across south central Alaska and Prince William Sound. High surf caused extensive damage along Lowell Point road and the shore line around Seward and the sea wall near the Sea Life Center were damaged.
Wrn PWS Snd & Kenai Mtns	2/8/2010	Blizzard A strong north Pacific storm moved to the eastern Aleutians. This storm produced blizzards across the central Aleutians to the Pribilof Islands and along the Bering Sea coast of the Kuskokwim Delta. This storm also produced high wind across Kodiak Island and pushed snow and strong wind into Portage Valley.

Table 5-10 Severe Weather Events

Location	Date	Event Type and Magnitude
Wrn PWS Snd & Kenai Mtns	3/5/2010	Blizzard, High Wind: 80.5 mph (70 kts.) An intense storm caused high wind and blizzard conditions from the Central Aleutians across the Alaska Peninsula to the Pribilof Islands and across South Central Alaska and Prince William Sound.
Wrn PWS Snd & Kenai Mtns	5/11/2010	High Wind: 77 mph (67 kts.) A strong storm moved into Bristol Bay on May 11th. The associated front moved to along the North Gulf Coast producing the typical high wind through the gaps and across the Chugach Mountains. Peak gusts to 77 mph were observed at the Portage visitor center and to 81 mph along Turnagain Arm.
Seward	10/2/2010	Flood Flooding of the Resurrection River. Light rain in Seward on Sept 29. Light rain through Sept 30, with moderate and even heavy rain Oct 1 and Oct 2. Heavy rainfall along the Eastern Kenai Mountains caused the Resurrection River near Seward, Alaska to reach flood stage. It was over flood stage from Oct 2 at 7 AM ADT through 4 PM ADT Oct 2nd. The crest was at 18.17 ft, which is .67 ft over flood stage. In addition, the Seward Emergency Manager reported a mudslide on mile 19 with only one lane open. Water was up to the road at Salmon Creek road and Nash road. There was also an unconfirmed report of water over the bridge near the prison.
Wrn PWS Snd & Kenai Mtns	11/22/2010	Ice Storm A storm in the Bering Sea resulted in freezing rain that deposited over one quarter inch of ice across portions of south central Alaska. Freezing rain below warning criteria also fell across the Copper River Basin and the western Kenai Peninsula and isolated portions of northern Prince William Sound.
Wrn PWS Snd & Kenai Mtns	12/3/2010	Blizzard Strong wind combined with snow produced blizzard conditions across portions of southwest that then spread into the Cook Inlet region and Prince William Sound.
Wrn PWS Snd & Kenai Mtns	12/22/2010	High Wind: 77 mph (67 kts.) A strong Gulf of Alaska storm coupled with deep cold arctic air over interior Alaska produced strong north winds through the Chugach Mountains.
Wrn PWS Snd & Kenai Mtns	1/3/2011	Blizzard, High Wind: 74.8 mph (65 kts.) A strong low in Bristol Bay produced wind and snow resulting in blizzard conditions in the Kuskokwim Delta. This same storm also produced strong wind through Portage Pass.
Wrn PWS Snd & Kenai Mtns	2/13/2011	Blizzard A strong storm in the Gulf of Alaska produced high winds and snow with blowing snow in the northern and western portions of Prince William Sound as well as strong wind out of the Copper River Delta.
Wrn PWS Snd & Kenai Mtns	4/7/2011	Blizzard, High Wind: 65.5 mph (57 kts.) A large intense Bering Sea storm impacted Aleutian Islands to south central Alaska April 5th through the 7th. Wind gust reached 94 mph along Turnagain Arm and ranged from 72 to 78 mph along the Aleutian Islands… Blizzard conditions also occurred in the Chugach Mountains through Thompson Pass.
Wrn PWS Snd & Kenai Mtns	10/25/2011	High Wind: 69 mph (60 kts.) This storm produced hurricane force wind gust across the Alaska Peninsula to Kodiak Island and across the Kenai

Table 5-10 Severe Weather Events

Location	Date	Event Type and Magnitude
		Peninsula and eastern Prince William Sound. The resulting rough surf in Whittier washed 3 feet of the break water from the harbor area. High wind in eastern prince William Sound flipped a small plane over in the community of Ellamar.
Wrn PWS Snd & Kenai Mtns	11/3/2011	Blizzard, A strong storm moved into the eastern Bering Sea producing strong wind and blizzard conditions from the Bering Sea Coast across the Alaska Peninsula into the south central region of Alaska.
Wrn PWS Snd & Kenai Mtns	12/18-22/2011	Blizzard, High Wind: 100 mph (87 kts.) Hgh wind in south central region of Alaska and Prince William Sound along with the high wind, snow and blowing snow in Portage Valley and Thompson Pass produced blizzard conditions.
Wrn PWS Snd & Kenai Mtns	1/10/2012	Blizzard The blizzard conditions and an avalanche forced the Seward highway to be closed the night of the 10th through the afternoon of the 11th.

Location

Winter storms occur every year in the SBCFSA and the entire area is equally vulnerable to the risk of a winter storm event with the area receiving an average annual snowfall of about 33 inches, an average precipitation of 16 inches; most falling in the form of snow. Severe winter storms statewide have a recurrence interval of about every 13 years. Based on the recurrence interval, the probability of a severe winter storm occurring in the Planning Area is with all critical facilities and residences within the SBCFSA are highly vulnerable to the effects of a severe winter storm.

Extent

The entire SBCFSA is equally vulnerable to the severe weather effects with residents experiencing severe storm conditions with heavy snow depths; wind speeds exceeding 100 mph; and extreme low temperatures that reach -34ºF.

Based on past severe weather events and the criteria identified in Table 5-3, the extent of severe weather in the SBCFSA are considered limited where injuries do not result in permanent disability, complete critical facility shutdown would be unlikely for more than one week, and less than 10 percent of property would be severely damaged.

Impact

The intensity, location, and the land's topography influence the impact of severe weather conditions on a community.

Heavy snow can immobilize a community by bringing transportation to a halt. Until the snow can be removed, airports and roadways are impacted, even closed completely, stopping the flow of supplies and disrupting emergency and medical services. Accumulations of snow can cause roofs to collapse and knock down trees and power lines. Heavy snow can also damage light aircraft and sink small boats. A quick thaw after a heavy snow can cause substantial flooding.

The cost of snow removal, repairing damages, and the loss of business can have severe economic impacts on cities and towns.

Injuries and deaths related to heavy snow usually occur as a result of vehicle and or snow machine accidents. Casualties also occur due to overexertion while shoveling snow and hypothermia caused by overexposure to the cold weather.

Extreme cold can also bring transportation to a halt. Aircraft may be grounded due to extreme cold and ice fog conditions, cutting off access as well as the flow of supplies to communities. Long cold spells can cause rivers to freeze, disrupting shipping and increasing the likelihood of ice jams and associated flooding.

Extreme cold also interferes with the proper community infrastructure functions by causing fuel to congeal in storage tanks and supply lines, stopping electric generation. Without electricity, heaters and furnaces do not work, causing water and sewer pipes to freeze or rupture. If extreme cold conditions are combined with low or no snow cover, the ground's frost depth can increase, disturbing buried pipes. The greatest danger from extreme cold is its effect on people. Prolonged exposure to the cold can cause frostbite or hypothermia and become life-threatening. Infants and elderly people are most susceptible. The risk of hypothermia due to exposure greatly increases during episodes of extreme cold, and carbon monoxide poisoning is possible as people use supplemental heating devices.

Probability of Future Events

Based on previous occurrences and the criteria identified in Table 5-2, it is likely a severe storm event will occur in the next three years (event has up to 1 in 3 years chance of occurring) as the history of events is greater than 20 percent but less than or equal to 33 percent likely per year.

5.3.8 Wildland-Urban Interface Fire

5.3.8.1 Nature

A wildland fire is a type of wildfire that spreads by rapidly consuming vegetation. It often begins unnoticed, spreads quickly, and is usually signaled by dense smoke that may be visible from great distances. Wildland fires can be caused by human activities (such as arson or campfires) or by natural events such as lightning. Wildland fires often occur in forests or other areas with ample vegetation and may quickly spread to threat the urban environment. Subsequently, these wildland fires can be classified as wildland-urban fires, interface, or inter-mix fires. Prescribed burns are typically set by Department of Forestry or other fire agencies to reduce the fire hazard in predetermined areas.

The following three factors contribute significantly to wildland-urban fire behavior and can be used to identify high fire hazard areas.

- **Topography** describes slope increases, which influences the wildland fire spread rate. South-facing slopes are also subject to more solar radiation, making them drier and thereby intensifying fire spread behavior. However, ridge tops may mark the end of a fire spread since fire spreads more slowly or may even be unable to spread downhill.

- **Fuel** is the vegetation type and condition that plays a significant role a fire's occurrence and spread potential. Certain plant types are more susceptible to burning or will burn with greater intensity. Dense or overgrown vegetation increases the amount of combustible material available to fuel a fire (referred to as the "fuel load"). The ratio of living-to-dead plant matter is also important. The risk of fire is increased significantly during periods of prolonged drought as the moisture content of both living and dead plant matter decreases. The fuel load continuity, both horizontally and vertically, is also an important factor.
- **Weather** is the most variable factor affecting wildland fire behavior. Temperature, humidity, wind, and lightning can affect ignition opportunities and fire spread potential. Extreme weather, such as high temperatures and low humidity, can lead to extreme fire activity. By contrast, cooling and higher humidity often signal reduced fire occurrence and easier containment.

Wildland-urban fire frequency and severity also depends on other hazards, such as lightning, drought, and insect infestations (such as spruce-bark beetle infestation damages). If not promptly controlled, wildland fires may grow into an emergency or disaster threatening population centers. Even small fires can be devastating. In addition to affecting people, wildland fires may severely affect livestock, pets, wildlife, and fish stocks. Such events may require emergency water, food, evacuation, and shelter.

The indirect effects of wildland-urban fires can be catastrophic. In addition to stripping the land of vegetation and destroying forest resources, large, intense fires can harm the soil, waterways, and the land itself. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and increase river and stream siltation, thereby reducing flood potential, harming aquatic life, and degrading water quality. Vegetative striped lands also increase ground failure and debris flow hazards.

5.3.8.2 History

The Bear Creek Fire Service Area (BCFSA) was established to provide services to those facilities outside of the City of Seward's Fire Department. The Bear Creek Volunteer Fire & EMS website states:

> *"In 1976 a roadside food market caught fire during the night at mile 5.8 of the Seward Highway. A call for help dispatched Seward Volunteer Fire Department with one truck and several volunteers from their station 5 miles away.*
>
> *After arriving on scene, the engine quickly emptied its 500 gallons of water. The apparatus wasn't equipped to draft water and could only refill through a hydrant. Unfortunately, there were no hydrants within 4 miles and the market burned to the ground.*
>
> *After this d[i]sastrous fire, friends and neighbors of the roadside market united to establish the Bear Creek Fire Service Area. The doors officially opened in 1977, when the picture above was taken.*
>
> *Since the original building was constructed, the department has expanded to include a second apparatus building and a pump shed"* (BCFSA 2012).

The BCFSA's responsibilities extend from Seward Highway mile 3.5 to Mile 8. The area contains mostly residential buildings, but several commercial businesses are also present along with the Alaska Railroad, National Park Service, State Parks, and the US Forest Service offices and infrastructure.

Wildland fires have not been documented within the boundaries of the SBCFSA; however, wildland fires have occurred in the SBCFSA's vicinity. The Alaska Interagency Coordination Center (AICC) lists only 31 wildland fires (Table 5-11) that occurred within 50 miles of the SBCFSA during the past 72 year historical period (i.e., from 1939 to 2012); none of which threatened residential properties, commercial or public locations.

Table 5-11 Wildfire Locations Since 1939 Within 50 Miles Of SBCFSA

Fire Name	Fire Year	Estimated Acres	Latitude	Longitude	Cause
Vfd Bear Creek # 1	2011	0.1	60.2463875	-149.3494415	Human-Railroad
Lowell Point St Park	2010	2	60.065834	-149.4411163	Human
Bear Lake	2009	0.1	60.1833344	-149.3500061	Human-Campfire
Harbor View	2007	0.5	60.25	-149.4166718	Human
Snow River	2005	0.1	60.26583	-149.3278	Lightning
Tonsina Creek Fire	2005	3	60.06667	-149.45	Human
Nash Road Fire	2003	0.1	60.13334	-149.35	Human
Clearcut 103	2003	0.1	60.15	-149.3833	Human
Seward Vfd #1	2001	1	60.13334	-149.4167	Other
Japanese Creek	2000	2	60.11666	-149.45	Children
Camelot	1998	0.1	60.13334	-149.3833	Warming Fire
Mile 4 Seward	1997	0.3	60.1500015	-149.4166718	Slash Burn
Old Nash #2	1997	0.5	60.1333351	-149.3999939	Slash Burn
White`S Mill	1997	0.1	60.1500015	-149.3999939	Land Clear
Old Nash Road	1997	0.1	60.1500015	-149.3999939	Land Clear
Camelot	1997	0.1	60.1333351	-149.3833313	Warming Fire
High School	1997	0.5	60.1166649	-149.4166718	Slash Burn
Resurrection	1996	0.1	60.1833344	-149.5833282	Human-Campfire
Seward Vfd #1	1996	0.2	60.1333351	-149.4499969	Children
Powder Road	1996	0.1	60.1833344	-149.5500031	Human-Campfire
Lost Lake Trail	1996	0.1	60.1833344	-149.4166718	Human-Campfire
Bear Creek Vfd	1996	0.1	60.2666664	-149.3333282	Other
Unnamed	1995	0.1	60.1833344	-149.5833282	Human-Campfire
Exit Glacier	1994	0.1	60.1666679	-149.5166626	Campfire
Exit Glacier	1993	5.5	60.1666679	-149.4833374	Other
Exit Glacier Ii	1993	0.1	60.1833344	-149.5166626	Debris
Exit Glacier Iii	1993	0.1	60.1833344	-149.5166626	Debris
Marathon	1992	0.1	60.0833321	-149.4499969	Not Identified
Power Pole	1992	0.1	60.2666664	-149.3666687	Not Identified
001 Iditarod Trail	1991	0.1	60.1666679	-149.3999939	Not Identified
Lost Lake Sub Div	1992	2	60.1833344	-149.3333282	Not Identified

(AICC 2012)

All SBCFSA fires appear to have occurred within the mountainous areas as depicted by Figure 5-27.

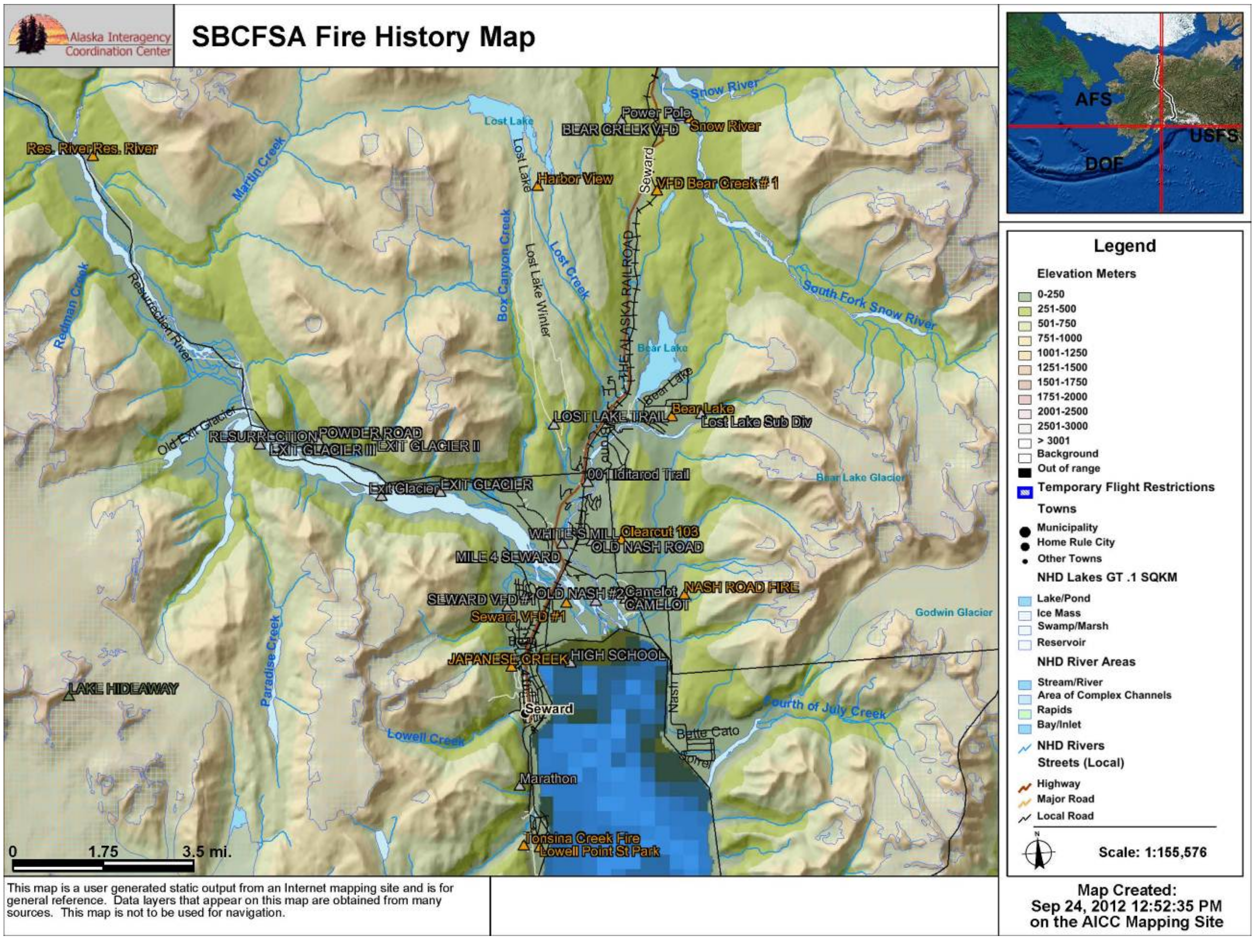


Figure 5-27 SBCFSA's Historical Wildfires (AICC 2012)

5.3.8.3 Location, Extent, Impact, and Probability of Future Events

Location

Under certain conditions wildland fires may occur in any area with fuel surrounding the SBCFSA. Since fuels data is not readily available, for the purposes of this plan, all areas outside SBCFSA limits are considered to be vulnerable to tundra/wildland fire impacts. Since 1939, 31 SBCFSA wildland fire events have occurred within 50 miles. (Figure 5-25).

Extent

Generally, fire vulnerability dramatically increases in the late summer and early fall as vegetation dries out, decreasing plant moisture content and increasing the ratio of dead fuel to living fuel. However, various other factors, including humidity, wind speed and direction, fuel load and fuel type, and topography can contribute to the intensity and spread of wildland fires. The common causes of wildland fires in Alaska include lightning strikes and human negligence.

Fuel determines how much energy the fire releases, how quickly the fire spreads, and how much effort is needed to contain the fire. Weather is the most variable factor. High temperatures and low humidity encourage fire activity while low temperatures and high humidity retard fire spread. Wind affects the speed and direction of fire spread. Topography directs air movement, which in-turn affects fire behavior. When the terrain funnels air, as happens in a canyon, it can lead to faster spreading. Fire also spreads up-slope faster than down-slope.

Figure 5-28 depicts USGS identified fuel types as a wildland fire potential location indicator.

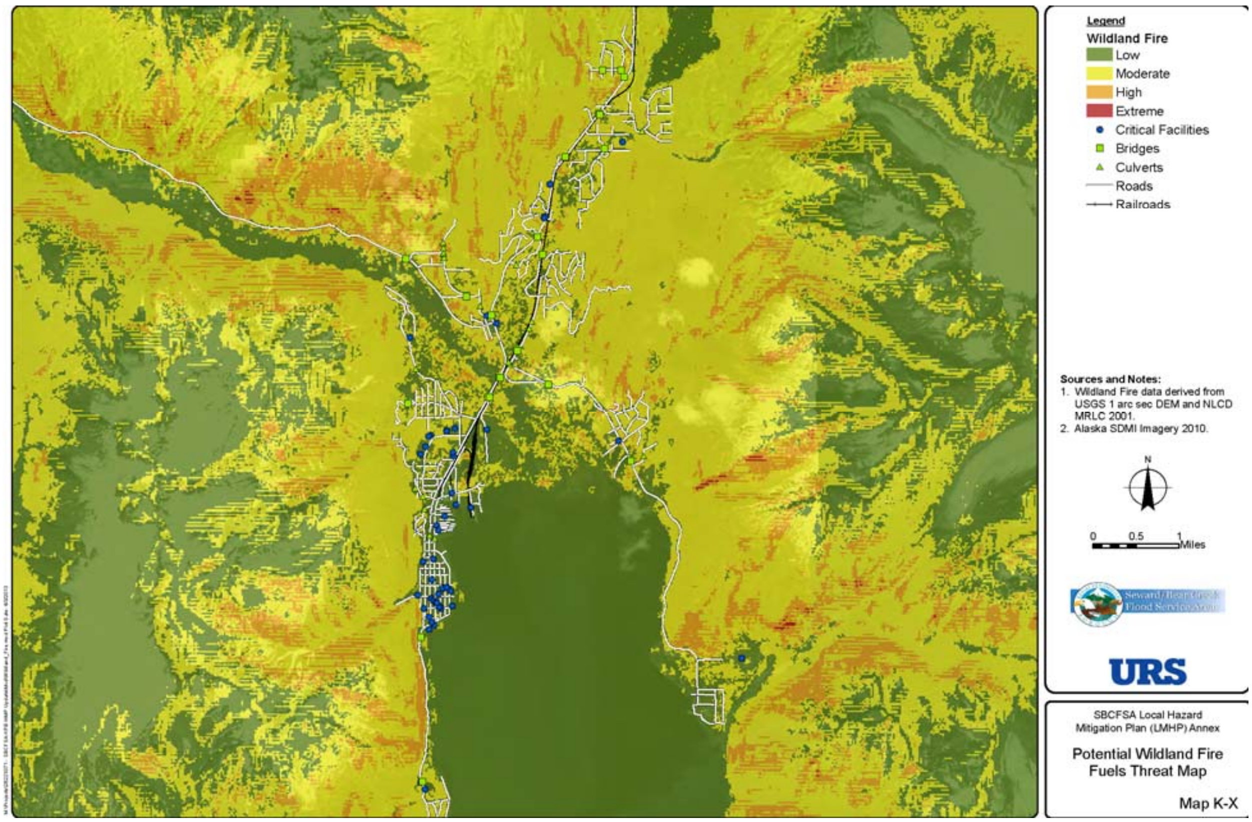


Figure 5-28 SBCFSA Wildland Fire Fuel Types

Very few fires in the SBCFSA exceeded 1 acre. It is difficult to determine the average number of acres burned as the fires were vastly different for each of the 31 wildland fire events identified in Table 5-11 (DOF 2012). An average based on such diverse data would easily be overstated.

Based on the limited number of past wildland fire events and the criteria identified in Table 5-11, the magnitude and severity of impacts in the SBCFSA are considered negligible with minor injuries, there is potential for critical facilities to be shut down for less than 24 hours, less than 10 percent of property or critical infrastructure being severely damaged, and little to no permanent damage to transportation or infrastructure or the economy.

Impact

Impacts of a wildland fire that interfaces with the population center of the SBCFSA could grow into an emergency or disaster if not properly controlled. A small fire can threaten lives and resources and destroy property. In addition to impacting people, wildland fires may severely impact livestock, pets, wildlife, and fish stocks. Such events may require emergency watering and feeding, evacuation, and alternative shelter.

Figure 5-29 displays the largest wildland fire perimeters.

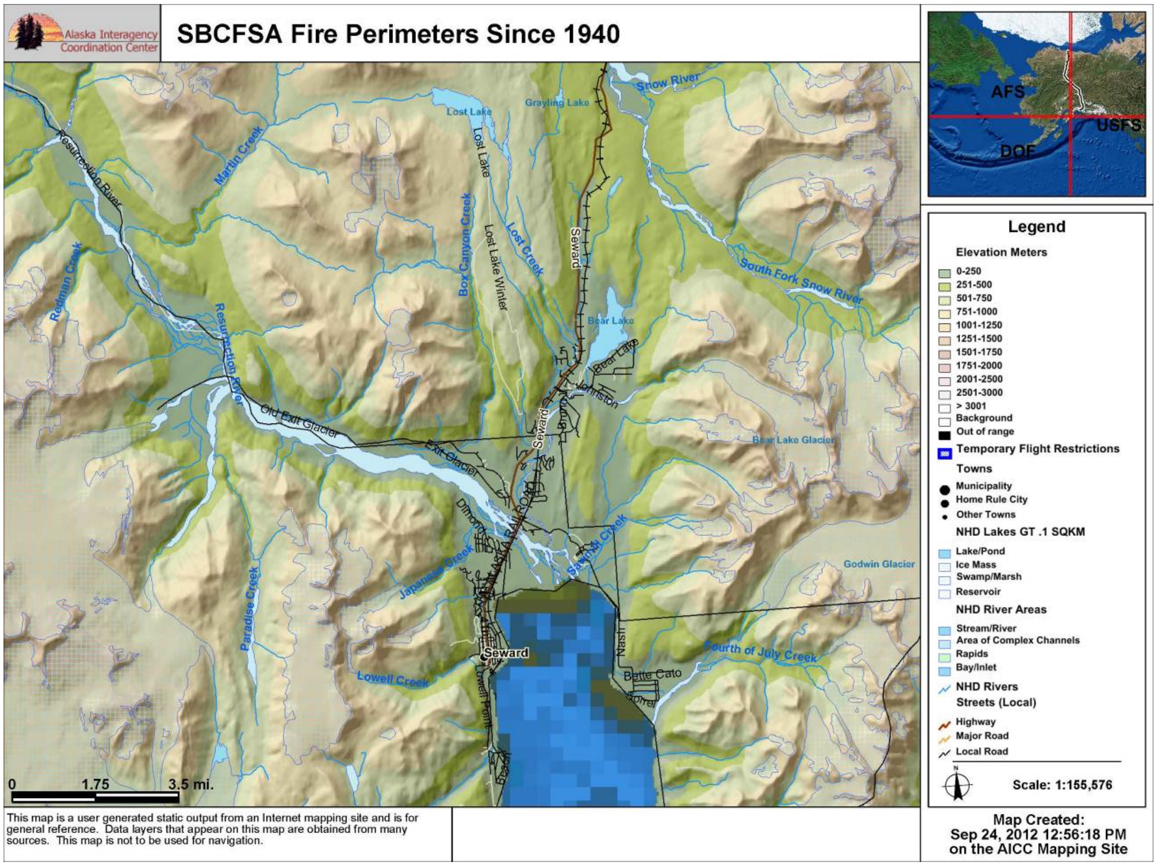


Figure 5-29 **SBCFSA Fire Perimeters Since 1940**

Indirect impacts of wildland fires can be catastrophic. In addition to stripping the land of vegetation and destroying forest resources, large, intense fires can harm the soil, waterways, and the land itself. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and enhance siltation of rivers and streams, thus increasing flood potential, harming aquatic life, and degrading water quality.

Probability of Future Events

Fire is recognized as a critical feature of the natural history of many ecosystems. It is essential to maintain the biodiversity and long-term ecological health of the land. The role of wildland fire as an essential ecological process and natural change agent has been incorporated into the fire management planning process and the full range of fire management activities is exercised in Alaska, to help achieve ecosystem sustainability, including its interrelated ecological, economic, and social consequences on firefighters, public safety and welfare; natural and cultural resources threatened; and the other values to be protected dictate the appropriate management response to the fire. In Alaska, and within 50 miles of the SBCFSA, the natural fire regime is characterized by a return interval of approximately 100 due to their dense timber and high susceptibility to spruce bark beetle infestation, vegetation, gently rolling topography, and coastal location.

Based on the history of wildland fires in the SBCFSA area and applying the criteria identified in Table 5-2, it is unlikely but possible a wildland-urban fire event will occur within in the next ten years. The event has up to 1 in 10 years chance of occurring and the history of events is less than or equal to 10 percent likely each year.

Based on climate change scenarios considered, average annual temperatures are expected to increase throughout the SBCFSA and surrounding areas. As a result, it is possible that the risk of fire could increase within the SBCFSA due to changing local conditions as a result of overall warmer temperatures. See Appendix I for additional information on climate change analysis and projected impacts on local hazards, including wildfires.

6.1 VULNERABILITY ANALYSIS OVERVIEW

A vulnerability analysis predicts the extent of exposure that may result from a hazard event of a given intensity in a given area. The analysis provides quantitative data that may be used to identify and prioritize potential mitigation measures by allowing communities to focus attention on areas with the greatest risk of damage. A vulnerability analysis is divided into eight steps:

1. Asset Inventory
2. Exposure Analysis For Current Assets
3. Repetitive Loss Properties
4. Land Use and Development Trends
5. Vulnerability Analysis Methodology
6. Data Limitations
7. Vulnerability Exposure Analysis
8. Future Development

This section provides an overview of the vulnerability analysis for current assets, and area future development initiatives.

DMA 2000 Recommendations
Assessing Risk and Vulnerability, and Analyzing Development Trends
§201.6(c)(2)(ii): The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. *All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods.* The plan should describe vulnerability in terms of: §201.6(c)(2)(ii)(A): The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; §201.6(c)(2)(ii)(B): An estimate of the potential dollar losses to vulnerable structures identified in … this section and a description of the methodology used to prepare the estimate. §201.6(c)(2)(ii)(C): Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.
1. REGULATION CHECKLIST
ELEMENT B. Risk Assessment, Assessing Vulnerability, Analyzing Development Trends
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))
B4. Does the Plan address NFIP insured structures within each jurisdiction that have been repetitively damaged by floods?
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))
Source: FEMA, October 2011.

The requirements for a vulnerability analysis as stipulated in DMA 2000 and its implementing regulations are described here.

- A summary of the community's vulnerability to each hazard that addresses the impact of each hazard on the community.
- Identification of the types and numbers of RL properties in the identified hazard areas.
- An identification of the types and numbers of existing vulnerable buildings, infrastructure, and critical facilities and, if possible, the types and numbers of vulnerable future development.
- Estimate of potential dollar losses to vulnerable structures and the methodology used to prepare the estimate.

Table 6-1 lists the SBCFSA population, building stock, and infrastructures' potential hazard vulnerability.

Table 6-1 Vulnerability Overview

Hazard	Area's Hazard Vulnerability			
	Percent of Jurisdiction's Geographic Area	Percent of Population	Percent of Building Stock	Percent of Critical Facilities and Utilities
Earthquake	100	100	100	100
Erosion	< 10	~ 10	< 10	< 5
Flood	< 10	~ 10	< 10	< 5
Ground Failure	< 5	< 5	< 5	< 5
Tsunami/Seiche	< 5	< 5	< 5	< 5
Volcano	100	100	100	100
Weather	100	100	100	100
Wildand Fire	100	100	100	100

6.2 LAND USE AND DEVELOPMENT TRENDS

Land use in the SBCFSA is predominately residential with limited area for commercial services. Community (or institutional) facilities are primarily located within Seward's City Limits. Suitable developable vacant land is in short supply within the boundaries of the SBCFSA due to steep mountain slopes, water bodies, and protected forests; open space and various hydrological bodies exist throughout the area.

The City of Seward's 2005 Comprehensive Development Plan (2020 Plan), Volume I, states in Section 3 the City's "Goals, Objectives, and Implementation Action Items", which include:

3.2 LAND USE

3.2.1 Promote residential and commercial development within the city of Seward and its vicinity in accordance with community values.

3.2.1.1 Manage land use to facilitate economic development while maintaining the historic, small town character of Seward.

3.2.1.2 Expand the opportunity for affordable, diverse, year-round housing through appropriate land use regulations.

3.2.1.3 Establish an attractive highway corridor from Mile 0 to 8.

3.2.2 Improve the capacity of the office of Community Development.

3.2.2.1 Maintain community vision through rigorous implementation and update of the Comprehensive and Land Use plans.

3.2.2.2 Improve the capability of the office of Community Development to develop land use and other maps in Seward.

3.2.3 Identify habitats such as eagle nesting and roosting areas, anadromous streams, wetlands and other wildlife areas.

3.3 HOUSING

3.3.1 Encourage development of new housing in Seward.

3.3.1.1 Support a range of housing choices that meet the needs of people in various income and age groups.

3.3.1.2 Create incentives to provide land for housing development within the City of Seward.

3.3.1.3 Assess solutions to extend cost-effective utilities to home sites on land zoned for residential development.

3.4 TRANSPORTATION

3.4.1 Update and use the Seward Transportation Plan (1999) as the primary tool to ensure safe and convenient transportation facilities.

3.4.1.1 Provide safe and efficient vehicular transportation facilities that meet the needs of the community.

3.4.1.2 Expand and maintain existing sidewalks and the multi-purpose trail system in order to provide safe, fully accessible, pedestrian pathways throughout the city.

3.4.1.3 Improve the usability of the state owned airport.

3.4.1.4 Support retention of the Alaska Marine Highway presence in Seward.

3.5 PORT AND HARBOR DEVELOPMENT

3.5.1 Create a thriving port of Seward through harbor improvements, infrastructure expansion, and implementation of management plans.

3.5.1.1 Encourage the growth and development of an efficient, functional small boat harbor that meets Seward's commercial and recreational needs.

3.5.1.2 Plan for adequate port infrastructure that will serve the needs of users in the main industrial/Alaska Railroad area and at the Seward Marine Industrial Center (SMIC), sustain an increase above the current activity, and attract new business…

3.8 NATURAL HAZARDS

3.8.1 Promote community safety from natural disasters through mitigation measures and preparedness training.

3.8.1.1 Protect citizens from natural hazards by using appropriate land use policies and regulations.

3.8.1.2 Create sound public uses of potentially hazardous lands.

3.8.1.3 Mitigate flood hazards.

3.8.1.3 Mitigate flood hazards.

3.8.2 Plan and prepare for disasters.

(Seward City, 2005).

The City of Seward 2020 Comprehensive Plan, Volume II (CSP 2005b) describes their current land use capability in Section 3.2.1. in the following way:

In the developed part of Seward, most land is held privately, but the City of Seward,

Kenai Peninsula Borough, State of Alaska, and Alaska Railroad Corporation (ARRC) have developed substantial portions of public lands. The city, state and ARRC also own undeveloped lands within city limits.

Undeveloped city land is concentrated in the southwest part of town and along the northeastern side of Resurrection Bay. Large blocks of state land are located along the

Resurrection River and the western boundary of city land. The ARRC owns blocks in the harbor and industrial parts of town. These are strategic locations, which can influence the type of development that occurs in Seward.

The borough owns lands developed for the schools and the waste transfer facility while the state has parcels developed throughout town for AVTEC, the airport, and road maintenance facilities.

The Kenai Peninsula Borough Comprehensive Plan (KPB 2005) describes the breakdown of land ownership (as of 2004) in Chapter 6 in the following figure (Figure 6-2):

Land Ownership by Major and Minor Category
2004

Owner	Acres	Percent of Total
FEDERAL		
Lake Clark National Park (NP)	1,523,000	
Katmai NP	588,000	
Kenai Fjords NP	574,000	
Kenai National Wildlife Refuge	1,894,000	
Alaska Marine National Wildlife Refuge	24,000	
Chugach National Forest	1,216,000	
Public Domain and Other Federal	1,035,375	
Total Federal	**6,854,375**	**65.5%**
STATE		
Department of Natural Resources	2,180,794	
Aviation Division	1,087	
Fish and Game	407	
Department of Transportation	159	
Mental Health Trust	18,7724	
University of Alaska	15,048	
Alaska Railroad Corporation	512	
Other State	49	
Total State	**2,223,923**	**21.3%**
BOROUGH	**72,409**	**0.7%**
CITY	**17,116**	**0.2%**
NATIVE CORPORATION OR TRIBE/VILLAGE		
Chugach Alaska Corporation	52,684	
Cook Inlet Region, Inc.	523,108	
English Bay Corporation	61,864	
Kenai Natives Association, Inc.	8,294	
Nanwalek Village and Council	82	
Ninilchik Native Association and Village Council	44,335	
Port Graham Corporation and Village Council	97,057	
Salamatof Native Association, Inc.	24,060	
Seldovia Native Association, Inc.	72,809	
Tyonek Native Corporation and Village	78,849	
Total Native Land	**929,174**	**8.9%**
OTHER PRIVATE LAND	**357,826**	**3.4%**
TOTAL ALL OWNERS	**10,458,699**	**100%**

Source: KPB Assessing Department, Cogan Owens Gogan

Figure 6-1 Kenai Peninsula Borough Comprehensive Plan (KPB 2005)

6.3 VULNERABILITY EXPOSURE ANALYSIS FOR CURRENT ASSETS

6.3.1 Asset Inventory

Asset inventory is the first step of a vulnerability analysis. Assets that may be affected by hazard events include population (for community-wide hazards), residential buildings (where data is available), and critical facilities and infrastructure. The assets and associated values throughout the SBCFSA are identified and discussed in detail in the following sections.

6.3.1.1 Population and Building Stock

For this analysis, several different sources were examined to determine the most appropriate structure inventory data for flood analysis. For example, Table 6-3 shows 2010 U.S. Census data and more detailed 2012 population data from the Alaska Department of Labor (DOL). The table delineates population data for the study's population areas within the SBCFSA (i.e. City of Seward, Bear Creek, and Lowell Point) and also provides residential structure numbers and replacement value estimates. (US Census 2010, DOL 2012)

Table 6-3 Estimated Population and Building Inventory

Location	Population		Residential Buildings	
	2010 Census	DOL 2012	Total Structure Count	Total Structure Replacement Value[1] ($)
City of Seward	2,693	2,733	947	181,824,000
Bear Creek	1,956	1,958	720	134,064,000
Lowell Point	80	71	71	9,230,000
Total	**4,729**	**4,762**	**1,738**	**$325,118,000**

Sources: The SBCFSA, U.S. Census 2010, and 2012 Alaska Department of Labor.

[1] The 2010 US Census estimates residential building values at City of Seward: $192,000, Bear Creek: $186,200, and Lowell Point: $130,000.

A total of 1,738 single-family residential buildings are shown in Table 6-3. Replacement values for those structures were obtained from the Kenai Peninsula Borough's parcels database.

Table 6-4 summarizes the flood analysis study results for the total structure counts and structure replacement values for structure grouping types for the entire census tract for the SBCFSA. (See Appendix J for detailed Hazus analysis.)

Table 6-4 Hazus Major Release 2.1 Building Inventory Estimates for SBCFSA

Occupancy Type	Total Structure Count	Total Structure Replacement Values[1]	Total Contents Replacement Values[1]
Residential	1919	$418,708,000	$209,354,000
Commercial and Industrial	376	$233,424,000	$247,439,000
Other[2]	52	$118,258,000	$139,097,000
Total	**2,347**	**$770,390,000**	**$595,890,000**

Source: *KPB Parcel Data, KPB Building Data, KPB aerial photography, RSMeans 2012 Residential Cost Data and Light Commercial Cost Data, Hazus default data for region, field survey, publically available aerial and street level photography*

[1] *2012 Dollars from RSMeans 2012 Residential Cost Data and Light Commercial Cost Data.*

[2] *Other occupancy types include Government, Education, Religion, and Agriculture.*

The residential structure count of 1,919 is much closer to the 1,738 value in Table 6-3 than the 3,622 estimate from Hazus default General Building Stock (GBS) in Appendix J, Table J-1. For non-residential structures, the Hazus user-defined facilities (UDF) had much higher counts and replacement values than the Hazus GBS values.

6.3.1.2 Existing Infrastructure

Table 6-5 list the SBCFSA's DCRA funded "completed" infrastructure improvement projects. They provide a depiction of the community's ongoing development trends and focus toward improving aging infrastructure.

Table 6-5 Completed Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
Division of Community and Regional Affairs (DCRA)	2009	Funded	Waterfront Pavilion - Comments: Legislative Grant	Completed	$195,000
Denali Commission (Denali)	2008	Funded	Providence Seward Endoscopy Equipment - Comments: Funding includes purchase and installation of endoscopy equipment.	Project Close-out Complete	$84,498
Department of Health and Human Services (DHSS)	2008	Funded	Seaview Community Services - Comments: Other funding: Denali Commission.	Completed	$18,885
Denali	2008	Funded	East Harbor Reconstruction - Comments: This project will expand the Seward boat harbor to house large commercial fishing and US Coast Guard vessels. Construction includes floats, gangway and approach, utilities and fire suppression system. This large-vessel harbor will improve maneuver safety and overall operations. This facility also extends the life of other harbor areas through reduced wear on smaller floats, piling and gear.	Project Close-out Complete	$5,500,000
DCRA	2008	Funded	Shellfish Enhancement Project - Comments: Legislative Grant - Named Recipient	Completed	$250,000
DCRA	2007	Funded	Lowell Point Fire Department Building - Comments: Legislative Grant Lowell Point Fire Department Building	Completed	$30,000
DCRA	2007	Funded	Seward Senior and Community Center Repairs - Comments: Legislative Grant	Completed	$50,000
DCRA	2007	Funded	T-Dock and Bulkhead Phase (Ph) 2 - Comments: Legislative Grant	Completed	$1,000,000
DCRA	2007	Funded	T-Dock and Bulkhead Ph 2 - Comments: Legislative Grant	Completed	$1,200,000
DCRA	2007	Funded	Aluttiiq Pride Shellfish Hatchery - Comments: Legislative Grant	Completed	$150,000
Denali	2006	Funded	Facility Improvements (SCS) - Comments: Seaview Community Services (SCS)	Project Close-out Complete	$33,119
DCRA	2006	Funded	T-dock and Bulkhead - Comments: Legislative Grant	Completed	$2,000,000
Denali	2005	Funded	Repair & Renovation: Domestic Violence Facility (SCS) - Comments: Seaview Community Services (SCS)	Project Close-out Complete	$71,379
DHSS	2005	Funded	Sea View Community Services - Deferred Maintenance Roof Design, Construction, Carport Heater	Completed	$89,490

Table 6-5 Completed Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
Alaska Energy Authority (AEA)	2005	Funded	Alaska Vocational Technical Center (AVTEC) Power System Upgrade - Comments: Other funding: Denali Commission $153,507. Upgrade to the switchgear and engine controls of the school's powerhouse operator training equipment, for consistency with the village powerhouse upgrade projects simultaneously occurring.	Completed	$153,507
Department Of Transportation And Public Facilities (DOT/PF)	2004	Funded	North Forest Acres Road Construction - Comments: Construct a new industrial service road from the Seward Highway (Milepost [MP] 2.8) to the landfill and rock quarry near Jappanese Creek. The road will be constructed on top of a flood control levee that is being constructed by the US Corps of Engineers (USACE) in cooperation with the City of Seward. North Forest Acres Road Construction	Completed	$200,000
Denali	2004	Funded	Design Long Term Care Facility - Comments: Scope of work: design of long term care facility in Seward, AK	Project Close-out Complete	$1,665,000
DCRA	2004	Funded	Pristine Products: Floating Oyster Smokehouse Construction - Comments: Fish Econ Dev. Grant	Completed	$26,588
DCRA	2004	Funded	Portage Distributing: Processing Plant Upgrades - Comments: Fish Econ Dev. Grant	Completed	$155,930
DCRA	2004	Funded	Marketing Smoked Salmon Sausage - Comments: Salmon Marketing	Completed	$150,000
DCRA	2004	Funded	Algae Rearing System - Comments: Fish Economic Development Grant	Completed	$554,781
DOT/PF	2003	Funded	Commuter Bus Purchase - Comments: Purchase two 18-passenger busses with wheelchair lifts, four all-weather waiting stations and signage to operate a local transit system. (Seward)	Completed	$146,500
Federal Aviation Administration (FAA)	2003	Funded	Conduct Airport Master Plan Study - Comments: Other funding: DOT/PF	Completed	$92,288
DCRA	2003	Funded	Communication System Upgrade - Comments: Capital Matching	Completed	$92,396
DCRA	2003	Funded	Police Console - Comments: Legislative Grant	Completed	$75,000
DHSS	2003	Funded	Sea View Community Services - Equipment - Comments: Capital Grant. Purchase of appliances and furniture. Sea View Community Services - Equipment	Completed	$24,909
Department Of Environmental Conservation (DEC) /Municipal Matching Grants And Loans (MGL)	2003	Funded	Gateway to Forest Avenue Waterline Extension - Comments: Other funding: Environmental Protection Agency (EPA) $297,400. Construction of a water line to the undeveloped lots for fire protection and domestic use.	Completed	$566,571
Alaska Housing Finance Corporation (AHFC)	2003	Funded	Glacier View Renovation - Comments: Construction Dept. - 30 unit senior housing	Completed	$1,180,206
DHSS	2003	Funded	Sea View Community Services - Computer Server Replacement - Comments: Capital Grant.	Completed	$142,041

Table 6-5 Completed Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
DHSS	2003	Funded	Sea View Community Services - Computer System Renovation and Training. - Comments: Capital Grant.	Completed	$119,369
AEA- Alternative Energy And Energy Efficiency (AEEE)	2003	Funded	Fuel Cell Demonstration - Comments: Other funding: US Department of Energy (DOE). Install a fuel cell at Exit Glacier in Seward.	Completed	$25,000
DHSS	2003	Funded	Providence Seward Medical and Care Center - Purchase new computerized axial tomography (CT) scanner - Comments: Other Funding: Denali Commission. Purchase and installation of a refurbished CT Scanner, accessories, and mobile trailer. The scanner will be permanently housed in the trailer located immediately adjacent to the hospital. This project will eliminate the need for long distance travel by patience in need of this service.	Completed	$583,770
Denali	2003	Funded	Fuel Cell Demonstration Project - Comments: Funding to assist the Alaska Energy Authority in the fuel cell demo project at the National Park Service's (NPS) new Exit Glacier Visitor Center. The outcome of this demo could be useful in assessing future direction of energy projects in Alaska.	N/A	$25,000
Alaska Department Of Education And Early Development (DEED)	2002	Funded	Seward Middle School Roof	Completed	$278,275
US Army Corps of Engineers (USACE)	2002	Funded	Harbor/Construction Ph 1 - Comments: Design due April 2002	Completed	$2,500,000
Denali	2002	Funded	Unknown	Project Close-out Complete	$89,823
DOT/PF	2002	Funded	Spruce Creek Bridge #1783 - Comments: Construct Spruce Creek Bridge in Seward.	Completed	$289,000
DOT/PF	2002	Funded	Nash Road: MP 0.0 to MP 5.3 Rehabilitation, Ph 2 - Comments: Resurface 5.3 miles of road to include signing, striping, and drainage improvements.	Completed	$4,730,000
DCRA	2002	Funded	Seward Shipyard Portable Work Station - Comments: Legislative Grant	Completed	$1,000,000
DOT/PF	2002	Funded	Harbor Pedestrian Pathway	Completed	$675,000
DCRA	2002	Funded	Fire Hydrant Upgrade - Comments: Capital Matching	Completed	$88,088
DOT/PF	2001	Funded	Exit Glacier Road MP 3.9 to 7.3	Completed	$2,568,602
DHSS	2001	Funded	Sea View Community Services - Facility repairs, upgrades, and safety improvements - Comments: Capital Grant.	Completed	$56,509
DCRA	2001	Funded	City Hall Facilities & Equipment - Comments: Capital Matching	Completed	$90,466
DOT/PF	2001	Funded	Exit Glacier Road MP 7.3 to 8.8	Completed	$590,368
Economic Development	2001	Funded	Unknown	Completed	$1,300,000

Table 6-5 Completed Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
Administration (EDA)					
AHFC	2001	Funded	Glacier View valves, roof, elevator	Completed	$191,482
DCRA	2001	Funded	Media Campaign to Encourage Economic Growth - Comments: Mini-Grant	Completed	$26,000
DEC/MGL	2001	Funded	Water/Sewer System Analysis/Prelim Design - Comments: Analysis and design of water and sewer improvements needed throughout the City.	Completed	$189,200
Denali	2001	Funded	Construction & renovation of regional dental clinic & multi-purpose health care - Comments: Construction & renovation of regional dental clinic & multi-purpose health care provider training room	Construction Complete	$953,034
DHSS	2001	Funded	Wesley Nursing Home - Community Needs Assessment and Engineering Building Assessment. - Comments: Other Funding: Federal $25,000.	Completed	$100,000
DEC/MGL	2000	Funded	Water Distribution System Analysis - Comments: Other funding: AHFC $24.800.	Completed	$118,700
DHSS	2000	Funded	Sea View Community Services - City System Sewer Line Hookup for the Assisted Living Home - Comments: Capital Grant.	Completed	$102,200
AHFC	2000	Funded	Glacier View Windows	Completed	$123,657
DOT/PF	2000	Funded	Seward Railcar Preservation - Comments: Preservation of a 1916 Alaska Railroad railcar. The railcar is to be used as a visitor center/museum. Work would include restrooms.	Completed	$60,000
DOT/PF	2000	Funded	Pathway Construction - Comments: Construct pedestrian paths along Van Buren Avenue from 4th Ave to 2nd Ave; along Railway Ave from 6th Avenue to 4th Avenue with wheelchair access from Railway Ave; to the historic Railroad Depot; and along Coolidge Drive from Swetmann Avenue to Seward Highway. Pathway Construction	Completed	$310,000
DOT/PF	2000	Funded	Seward Intermodal Freight and Passenger Facilities - Comments: Construct capital improvements to intermodal freight and passenger facilities.	Completed	$6,852,100
DCRA	2000	Funded	Curb Cuts for ADA Compliance-Sidewalk, Curb, Gutters - Comments: Capital Matching	Completed	$34,564
DCRA	2000	Funded	Fire Department Fire Hose Replacement - Comments: Capital Matching	Completed	$40,000
DCRA	1999	Funded	Replacement electric generator - Comments: Legislative Grant	Completed	$1,088,500
DCRA	1999	Funded	ADA Campsites and Sewer Dump Station - Comments: Capital Matching	Completed	$32,925
DCRA	1999	Funded	Library Parking Lot Paving - Comments: Capital Matching	Completed	$11,008
Housing and Urban Development	1999	Funded	Alaska Vocational Technical Center - Maritime Vessel Simulator - Comments: Economic	Completed	$2,500,000

Table 6-5 Completed Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
(HUD)			Development Initiative (EDI) Program		
DCRA	1999	Funded	911 Equipment Replacement - Comments: Capital Matching	Completed	$34,155
DCRA	1998	Funded	Community Facilities and Equipment - Comments: Capital Matching	Completed	$38,548
DCRA	1998	Funded	Harbor Plaza Renovation - Comments: Capital Matching Harbor Plaza Renovation	Completed	$55,670
DOT/PF	1998	Funded	Seward Hwy: MP 0 to 8 Reconstruction and Pathway - Seward to Grouse Creek Canyon	Completed	$17,018,556
DCRA	1998	Funded	Library Information and Technology Automation Project - Comments: Capital Matching	Completed	$26,611
DCRA	1997	Funded	Museum Darkroom - Comments: Capital Matching	Completed	$10,465
DCRA	1997	Funded	Street Paving - Comments: Capital Matching	Completed	$18,236
DCRA	1997	Funded	Historical Records Preservation - Comments: Capital Matching	Completed	$24,841
DCRA	1997	Funded	Library Basement Remodeling - Comments: Capital Matching	Completed	$12,396
DCRA	1997	Funded	Prismatic Surgical Lighting Purchase - Comments: Capital Matching	Completed	$19,862
DCRA	1997	Funded	Children's Library Renovation - Comments: Capital Matching	Completed	$12,396
DCRA	1997	Funded	Historical Records Preservation - Comments: Capital Matching	Completed	$33,546
DCRA	1996	Funded	Refurbish Seward Community Cemetery - Comments: Capital Matching Refurbish Seward Community Cemetery	Completed	$14,867
DCRA	1996	Funded	Purchase Rescue / Emergency Response Vehicle - Comments: Capital Matching	Completed	$58,172
DOT&PF	1996	Funded	Seward Highway (Hwy): MP 90.3 to 97, Ph 3	Completed	$8,702,640
DCRA	1996	Funded	Purchase Electrocardiogram and Dynamap Critical Care Monitoring System - Comments: Capital Matching	Completed	$15,199
DCRA	1996	Funded	Kenai Peninsula Borough - Seward High School Re-roof - Comments: Legislative Grant	Completed	$29,901
DOT/PF	1996	Funded	Seward Hwy: MP 8 To 18 Rehabilitation	Completed	$24,269,418
DCRA	1995	Funded	Emergency Response Vehicle - Comments: Capital Matching	Completed	$50,993
FAA	1995	Funded	Seward Airport: Improve Airport Drainage - Comments: Other funding: DOT/PF	Completed	$699,992
DCRA	1995	Funded	Gateway Subdivision Land Acquisition/Park Construction - Comments: Capital Matching	Completed	$59,249
DCRA	1994	Funded	Replace Anesthesia Machine - Comments: Capital Matching	Completed	$25,700
DCRA	1994	Funded	Hospital Equipment - Comments: Legislative Grant Hospital Equipment	Completed	$50,000
DCRA	1994	Funded	Cruise Ship Dock - Comments: Legislative Grant	Completed	$450,000

Table 6-5 Completed Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
DCRA	1994	Funded	Alaska Sea-Life Center Start-up Costs - Comments: Legislative Grant	Completed	$100,000
DCRA	1994	Funded	Development of the Alaska Sea Life Center - Comments: Legislative Grant. A Recreation and Marine Mammal Rehabilitation Center and Center for Education and Research Related to the Natural Resources Injured by the Exxon Valdez Oil Spill	Completed	$12,500,000
DCRA	1994	Funded	Community Bike Path Extension - Comments: Capital Matching	Completed	$50,802
DCRA	1994	Funded	Replace Anesthesia Machine - Comments: Capital Matching	Completed	$25,700
DCRA	1994	Funded	Renovate Radio Dispatch Electrical Wiring and Radios - Comments: Capital Matching	Completed	$17,000
DCRA	1994	Funded	Purchase Emergency Shelter Supplies - Comments: Capital Matching	Completed	$26,501
FAA	1991	Funded	Acquire Land for Development - Comments: Other funding: DOT/PF	Completed	$221,744
FAA	1991	Funded	Improve Access Road - Comments: Other funding: DOT/PF	Completed	$376,125
FAA	1991	Funded	Construct Apron - Comments: Other funding: DOT/PF Construct Apron	Completed	$828,880
FAA	1991	Funded	Construct Taxiway - Comments: Other funding: DOT/PF	Completed	$39,946

(DCRA 2013)

6.3.1.3 Existing Critical Facilities and Infrastructure

A critical facility is defined as a facility that provides essential products and services to the general public, such as preserving the quality of life in the SBCFSA and fulfilling important public safety, emergency response, and disaster recovery functions. The critical facilities profiled in this plan include the following:

- Government facilities, such as SBCFSA and tribal administrative offices, departments, or agencies
- Emergency response facilities, including police department and firefighting equipment
- Educational facilities, including K-12
- Care facilities, such as medical clinics, congregate living health, residential and continuing care, and retirement facilities
- Community gathering places, such as community and youth centers
- Utilities, such as electric generation, communications, water and waste water treatment, sewage lagoons, landfills.

The SBCFSA's critical facilities and infrastructure data is not included within the HMP for Homeland Security reasons. Please contact the Kenai Peninsula Borough Emergency Manager to acquire this data.

6.4 REPETITIVE LOSS PROPERTIES

This section estimates the number and type of structures at risk to repetitive flooding. (Properties which have experienced RL and the extent of flood depth and damage potential.)

DMA 2000 Requirements
Addressing Risk and Vulnerability to NFIP Insured Structures §201.6(c)(2)(ii): The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. *All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods.* The plan should describe vulnerability in terms of: §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of] the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; §201.6(c)(2)(ii)(B): The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate; §201.6(c)(2)(ii)(C): The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. §201.6(c)(3)(ii): The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.
1. REGULATION CHECKLIST
ELEMENT B. NFIP Insured Structures
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods?
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate?
Source: FEMA, October 2011.

The SBCFSA participates in the NFIP through the Kenai Peninsula Borough. There is one repetitive flood property within the SBCFSA that fulfills NFIP criteria. (Table 6-6) This property was identified by the SBCFSA during the September 2012 federally declared flood disaster (FEMA 4095-DR). This property is uninsured and therefore ineligible to file NFIP damage claims.

Future HMP updates will strive to obtain more comprehensive property loss information as indicated in Table 6-6 and identified in the Mitigation Strategy, Table 7-8, Action ID: FL 6.2. to garner additional National Flood Insurance Program (NFIP) and Community Rating System (CRS) benefits.

Table 6-6 Repetitive Loss Properties

Type (RL/SRL)	Community Name	Occupancy (#)	No. of Losses	Flood Insurance (Yes/No)	Structure Value ($)[1]	Total Claims ($)[2]
RL	House #1: Describe location	Single Family	N/A	Yes	Unknown	Unknown

[1]Insured structural value as of *date*.
[2]Content and building claims.

(KPB 2010)

The City of Seward and KPB have been active NFIP participant since November 20, 1988 and November 12, 1986 as shown in Tables 6-7 and 6-8 respectively.

The City of Seward's FEMA issued Flood Insurance Rate Maps (FIRMs) delineate the SBCFSA's floodplain. Their numbers are: 020012IND0, 0200123255A, 020012360A, 0200123265A, 0200123270A, all of which encompass the SBCFSA.

Table 6-7 NFIP Participation Data

(City of Seward, 020113)

Category	Data	Category	Data
Date joined NFIP	11/20/1986	**Number of policies in force**	14
CRS class / discount	07/15%	**Insurance in force**	$4,357,600
CAV date	06/18/2010	**Number of paid losses**	--
CAC date	--	**Total losses paid**	--
Date of current FIRM	12/06/1999	**Substantial damage claims since 1978**	--

CAC = Community Assistance Contact
CAV = Community Assistance Visit
CRS = Community Rating System
FIRM = Flood Insurance Rate Map
NFIP = National Flood Insurance Program

Table 6-8 NFIP Participation Data

(Kenai Peninsula Borough, 020012)

Category	Data	Category	Data
Date joined NFIP:	11/20/1986	**Number of policies in force**	324
Reinstatement Date:	11/20/1986		
CRS class / discount	08/10%	**Insurance in force**	$70,655,200
CAV date	07/10/2007	**Number of paid losses**	35
CAC date	10/09/2003	**Total losses paid**	$410,727.08
Date of current FIRM	12/06/1999	**Substantial damage claims since 1978**	5

CAC = Community Assistance Contact
CAV = Community Assistance Visit
CRS = Community Rating System
FIRM = Flood Insurance Rate Map
NFIP = National Flood Insurance Program

6.5 VULNERABILITY ANALYSIS METHODOLOGY

A conservative exposure-level analysis was conducted to assess the risks of the identified hazards. This analysis is a simplified assessment of the potential effects of the hazards on values at risk without consideration of probability or level of damage.

The methodology used a two pronged effort. First, The Planning Team used the State's Critical Facility Inventory and locally obtained GPS coordinate data to identify critical facility locations in relation to potential hazard's threat exposure and vulnerability. Second this data was used to develop a vulnerability assessment for those hazards where GIS based hazard mapping information was available.

Replacement structure and contents values were developed for physical assets. These value estimates were provided by the Planning Team. For each physical asset located within a hazard area, exposure was calculated by assuming the worst-case scenario (that is, the asset would be completely destroyed and would have to be replaced). Finally, the aggregate exposure, in terms of replacement value or insurance coverage, for each category of structure or facility was estimated. A similar analysis was used to evaluate the proportion of the population at risk. However, the analysis simply represents the number of people at risk; no estimate of the number of potential injuries or deaths was prepared.

6.6 DATA LIMITATIONS

The vulnerability estimates provided herein use the best data currently available, and the methodologies applied result in a risk approximation. These estimates may be used to understand relative risk from hazards and potential losses. However, uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning hazards and their effects on the built environment as well as the use of approximations and simplifications that are necessary for a comprehensive analysis.

It is also important to note that the quantitative vulnerability assessment results are limited to the exposure of people, buildings, and critical facilities and infrastructure to the identified hazards. It was beyond the scope of this HMP to develop a more detailed or comprehensive assessment of risk (including annualized losses, people injured or killed, shelter requirements, loss of facility/system function, and economic losses). Such impacts may be addressed with future updates of the HMP.

6.7 VULNERABILITY EXPOSURE ANALYSIS

The Kenai Peninsula Borough provided extensive area wide GIS data which formed the basis for the SBCFSA's critical facility hazard exposure analysis.

6.7.1 Existing Infrastructure

Tables 6-9, 6-10, and 6-11 summarize the results of the GIS-based exposure analysis for SBCFSA's loss estimations.

Table 6-9 SBCFSA Potential Hazard Exposure Analysis Overview – Population and Buildings

Hazard Type		Hazard Area	Methodology	Population Number[1]	Buildings			
					Residential		Non-Residential	
					Number	Value ($)[2]	Number	Value ($)[2]
Earthquake[3]		Strong	9-20% (g)	4,762	1,919	$418,708,000	478	$351,682,000
		Very strong	20-40% (g)					
		Severe	>40-60% (g)					
Erosion		Within 30 ft of erosion areas	Descriptive	Unknown	12	$2,051,300	4	$31,881,600
Flood	Riverine Flood[4]	Moderate	500-year floodplain	755	272	$59,468,713	100	$89,063,105
		High	100-year floodplain	558	199	$42,928,270	76	$75,883,673
	Coastal Flood	High	Coastal VE Flood Zone	117	51	$13,013,583	7	$20,182,014
Ground Failure (Avalanche, landslide, subsidence, unstable soils)		Low	0-11%	Unknown	1,885	$418,708,000	428	$351,682,000
		Moderate	11-21%	Unknown	23	$3,520,000	Unknown	Unknown
		High	21-41%	Unknown	11	$9,506,400	Unknown	Unknown
		Very High	> 41%	Unknown	Unknown	Unknown	Unknown	Unknown
Severe Weather		--	descriptive	4,762	1,919	$418,708,000	478	$351,682,000
Tsunami Seiche		DGGS GIS	descriptive	645	184	$78,182,123	134	$221,500,871
Volcanic		--	descriptive	4,762	1,919	$418,708,000	478	$351,682,000
Wildland Fire		Low	Low fuel rank	Unknown	892	$217,771,800	298	$351,682,000
		Moderate	Moderate fuel rank	Unknown	968	$375,945,900	127	$142,270,300
		High	High fuel rank	Unknown	59	$79,983,900	3	$860,000
		Extreme	Extreme fuel rank	Unknown	Unknown	Unknown	Unknown	Unknown

1. Affected population was estimated by multiplying the percentage of buildings impacted in each category by the total population.
2. Replacement values taken from User-Defined Facilities data based on KPB parcel datasets and RS Means information. Values are in 2012 dollars.
3. Exposure due to Earthquake is the same for all hazard levels.
4. Exposure due to Lowell Creek is not included in the Riverine Flood overview, as hazard events on Lowell Creek are more extreme than those included here.

Table 6-10 Potential Hazard Exposure Analysis – Critical Facilities

			Government and Emergency Response		Educational		Medical Care		Community	
Hazard Type	Hazard Area	Methodology	# Bldgs/ # Occ[3]	Value[1] ($)	# Bldgs/ # Occ[3]	Value[1] ($)	# Bldgs/ # Occ[3]	Value[1] ($)	# Bldgs/ # Occ[3]	Value[1] ($)
Earthquake[2]	Strong	9-20% (g)	9/NA[3]	$15,465,027	6/NA[3]	$42,501,375	3/NA[3]	$17,277,387	23/NA[3]	$45,324,661
	Very strong	20-40% (g)								
	Severe	>40-60% (g)								
Erosion	Within 30 ft of erosion areas	Descriptive	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
Flood – Riverine	Moderate	500-year floodplain	1/NA[3]	$2,002,127	0/NA[3]	--	1/NA[3]	$1,082,668	3/NA[3]	$3,469,176
Flood – Riverine	High	100-year floodplain	0/NA[3]	--	0/NA[3]	--	1/NA[3]	$1,082,668	2/NA[3]	$2,695,217
Flood – Coastal	High	Coastal VE Flood Zone	0/NA[3]	--	0/NA[3]	--	0/NA[3]	--	0/NA[3]	--
Ground Failure	Low	0-11%	9/NA[3]	$7,394,300	6/NA[3]	$121,762,600	3/NA[3]	$6,745,400	23/NA[3]	$100,789,300
	Moderate	11-21%	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
	High	21-41%	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
	Very High	> 41%	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
Severe Weather	--	Descriptive	19/NA[3]	$36,483,842	11/NA[3]	$142,498,908	1/NA[3]	$18,438,505	10/NA[3]	$19,442,383
Tsunami/ Seiche			2/NA[3]	$9,054,415	2/NA[3]	$4,246,316	0/NA[3]	--	0/NA[3]	--
Volcanic			19/NA[3]	$36,483,842	11/NA[3]	$142,498,908	1/NA[3]	$18,438,505	10/NA[3]	$19,442,383
Wildland/ Urban Interface Fire	Low	Low fuel rank	8/NA[3]	$7,071,600	5/NA[3]	$87,833,700	2/NA[3]	$4,576,000	15/NA[3]	$49,698,200
	Moderate	Moderate fuel rank	1/NA[3]	$322,700	1/NA[3]	$33,928,900	1/NA[3]	$2,169,400	8/NA[3]	$51,091,100
	High	High fuel rank	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
	Extreme	Extreme fuel rank	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown

1. Replacement values taken from User-Defined Facilities data based on KPB parcel datasets and RS Means information. Values are in 2012 dollars.
2. Exposure due to Earthquake is the same for all hazard levels.
3. NA = Not Available. Affected population cannot be estimated for these facilities.
4. Exposure due to Lowell Creek is not included in the Riverine Flood overview, as hazard events on Lowell Creek are more extreme than those included here.

Table 6-11 Potential Hazard Exposure Analysis – Critical Infrastructure

Hazard Type		Hazard Area	Methodology	Highway		Bridges		Transportation Facilities		Utilities	
				Miles	Value ($)	No.	Value ($)	# Bldgs/ # Occ[3]	Value ($)	# Bldgs/ # Occ[3]	Value ($)
Earthquake		Strong	9-20% (g)	Unknown	Unknown	26	Unknown	6/NA[3]	$2,724,133	2/NA[3]	$1,315,489
		Very strong	20-40% (g)								
		Severe	>40-60% (g)								
Erosion		Within 30 ft of erosion areas	Descriptive	Unknown	Unknown	22	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
Flood	Riverine	Moderate	500-year floodplain	Unknown	Unknown	Unknown	Unknown	0/NA[3]	--	0/NA[3]	--
		High	100-year floodplain	Unknown	Unknown	Unknown	Unknown	0/NA[3]	--	0/NA[3]	--
	Coastal	High	Coastal VE Flood Zone	Unknown	Unknown	Unknown	Unknown	0/NA[3]	--	0/NA[3]	--
Ground Failure		Low	0-11%	Unknown	Unknown	26	Unknown	6/NA[3]	$36,605,700	2/NA[3]	$40,980,000
		Moderate	11-21%	Unknown	Unknown	Unknown	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
		High	21-41%	Unknown	Unknown	Unknown	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
		Very High	> 41%	Unknown	Unknown	Unknown	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
Severe Weather		--	Descriptive	Unknown	Unknown	26	Unknown	7/NA[3]	$3,953,138	2/NA[3]	$1,928,097
Tsunami/ Seiche		--	Descriptive	Unknown	Unknown	2	Unknown	3/NA[3]	$181,371	1/NA[3]	$3,700,935
Volcanic		--	Descriptive	Unknown	Unknown	26	Unknown	7/NA[3]	$3,953,138	2/NA[3]	$1,928,097
Wildland/ Urban Interface Fire		Low	Low fuel rank	Unknown	Unknown	15	Unknown	5/NA[3]	$34,489,500	2/NA[3]	$4,098,000
		Moderate	Moderate fuel rank	Unknown	Unknown	10	Unknown	1/NA[3]	$2,116,200	--/NA[3]	Unknown
		High	High fuel rank	Unknown	Unknown	1	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown
		Extreme	Extreme fuel rank	Unknown	Unknown	Unknown	Unknown	--/NA[3]	Unknown	--/NA[3]	Unknown

1. Replacement values taken from User-Defined Facilities data based on KPB parcel datasets and RS Means information. Values are in 2012 dollars.
2. Exposure due to Earthquake is the same for all hazard levels.
3. NA = Not Available. Affected population cannot be estimated for these facilities.
4. Exposure due to Lowell Creek is not included in the Riverine Flood overview, as hazard events on Lowell Creek are more extreme than those included here.

The following narrative discussion contains the tabulated data from GIS analysis and information obtained from the Planning Team.

6.7.2 Exposure Analysis – Hazard Narrative Summaries

Earthquake

The community has historically experienced significant seismically activity which generated damaging ground movement that resulted in extensive infrastructure damages. Although all structures are exposed to earthquakes, buildings within the SBCFSA constructed with wood have slightly less vulnerability to the earthquake effects than those with masonry.

Based on earthquake probability (PGA) maps produced by the USGS, the entire SBCFSA area is at risk of experiencing moderate earthquake impacts a result of its proximity to very active fault zones. The probability is high (see Section 5.3.1.3).

Impacts to the community such as significant ground movement that may result in infrastructure damage are expected. The entire existing and future SBCFSA population, residences, and critical facilities are exposed to the effects of an earthquake.

All SBCFSA residential structures, critical facilities, and infrastructure are equally affected by all earthquake risk levels (areas of strong, very strong, severe shaking risk).

This includes:

- 4,762 people in 1,919 residences (approximate value $418,708,000)
- 478 facilities (approximate value $351,682,000
- 9 government\emergency response facilities (approximate value $15,465,027)
- 6 educational facilities (approximate value $42,501,375)
- 3 care facilities (approximate value $17,277,387)
- 23 community facilities (approximate value $45,324,661)
- 6 transportation facilities (approximate value $2,724,133)
- Two utility facilities (approximate value $1,315,489)

Impacts to future populations, residences, critical facilities, and infrastructure are anticipated at the same impact level as the SBCFSA is located in an area with a high probability of strong shaking (i.e., >4.8M).

Erosion

Impacts from erosion include loss of land and any development on that land. Erosion can cause increased sedimentation of harbors and river deltas and hinder channel navigation, reduction in water quality due to high sediment loads, loss of native aquatic habitats, damage to public utilities (docks, harbors, electric and water/wastewater utilities), and economic impacts associated with costs trying to prevent or control erosion sites. (See Section 5.3.2.3). Only the building's location can lessen its vulnerability to erosion in the SBCFSA.

Impacts to future populations, residences, critical facilities, and infrastructure are anticipated at the same impact level until the SBCFSA institutes land use controls prohibiting new construction in erosion prone areas. Impacts could also be lessened if affected properties could be relocated.

Based on potential 30ft riverine and coastal erosion areas, SBCFSA infrastructure affected by erosion potentially include:

- 12 residences (approximate value $2,051,300)
- Two bridges (approximate value unknown)

Impacts to future populations, residences, critical facilities, and infrastructure are anticipated at the same impact level.

Flood

Riverine

The SBCFSA Board of Directors stated "the majority of the SBCFSA is located within the 100 year floodplain." Impacts associated with flooding in the SBCFSA is water damage to structures and contents, roadbed and railroad bed erosion, saturation, and damage, areas of standing water in roadways, and damage or displacement of fuel tanks, power lines, or other infrastructure. Buildings on slab foundations, not located on raised foundations, and/or not constructed with materials designed to withstand flooding events (e.g., cross vents to allow water to pass through an open area under the main floor of a building) are more vulnerable to the impacts of flooding (see Section 5.3.3.3). This includes:

100 Year (1% Chance Probability):

- o 558 people in 199 residences (approximate value $42,928,270)
- o One care facility (approximate value $1,082,668)
- o Two community facilities (approximate value $$2,695,217)

500-Year (20% Chance Probability):

- o 755 people in 272 residences (approximate value $59,468,713)
- o One care facility (approximate value $1,082,668)
- o Three community facilities (approximate value $3,469,176)

The SBCFSA anticipates that impacts to future populations, residences, critical facilities, and infrastructure are at the same historical impact level.

Coastal

Coastal flooding is generally caused by wave run-up, resulting from a combination of any or all of the following factors: astronomical tides, storm surge (the rise in water from wind stress and low atmospheric pressure), waves, and peak still-water elevation. Winter storms along the Resurrection, in conjunction with high tides and strong winds, can cause significant wave run-up throughout SBCFSA coastal areas. Impacts from coastal flooding are similar in nature to riverine flooding, namely:

- Water inundation causing structural and contents water damage.

- High-velocity flow as well as debris impacts carried by floodwaters that can damage structures, roads, bridges, culverts, and other features. Debris may also accumulate around bridge piers and in culverts, decreasing flow capacity or causing overtopping or backwater effects.
- Sewage and hazardous or toxic materials releases occur when wastewater treatment plants are inundated, storage tanks are damaged, and pipelines are severed.

Coastal flood damages to the SBCFSA could include:

  - o 117 people in 51 residences (approximate value $13,013,583)

Impacts to future populations, residences, critical facilities, and infrastructure are anticipated at the same impact level.

Ground Failure

Ground Failure occurs throughout Alaska from avalanches, landslides, land subsidence, soil instability, and melting permafrost. These hazards periodically cause houses to shift due to ground shifting, sinking, and upheaval. According to mapping completed by the DGGS, the SBCFSA has not permafrost threat. However, there are substantial historical narratives to inundate the area has experienced avalanche, landslide, and unstable soil impacts, both direct and indirect which prohibited community ingress and egress due to Highway 9 (Seward Highway) being the only access road (see Section 5.3.4.3).

Impacts associated with ground failure include surface subsidence, building, infrastructure, and/or road damage. Buildings that are built on slab foundations and/or not constructed with materials designed to accommodate ground movement associated with other land subsidence and impacts are more vulnerable to damage.

Areas with 0-11 Percent Grade:

- 1,885 residences (approximate value $418,708,000)
- Nine government/emergency response facilities (approximate value $7,394,300)
- Six educational facilities (approximate value $121,762,600)
- Three care facilities (approximate value $6,745,400)
- 23 community facilities (approximate value $100,789,300)
- 26 bridges (approximate value unknown)
- Six transportation facilities (approximate value $36,605,700)
- Two utilities (approximate value $40,980,000)

Areas with 11-21 Percent Grade:

- 23 residences (approximate value $3,520,000)

Areas with 21-41 Percent Grade:

- 11 residences (approximate value $9,506,400)

The SBCFSA anticipates that impacts to future populations, residences, critical facilities, and infrastructure are at the same historical impact level.

Severe Weather

Impacts associated with severe weather events includes roof collapse, tree and power line falling, light aircraft and small boat sinking damages, injury and snow machine or vehicle accidents, overexertion while shoveling all due to heavy snow deaths A quick thaw after a heavy snow can also cause substantial flooding. Impacts from extreme cold include hypothermia, halting transportation from fog and ice, congealed fuel, frozen pipes, utility disruptions, frozen pipes, and carbon monoxide poisoning. Section 5.3.7.3 provides additional detail regarding severe weather the impacts. Buildings that are older and/or not constructed with materials designed to withstand heavy snow and wind (e.g., hurricane ties on crossbeams) are more vulnerable to the severe weather impacts of severe weather.

Using information provided by the SBCFSA and the National Weather Service, the entire existing and future SBCFSA's population, residences, and critical facilities are equally exposed to the effects of a severe weather event.

This includes:

- 4,762 people in 1,919 residences (approximate value $418,708,000)
- 19 government\emergency response facilities (approximate value $36,483,842)
- 11 educational facilities (approximate value $142,498,908)
- One care facility (approximate value $18,438,505)
- 10 community facilities (approximate value $19,442,383)

The SBCFSA anticipates that impacts to future populations, residences, critical facilities, and infrastructure are at the same historical impact level.

Tsunami and Seiche

The UAF/GI, DGGS, and WC/ATWC indicates there are significant distant and local source tsunami threats for SBCFSA populations and infrastructure located within the identified Resurrection Bay tsunami impact area. (See Section 5.3.5.3)

Using information provided by the UAF/GI, DGGS, and WC/ATWC; SBCFSA's residential structures and infrastructure located adjacent to the Resurrection Bay have a great risk from tsunamigenic impacts.

Potentially threatened population and infrastructure includes:

- 645 people in 184 residences (approximate value $78,182,123)
- 134 non-residential facilities (approximate value $221,500,871
- Two government\emergency response facilities (approximate value $9,054,415)
- Two educational facilities (approximate value $4,246,316)
- Two bridge facilities (approximate value unknown)

- Three transportation facilities (approximate value $181,371)
- One utility facility (approximate value $3,700,935)

The SBCFSA anticipates that impacts to future populations, residences, critical facilities, and infrastructure are at the same historical impact level.

Volcano

Impacts associated with a volcanic eruption include strain on resources should other hub communities be significantly affected by volcanic eruption. An eruption of significant size in southcentral Alaska will certainly affect air routes, which in turn affects the entire state. Other impacts include respiratory problems from airborne ash, displaced persons, lack of shelter, and personal injury. Other potential impacts include general property damage (electronics and unprotected machinery), structural damage from ash loading, state/regional transportation interruption, loss of commerce, and contamination of water supply. (See Section 5.3.6.3)

Using information provided by the SBCFSA, the USGS, and the Alaska Volcano Observatory, the entire existing and future SBCFSA population, residences, and critical facilities are equally at risk from the effects of a volcanic eruption.

All SBCFSA residential structures, critical facilities, and infrastructure are equally vulnerable to all volcanic impact levels.

This includes:

- 4,762 people in 1,919 residences (approximate value $418,708,000)
- 478 non-residential facilities (approximate value $351,682,000
- 19 government\emergency response facilities (approximate value $36,483,842)
- 11 educational facilities (approximate value $142,498,908)
- One care facility (approximate value $18,438,505)
- 10 community facilities (approximate value $19,442,383)

The SBCFSA anticipates that impacts to future populations, residences, critical facilities, and infrastructure are at the same historical impact level.

Wildland/Urban Interface Fire

Impacts associated with a wildland fire event include the potential for loss of life and property destruction. It can also impact livestock, pets, and wildlife; destroy forest resources; and contaminate water supplies. Buildings closer to the outer edge of town (structures more likely to have a lot of vegetation surrounding the structure) and those constructed with wood are some of the buildings that are more vulnerable to wildland/urban interface fire impacts.

According to the Alaska Fire Service, there are no wildland fire areas within the SBCFSA's boundaries. However, several wildland fires have occurred within a 50-mile radius of the designated area (see Section 5.3.8.3). There is potential for wildland/urban interface fires within the SBCFSA.

Wildland fire hazard areas were identified using a model incorporating slope, aspect, and fuel load (See Figure 5-12). South-facing, steep, and heavily vegetated areas were assigned the highest fuel values while areas with little slope and natural vegetation were assigned the lowest fuel risk values. Risk levels of low, moderate, high, and extreme were assigned to the entire region based on the results of this modeling.

The SBCFSA has critical facilities and infrastructure located within areas of low, moderate, and high risk:

Low Risk Areas Contain:

- 892 residences (approximate value $217,771,800)
- Eight government/emergency response facilities (approximate value $7,071,600)
- Five educational facilities (approximate value $87,833,700)
- Two medical care facility (approximate value $4,576,000)
- 15 community facilities (approximate value $49,698,200)
- 15 bridge facilities (approximate value unknown)
- Five transportation facilities (approximate value $34,489,500)
- Two utilities (approximate value $4,098,000)

Moderate Risk Areas Contain

- 968 residences (approximate value $375,945,900)
- One government/emergency response facilities (approximate value $322,700)
- One educational facilities (approximate value $33,928,900)
- One medical care facility (approximate value $2,169,400)
- Eight community facilities (approximate value $51,091,100)
- 10 bridge facilities (approximate value unknown)
- One transportation facilities (approximate value $2,116,200)

High Risk Areas Contain

- 59 residences (approximate value $79,983,900)
- One bridge facilities (approximate value unknown)

The SBCFSA anticipates that impacts to future populations, residences, critical facilities, and infrastructure are at the same historical impact level.

6.8 FUTURE DEVELOPMENT

6.8.1 Future Land Use

To represent future land use scenarios, additional points were added to the User-Defined Facility (UDF) data in locations where growth is expected during five and ten year build-out scenarios.

An additional 425 structures were added by the 10-year build-out scenario to the UDF data as summarized in Table 6-12.

Table 6-12 lists data used to develop future structure models for the SBCFSA.

Table 6-12 Additional Future Structures Modeled with Hazus User Defined Facilities

Occupancy Type	Total Structure Count	Total Structure Replacement Value[1]	Total Contents Replacement Value[1]
Residential	414	$100,227,000	$50,113,000
Commercial and Industrial	11	$8,464,000	$12,696,000
Other[2]	0	$0	$0
Total	**425**	**$108,691,000**	**$62,809,000**

[1] 2012 Dollars from RSMeans 2012 Residential Cost Data and Light Commercial Cost Data.
[2] Other occupancy types include Government, Education, Religion, and Agriculture.

The additional residential structures are assumed to be 2,000 square foot single family residences and the additional non-residential structures are 5,000 square foot industrial structures. See Appendix K for figures depicting the future build-out scenarios.

The City of Seward 2020 Comprehensive Plan (CSP 2005a) describes their Future Land Use goals as:

> *3.2.1 Promote residential and commercial development within the city of Seward and its vicinity in accordance with community values.*
>
> *3.2.1.1 Manage land use to facilitate economic development while maintaining the historic, small town character of Seward.*
>
> > *• Use city-owned land and tidelands to encourage feasible and sound economic development by setting development standards and performance periods through the leasing process.*
> >
> > *• Evaluate for disposal city-owned lands which have not or will not be dedicated to a public purpose.*
> >
> > *• Develop infrastructure and utility expansion plans for currently undeveloped residential and commercial property, including ways to reduce service costs once operational.*
> >
> > *• Evaluate ordinance requirements and provide incentives for property owners that balance economic development with design that is compatible with the historic character of Seward, and provides amenities such as landscaping and adequate parking.*
> >
> > *• Ensure uniform and consistent enforcement of the zoning code, building code, subdivision ordinance, and city lease agreements, and evaluate potential code changes to make enforcement easier.*
> >
> > *• Improve methods of communicating and achieving development requirements in each zoning district by preparing information packets that include: construction permits, code requirements, and means of minimizing pollution and drainage problems; and by streamlining the plan approval and building inspection processes.*
> >
> > *• Revise the Resource Management District to require rezoning before development for residential, commercial or industrial use.*

• Evaluate reducing the number of zoning districts by combining Urban Residential and Office Residential.

• Make code changes to allow more reasonable rebuilding of nonconforming uses after fire or other significant damage or allow expansion of non-conforming uses to a limited extent.

• Support the on-going dialogue with the Alaska Railroad Corporation and the State of Alaska regarding the status and disposition of their undeveloped lands.

• Find land suitable for cemetery expansion.

• Research Conservation options for environmentally sensitive areas.

(CSP 2005a)

The Kenai Peninsula Borough's Comprehensive Plan 2020 (KPB 2005) describes their Land Use Goals as follows (overarching goals are listed below, while additional goal objectives and specific implementation actions can be seen within the Plan in Chapter 6, "Land Ownership, Management and Use", pages 32-38) as:

Borough Land Management

- *To obtain clear title to and manage or dispose of borough-owned land, timber and gravel resources for the benefit of borough residents.*
- *To support efforts to foster responsible agricultural growth and diversity in the Kenai Peninsula Borough.*
- *To ensure that the interests of the Borough and its residents are adequately considered in management decisions regarding state and federal land within the Borough.*

Private Land

- *To increase public access to knowledge and information about land characteristics and the location of existing land uses.*
- *To maintain the freedom of property owners in rural areas of the Borough to make decisions and control use of their private land consistent with other goals and objectives of this Comprehensive Plan.*
- *To reduce conflicts arising from incompatible land uses outside of incorporated cities.*
- *To assess and help identify wetlands, floodplains, erosion prone areas, and landslide or avalanche zones.*

(KPB 2005)

6.8.1.1 Future Critical Facilities and Infrastructure

Immediate plans for future development in the SBCFSA includes: Seward marina upgrades, harbor and vessel security, Seawater Intake Pipelines Bio-fouling Remediation, Alutiq Pride Shellfish Hatchery Repairs and Upgrade, Dredging Cruise Ship Berthing Basins and Approaches, and the Seward community library and museum construction.

6.8.1.2 Planned and Funded Projects

Table 6-12 delineates the SBCFSA's, City of Seward's, and KPB's future, planned, and funded projects that pertain to the project area; and their tentative completion status.

Table 6-12 Planned and Funded Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
Division of Community and Regional Affairs (DCRA)	2011	Funded	Mooring Dolphins and Dock Improvements at Seward Marine Center - Comments: Legislative - lengthen a dock and affix mooring structures	Preliminary	$2,000,000
DCRA	2011	Funded	Security and Fire Protection for Commercial Passenger Vessels - Comments: Legislative - security float; previous funding $2,202,505	Pending	$5,202,505
DCRA	2011	Funded	Commercial Passenger Vessel Harbor Security - Coast Guard Building Relocation - Comments: Legislative - relocate building	Pending	$300,000
DCRA	2011	Funded	Seward - Community Library (HD 33-35) - Comments: Legislative - Seward Community Library/ Museum Facility; previous funding $1,080,000	Preliminary	$10,000,000
DCRA	2011	Funded	Alaska Community Foundation - Jesse Lee Home Restoration - Comments: Legislative Grant - Restore residential charter school. Prior Year Funding History: FY 09 - $ 500,000, project dates07/01/2010 - 06/30/2015.	Preliminary	$1,500,000
DCRA	2011	Funded	Alaska Sealife Center - Seawater Intake Pipelines Biofouling Remediation - Comments: Legislative Grant - renovate saltwater intake system and relocate freshwater pumping system	Completed	$1,000,000
DCRA	2011	Funded	Alutiq Pride Shellfish Hatchery Repairs and Upgrade - Comments: Legislative Grant - replace lighting system; completion fall 2010	Preliminary	$150,000
DCRA	2010	Funded	Dredging Cruise Ship Berthing Basins and Approaches - Comments: Legislative Grant - Dredge the berthing basins and approaches to the berths to accommodate the larger class vessels.	Preliminary	$4,500,000
DCRA	2010	Funded	Bus Transportation Assistance for Cruise Ship Passengers. - Comments: Legislative Grant - Transportation Assistance to Cruise Ship Passengers for bus transportation assistance to cruise ship passengers.	Preliminary	$167,000
Department of Transportation and Public Facilities (DOT/PF)	2010	Funded	Regulator Building - Comments: Replace regulator building at Seward Airport.	Preliminary	$330,000
Alaska Energy Authority / Alternative	2010	Funded	Fourth of July Creek Hydroelectric Recon-Hydro - Comments: OTHER FUNDING:	Preliminary	$40,000

Table 6-12 Planned and Funded Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
Energy And Energy Efficiency (AEA-AEEE			Federal		
Alaska Native Tribal Health Consortium (ANTHC)	2009	Funded	Employee parking lot paving at the Northstar Health Clinic in Seward, Alaska.	Preliminary	$57,210
DOT/PF	2009	Funded	Seward Highway Maintenance Station Replacement - Comments: Legislative Grant	Preliminary	$3,200,000
Department Of Natural Resources (DNR)	2008	Funded	Jesse Lee Home Preservation - Comments: Legislative Grant Jesse Lee Home Preservation	Preliminary	$1,000,000
Department Of Environmental Conservation (DEC) Municipal Matching Grants And Loans (MGL)	2004	Funded	Water Source Study - Comments: Identify and preliminary design for compliance with new drinking water regulations	Preliminary	$142,571
DCRA	2009	Funded	Fish Ditch Restoration - Comments: Legislative Grant	Contract	$61,250
Economic Development Administration (EDA)	2007	Funded	Marine Safety and Fire training bldg. - Comments: Construction Grants	Contract	$3,350,000
Federal Aviation Administration (FAA)	2005	Funded	Rehabilitate Runway - Comments: Other funding: DOT/PF	Contract	$42,000
FAA	2005	Funded	Rehabilitate Runway - Comments: Other funding: DOT/PF	Contract	$52,500
FAA	2004	Funded	Conduct Airport Master Plan Study - Comments: Other funding: DOT/PF	Contract	$381,044
EDA	2004	Funded	AVTEC Technology Center - Comments: A new 10,000 sq. ft. facility on the Seward campus to house distance education training programs. Estimated 730 job trainees in first two years; significant $ anticipated	Contract	$2,622,272
US Army Corps of Engineers (USACE)	2003	Funded	Harbor/Construction Phase (Ph) 2 - Comments: Construct a new rubble mound breakwater east of the existing harbor, demolish a portion of the existing east and south rubble mound breakwaters, construct a new south rubble mound breakwater head. Dredge, excavate and dispose of material for a new entrance channel and mooring areas. Place dredged material in 2 inter-tidal, 1 sub-tidal and 1 deep-water disposal areas within the immediate vicinity. Construct the existing entrance channel closure. Construct various rock layers to provide slope protection for dredged cut slopes and disposal areas.	Contract	$8,468,050
USACE	2002	Funded	Lowell Creek Tunnel Repair - Comments: Repair of approximately 2100 feet of tunnel invert of the Lowell Creek Flood Control	Contract	$1,030,000

Table 6-12 Planned and Funded Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
			Project.		
DOT/PF	2010	Funded	Seward Road Improvements - Comments: Rehabilitate or improve various City streets or roads Seward Road Improvements	Design	$5,000,000
DOT/PF	2006	Funded	Kenai Fjords National Park - Comments: Recondition and pave 1.5 miles of the Exit Glacier road and loop parking area within Kenai Fjords National Park.	Design	$261,000
Alaska Department of Education an d Early Development (DEED)	2003	Funded	Seward Middle School Replacement - Comments: Debt reimbursement at 70%	Design	$21,000,000
DOT/PF	2002	Funded	Seward Hwy: Scenic Byway Interpretive Sites, Ph 2 - Comments: Planning, design, and construction of six interpretive sites between MP 18-91 of the Seward Highway Scenic Byway, along with a series of route and site identifier signs along the entire length.	Design	$3,185,000
DCRA	2012	Funded	Kitchen Expansion Project	Construction	$100,000
Denali Commission (Denali)	2010	Funded	Alaska Vocational Technical Center (AVTEC) Seward Wind Turbine - Comments: To purchase and install a 100 kilowatt (kW) wind turbine at AVTEC campus in Seward for wind technician training	In-Progress	$1,011,288
AEA- Legislative Grant (LEG)	2009	Funded	Purchase Backup Generators - Comments: Legislative Grant State Legislative Action (SLA) 2008, Page 61, Line 25-27	Construction	$2,000,000
DCRA	2009	Funded	Road/Levee Construction - Comments: Legislative Grant	Construction	$1,750,000
DCRA	2008	Funded	Levee Construction - Comments: Legislative Grant - Grants to Municipalities	Construction	$1,000,000
AEA-**Rural Power System Upgrade** (RPSU)	2007	Funded	AVTEC Switchgear upgrade and compatibility - Comments: OTHER FUNDING: Denali Commission $220,000. Upgrade AVTEC Switchgear equipment so trainees can learn on equipment they will most likely encounter in new power plants.	Construction	$220,000
DCRA	2006	Funded	Seward Elementary Gym Floor and Carpet Replacement - Comments: Legislative Grant Seward Elementary Gym Floor and Carpet Replacement	Construction	$170,000
DOT/PF	2002	Funded	Port Avenue Rehabilitation - Comments: Resurface Port Avenue (aka Dock Road) from the Seward Highway (MP 0.0) to the end of the paved road (MP 0.4).	Construction	$2,695,000
DOT/PF	2001	Funded	Harbor Expansion - Comments: Pending federal appropriation	Construction	$12,341,000
Denali	2010	Funded	Providence Seward Medical & Care Center Electronic Health Records - Comments:	In-Progress	$599,984

Table 6-12 Planned and Funded Projects

Lead Agency	Fiscal Year	Project Status	Project Description/Comments	Project Stage	Total Cost
			Authorized ASHNHA to proceed with funding the Providence Seward Medical & Care Center Electronic Health Records project, fully described in Seward Medical & Care Center's FY2010 Primary Care in Hospitals (PCIH) application.		
Denali	2009	Funded	Alaska Sea life Center Seawater Heat Pump Demonstration Project - Comments: The project includes the design and installation of a seawater heat pump, utilizing the existing seawater intake system, to lift latent heat from raw seawater in Resurrection Bay at temperatures ranging from 37 degrees Fahrenheit (°F) to 55 °F and transfer the energy into building heat at a temperature of 120 °F, to demonstrate that seawater heat pumps can provide financial and environmental benefits.	In-Progress	$479,685

(DCRA 2013)

The Kenai Peninsula Borough (KPB) produces a Comprehensive Plan as part of its planning requirements, the most recent of which was adopted in 2005. One of the stated primary purposes of the Comprehensive Plan is to "Describe existing and expected future conditions in the Borough during the planning period" (KPB 2005) For the most recent Comprehensive Plan, that period is 2005 to 2015. Seward city also produces a Comprehensive Plan for areas within the city boundaries, the most recent being the City of Seward 2020 Comprehensive Plan, which was produced in 2005. For reasons including the KPB and Seward city planning periods and forecasts, this HMP has chosen to look at development trends within the SBCFSA for two build-out scenarios: a 5-year scenario (2017), and a 10-year scenario (2022).

An additional resource that will be used to support choices made in the build-out scenarios discussed below is the KPB "Municipal Entitlement Land Selection Finalization Project 2013". Based on the Mandatory Borough Act of 1964 and the 1978 Municipal Entitlement Act, A.S. 29.65.10, the KPB is still entitled to receive 28,000 acres of its original allocation of 155,780 acres. Areas within the SBCFSA

The purpose of developing proposed build-out scenarios is to anticipate future change in land use, where possible, within the SBCFSA in order to be able to create plans according to the most informed development trends. In addition, by considering projected build-out scenarios planners increase their ability to reduce vulnerability and develop appropriate mitigation strategies given the projected future land use scenarios. Build-out scenarios are, by nature, based on best available information from State, Borough, and City plans and officials, as well as historical trends, and are not meant to be anything more than potential scenarios for consideration. Instead of representing what *will* happen, build-out scenarios represent what *could* happen, so that planners can consider potential future scenarios within their planning area.

The two future build-out scenarios below assess trends and patterns to project potential changes in types of land use (e.g. residential, commercial, industrial, natural), density of development (e.g., low, medium, high), and location of development.

5-Year Build-Out Scenario (2017)

In its 2005 Comprehensive Plan, KPB presents low-growth rate for the Boroughs population through 2018, as projected by State of Alaska Department of Labor and Workforce Development in 1998 (20-year projection) and the Institute of Social and Economic Research in 2001 (25-year projection), siting “significant development projects are not envisioned in the near future” (KPB 2005)

For the most part, Seward city is currently built out to its fullest potential within city boundaries. Most city land is currently developed to the extent that it can be developed, given the city’s boundaries and geographic constraints (e.g. steep mountains to the west, Resurrection River valley to the north, Resurrection Bay, etc.). There are no current or future plans for a change in the city’s ratio of residential to non-residential housing. Though there are significant initiatives occurring within Seward (i.e., expansion of Institute of Marine Sciences; new AVTEC dormitories; opening of new Library in 2013; etc.), there is little projection of significant change to the city’s footprint in the 5-year build-out scenario.

The lone exception to this is the potential development at Seward Marine Industrial Center (SMIC). Within Seward city boundaries, along the east coast of Resurrection Bay is the industrial complex called SMIC, which contains docks, boat lift, upland staging/repair, utility, and wastewater treatment facilities. In 2008 Seward City Council passed a new resolution (2008-33) adopting the current SMIC Development Plan. The purpose of this Plan is to encourage and promote private sector growth and development at the SMIC. Currently, there are acres available for lease and development. SMIC is currently zoned as industrial. Current initiatives exist to encourage the Coastal Villages Regional Fund (CVRF) to move its entire fleet of fishing vessels from Seattle, WA to Seward and potentially the SMIC site. In 2012, the decision was made to park 5 of CVRF’s vessels in Seward, and there are ongoing discussions about moving the remaining vessels to Seward, as well (CVRF 2012). The State of Alaska has included $10 Million dollars for Seward’s port project in its transportation bond package, which was passed by voters in early November, 2012. If this port expansion plan were to occur, it is possible that it would begin within the 5-year build out scenario. If this were the case, though, the full development would more likely be achieved within the 10-year build out scenario.

Outside of Seward city limits there is a much higher chance for residential development to occur within SBCFSA limits within the 5-year build out scenario. Infill within some existing subdivisions is likely, as are the developments of new subdivisions. Based on recent trends, current platting, and current development, our analysis suggests that single-family residential developments could occur within Forest Acres Subdivision; Phase 5 of the Nash Woods Subdivision; the Rough Subdivision; and a long Beach Drive. These are represented in the figure below.

Maps K-7a and K-7b, in Appendix K, present the projected land use development within the SBCFSA for the 5-year build out scenario.

10-Year Build-Out Scenario (2022)

Within a 10-year period, there is greater likelihood for additional development in the SBCFSA, both within Seward city limits as well as outside of city limits.

As was discussed in the 5-year build out scenario, the SMIC port project is the major development initiative occurring within Seward's city limits. Within the 10-year build out scenario it is possible that the SMIC area will have developed with industrial facilities to its capacity. In doing so, and in brining CVRF fishing vessels to Seward, the potential exists for a need for additional housing development. If this were to occur, it is most likely that residential development would occur on the area north of SMIC at the 4th of July Creek Subdivision #2, locally known as the Nash Road Bench Area. The terrain directly east of Nash Road is very steep, but above this area is a bench, which is where it is most likely that single family residential houses would be developed. This can be seen in Appendix K, Map K-7b.

Furthermore, there is the potential for limited additional residential build-out within Seward city limits in the 10-year forecast. Several parcels of land could follow adjacent parcel trends and become single-family residential subdivisions in this time period. For the purpose of this Plan, parcels that could potentially be developed in the 10-year scenario include the Gateway subdivision.

Outside of Seward city limits there remains a much higher chance for residential development to occur within SBCFSA limits within the 10-year build out scenario. Infill within some existing subdivisions is likely, as are the developments of new subdivisions. In addition, Kenai Peninsula Borough is in the process of a "Municipal Entitlement Land Selection Finalization Project 2013" (http://www.borough.kenai.ak.us/landmgt/entitlements/projectinformation), which will provide additional developable land to the KPB in the SBCFSA. This LHMP, based on referenced Plans, discussions with planners, and the "Municipal Entitlement Land Selection Finalization Project 2013", has identified the Subdivisions of Clan Maxwell, Lost Lake, and Bryson, in addition to the parcels surrounding the north and east of Bear Lake, as well as the area known as "Blueberry Hill", as potential developments within the 10-year build out scenario.

Maps K-7a and K-7b, in Appendix K, present the projected land use development within the SBCFSA for the 10-year build out scenario.

7.1 MITIGATION STRATEGY OVERVIEW

This section outlines the six-step process for preparing a mitigation strategy including:

1. Identifying each jurisdiction's existing authorities for implementing mitigation action initiatives
2. NFIP Participation
3. Developing Mitigation Goals
4. Identifying Mitigation Actions
5. Evaluating Mitigation Actions
6. Implementing Mitigation Action Plans

DMA requirements for developing a comprehensive mitigation strategy include:

DMA 2000 Requirements
Identification and Analysis of Mitigation Actions §201.6(c)(3): [The plan shall include the following:] A *mitigation strategy* that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools. §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards. §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. §201.6(c)(3)(iii): [The hazard mitigation strategy shall include an] action plan, describing how the action identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs. §201.6(c)(3)(iv): [For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan. Requirement §201.6(c)(4): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvements, when appropriate.
ELEMENT C. Mitigation Strategy
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs?
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? *(Addressed in Section 6.4)*
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards?
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure?
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction?

DMA 2000 Requirements
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate?
Source: FEMA, October 2011.

7.2 IMPLEMENTATION THROUGH EXISTING PLANNING MECHANISMS

The requirements for implementation through existing planning mechanisms, as stipulated in the DMA 2000 and its implementing regulations, are described below.

DMA 2000 Requirements
Incorporation into Existing Planning Mechanisms §201.6(c)(3): [The plan shall include the following:] A *mitigation strategy* that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools.
ELEMENT C. Incorporate into Other Planning Mechanisms
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs?
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate?
Source: FEMA, October 2011.

7.3 SBCFSA CAPABILITY ASSESSMENT

The SBCFSA's capability assessment reviews the technical and fiscal resources available to the special service area. This section outlines the resources available to the SBCFSA for mitigation and mitigation related funding and training. Tables 7-1, 7-2, and 7-3 delineate the SBCFSA's regulatory tools, technical specialists, and financial resource available for project management. Additional funding resources are identified in Appendix B.

Table 7-1 SBCFSA's Regulatory Tools

Regulatory Tools (ordinances, codes, plans)	Existing?	Comments (Year of most recent update; problems administering it, etc.)
Comprehensive Plan	Yes	Kenai Peninsula Borough Comprehensive Plan, June 2005, defines the Borough's land use, housing, economic development, and natural hazard trends and impacts.
Comprehensive Plan	Yes	City of Seward, 2020 Comprehensive Plan, Volume I, July 29, 2005, Defines the City's land use, housing, economic development, and natural hazard trends and impacts.
Economic Development Plan	Yes	Kenai Peninsula Borough Situations and Prospects, Economic Trends for Year Ending December 31, 2006
Land Use Plan	Yes	Within both KPB and Seward's Comprehensive Plans

Table 7-1 SBCFSA's Regulatory Tools

Regulatory Tools (ordinances, codes, plans)	Existing?	Comments (Year of most recent update; problems administering it, etc.)
Emergency Response Plan	Yes	Both KPB and Seward possess approved EOPs.
Wildland Fire Protection Plan	No	
Building code	Yes	City of Seward has building code.
Zoning ordinances	Yes	City of Seward has zoning ordinances.
Subdivision ordinances or regulations	Yes	City of Seward has subdivision ordinances.
Special purpose ordinances	No	The SBCFSA can exercise this authority.

Local Resources

The SBCFSA has access to KPB's fiscal, planning, and land management staff that will allow it to implement hazard mitigation activities. The resources available in these areas have been assessed by the hazard mitigation Planning Team, and are summarized below.

Table 7-2 SBCFSA's Technical Specialists for Hazard Mitigation

Staff/Personnel Resources	Y/N	Department/Agency and Position
Planner or engineer with knowledge of land development and land management practices	No	The SBCFSA works with the KPB Land Resources Staff.
Engineer or professional trained in construction practices related to buildings and/or infrastructure	No	The SBCFSA works with the City of Seward and KPB engineers on an as needed basis.
Planner or engineer with an understanding of natural and/or human-caused hazards	No	The SBCFSA works with the City of Seward and KPB planners and engineers on an as needed basis.
Floodplain Management	Yes	KPB: Floodplain Administrator SBCFSA: Water Resource Manager, Flood Service Area Coordinator, Certified Floodplain Manager (CFM) with extensive floodplain and land management experience.
Surveyors	No	The SBCFSA works with the City of Seward and KPB engineers on an as needed basis.
Staff with education or expertise to assess the jurisdiction's vulnerability to hazards	No	The SBCFSA works with the City of Seward Fire Chief and Public Works Director and the KPB Emergency Manager to address hazard vulnerabilities.
Personnel skilled in Geospatial Information System (GIS) and/or HAZUS-MH	No	The SBCFSA works with the City of Seward and KPB GIS and land resources staffs on an as needed basis.
Scientists familiar with the hazards of the jurisdiction	No	The SBCFSA works with the U.S. Fish & Wildlife Service local office; Alaska Dept. of Fish & Game local office, the UAF, and USGS.

Emergency Manager	No	The SBCFSA works with the City of Seward Fire Chief and Public Works Director and the KPB Emergency Manager to address hazard vulnerabilities.
Finance (Grant writers)	Yes	SBCFSA: Water Resource Manager, Flood Service Area Coordinator with extensive grant writing, floodplain, and land management experience.
Public Information Officer	Yes	The SBCFSA Board of Directors manages these duties either singly or along with the City of Seward and KPB Public Information staffs on an as needed basis.

Table 7-3 Financial Resources Available for Hazard Mitigation

Financial Resource	Accessible or Eligible to Use for Mitigation Activities
General funds	Limited funding, can exercise this authority with voter approval
Community Development Block Grants	Not available to the SBCFSA
Capital Improvement Projects Funding	Limited funding, can exercise this authority with voter approval
Authority to levy taxes for specific purposes	Limited funding, can exercise this authority with voter approval
Incur debt through general obligation bonds	Can exercise this authority with voter approval
Incur debt through special tax and revenue bonds	Can exercise this authority with voter approval
Incur debt through private activity bonds	Can exercise this authority with voter approval
Hazard Mitigation Grant Program (HMGP)	FEMA funding which is available to local and tribal communities and special service areas after a Presidentially-declared disaster. It can be used to fund both pre- and post-disaster mitigation plans and projects.
Pre-Disaster Mitigation (PDM) grant program	FEMA funding which is available on an annual basis. This grant can only be used to fund pre-disaster mitigation plans and projects.
Flood Mitigation Assistance (FMA) grant program	FEMA funding which is available on an annual basis. This grant can be used to mitigate repetitively flooded structures and to provide infrastructure to protect repetitively flooded structures.
United State Fire Administration (USFA) Grants	The purpose of these grants is to assist state, regional, national or local organizations to address fire prevention and safety. The primary goal is to reach high-risk target groups including children, seniors and firefighters.
Fire Mitigation Fees	Finance future fire protection facilities and fire capital expenditures required because of new development within Special Districts.

The Planning Team developed the following mitigation goals and potential mitigation actions for the SBCFSA within Section 7.4 and 7.5 respectively.

7.4 DEVELOPING MITIGATION GOALS

The requirements for the local hazard mitigation goals, as stipulated in DMA 2000 and its implementing regulations are described below.

DMA 2000 Requirements
Local Hazard Mitigation Goals §201.6(c)(3)(i): The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
ELEMENT C. Mitigation Goals
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards?
Source: FEMA, October 2011.

The exposure analysis results were used as a basis for developing the mitigation goals and actions. Mitigation goals are defined as general guidelines that describe what a community wants to achieve in terms of hazard and loss prevention. Goal statements are typically long-range, policy-oriented statements representing community-wide visions. As such, eleven goals were developed to reduce or avoid long-term vulnerabilities to the identified hazards (Table 7-4). In addition to considering historic and current hazards, these goals consider and reflect information gained from a comprehensive assessment of projected hazards resulting from potential climate change and associated impacts to the SBCFSA and surrounding region.

The Mitigation Action Plan (MAP) is made more robust by considering potential future climate change and its effect on local and regional hazards as planners and decision makers can make informed decisions today that will reduce future vulnerability and decrease the risk of harm or damage.

Table 7-4 Mitigation Goals

No.	Goal Description
Multi-Hazard	
1	Promote recognition and mitigation of all natural hazards that affect the SBCFSA.
2	Promote cross-referencing mitigation goals and actions with other SBCFSA, City of Seward, and KPB planning mechanisms and projects.
3	Reduce vulnerability, damage, or loss of structures from all natural hazards that affect the SBCFSA.
Natural Hazards	
4	Reduce vulnerability, damage, or loss of structures from **earthquake** damage.
5	Reduce vulnerability, damage, or loss of structures from **erosion**.
6	Reduce vulnerability, damage, or loss of structures from **flood**.
7	Reduce vulnerability, damage, or loss of structures from **ground failure**.

Table 7-4 Mitigation Goals

No.	Goal Description
8	Reduce vulnerability, damage, or loss of structures from **tsunami or seiche**.
9	Reduce vulnerability, damage, or loss of structures from **volcanic debris** impacts
10	Reduce vulnerability, damage, or loss of structures from **severe weather** damage.
11	Reduce vulnerability, damage, or loss of structures from **wildland fire**.

The Planning Team then developed the new MAP listing only those projects that remained as ongoing, deferred, and newly implemented mitigation actions.

7.5 IDENTIFYING MITIGATION ACTIONS

The requirements for the identification and analysis of mitigation actions, as stipulated in DMA 2000 and its implementing regulations are described below.

DMA 2000 Requirements
Identification and Analysis of Mitigation Actions §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.
ELEMENT C. Mitigation Actions
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure?
Source: FEMA, October 2011.

After mitigation goals and actions were developed, the Planning Team reviewed the current FHMP and assessed the existing as well as potential new mitigation actions to carry forward into the MAP. Mitigation actions are activities, measures, or projects that help achieve the goals of a mitigation plan. Mitigation actions are usually grouped into three broad categories: property protection, public education and awareness, and structural projects.

7.5.1 Determine Existing HMP's Mitigation Strategy's Progress

7.5.1.1 Mitigation Action Progress-HMP Update

FEMA requires that HMP Updates define the status of their prior existing HMP's Mitigation projects, action items, and activities. The jurisdiction must indicate whether the actions were completed, deleted, or deferred with an explanation for any change in their status. The Planning Team determined to label activities as either "ongoing" or "new" projects as well as "deferred", or "deleted".

7.5.1.2 Updated HMP's Mitigation Action Plan Report (Status)

The SBCFSA 2010 Flood Hazard Mitigation Plan listed 52 mitigation action items selected for implementation for the plan's five year planning cycle. On March 13, 2013, the Planning Team reviewed the existing actions depicted in Table 7-5 below (in blue text). The review found action items completed, completed but still ongoing, ongoing, deleted, and newly considered action items. Many actions were analyzed and combined for greater applicability for an all-hazards approach.

The Planning Team placed particular emphasis on projects and programs that support their HMP goals; reduce the impacts of multiple hazards that address infrastructure, the built environment (both new and existing), and actions that assure the SBCFSA maintains NFIP compliance. They also considered actions concerning:

- Future Development: actions that would prevent new residential and/or critical facility siting within identified or potential hazard impact areas.
- Land Use: potential development in light of current and future hazard conditions.
- Climate Change: future hazard conditions (e.g. type, frequency, intensity, location of hazard) dependent upon future climate change scenarios

On March 13, 2013, the Planning Team reviewed a comprehensive list of 85 potential mitigation actions that would potentially reduce natural hazard impacts within and surrounding the SBCFSA. The SBCFSA, City of Seward, and KPB identified their respective "ongoing" projects from within the list to demonstrate their continuous commitment to protecting people and facilities from potential damage and loss.

Table 7-5 provides the Potential Projects list as they apply to each stated hazard mitigation goal.

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the SBCFSA's pre-identified 2010 Mitigation Action Items)

Goals		Actions		
No.	**Description**	**Status:** *Considered, Selected Complete, Deferred, Deleted, or Ongoing*	**Authority**	**Description**
MH 1	Promote recognition and mitigation of all natural hazards that affect the SBCFSA.	O	FSA	Develop a strategy for accessing (applying for and managing) mitigation grant funds
		O	FSA	Organize a Floodproofing Workshop for Homeowners and Businesses to learn about techniques and funding sources for elevating, and floodproofing structures (agency(ies) to participate – USACE Floodproofing Committee, FEMA, DCCED; Businesses to support SBS, Wells Fargo, others)
		O	FSA	Strive to formalize a Hazard Mitigation Planning Team to develop a sustainable process for implementing, monitoring, reviewing, and evaluating community wide mitigation actions.
		O	FSA, City, KPB	Hold periodic outreach events or activities to educate population concerning existing natural hazards. Activities are designed to provide pertinent natural hazards information to residents about recognizing and mitigating hazards that could potentially affect the SBCFSA. Potential subjects could include: benefits of participating in the NFIP; safe "FireWise" practices; river, stream or creek levee or channel breach; tsunami warnings and response; other emergency management

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the SBCFSA's pre-identified 2010 Mitigation Action Items)

Goals		Actions		
No.	**Description**	**Status:** *Considered, Selected Complete, Deferred, Deleted, or Ongoing*	**Authority**	**Description**
				focused subjects; etc.)
		O	KPB	Develop an outreach program to educate the public concerning NFIP participation benefits, floodplain development, land use regulation, and NFIP flood insurance availability to facilitate continued compliance with the NFIP.
		O	FSA, City, KPB	Develop, produce, and distribute information materials concerning mitigation, preparedness, and safety procedures for all identified natural hazards.
		O	FSA, City, KPB	Develop and implement strategies and educational outreach programs for debris management from natural hazard events.
		O	City, KPB	Review ordinances and develop outreach programs to assure fuel or propane tanks are properly anchored and hazardous materials are properly stored and protected from known natural hazards such as flood or seismic events.
		O	FSA, City, KPB	Disseminate FEMA pamphlets to educate and encourage homeowners concerning structural and non-structural retrofit benefits.
		O	FSA, City, KPB	Develop outreach program to educate residents concerning all-hazard benefits of modern building code compliance during rehabilitation or major repairs for residences or businesses.
		O	KPB	Develop outreach program to educate residents concerning flood proofed well and sewer/septic facility installations.
		O	City, KPB	Update public emergency notification procedures and develop an outreach program for potential hazard impacts or events.
		O	FSA	Disseminate information to increase public knowledge about flood insurance, and the natural and beneficial floodplain functions.
		O	FSA, City, KPB	Identify critical facilities and vulnerable populations based on identified (and mapped where applicable) high hazard areas.
		O	FSA, City, KPB	Identify evacuation routes away from high hazard areas and develop outreach program to educate the public concerning warnings and evacuation procedures.
		O	City, KPB	Acquire emergency warning methods to communicate critical emergency warnings and alerts. City uses radios, cell phones, alert sirens, etc.
		O	City, KPB	Implement 911 reverse call to notify residents
MH 2	Promote cross-referencing mitigation goals and actions with other SBCFSA, City of Seward, and KPB planning mechanisms and projects.	Deleted	Replaced with Similar Action	Express concern and provide recommendations to the appropriate agencies.
		O	FSA (Reworded)	Establish a cooperative relationship with the City of Seward to ensure hazard mitigation efforts are not being duplicated or opportunities missed.
		O	FSA (Reworded)	Coordinate with the Kenai Peninsula Borough and other appropriate agencies to obtain funding and permitting to establish an annual maintenance schedule and contract to remove excess debris throughout the SBCFSA.
		O	City, KPB (Reworded)	Develop, implement, and improve enforcement of floodplain management ordinances.
		O	City, KPB	Prohibit below grade crawlspaces and basements throughout the Service

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the SBCFSA's pre-identified 2010 Mitigation Action Items)

Goals		Actions		
No.	**Description**	**Status:** *Considered, Selected Complete, Deferred, Deleted, or Ongoing*	**Authority**	**Description**
				Area unless PE, architect or Professional Land Surveyor certifies that building site is not subject to flooding, localized drainage, or high ground water.
		O	City, KPB	Avoid building more new homes in the floodway (existing ordinance); revise floodplain ordinance to prohibit any new subdivision of land within the mapped floodplain.
		O	City, KPB	Increase enforcement including fostering a partnership (M.O.U.) for enforcement uniformly within the City and Borough specific to the SBCFSA.
		O	KPB	Review KPB Habitat Protection Ordinance for extension to Service Area for flood/erosion regulation purposes – recognizing gravel/sediment removal needs to continue. Modify ordinance to increase KPB enforcement and field staff.
		O	FSA, City, KPB	The SBCFSA will manage their existing plans to incorporate mitigation planning provisions into all service area planning processes such as comprehensive, capital improvement, and land use plans, etc. to demonstrate multi-benefit considerations and facilitate using multiple funding source consideration.
		O	FSA	Improve flood and erosion hazard aspects in land use decisions, subdivision actions, and Plans that affect the SBCFSA including: KPB All-Hazards Plan, Comprehensive Plan, Coastal Management; Wetlands Management Plan, Seward Long-term development plan.
		C	City, KPB	Develop process to regulate future development in potential high hazard areas (permitting, geotechnical review, soil stabilization techniques, etc.).
		O	City, KPB	Integrate the Mitigation Plan findings for enhanced emergency planning.
		O	FSA, City, KPB	Develop, incorporate, and enforce building ordinances to reflect survivability from flood, fire, wind, seismic, and other hazards to ensure occupant safety.
		O	City, KPB	Develop and incorporate mitigation provisions and recommendations into all community plans and community development processes to maintain protect critical infrastructure, residences, and population from natural hazard impacts.
		O	City, KPB	Update or develop, implement, and maintain jurisdictional debris management plans.
		O	FSA, KPB	Identify and list repetitively flooded structures and infrastructure, analyze the threat to these facilities, and raise mitigation action priorities to protect the threatened population.
		Deleted	Reworded for new action	The entirety of Resurrection River needs to be surveyed and a hydrologist report generated, starting at the mean-low mark working up to the headwaters at Exit Glacier.
		Deleted	Reworded for new action	Perform needed sediment bed load mapping and engineering analysis necessary to obtain permits for channel drainage maintenance.
		C	City, KPB	Develop prioritized list of mitigation actions for threatened critical facilities and other buildings or infrastructure.
		O	City, KPB	Update Emergency Response Plans to discuss volcanic ashfall, tsunami,

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the SBCFSA's pre-identified 2010 Mitigation Action Items)

Goals		Actions		
No.	**Description**	**Status:** *Considered, Selected Complete, Deferred, Deleted, or Ongoing*	**Authority**	**Description**
				and stormwater event management; prioritize response actions; and initiate actions to fill capability gaps.
		C	City, KPB	Require construction companies to provide as-built plans once facilities are constructed.
		C	City, KPB	Develop a community-wide database of as-built plans to enable the community to keep track of existing infrastructure and to determine future requirements. This will eliminate expensive investigations to determine if existing utility infrastructure exists prior to new construction.
		S	FSA, City, KPB	Adopt the Risk MAP coastal velocity zone mapping studies into the floodplain code.
MH 3	Reduce vulnerability, damage, or loss of structures from all natural hazards that affect the SBCFSA.	O	City	Encourage utility companies to evaluate and harden vulnerable infrastructure elements for sustainability.
		Deleted	Reworded -combined for all-hazards	Encourage the Kenai Peninsula Borough, the State of Alaska, the City of Seward and other interested Land Trusts to acquire and obtain land for floodplain conservation.
		Deleted	Reworded -combined for all-hazards	Support elevation, floodproofing, buyout or relocation of structures that are highest risk, repetitive losses or substantially damaged, or are in imminent threat of loss due to location on eroding banks.
		Deleted	Reworded -combined for all-hazards	Consider land swaps where appropriate.
		O	FSA, City, KPB	Relocate or acquire (buy-out and demolish) structures away from hazard prone area (erosion, flood, ground failure, etc.) Property deeds "must be" restricted for open space uses for perpetuity to keep people from rebuilding in known hazard areas.
		O	City	Harden utility headers located along river embankments to mitigate potential flood, debris, and erosion damages.
		O	City	Purchase and install generators with main power distribution disconnect switches for identified and prioritized critical facilities susceptible to short term power disruption. (i.e. first responder, medical facilities, schools, correctional facilities, and water and sewage treatment plants, etc.)
		O	FSA, City, KPB	Develop vegetation projects to restore clear-cut and riverine erosion damage and to restore slope stability in avalanche and landslide areas.
		O	City, KPB	Perform hydrologic and hydraulic engineering, drainage, and bed loading studies and analyses for each watershed. Use information obtained for feasibility determination and project design. This information should be a key component, directly related to a proposed project in order to qualify for FEMA funding.
		C	KPB	Develop a vegetation management plan addressing slope-stabilizing root strength to maintain or encourage precipitation containment.
		C	KPB	Develop land use guidelines to minimize vegetation removal to maintain slope stability to reduce rain, snowmelt run-off, and erosion.

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the SBCFSA's pre-identified 2010 Mitigation Action Items)

Goals		Actions		
No.	Description	Status: *Considered, Selected Complete, Deferred, Deleted, or Ongoing*	Authority	Description
EQ4	Reduce vulnerability, damage, or loss of structures from earthquake damage.	O	City	Evaluate critical public facilities with significant seismic vulnerabilities and complete retrofit. (e.g. evaluate fire stations, public works buildings, potable water systems, wastewater systems, electric power systems, and bridges, etc.)
		O	City	Inspect, prioritize, and retrofit any critical facility or public infrastructure that does not meet current State adopted Building Codes.
		C: O:	FSA City, KPB	Install non-structural seismic restraints for large furniture such as bookcases, filing cabinets, heavy televisions, and appliances to prevent toppling damage and resultant injuries to small children, elderly, and pets.
ER 5	Reduce vulnerability, damage, or loss of structures from erosion.	O	FSA, City, KPB	Develop mitigation initiatives such as: Rip-rap (large rocks), sheet pilings, gabion baskets, articulated matting, concrete, asphalt, vegetation, or other armoring or protective materials to provide river bank protection.
		O	FSA, City, KPB	Harden culvert entrance bottoms with, concrete, rock, or similar material to reduce erosion or scour.
		O	FSA, City, KPB	Install walls at the end of a drainage structure to prevent embankment erosion at its entrance or outlet. (headwalls- or wing-walls).
		S	FSA	Harden and/or retrofit existing levees to qualify for USACE certification.
FL 6	Reduce vulnerability, damage, or loss of structures from flooding.	O	FSA	Perform periodic river and stream bed-load removal
		O	FSA	Pursue federal and state funding to improve and update Flood Insurance Rate Maps (FIRMs), as well as other maps and plans that may be more appropriate such as Drainage Plans or watershed management plans in order to meet other goals. This should also include extending coastal floodplain mapping to Lowell Point.
		O	FSA (Reworded)	Work with the US Army Corp of Engineers (USACE) to develop a direct channel to direct water conveyance away from the three Seward Highway Bridges and the airport directing flow to Resurrection Bay.
		O	FSA (Reworded)	Work with USACE, NRCS, and State to purse sediment and debris management at the mouth of the Resurrection River. This will reduce debris accumulation, encourage water movement from high to low areas; and lessen upstream flood potential.
		O	FSA, City, KPB	Develop and maintain NFIP-compliant Repetitive Loss property inventory. Inventory should include property type, structure type, number of buildings, and their geo-referenced locations.
		O	FSA, City, KPB	Establish flood mitigation priorities for critical facilities, residential structures, and commercial buildings located within the identified flood hazard area(s) (100- and 500-year floodplains, stormwater, etc.) based on current base flood elevation (BFE) and survey elevation data.
		O	FSA, City, KPB	Determine and implement most cost beneficial and feasible mitigation actions for locations with repetitive flooding, significant historical damages, or road closures.
		O	FSA (Reworded)	Pursue an exemption to the Alaska Department of Natural Resources (DNR) Material Sales Fees for sediment and debris management on navigable rivers and streams.
		O	FSA	Seek amendment or standing waiver for State Material Sales Fees for

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the SBCFSA's pre-identified 2010 Mitigation Action Items)

Goals: No.	Goals: Description	Actions: Status: Considered, Selected Complete, Deferred, Deleted, or Ongoing	Actions: Authority	Actions: Description
				stream channel maintenance wherein no fees are required from the permitee when activities are focused on maintaining flood carrying capacity.
		S	FSA, City, KPB	Work with State of Alaska Department of Natural Resources to resolve bed load resultant debris removal and financial constraints from Japanese Creek, Resurrection River, and other problematic streams within SBCFSA.
		O	FSA (Reworded)	Evaluate each watershed to develop land use plans for removing and storing creek bed load to: • Perform periodic sediment management/bed load removal as necessary. • Identify and permit fill areas for future flood-free development sites. • Identify storage sites that limit gravel transportation costs.
		S	FSA, City, KPB	Apply for grant funding to assist critical facilities, public infrastructure, and residential properties with elevating flood threatened structures at least two feet above the identified Base Flood Elevation (BFE).
		S	FSA, City, KPB	Acquire and maintain NOAA/NWS stream flow and rainfall measuring gages.
		O	FSA, City, KPB	Increase culvert sizes to increase their drainage capacity or efficiency. Specific locations that would benefit from this improvement include: • Bear Creek at Bear Lake Rd • Grouse Creek at Timber Lane • Kwechak Creek at Bruno Road • Salmon Creek at Nash Road • Salmon Creek at the Alaska Railroad culvert northeast of Salmon Creek Road • Salmon Creek at Seward Highway MM 13.9 • Salmon Creek at the Alaska Railroad adjacent to Seward Highway MM 13.9 • Salmon Creek Overflow at Seward Highway and Granite Loop • Sawmill Creek at Nash Road
		S	FSA, City, KPB	Construct debris basins or other debris catchment devices to retain debris to prevent downstream drainage structure clogging.
		S	FSA, City, KPB	Seek funding for sediment and debris management to remove excessive stream bed sediment load, gravel, and glacial debris.
GF 7	Reduce vulnerability, damage, or loss of structures from ground failure.	O	KPB	Complete a ground failure (avalanche, landslide etc.) location inventory; identify (and map) threatened critical facilities, residential buildings, infrastructure, and other essential buildings.
		S	FSA, City, KPB	Install wire matting, debris catchment structure, cliff stabilization etc. to prevent Lowell Canyon Creek diversion tunnel obstruction and diversion dam overtopping from landslide debris, woody vegetation, trees, etc.
TS 8	Reduce vulnerability, damage, or loss of structures from tsunami or seiche	C	FSA, KPB	Construct tsunami evacuation structures for remote locations sited in potential tsunami impact areas.
		O	City, KPB	Install tsunami evacuation route signs throughout the communities.
		O	City, KPB	Install tsunami warning siren and early alert system.
		O	City	Install tsunami specific interpretive signs at public facilities.

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the SBCFSA's pre-identified 2010 Mitigation Action Items)

Goals		Actions		
No.	**Description**	**Status:** *Considered, Selected Complete, Deferred, Deleted, or Ongoing*	**Authority**	**Description**
VO 9	Reduce vulnerability, damage, or loss of structures from volcanic debris impacts	C	City	Evaluate water treatment plant's capability to deal with high turbidity from ash fall events.
		C	City	Upgrade water and wastewater treatment facilities' physical plants to deal with ash fall events.
		C	City	Develop water and wastewater plant protection or sustainability plans.
		O	City, KPB	Evaluate potential air quality impacts to public facilities during an ashfall event.
SW 10	Reduce vulnerability, damage, or loss of structures from severe weather damage.	O	FSA, City, KPB, State	Develop and implement programs to coordinate maintenance and mitigation activities to reduce risk to public infrastructure from severe winter storms (snow load, ice, and wind).
		O	FSA, City, KPB, State	Develop and implement tree clearing mitigation programs to keep trees from threatening lives, property, and public infrastructure from severe weather events.
		O	FSA, City, KPB, State	Develop, implement, and maintain partnership program with electrical utilities to use underground utility placement methods where possible to reduce or eliminate power outages from severe winter storms. Consider developing incentive programs.
WF 11	Reduce vulnerability, damage, or loss of structures from wildland fires.	O	City	Develop Community Wildland Fire Protection Plan to mitigate wildland fire threat.
		O	FSA, City, KPB,	Hold FireWise workshop to educate residents and contractors concerning fire resistant landscaping.
		O	City, KPB	Promote FireWise building siting, design, and construction processes and materials.
		O	City, KPB	Provide wildland fire hazard outreach information in an easily distributed format for all residents.
		O	City, KPB	Develop, adopt, and enforce burn ordinances that control outdoor burning, requires burn permits, and restricts open campfires during identified weather periods (windy, dry, etc.).
		O	KPB	Identify, develop, implement, and enforce mitigation actions such as fuel breaks and reduction zones for potential wildland fire hazard areas.
		C	KPB	Install dry hydrants at strategic locations to enable rapid fire response.

7.6 EVALUATING AND PRIORITIZING MITIGATION ACTIONS

The requirements for the evaluation and implementation of mitigation actions, as stipulated in DMA 2000 and its implementing regulations are described below.

DMA 2000 Requirements: Mitigation Strategy - Implementation of Mitigation Actions
Implementation of Mitigation Actions
§201.6(c)(3)(iii): [The hazard mitigation strategy shall include an] action plan, describing how the action identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.
ELEMENT C. MITIGATION STRATEGY
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))
Source: FEMA, October 2011.

The Planning Team reviewed how hazard impacts would potentially affect the SBCFSA and its constituent members. Current impacts, as well as future hazard impacts resulting from potential climate change were considered for this Mitigation Strategy. Items that were considered are defined in Table 7-6, the simplified Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) evaluation criteria. The Benefit-Cost Analysis Fact Sheet (Appendix E) provided additional information for consideration; opportunities and constraints to implementing each particular mitigation action.

Table 7-6 STAPLEE Evaluation Criteria

Evaluation Category	Discussion "It is important to consider…"	Considerations
Social	The public support for the overall mitigation strategy and specific mitigation actions.	Community acceptance Adversely affects population
Technical	If the mitigation action is technically feasible and if it is the whole or partial solution.	Technical feasibility Long-term solutions Secondary impacts
Administrative	If the community has the personnel and administrative capabilities necessary to implement the action or whether outside help will be necessary.	Staffing Funding allocation Maintenance/operations
Political	What the community and its members feel about issues related to the environment, economic development, safety, and emergency management.	Political support Local champion Public support
Legal	Whether the community has the legal authority to implement the action, or whether the community must pass new regulations.	Local, State, and Federal authority Potential legal challenge
Economic	If the action can be funded with current or future internal and external sources, if the costs seem reasonable for the size of the project, and if enough information is available to complete a Federal Emergency Management Agency (FEMA) Benefit-Cost Analysis.	Benefit/cost of action Contributes to other economic goals Outside funding required FEMA Benefit-Cost Analysis
Environmental	The impact on the environment because of public desire for a sustainable and environmentally healthy community.	Effect on local flora and fauna Consistent with community environmental goals Consistent with local, state, and Federal laws

The SBCFSA, City of Seward, and KPB identified 52 current mitigation activities some of which were deleted, reworded, or combined to prevent duplication (Table 7-5). These actions were updated for this LHMP and are classified as "ongoing" within Tables 7-8 and 7-9; and further defined in their respective City of Seward or Kenai Peninsula Borough HMPs.

On March 13, 2013, the hazard mitigation Planning Team prioritized 47 mitigation actions that were chosen to carry forward into the SBCFSA Mitigation Action Plan (MAP). The hazard mitigation Planning Team considered each hazard's history, extent, and probability to determine each potential actions priority. A rating system based on high, medium, or low was used.

- High priorities are associated with actions for hazards that impact the community on an annual or near annual basis and generate impacts to critical facilities and/or people.
- Medium priorities are associated with actions for hazards that impact the community less frequently, and do not typically generate impacts to critical facilities and/or people.
- Low priorities are associated with actions for hazards that rarely impact the community and have rarely generated documented impacts to critical facilities and/or people.

The Mitigation Action Plan represents mitigation projects and programs to be implemented through the cooperation of multiple entities in the SBCFSA. To complete this task, the Planning Team first prioritized the hazards that were regarded as the most significant within the community (earthquake, erosion, flood, ground failure, tsunami, volcano, severe weather, and wildland fire).

Prioritizing the mitigation actions in the MAP Matrix was completed to provide the SBCFSA with an approach to implementing the Mitigation Action Plan. SBCFSA reserves the right to focus on individual actions as events or funding opportunities dictate. Table 7-8 delineates the SBCFSA's mitigation action priorities.

Note: *Blue text identifies the SBCFSA's existing actions brought forward from the 2010 SBCFSA Flood Hazard Mitigation Plan.*

A qualitative statement is provided regarding the benefits and costs and, where available, the technical feasibility for each action considered for implementation within the MAP. A detailed cost-benefit analysis is anticipated as part of the application process for those projects the SBCFSA chooses to submit for funding.

7.7 IMPLEMENTING A MITIGATION ACTION PLAN

Table 7-7 delineates the acronyms used in the Mitigation Action Plan (MAP) (Table 7-8). See Appendix B for complete agency funding source descriptions.

The SBCFSA's Mitigation Action Plan, Table 7-8, depicts how each mitigation action will be implemented and administered by the Planning Team. The MAP delineates each selected mitigation action, its priorities, the responsible entity, the anticipated implementation timeline, and provides a brief explanation as to how the overall benefit/costs and technical feasibility were taken into consideration.

Table 7-7 Potential Funding Source Acronym List

Seward Bear Creek Flood Service Area (SBCFSA)
City of Seward (City)
Kenai Peninsula Borough (KPB)
Qutekcak Tribal Council (Tribe)
Federal Management Agency (FEMA)/ *Hazard Mitigation Assistance (HMA) Grant Programs,* *Emergency Management Program Grant (EMPG)* *Debris Management Grant* *Flood Mitigation Assistance Grants* *National Earthquake Hazards Reduction Program (NEHRP)* *National Dam Safety Program (NDS)*
US Department of Homeland Security (DHS) *Citizens Corp Program (CCP)* *Emergency Operations Center (EOC)* *Homeland Security Grant Program (HSGP)* *State Homeland Security Program (SHSP)*
US Department of Commerce (DOC)/ *Remote Community Alert Systems Program (RCASP)* *National Oceanic and Atmospheric Administration (NOAA)*
Denali Commission (Denali) *Energy Program,* *Solid Waste Program,*
Alaska Department of Military and Veterans Affairs (DMVA), Division of Homeland Security and Emergency Management (DHSEM) *Mitigation Section (for PDM & HMGP projects and plan development)* *Preparedness Section (for community planning)* *State Emergency Operations Center (SEOC for emergency response)*

Alaska Department of Community, Commerce, and Economic Development (DCCED) Division of Community and Regional Affairs (DCRA)/
Community Development Block Grant (CDBG)
Alaska Climate Change Impact Mitigation Program (ACCIMP)
Flood Mitigation Assistance Grants (FMA)

Alaska Department of Transportation
State road repair funding

Alaska Energy Authority (AEA)
AEA/Bulk Fuel (ABF)
AEA/Alternative Energy and Energy Efficiency (AEEE)

Alaska Department of Environmental Conservation (DEC)/
V*illage Safe Water (VSW),*
DEC/Alaska Drinking Water Fund (ADWF),
DEC/Alaska Clean Water Fund [ACWF],
DEC/Clean Water State Revolving Fund (CWSRF)

US Army Corp of Engineers (USACE)/
Planning Assistance
Capital Projects: Erosion, Flood, Ports & Harbors,

Alaska Division of Forestry (DOF)/
Volunteer Fire Assistance and Rural Fire Assistance Grant (VFAG/RFAG),
Assistance to Firefighters Grant (AFG),
Fire Prevention and Safety (FP&S),
Staffing for Adequate Fire and Emergency Response Grants (SAFER)
Emergency Food and Shelter (EF&S)

US Department of Agriculture (USDA)/
Emergency Watershed Protection Program (EWP])
Emergency Conservation Fund (ECF),
Rural Development (RD)

US Geological Survey (USGS)
Alaska Volcano Observatory (AVO)

Assistance to Native Americans (ANA)
(NAFSMA),

Natural Resources Conservation Service (NRCS)/
Emergency Watershed Protection Program (EWP)
Wildlife Habitat Incentives Program (WHIP)
Watershed Planning

US Army Corps of Engineers (USACE)/
Planning Assistance Program

Lindbergh Foundation Grant Programs (LFGP)

Rasmuson Foundation Grants (LFG)

Resurrection Bay Conservation Alliance (RBCA)

Table 7-7 contains the SBCFSA's MAP Matrix that designates mitigation action priorities, explains their overall benefit/costs and technical feasibility considerations, and describes each mitigation action's potential funding and implementation responsibility.

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
Multi-Hazards						
MH 1.1	Develop a strategy for accessing (applying for and managing) mitigation grant funds	High	SBCFSA, City, KPB	SBCFSA	Ongoing	B/C: This ongoing activity is essential for the City as there are limited funds available to accomplish effective mitigation actions. TF: This activity is ongoing demonstrating its feasibility.
MH 1.2	Identify and pursue funding opportunities to implement mitigation actions.	High	SBCFSA, City, KPB	City, KPB	Ongoing	B/C: This ongoing activity is essential for the City as there are limited funds available to accomplish effective mitigation actions. TF: This activity is ongoing demonstrating its feasibility.
MH 1.3	Organize a Floodproofing Workshop for Homeowners and Businesses to learn about techniques and funding sources for elevating, and floodproofing structures (agency[ies]) to participate – USACE Floodproofing Committee, FEMA, DCCED; Businesses to support SBS, Wells Fargo, others)	Low	SBCFSA, City, KPB	City, KPB, HMA Programs, NRCS, USACE, USDA/EWP, USDA/ECP, DCRA/ ACCIMP	Ongoing	B/C: Flood hazard mitigation is among FEMA's highest national priorities. FEMA desires communities focus on repetitive flood loss properties. This activity will ensure the City and Tribal Councils focus on priority flood locations and projects. TF: Low to no cost makes this outreach activity very feasible.
MH 1.4	Strive to formalize a Hazard Mitigation Planning Team to develop a sustainable process for implementing, monitoring, reviewing, and evaluating community wide mitigation actions.	Low	SBCFSA, City, KPB	SBCFSA, City, KPB	Ongoing	B/C: The existing team has gained experienced throughout this process which can provide invaluable insight for ensuring a sustained effort toward mitigating natural hazard damages. TF: This is feasible to accomplish as no cost is associated with the action and only relies on member availability and willingness to serve their community.

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
MH 1.5	Hold periodic outreach events or activities to educate population concerning existing natural hazards. Activities are designed to provide pertinent natural hazards information to residents about recognizing and mitigating hazards that could potentially affect the SBCFSA.	Medium	SBCFSA, City, KPBA	City, KPB, FEMA HMA Programs, AFG, FP&S, SAFER, ANA, EEFSP, Lindbergh, Rasmuson, Denali Commission	Ongoing	B/C: Sustained mitigation outreach program has minimal cost and will help build and support area-wide capacity. This type activity enables the public to prepare for, respond to, and recover from disasters. Potential subjects could include: benefits of participating in the NFIP; safe “FireWise” practices; river, stream or creek levee or channel breach; tsunami warnings and response; other emergency management focused subjects; etc.) TF: This low cost activity can be combined with recurring community meetings where hazard specific information can be presented in small increments. This activity is ongoing demonstrating its feasibility.
MH 1.6	Develop, produce, and distribute information materials concerning mitigation, preparedness, and safety procedures for all identified natural hazards.	Low	SBCFSA, City, KPB	City, KPB, FEMA HMA Programs, DOF	Ongoing	B/C: Sustained mitigation outreach programs have minimal cost and will help build and support area-wide capacity. This type activity enables the public to prepare for, respond to, and recover from disasters. TF: This low cost activity can be combined with recurring community meetings where hazard specific information can be presented in small increments. This activity is ongoing demonstrating its feasibility.
MH 1.7	Develop and implement strategies and educational outreach programs for debris management from natural hazard events.	Medium	SBCFSA, City, KPB	City, KPB, FEMA HMA Programs	Ongoing	B/C: Debris management is an essential disaster management necessity. Focused and coordinated planning enables effective damage abatement and ensures proper attention is assigned to reduce losses, damage, and materials management. TF: This action is feasible with limited fund expenditures.
MH 1.8	Disseminate FEMA pamphlets to educate and encourage homeowners	Low	SBCFSA	City, KPB, FEMA HMA Programs, AFG,	Ongoing	B/C: FEMA provides free publications for community education purposes.

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
	concerning structural and non-structural retrofit benefits.			FP&S, and SAFER		TF: Low to no cost makes this a very feasible project to successfully educate large populations.
MH 1.9	Develop outreach program to educate residents concerning all-hazard benefits of modern building code compliance during rehabilitation or major repairs for residences or businesses.	Low	SBCFSA, City, KPB	City, KPB, FEMA HMA Programs, AFG, FP&S, SAFER, ANA, EEFSP, Lindbergh, Rasmuson, Denali Commission	Ongoing	B/C: Sustained mitigation outreach programs have minimal cost and will help build and support area-wide capacity. This type activity enables the public to prepare for, respond to, and recover from disasters. TF: This low cost activity can be combined with recurring community meetings where hazard specific information can be presented in small increments. This activity is ongoing demonstrating its feasibility.
MH 1.10	Disseminate information to increase public knowledge about flood insurance, and the natural and beneficial floodplain functions.	High	SBCFSA	SBCFSA, City, KPB, FEMA	Ongoing	B/C: NFIP participation while one of FEMA's highest priorities also enables communities with an effective program focus on repetitive flood loss properties and other priority flood locations and projects. TF: SBCFSA is currently a member through KPB and residents enjoy lower cost insurance. Continuation is relatively simple. KPB is also a CRS jurisdiction providing larger insurance discounts.
MH 1.11	Identify critical facilities and vulnerable populations based on identified (and mapped where applicable) high hazard areas.	Medium	SBCFSA, City, KPB	City, Denali Commission, DCRA, DHS, DOF	Ongoing	B/C: This project will ensure the community looks closely at their hazard areas to ensure they can safely evacuate their residents and visitors to safety during a natural hazard event. TF: This is technically feasible using existing city and tribal resources.
MH 1.12	Identify evacuation routes away from high hazard areas and develop outreach program to educate the public concerning warnings and evacuation procedures.	Low	SBCFSA, City, KPB	City, Denali Commission, DCRA, DHS, DOF	Ongoing	B/C: This project will ensure the community looks closely at their hazard areas to ensure they can safely evacuate their residents and visitors to safety during a natural hazard event. TF: This is technically feasible using existing city and tribal resources.

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
MH 1.13	Establish a cooperative relationship with the City of Seward to ensure hazard mitigation efforts are not being duplicated or opportunities missed.	High	SBCFSA, City, KPB	SBCFSA, City	Ongoing	B/C: Coordinated planning ensures effective damage abatement and ensures proper attention is assigned to reduce losses and damage to structures and City residents. TF: This is feasible to accomplish as no cost is associated with the action and only relies on member availability and willingness to serve their community.
MH 1.14	Coordinate with the Kenai Peninsula Borough and other appropriate agencies to obtain funding and permitting to establish an annual maintenance schedule and contract to remove excess debris throughout the SBCFSA.	High	SBCFSA	SBCFSA, City, KPB, DOT/PF, ARRC	Ongoing	B/C: Coordinated planning ensures effective damage abatement and ensures proper attention is assigned to reduce losses and damage to structures and City residents. TF: This is technically feasible because it requires application of knowledge of the hazard mitigation plan and other planning efforts. Feasibility is reliant on technical skills already possessed by employees holding positions that would implement this action.
MH 2.1	The SBCFSA will manage their existing plans to incorporate mitigation planning provisions into all service area planning processes such as comprehensive, capital improvement, and land use plans, etc. to demonstrate multi-benefit considerations and facilitate using multiple funding source consideration.	Medium	SBCFSA	SBCFSA	Ongoing	B/C: Coordinated planning ensures effective damage abatement and ensures proper attention is assigned to reduce losses and damage to structures and residents. TF: This is feasible to accomplish as cost can be associated with plan reviews and updates. The action relies on staff and review committee availability and willingness to serve their community.
MH 2.2	Improve flood and erosion hazard aspects in land use decisions, subdivision actions, and Plans that affect the SBCFSA including: KPB All-Hazards Plan, Comprehensive Plan, Coastal Management; Wetlands Management Plan, Seward Long-term development plan.	High	SBCFSA	SBCFSA, City, KPB, DOT/PF, ARRC	Ongoing	B/C: Coordinated planning ensures effective damage abatement and ensures proper attention is assigned to reduce losses and damage to structures and City residents. TF: This is technically feasible because it requires application of knowledge of the hazard mitigation plan and other planning efforts. Feasibility is reliant on technical skills already possessed by employees holding

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
						positions that would implement this action.
MH 2.3	Develop, incorporate, and enforce building ordinances to reflect survivability from flood, fire, wind, seismic, and other hazards to ensure occupant safety.	Low	SBCFSA, City, KPB	City, KPB, NRCS, ANA, USACE, USDA, Lindbergh	Ongoing	B/C: Ordinance development, implementation, and enforcement can effectively reduce future losses to hazardous events. Building codes can actually assist bush communities through making maximum use of materials and shipping costs the first time. TF: This project is technically feasible as the community need only demonstrate cost savings by demonstrating losses from history utility impacts and down time.
MH 2.5	Adopt the Risk MAP coastal velocity zone mapping studies into the floodplain code.	High	City, KPB	SBCFSA, City, KPB	1-3 years	B/C: Coordinated planning ensures effective damage abatement and ensures proper attention is assigned to reduce losses and damage to structures and City residents. TF: This action is feasible with limited fund expenditures.
MH 2.6	Relocate or acquire (buy-out and demolish) structures away from hazard prone area (erosion, flood, ground failure, etc.)	Medium	SBCFSA, City, KPB	City, KPB, HMA Programs, NRCS, ANA, USACE, USDA, Lindbergh Grants Program	Ongoing	B/C: This project would remove threatened structures from hazard areas, eliminating future damage while keeping land clear for perpetuity. To qualify for FEMA funding, property deeds "must be" restricted for open space uses for perpetuity to keep people from rebuilding in known hazard areas. F: This project is feasible using existing staff skills, equipment, and materials. Acquiring contractor expertise may be required for large facilities.
Natural Hazards						
EQ 4.1	Install non-structural seismic restraints for large furniture such as bookcases, filing cabinets, heavy televisions, and	Low	SBCFSA	City, KPB, Tribe, HMA Programs, ANA, EFSP,	Ongoing	B/C: Non-structural mitigation projects have minimal cost and will help the community reduce recurring earthquake impact damages from future events.

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
	appliances to prevent toppling damage and resultant injuries to small children, elderly, and pets.					TF: This project is technically feasible using existing Tribal Council staff
ER 5.1	Develop mitigation initiatives such as: Rip-rap (large rocks), sheet pilings, gabion baskets, articulated matting, concrete, asphalt, vegetation, or other armoring or protective materials to provide river bank protection.	High	SBCFSA, City, KPB	City, KPB, Tribe, HMA Programs, NRCS, ANA, USACE, USDA, Lindbergh Grants Program	Ongoing	B/C: Improving embankment and slope stability will greatly reduce potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
ER 5.2	Harden culvert entrance bottoms with concrete, rock, or similar material to reduce erosion or scour.	Medium	SBCFSA, City, KPB	City, Tribe, HMA Programs, ANA, NRCS, USACE	Ongoing	B/C: This retrofit project can be a very cost effective method for bush communities as materials and shipping costs are very high. This project is technically feasible as the community need only demonstrate cost savings by demonstrating losses from history utility impacts and down time.
ER 5.3	Install walls at the end of a drainage structure to prevent embankment erosion at its entrance or outlet. (headwalls- or wing-walls).	Medium	SBCFSA	City, Tribe, HMA Programs, ANA, NRCS, USACE	Ongoing	B/C: This retrofit project can be a very cost effective method for bush communities as materials and shipping costs are very high. TF: This project is technically feasible as the community need only demonstrate cost savings by demonstrating losses from history utility impacts and down time.
ER 5.4	Harden and/or retrofit existing levees to qualify for USACE certification.	High	SBCFSA, City, KPB	City, Tribe, HMA Programs, ANA, NRCS, USACE	3-5 years	B/C: Pre-planning and implementing appropriate embankment stability will greatly reduce or delay potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill to implement this

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
						action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
FL 6.1	Pursue federal and state funding to improve and update Flood Insurance Rate Maps (FIRMs), as well as other maps and plans that may be more appropriate such as Drainage Plans or watershed management plans in order to meet other goals. This should also include extending coastal floodplain mapping to Lowell Point.	High	SBCFSA	City, KPB, Tribe, HMA Programs, ANA, USACE, NRCS, Lindbergh, Rasmuson, Denali Commission	Ongoing	B/C: Improving water flow capability will greatly reduce potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
FL 6.2	Identify and list repetitively flooded structures and infrastructure, analyze the threat to these facilities, and raise mitigation action priorities to protect the threatened population.	High	SBCFSA	City, KPB, FEMA HMA, AFG, FP&S, SAFER, ANA, EEFSP, Lindbergh, Rasmuson, Denali Commission	Ongoing	B/C: Repetitive damage reduction is a high priority for FEMA and will therefore benefit the community greatly. Identifying RL and SRL properties is the first step to reducing losses. Coordinated planning ensures effective damage abatement and ensures proper attention is assigned to reduce losses and damage to structures and City residents. TF: This is feasible to accomplish as no cost is associated with the action until appropriate mitigation actions are identified. This activity relies on community member availability and willingness to serve their community.
FL 6.2	Work with the USACE to develop a direct channel to direct water conveyance away from the three Seward Highway Bridges and the airport directing flow to Resurrection Bay.	High	SBCFSA	City, KPB, USACE, NRCS	Ongoing	B/C: Improving water flow capability will greatly reduce potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill to implement this action. Specialized skills may need to be contracted-out

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
						with materials and equipment barged in depending on the method selected.
FL 6.3	Work with USACE, NRCS, and State to purse sediment and debris management at the mouth of the Resurrection River.	High	SBCFSA	City, KPB, Tribe, HMA Programs, ANA, USACE, NRCS, Lindbergh, Rasmuson, Denali Commission	Ongoing	B/C: Scheduling maintenance and implementing cost beneficial mitigation activities will potentially reduce severe debris loading, road, bridge, and property damages caused by heavy floods with high water flow. This will reduce debris accumulation, encourage water movement from high to low areas; and lessen upstream flood potential. TF: This type activity is technically feasible within the community typically using existing labor, equipment, and materials. Specialized methods are not new to rural communities as they are used to importing required contractors.
FL 6.4	Develop and maintain NFIP compliant Repetitive Loss property inventory. Inventory should include property type, structure type, number of buildings, and their geo-referenced locations.	High	SBCFSA	City, KPB, Tribe, HMA Programs, ANA, USACE, NRCS, Lindbergh, Rasmuson, Denali Commission	Ongoing	B/C: Repetitive damage reduction is a high priority for FEMA and will therefore benefit the community greatly. Identifying RL and SRL properties is the first step to reducing losses. Coordinated planning ensures effective damage abatement and ensures proper attention is assigned to reduce losses and damage to structures and City residents. TF: This is feasible to accomplish as no cost is associated with the action until appropriate mitigation actions are identified. This activity relies on community member availability and willingness to serve their community.
FL 6.5	Establish flood mitigation priorities for critical facilities, residential structures, and commercial buildings located within the identified flood hazard area(s) (100- and 500-year floodplains, stormwater,	High	SBCFSA	City, KPB, Tribe, HMA Programs, ANA, USACE, NRCS, Lindbergh, Rasmuson, Denali	Ongoing	B/C: Flood hazard mitigation is among FEMA's highest national priorities. FEMA desires communities focus on repetitive flood loss properties. This activity will ensure the City and Tribal Councils focus on priority flood locations and projects.

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
	etc.) based on current base flood elevation (BFE) and survey elevation data.			Commission		TF: Low to no cost makes this outreach activity very feasible.
FL 6.6	Determine and implement most cost beneficial and feasible mitigation actions for locations with repetitive flooding, significant historical damages, or road closures.	High	SBCFSA	City, KPB, Tribe, HMA Programs, ANA, USACE, NRCS, Lindbergh, Rasmuson, Denali Commission	Ongoing	B/C: Flood hazard mitigation is among FEMA's highest national priorities. FEMA desires communities focus on repetitive flood loss properties. This activity will ensure the City and Tribal Councils focus on priority flood locations and projects. TF: Low to no cost makes this outreach activity very feasible.
FL 6.7	Obtain an exemption to the Alaska Department of Natural Resources (DNR) Material Sales Fees on navigable rivers and streams for sediment and debris management, stream channel maintenance, and flood control or other flood mitigation projects.	High	SBCFSA	SBCFSA, City, KPB, Tribe, DCRA, Denali Commission	1-3 years	B/C: Improving water flow capability will greatly reduce potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
FL 6.8	Develop Bridge Maintenance with KPB, DOT/PF, and ARRC for all stream crossings throughout the flood service area to include: sediment removal under bridges.	High	SBCFSA	SBCFSA, City, KPB, Tribe, DOT/PF, ARRC, Denali Commission	1-3 years	B/C: Improving water flow capability will greatly reduce potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
FL 6.9	Evaluate each watershed to develop land use plans for removing and storing creek bed load to:	High	SBCFSA	City, KPB, Tribe, HMA Programs, ANA, DOT/PF, Denali	3-5 years	B/C: Improving water flow capability will greatly reduce potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
	• Perform periodic sediment management/bed load removal as necessary. • Identify and permit fill areas for future flood-free development sites. • Identify storage sites that limit gravel transportation costs.			Commission, NRCS, USACE, USDA/EWP, USDA/ECP, USACE, DCRA/ ACCIMP		facilities. TF: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
FL 6.10	Seek funding for sediment and debris management to remove excessive stream bed sediment load, gravel, and glacial debris.	High	SBCFSA	City, KPB, Tribe, HMA Programs, NRCS, ANA, USACE, US USDA, Lindbergh Grants Program	2-4 years	B/C: Improving water flow capability will greatly reduce potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
FL 6.11	Apply for grant funding to assist critical facilities, public infrastructure, and residential properties with elevating flood threatened structures at least two feet above the identified Base Flood Elevation (BFE). *(Current FEMA minimum is 1 ft. above BFE.)*	High	SBCFSA	City, KPB, Tribe, HMA Programs, ANA, Denali Commission, NRCS, USACE, USACE, DCRA/ ACCIMP	1-5 years	B/C: Acquiring funding is essential for the SBCFSA as there are limited funds available to accomplish effective mitigation actions. This project would exceed FEMA minimum requirements for flood threatened structures by “at least” one foot. F: This project is feasible using existing staff skills, equipment, and materials. Acquiring contractor expertise may be required for large facilities.
FL 6.12	Acquire and maintain NOAA/NWS stream flow and rainfall measuring gages.	High	SBCFSA	City, KPB, Tribe, NOAA	2-4 years	B/C: This project would potentially provide near-term flood threat warning, enabling responders to mitigate potential damages. TF: This project is feasible using existing staff skills, equipment, and materials.
FL	Increase culvert sizes to increase their	High	SBCFSA	City, KPB, Tribe,	Ongoing	B/C: Improving water flow capability will greatly reduce

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
6.13	drainage capacity or efficiency. Specific locations that would benefit from this improvement include: • Bear Creek at Bear Lake Rd • Grouse Creek at Timber Lane • Kwechak Creek at Bruno Road • Salmon Creek at Nash Road • Salmon Creek at the Alaska Railroad culvert northeast of Salmon Creek Road • Salmon Creek at Seward Highway MM 13.9 • Salmon Creek at the Alaska Railroad adjacent to Seward Highway MM 13.9 • Salmon Creek Overflow at Seward Highway and Granite Loop • Sawmill Creek at Nash Road			HMA Programs, NRCS, ANA, USACE, US USDA, Lindbergh Grants Program		potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
FL 6.14	Construct debris basins or other debris catchment devices to retain debris to prevent downstream drainage structure clogging.	High	SBCFSA	City, KPB, Tribe, HMA Programs, NRCS, ANA, USACE, US USDA, Lindbergh Grants Program	2-4 years	B/C: Improving water flow capability will greatly reduce potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
GF 7.1	Install wire matting, debris catchment structure, cliff stabilization etc. to prevent Lowell Canyon Creek diversion tunnel obstruction and diversion dam overtopping from landslide debris,	High	SBCFSA, City	City, KPB, Tribe, HMA Programs, NRCS, ANA, USACE, US USDA, Lindbergh Grants Program	3-5 years	B/C: Hardening infrastructure to reduce natural hazard damages potentially reduces future catastrophic impacts to critical facilities at exceedingly higher costs. TF: The City has the technical capability to manage and

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
	woody vegetation, trees, etc.					conduct this project.
GF 7.2	Develop vegetation projects to restore clear-cut and riverine erosion damage and to restore slope stability in avalanche and landslide areas.	Low	SBCFSA	City, KPB, HMA Programs, ANA, NRCS, USACE, RBCA	Ongoing	B/C: Improving slope stability will greatly reduce potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: Technically feasible as the community has the skill to implement this action using native materials and equipment.
SW 10.1	Develop and implement programs to coordinate maintenance and mitigation activities to reduce risk to public infrastructure from severe winter storms (snow load, ice, and wind).	Low	SBCFSA, City, KPB	City, KPB, Tribe, DCCED/CDBG, Denali Commission	3-5 years	B/C: Scheduling maintenance and implementing mitigation activities will potentially reduce severe winter storm damages caused by heavy snow loads, wind, and freezing rain. TF: This type activity is technically feasible within the community typically using existing labor, equipment, and materials. Specialized methods are not new to rural communities as they are used to importing required contractors.
SW 10.2	Develop and implement tree clearing mitigation programs to keep trees from threatening lives, property, and public infrastructure from severe weather events.	Low	SBCFSA, City, KPB	City, Tribe, HMA Programs, AFG, FP&S, SAFER DOF: VFAG, RAGP, FireWise	Ongoing	B/C: This mitigation activity will reduce severe winter storm damages caused by heavy snow loads and icy rain by avoiding damage to structures and infrastructure. TF: This type activity is technically feasible within the community by implementing existing programs such as Fire Wise and other State and Federal agency programs.
SW 10.3	Develop, implement, and maintain partnership program with electrical utilities to use underground utility placement methods where possible to reduce or eliminate power outages from	Low	SBCFSA, City, KPB	City, Tribe, HMA Programs, AFG, FP&S, SAFER DOF: VFAG, RAGP, FireWise	Ongoing	B/C: Implementing this mitigation activities will potentially reduce ancillary damage from severe winter storms caused by heavy snow loads, icy rain, and wind. TF: This type activity is technically feasible within the

Table 7-8 SBCFSA Mitigation Action Plan (MAP) Matrix

(See acronym and abbreviations list for complete titles)

Action ID	Description	Priority (Low, Medium, High)	Responsible Entity or Department: SBCFSA, City of Seward (City), KPB	Potential Funding	Time-frame (3-5 years 2-4 Years 1-3 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
	severe winter storms. Consider developing incentive programs.					community typically using existing labor, equipment, and materials.
WF 11.1	Hold FireWise workshop to educate residents and contractors concerning fire resistant landscaping.	Low	SBCFSA, City, KPB	SBCFSA, City, KPB, Tribe, DOF: FP&S, VFAG, RAGP	Ongoing	B/C: Sustained mitigation outreach programs have minimal cost and will help build and support community capacity enabling the public to appropriately prepare for, respond to, and recover from disasters. T/F: This project is technically feasible using existing City and Tribal staff.

Table 7-9 delineates those activities the City of Seward and the Kenai Peninsula Borough are accomplishing to mitigate potential natural hazard impacts within the SBCFSA.

Table 7-9 City of Seward and KPB Identified On-Going Mitigation Activities

(Actions that occur within the FSA but not within SBCFSA authority or responsibility)

Goal	Authority to Implement	Activity Description
Multi-Hazard MH 1 Promote recognition and mitigation of all natural hazards that affect the SBCFSA.	City, KPB	Hold periodic outreach events or activities to educate population concerning existing natural hazards. Activities are designed to provide pertinent natural hazards information to residents about recognizing and mitigating hazards that could potentially affect the SBCFSA. Potential subjects could include: benefits of participating in the NFIP, safe “FireWise” practices; river, stream or creek levee or channel breach, tsunami warnings and response, other emergency management focused subjects, etc.)
	KPB	Develop an outreach program to educate public concerning NFIP participation benefits, floodplain development, land use regulation, and NFIP flood insurance availability to facilitate continued compliance with the NFIP.
	KPB	Develop an outreach program to educate public concerning NFIP participation benefits, floodplain development, land use regulation, and NFIP flood insurance availability to facilitate continued compliance with the NFIP.
	KPB	Develop outreach program to educate residents concerning flood proofed well and sewer/septic facility installations.
	City, KPB	Review ordinances and develop outreach programs to assure propane tanks are properly anchored and hazardous materials are properly stored and protected from known natural hazards such as flood or seismic events.
	City, KPB	Develop, produce, and distribute information materials concerning mitigation, preparedness, and safety procedures for all identified natural hazards.
	City, KPB	Develop and implement strategies and educational outreach programs for debris management from natural hazard events.
	City, KPB	Disseminate FEMA pamphlets to educate and encourage homeowners concerning structural and non-structural retrofit benefits.
	City, KPB	Develop outreach program to educate residents concerning all-hazard benefits of modern building code compliance during rehabilitation or major repairs for residences or businesses.
	City, KPB	Update public emergency notification procedures and develop an outreach program for potential hazard impacts or events.
	City, KPB	Identify critical facilities and vulnerable populations based on identified (and mapped where applicable) high hazard areas.
	City, KPB	Identify evacuation routes away from high hazard areas and develop outreach program to educate the public concerning warnings and evacuation procedures.
	City, KPB	Acquire emergency warning methods to communicate critical emergency warnings and alerts. City uses Radios, cell phones, alert sirens, etc.
	City, KPB	911 reverse call to notify residents.
Multi-Hazard MH 2 Promote cross-referencing mitigation goals and actions with other SBCFSA, City of Seward, and KPB planning mechanisms and	City, KPB	Improve enforcement of existing City and Borough NFIP flood damage prevention ordinances.
	City, KPB	Prohibit Below Grade crawlspaces and basements throughout the Service Area unless PE, architect or Professional Land Surveyor certifies that building site is not subject to flooding, localized drainage, or high ground water.
	City, KPB	Avoid building more new homes in the floodway (existing ordinance); revise floodplain ordinance to prohibit any new subdivision of land within the mapped floodplain.
	City, KPB	Increase enforcement including fostering a partnership (M.O.U.) for enforcement uniformly within the City and Borough specific to the SBCFSA.
	KPB	Review KPB Habitat Protection Ordinance for extension to Service Area for

Table 7-9 City of Seward and KPB Identified On-Going Mitigation Activities

(Actions that occur within the FSA but not within SBCFSA authority or responsibility)

Goal	Authority to Implement	Activity Description
projects.		flood/erosion regulation purposes – recognizing gravel/sediment removal needs to continue. Modify ordinance to increase KPB enforcement and field staff.
	City, KPB	The SBCFSA will manage their existing plans to incorporate mitigation planning provisions into all service area planning processes such as comprehensive, capital improvement, and land use plans, etc. to demonstrate multi-benefit considerations and facilitate using multiple funding source consideration.
	City, KPB	Integrate the Mitigation Plan findings for enhanced emergency planning.
	City, KPB	Develop, incorporate, and enforce building ordinances to reflect survivability from flood, fire, wind, seismic, and other hazards to ensure occupant safety.
	City, KPB	Develop and incorporate mitigation provisions and recommendations into all community plans and community development processes to maintain protect critical infrastructure, residences, and population from natural hazard impacts.
	City, KPB	Update or develop, implement, and maintain jurisdictional debris management plans.
	KPB	Identify and list repetitively flooded structures and infrastructure, analyze the threat to these facilities, and raise mitigation action priorities to protect the threatened population.
	City, KPB	Perform hydrologic and hydraulic engineering, drainage, and bed loading studies and analyses for each watershed. Use information obtained for feasibility determination and project design. This information should be a key component, directly related to a proposed project.
	City, KPB	Update Emergency Response Plans to discuss volcanic ashfall, tsunami, and stormwater event management, prioritize response actions, and initiate actions to fill capability gaps.
	City, KPB	Adopt the Risk Map coastal velocity zone mapping studies into the floodplain code.
Multi-Hazard **MH 3** Reduce vulnerability, damage, or loss of structures from all natural hazards that affect the SBCFSA.	City	Encourage utility companies to evaluate and harden vulnerable infrastructure elements for sustainability.
	City, KPB	Acquire (buy-out), demolish, or relocate structures from hazard prone area (erosion, flood, ground failure, etc.) Property deeds "must be" restricted for open space uses for perpetuity to keep people from rebuilding in known hazard areas.
	City	Harden utility headers located along river embankments to mitigate potential flood, debris, and erosion damages.
	City	Purchase and install generators with main power distribution disconnect switches for identified and prioritized critical facilities susceptible to short term power disruption. (i.e. first responder, medical facilities, schools, correctional facilities, and water and sewage treatment plants, etc.)
	City, KPB	Develop vegetation projects to restore clear-cut and riverine erosion damage and to slope stability in avalanche and landslide areas.
	KPB	Develop, implement, and enforce floodplain management ordinances.
Earthquake **EQ 4**	City	Evaluate critical public facilities with significant seismic vulnerabilities and complete retrofit. (e.g. evaluate fire stations, public works buildings, potable water systems, wastewater systems, electric power systems, and bridges, etc.)
	City	Inspect, prioritize, and retrofit any critical facility or public infrastructure that does not meet current State Adopted Building Codes.
	City, KPB	Install non-structural seismic restraints for large furniture such as bookcases, filing cabinets, heavy televisions, and appliances to prevent toppling damage and resultant injuries to small children, elderly, and pets.
Erosion	City, KPB	Develop mitigation initiatives such as: Rip-rap (large rocks), sheet pilings, gabion baskets, articulated matting, concrete, asphalt, vegetation, or other armoring or protective materials to provide river bank

Table 7-9 City of Seward and KPB Identified On-Going Mitigation Activities

(Actions that occur within the FSA but not within SBCFSA authority or responsibility)

Goal	Authority to Implement	Activity Description
ER 5		protection.
	City, KPB	Harden culvert entrance bottoms with asphalt, concrete, rock, or similar material to reduce erosion or scour.
	City, KPB	Install walls at the end of a drainage structure to prevent embankment erosion at its entrance or outlet. (End- or wing-walls).
Flood FL 6	City, KPB	Develop and maintain NFIP compliant Repetitive Loss, Severe Repetitive Loss, and Repetitive Flood Claim (RFC) property inventory. Inventory should include property type, structure type, number of buildings, and their geo-referenced locations.
	City, KPB	Establish flood mitigation priorities for critical facilities, residential structures, and commercial buildings located within the identified flood hazard area(s) (100- and 500-year floodplains, stormwater, etc.) based on current base flood elevation (BFE) survey elevation data.
	City, KPB	Determine and implement most cost beneficial and feasible mitigation actions for locations with repetitive flooding, significant historical damages, or road closures.
	City, KPB	Work with State of Alaska Department of Natural Resources to resolve bed load resultant debris removal and financial constraints from Japanese Creek, Resurrection River, and other problematic streams within SBCFSA.
	City, KPB	Apply for grant funding to assist critical facilities, public infrastructure, and residential properties with elevating flood threatened structures at least two feet above the identified Base Flood Elevation (BFE).
	City, KPB	Acquire and maintain NOAA/NWS stream flow and rainfall measuring gauges.
	City, KPB	Increase culvert sizes to increase their drainage capacity or efficiency.
	City, KPB	Construct debris basins or other debris catchment devices to retain debris in order to prevent downstream drainage structure clogging.
	City, KPB	Seek funding for sediment and debris management to remove excessive stream bed sediment load, gravel, and glacial debris.
Ground Failure GF 7	KPB	Complete a ground failure (avalanche, landslide etc.) location inventory; identify (and map) threatened critical facilities, residential buildings, infrastructure, and other essential buildings.
	City, KPB	Install wire matting, debris catchment structure, cliff stabilization etc. to prevent Lowell Canyon Creek diversion tunnel obstruction and diversion dam overtopping from landslide debris, woody vegetation, trees, etc.
Tsunami TS 8	KPB	Construct tsunami evacuation structures for remote locations sited in potential tsunami impact areas.
	City, KPB	Install tsunami evacuation route signs throughout the communities.
	City, KPB	Install tsunami warning siren and early alert system.
	City	Install tsunami specific interpretive signs at public facilities.
Volcano VO 9	City, KPB	Evaluate potential air quality impacts to public facilities during an ashfall event.
Severe Weather SW 10	City, KPB, State	Develop and implement programs to coordinate maintenance and mitigation activities to reduce risk to public infrastructure from severe winter storms (snow load, ice, and wind).
	City, KPB, State	Develop and implement tree clearing mitigation programs to keep trees from threatening lives, property, and public infrastructure from severe weather events.
	City, KPB	Develop, implement, and maintain partnership program with electrical utilities to use underground utility placement methods where possible to reduce or eliminate power outages from severe winter storms. Consider developing incentive programs.

Table 7-9 City of Seward and KPB Identified On-Going Mitigation Activities

(Actions that occur within the FSA but not within SBCFSA authority or responsibility)

Goal	Authority to Implement	Activity Description
Wildland Fire WF 11	City, KPB	Hold FireWise workshop to educate residents and contractors concerning fire resistant landscaping.
	City, KPB	Promote FireWise building siting, design, and construction processes and materials.
	City, KPB	Provide wildland fire hazard outreach information in an easily distributed format for all residents.
	City, KPB	Develop, adopt, and enforce burn ordinances that control outdoor burning, requires burn permits, and restricts open campfires during identified weather periods (windy, dry, etc.).
	KPB	Identify, develop, implement, and enforce mitigation actions such as fuel breaks and reduction zones for potential wildland fire hazard areas.

7.8 IMPLEMENTING MITIGATION STRATEGY INTO EXISTING PLANNING MECHANISMS

The requirements for implementation through existing planning mechanisms, as stipulated in the DMA 2000 and its implementing regulations, are described here.

DMA 2000 Requirements
Incorporation into Existing Planning Mechanisms §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.
ELEMENT C. Incorporate into Other Planning Mechanisms
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate?
Source: FEMA, October 2011.

After the adoption of the HMP, each Planning Team Member will ensure that the HMP, in particular each Mitigation Action Project, is incorporated into existing planning mechanisms. Each member of the Planning Team will achieve this incorporation by undertaking the following activities.

- Review the community-specific regulatory tools to determine where to integrate the mitigation philosophy and implementable initiatives. These regulatory tools are identified in Section 7.1 capability assessment.
- Work with pertinent community departments to increase awareness for implementing HMP philosophies and identified initiatives. Provide assistance with integrating the mitigation strategy (including the MAP) into relevant planning mechanisms (i.e. Comprehensive Plan, Capital Improvement Project List, Transportation Improvement Plan, etc.).

Implementing this philosophy and activities may require updating or amending specific planning mechanisms as identified in Section 3.5.3.2.

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Appendix A

SBCFSA Flood Hazard Mitigation Plan, 2010

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For additional SBCFSA flood mitigation programmatic and historical information, contact the SBCFSA to review the 2010 SBCFSA Flood Hazard Mitigation Plan.

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Appendix B

National Flood Insurance Program (NFIP)

&

Community Rating System (CRS)

Defined

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NATIONAL FLOOD INSURANCE PROGRAM

In 1968, Congress established the National Flood Insurance Program (NFIP). The goals of the program are to reduce future flood damage through floodplain management, and to provide people with flood insurance. The Kenai Peninsula Borough (KPB) has had a tumultuous history with the NFIP. The KPB was suspended from the program when the 1986 flood struck which meant flood insurance and federal disaster assistance was withheld within the mapped floodplain areas. The Borough Assembly quickly passed the necessary ordinance (Title 21.06) to join the NFIP.

The NFIP established Flood Insurance Rate Maps (FIRM) based on hydrologic studies of flood prone areas across the country. These maps have zones where the cost of insurance to property owners is adjusted according to the flood risk as compared to how the building is constructed. Generally, the higher the lowest floor is above flood levels, the lower will be the cost of the flood insurance. Structures built too low after the publish date of the FIRM will have much high flood rates.

The FIRMs include Flood Insurance Zones (A, A2 through A10, V, B, C, and D): In order to set actuarial insurance rates, the Federal Insurance Administration established the following flood hazard map zones:

Zone Designation	Zone Definition
A	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or Flood Hazard Factors determined.
AO	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown, but no Flood Hazard Factors determined.
Zone A2 through A5, and A10	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to Flood Hazard Factors.
Zone V	Special flood hazard areas along coasts inundated by the 100-year flood, as determined by approximate methods and that have additional hazards due to velocity (wave action); no base flood elevations shown or Flood Hazard Factors determined.
Zone V1 through V9, V11, V12, V16	Special flood hazard areas along coasts inundated by the 100-year flood, as determined by detailed methods, and that have
And V19	Additional hazards due to velocity (wave action); base flood elevations shown, and zones subdivided according to Flood Hazard Factors.
Zone B	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1-square mile. Zone B is not subdivided.
Zone X	Areas of minimal flooding.
Zone D	Areas of undetermined but possible flood hazard.

Flood insurance is available through the NFIP for anyone but is often mandatory through lenders on structures within the floodplain. It is also mandatory for any proposed acquisition and/or construction of buildings in flood hazard areas if any form of federal funding assistance for the development is sought.

Communities who chose to enact and enforce certain floodplain management practices and regulations and to abide by flood damage prevention ordinances and FIRMs developed by FEMA may apply for a part of the National Flood Insurance Program called the Community Rating System

(CRS). The CRS allows communities who enforce higher standards than federal minimum floodplain standards additional savings on flood insurance premiums to its citizens. Both the Kenai Peninsula Borough and the City of Seward participate in the Community Rating System as of November 2007.

FEMA is producing new DFIRMs (Digital Flood Insurance Rate Maps) for the State of Alaska as part of the congressionally mandated Map Modernization Program. Seward will receive its preliminary maps in March 2010. The new DFIRMs have discontinued “C” Zones which were replaced by “X” or “shaded X” zones. These zones are defined as:

> *“Areas outside the 1-percent annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than 1 foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevations or depths are shown within this zone.”*

Insurance purchase is not usually required in these zones.

Access to Flood Insurance Rate Maps and information on how they are to be used is available through the Kenai River Center in Soldotna, AK, 907.260.4882.

NFIP COMMUNITY RATING SYSTEM (CRS) IMPROVEMENTS

Channel and Basin Debris Removal (CDR)

The SBCFSA will analyze and consider how to support City and Borough improvements into their CRS scores, thus lowering flood insurance costs, by developing a service area-wide Sediment Channel and Basin Debris Removal (CDR) Plan following CRS guidelines:

Maximum Credit: 300 POINTS

CDR = the total of the following points, this is a hierarchal credit system where no credit is provided unless credited awarded for preceding activities.

200 points: Awarded if the community's drainage maintenance program includes all of the following:

- Community performs an inspection at least once each year.
- Community performs an inspection after each storm that could adversely impact the drainage system.
- Community performs inspections to address citizens’ complaints.
- Community takes action to perform maintenance and cleaning as identified during an inspection. Action taken must follow pre-identified community's drainage maintenance procedures and must comply with federal and state environmental protection laws and regulations.

50 points: Awarded if the community's program identifies specific “choke points” or other flow obstructions, erosion sites, or sedimentation problems. These points will be inspected and maintained differently or more frequently than other parts of the drainage system. These actions are separate from those credited under item 1(b), above.

The above items recognize maintenance work performed by a public works crew, usually without heavy equipment. The objective of these activities is to remove accumulated debris that obstructs flow which result in adjacent property flooding. It is important that the community's procedures spell-out what can and cannot be removed. In some areas with natural streams, some woody debris may remain without causing a flooding problem. In other areas, with concrete lined ditches, all debris may have to be removed to maintain the ditch's carrying capacity.

CRS depends upon regular inspection and maintenance. The community (or other non-Federal agency) must have a program or plan to regularly inspect its drainage facilities and remove debris as needed. Neither the cost of the work, nor the amount of debris removed, affects the credit. This credit is not eligible if the community simply responds to complaints. It must be defined within a program or plan.

CRS credit is not provided if local drainage maintenance procedures violate federal or state laws. There may be special restrictions on streams or a requirement to obtain a federal or state permit before certain work can proceed. Community programs or plans must include all restrictions or permitting requirements.

50 points: Awarded if the community has an ongoing program, such as a capital improvements plan, to eliminate or correct drainage problems, improve drainage or storage facilities, or to construct other facilities such as “low maintenance” channels. There is no credit for this item if it is a one-time activity. Communities must develop a funded “improvement” program for scheduled improvement projects or activities. There is no credit if the funded projects are not part of the drainage system that is described in the community's inspection and maintenance program.

The third credit item is designed to recognize a program that makes structural or permanent channel or basin changes to reduce flooding or maintenance problems – not for an ongoing maintenance program.

Creditable examples would be on-going programs to:

- Enlarge culvert and bridge openings to eliminate bottlenecks,
- Install permanent hard or soft bank protection measures,
- Install grates to catch debris during high flows,
- Build new retention basins to reduce flows into existing channels, and/or
- Convert problem channels into "low-maintenance" channels.

The capital improvements program should address the “‘choke points' and other obstructions to flows” that warrant the special attention that is credited in item (2). It must include community drainage system site improvements as defined in its procedures (see the documentation requirements in Section 544.a.2).

Note: *Once a capital improvements project is completed, it may qualify for CRS credit under Activity 530 (Flood Protection). Projects that protect repetitive loss properties receive higher credits in Activity 530.*

It is the community's responsibility to document the activity for credit even if a separate agency performs the inspection and/or debris removal. In the case of a drainage district or county-wide maintenance program, the community may find it advantageous to develop documentation usable by all affected communities or agencies to simplify the process.

If an agency other than the community performs the inspection and/or debris removal, it is nonetheless the community's responsibility to document the activity for credit. In the case of a drainage district or county-wide maintenance program, the community may find it advantageous to work with other affected communities and the larger agency to develop consistent documentation that can be used by all affected communities.

The service area has only one repetitive loss property which is a single family dwelling on plot designated TO1N RO1W S27SW0000024 FOLZ. Claims were made for flood loss on this property in 1995 and 2002. This property and structure are in A02 and A04 zones and have been mitigated using Federal Emergency Management Agencies (FEMA) Flood Mitigation Assistance (FMA) and Hazard Mitigation Grant Program (HMGP) funds, property owner's private funds, insurance proceeds, and Increased Cost of Compliance (ICC) funds.

Flood Programmatic Terminology	
100-year Base Flood:	Base flood means a flood having a 1% chance of being equaled or exceeded in any given year.
Alluvial fan:	An area at the base of a valley where the slope flattens out, allowing the floodwater to decrease in speed and spread out, dropping sediment and rock over a fan-shaped area.
Anadromous Stream:	A waterway extending from the salt water to fresh water which provides a
Channel:	Defined landforms that carry water.
Development:	Any man-made change to real estate including dredging and fill.
FEMA:	Federal Emergency Management Agency
FIRM:	Flood insurance rate map.
Flash flood:	A flood in hilly and mountainous areas that may come scant minutes after a heavy rain, one can also occur in urban areas where pavements and drainage improvements speed runoff to a stream.
Flood:	A general and temporary condition of partial or complete inundation of normally dry land areas.
Flood hazard mitigation:	All actions that can be taken to reduce property damage and the threat to life and public health from flooding.
Floodplain:	Any land area susceptible to being inundated by flood waters from any source.
Floodway:	The stream channel and that portion of the adjacent floodplain which must remain open to permit passage of the base flood.
Hydrology:	The science dealing with the waters of the earth; a flood discharge is developed by a hydrologic study.
Ice jam:	Flooding that occurs when warm weather and rain break up frozen rivers and the broken ice floats downriver until it is blocked by an obstruction, creating an ice dam that blocks the channel and causes flooding upstream.
LiDAR: An acronym for **Li**ght **D**etection **A**nd **R**anging (LiDAR)	A remote sensing technique that provides high resolution elevation data with a vertical accuracy not previously available for the Seward Bear Creek Service Area. LIDAR was used in the SBCFSA to map geomorphic features associated with floodplains and alluvial fans. High resolution LIDAR shows that floodplains and alluvial fans are geomorphically complex. LIDAR is an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target. The prevalent method to determine distance to an object or surface is to use laser

	pulses. Like the similar radar technology, which uses radio waves instead of light, the range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal. LiDAR for geographic mapping of ground features.
Mudslide:	A condition where there is a river, flow or inundation of liquid mud down a hillside.
Ordinance:	The generic term for a law passed by a local government.
Runoff:	Rainfall and snowmelt that reaches a stream.
Storm surge:	Water that is pushed toward shore by persistent high wind and changes in air pressure. The level of a large body of water can rise by several feet.
Surge-release flood:	Debris build-up, landslides or avalanches in narrow canyons can cause water to be artificially dammed during heavy rains causing water to be released in large amounts and at great velocity when the temporary dam gives way.
Tsunami:	A large wave caused by an underwater earthquake or volcano which can raise water levels as much as 15 feet.
Watershed:	An area that drains into a lake, stream or other body of water.

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Appendix C

Federal, State, and Other Funding Resources

Federal Funding Resources

The Federal government requires local governments to have a HMP in place to be eligible for mitigation funding opportunities through FEMA such as the UHMA Programs and the HMGP. The Mitigation Technical Assistance Programs available to local governments are also a valuable resource. FEMA may also provide temporary housing assistance through rental assistance, mobile homes, furniture rental, mortgage assistance, and emergency home repairs. The Disaster Preparedness Improvement Grant also promotes educational opportunities with respect to hazard awareness and mitigation.

- FEMA, through its Emergency Management Institute, offers training in many aspects of emergency management, including hazard mitigation. FEMA has also developed a large number of documents that address implementing hazard mitigation at the local level. Five key resource documents are available from FEMA Publication Warehouse (1-800-480-2520) and are briefly described here:
  - How-to Guides. FEMA has developed a series of how-to guides to assist states, communities, and tribes in enhancing their hazard mitigation planning capabilities. The first four guides describe the four major phases of hazard mitigation planning. The last five how-to guides address special topics that arise in hazard mitigation planning such as conducting cost-benefit analysis and preparing multi-jurisdictional plans. The use of worksheets, checklists, and tables make these guides a practical source of guidance to address all stages of the hazard mitigation planning process. They also include special tips on meeting DMA 2000 requirements (http://www.fema.gov/plan/mitplanning/resources.shtm#1).
  - Post-Disaster Hazard Mitigation Planning Guidance for State and Local Governments. FEMA DAP-12, September 1990. This handbook explains the basic concepts of hazard mitigation and shows state and local governments how they can develop and achieve mitigation goals within the context of FEMA's post-disaster hazard mitigation planning requirements. The handbook focuses on approaches to mitigation, with an emphasis on multi-objective planning.
  - A Guide to Recovery Programs FEMA 229(4), September 2005. The programs described in this guide may all be of assistance during disaster incident recovery. Some are available only after a Presidential declaration of disaster, but others are available without a declaration. Please see the individual program descriptions for details. (http://www.fema.gov/txt/rebuild/ltrc/recoveryprograms229.txt)
  - The Emergency Management Guide for Business and Industry. FEMA 141, October 1993. This guide provides a step-by-step approach to emergency management planning, response, and recovery. It also details a planning process that businesses can follow to better prepare for a wide range of hazards and emergency events. This effort can enhance a business's ability to recover from financial losses, loss of market share, damages to equipment, and product or business interruptions. This guide could be of great assistance to a community's industries and businesses located in hazard prone areas.
  - The FEMA Hazard Mitigation Assistance (HMA Unified Guidance, June 1, 2010. The guidance introduces the five HMA grant programs, funding opportunities, award

information, eligibility, application and submission information, application review process, administering the grant, contracts, additional program guidance, additional project guidance, and contains information and resource appendices(FEMA 2009).

- FEMA also administers emergency management grants (http://www.fema.gov/help/site.shtm) and various firefighter grant programs (http://www.firegrantsupport.com/) such as
    - Emergency Management Performance Grant (EMPG). This is a pass through grant. The amount is determined by the State. The grant is intended to support critical assistance to sustain and enhance State and local emergency management capabilities at the State and local levels for all-hazard mitigation, preparedness, response, and recovery including coordination of inter-governmental (Federal, State, regional, local, and tribal) resources, joint operations, and mutual aid compacts state-to-state and nationwide. Sub-recipients must be compliant with National Incident Management System (NIMS) implementation as a condition for receiving funds. Requires 50% match.
    - Assistance to Fire Fighters Grant (AFG), Fire Prevention and Safety (FP&S), Staffing for Adequate Fire and Emergency Response Grants (SAFER), and Assistance to Firefighters Station Construction Grant programs. Information can be found at: (http://forestry.alaska.gov/fire/vfarfa.htm).
- Department of Homeland Security provides the following grants:
    - Homeland Security Grant Program (HSGP), State Homeland Security Program (SHSP) are 80% pass through grants. SHSP supports implementing the State Homeland Security Strategies to address identified planning, organization, equipment, training, and exercise needs for acts of terrorism and other catastrophic events. In addition, SHSP supports implementing the National Preparedness Guidelines, NIMS, and the National Response Framework (NRF). Must ensure at least 25% of funds are dedicated towards law enforcement terrorism prevention-oriented activities.
    - Citizen Corps Program (CCP). The Citizen Corps mission is to bring community and government leaders together to coordinate involving community members in emergency preparedness, planning, mitigation, response, and recovery activities.
    - Emergency Operations Center (EOC) This program is intended to improve emergency management and preparedness capabilities by supporting flexible, sustainable, secure, strategically located, and fully interoperable EOCs with a focus on addressing identified deficiencies and needs. Fully capable emergency operations facilities at the State and local levels are an essential element of a comprehensive national emergency management system and are necessary to ensure continuity of operations and continuity of government in major disasters or emergencies caused by any hazard. Requires 25% match.
- U.S. Department of Commerce's grant programs include:
    - Remote Community Alert Systems (RCASP) grant for outdoor alerting technologies in remote communities effectively underserved by commercial mobile service for the

purpose of enabling residents of those communities to receive emergency messages. This program is a contributing element of the Warning, Alert, and Response Network (WARN) Act.

- National Oceanic and Atmospheric Administration (NOAA), provides funds to the State of Alaska due to Alaska's high threat for tsunami. The allocation supports the promotion of local, regional, and state level tsunami mitigation and preparedness; installation of warning communications systems; installation of warning communications systems; installation of tsunami signage; promotion of the Tsunami Ready Program in Alaska; development of inundation models; and delivery of inundation maps and decision-support tools to communities in Alaska.

- Department of Agriculture (USDA). Disaster assistance provided includes: Emergency Conservation Program, Non-Insured Assistance, Emergency Forest Restoration Program, Emergency Watershed Protection, Rural Housing Service, Rural Utilities Service, and Rural Business and Cooperative Service. (http://www.fsa.usda.gov/FSA/webapp?area=home&subject=diap&topic=landing)
- Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy, Weatherization Assistance Program (http://www1.eere.energy.gov/wip/wap.html). This program minimizes the adverse effects of high energy costs on low-income, elderly, and handicapped citizens through client education activities and weatherization services such as an all-around safety check of major energy systems, including heating system modifications and insulation checks.
    - The Tribal Energy Program offers financial and technical assistance to Indian tribes to help them create sustainable renewable energy installations on their lands. This program promotes tribal energy self-sufficiency and fosters employment and economic development on America's tribal lands. (http://www1.eere.energy.gov/wip/tribal.html)
- US Environmental Protection Agency (EPA). Under EPA's Clean Water State Revolving Fund (CWSRF) program, each state maintains a revolving loan fund to provide independent and permanent sources of low-cost financing for a wide range of water quality infrastructure projects, including: municipal wastewater treatment projects; non-point source projects; watershed protection or restoration projects; and estuary management projects. (http://yosemite.epa.gov/R10/ecocomm.nsf/6da048b9966d22518825662d00729a35/7b68c420b668ada5882569ab00720988!OpenDocument)
    - Public Works and Development Facilities Program. This program provides assistance to help distressed communities attract new industry, encourage business expansion, diversify local economies, and generate long-term, private sector jobs. Among the types of projects funded are water and sewer facilities, primarily serving industry and commerce; access roads to industrial parks or sites; port improvements; business incubator facilities; technology infrastructure; sustainable development activities; export programs; brownfields redevelopment; aquaculture facilities; and other infrastructure projects. Specific activities may include demolition, renovation, and construction of public facilities; provision of water or sewer infrastructure; or the development of stormwater control mechanisms (e.g., a retention pond) as part of an

industrial park or other eligible project. (http://cfpub.epa.gov/fedfund/program.cfm?prog_num=51)

- Department of Health and Human Services, Administration of Children & Families, Administration for Native Americans (ANA). The ANA awards funds through grants to American Indians, Native Americans, Native Alaskans, Native Hawaiians, and Pacific Islanders. These grants are awarded to individual organizations that successfully apply for discretionary funds. ANA publishes in the Federal Register an announcement of funds available, the primary areas of focus, review criteria, and the method of application. (http://www.acf.hhs.gov/programs/ana/programs/program_information.html)
- Department of Housing and Urban Development (HUD) provides a variety of disaster resources. They also partner with Federal and state agencies to help implement disaster recovery assistance. Under the *National Response Framework* the FEMA and the Small Business Administration (SBA) offer initial recovery assistance. (http://www.hud.gov/info/disasterresources_dev.cfm)
  - HUD, Office of Homes and Communities, Section 108 Loan Guarantee Programs. This program provides loan guarantees as security for Federal loans for acquisition, rehabilitation, relocation, clearance, site preparation, special economic development activities, and construction of certain public facilities and housing. (http://www.hud.gov/offices/cpd/communitydevelopment/programs/108/index.cfm)
  - HUD, Office of Homes and Communities, Section 184 Indian Home Loan Guarantee Programs. The Section 184 Indian Home Loan Guarantee Program is a home mortgage specifically designed for American Indian and Alaska Native families, Alaska Villages, Tribes, or Tribally Designated Housing Entities. Section 184 loans can be used, both on and off native lands, for new construction, rehabilitation, purchase of an existing home, or refinance.
  - Because of the unique status of Indian lands being held in Trust, Native American homeownership has historically been an underserved market. Working with an expanding network of private sector and tribal partners, the Section 184 Program endeavors to increase access to capital for Native Americans and provide private funding opportunities for tribal housing agencies with the Section 184 Program. (http://www.hud.gov/offices/pih/ih/homeownership/184/)
  - HUD/CDBG provides grant assistance and technical assistance to aid communities in planning activities that address issues detrimental to the health and safety of local residents, such as housing rehabilitation, public services, community facilities, and infrastructure improvements that would primarily benefit low-and moderate-income. persons (http://www.hud.gov/offices/cpd/communitydevelopment/programs/)
- Department of Labor (DOL), Employment and Training Administration, Disaster Unemployment Assistance. Provides weekly unemployment subsistence grants for those who become unemployed because of a major disaster or emergency. Applicants must have exhausted all benefits for which they would normally be eligible. (http://www.workforcesecurity.doleta.gov/unemploy/disaster.asp)
  - The Workforce Investment Act contains provisions aimed at supporting employment and training activities for Indian, Alaska Native, and Native Hawaiian individuals.

The Department of Labor's Indian and Native American Programs (INAP) funds grant programs that provide training opportunities at the local level for this target population. (http://www.dol.gov/dol/topic/training/indianprograms.htm)

- U.S. Department of Transportation, Hazardous Materials Emergency Preparedness Grant. To increase State, Territorial, Tribal and local effectiveness in safely and efficiently handling hazardous materials accidents and incidents, enhance implementation of the Emergency Planning and Community Right-to-Know Act of 1986, and encourage a comprehensive approach to emergency training and planning by incorporating the unique challenges of responses to transportation situations, through planning and training. Requires a 20% local match.
- Federal Financial Institutions. Member banks of Federal Deposit Insurance Corporation, Financial Reporting Standards or Federal Home Loan Bank Board may be permitted to waive early withdrawal penalties for Certificates of Deposit and Individual Retirement Accounts.
- Internal Revenue Service (IRS), Disaster Tax Relief. Provides extensions to current year's tax return, allows deductions for disaster losses, and allows amendment of previous year’s tax returns (http://www.irs.gov/newsroom/article/0,,id=108362,00.html).
- Natural Resources Conservation Service (NRCS) has several funding sources to fulfill mitigation needs. Further information is located at: http://www.ak.nrcs.usda.gov/sitemap.html
  - The Emergency Watershed Protection Program (EWP). This funding source is designed is to undertake emergency measures, including the purchase of flood plain easements, for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood or any other natural occurrence is causing or has caused a sudden impairment of the watershed.
  - Wildlife habitat Incentives Program (WHIP). This is a voluntary program for conservation-minded landowners who want to develop and improve wildlife habitat on agricultural land, nonindustrial private forest land, and Indian land.
  - Watershed Planning. NRCS watershed activities in Alaska are voluntary efforts requested through conservation districts and units of government and/or tribes. The watershed activities are lead locally by a "watershed management committee" that is comprised of local interest groups, local units of government, local tribal representatives and any organization that has a vested interest in the watershed planning activity. This committee provides direction to the process as well as provides the decision-making necessary to implement the process. Technical assistance is provided to the watershed management committee through a "technical advisory committee" comprised of local, state and federal technical specialist. These specialists provide information to the watershed management committee as needed to make sound decisions. NRCS also provides training on watershed planning organization and process.
- U.S. SBA Disaster Assistance (http://www.sba.gov/category/navigation-structure/starting-managing-business/managing-business/running-business/emergency-

preparedness-and-disaster-) provides information concerning disaster assistance, preparedness, planning, cleanup, and recovery planning.

  - May provide low-interest disaster loans to individuals and businesses that have suffered a loss due to a disaster. (http://www.sba.gov/category/navigation-structure/loans-grants/small-business-loans/disaster-loans). Requests for SBA loan assistance should be submitted to DHS&EM.

- United States Army Corps of Engineers (USACE) Alaska District's Civil Works Branch studies potential water resource projects in Alaska. These studies analyze and solve water resource issues of concern to the local communities. These issues may involve navigational improvements, flood control or ecosystem restoration. The agency also tracks flood hazard data for over 300 Alaskan communities on floodplains or the sea coast. These data help local communities assess the risk of floods to their communities and prepare for potential future floods (http://www.poa.usace.army.mil/en/cw/index.htm). The USACE is a member and co-chair of the Alaska Climate Change Sub-Cabinet.

State Funding Resources

- DHS&EM is responsible for improving hazard mitigation technical assistance for local governments for the State of Alaska. Providing hazard mitigation training, current hazard information and communication facilitation with other agencies will enhance local hazard mitigation efforts. DHS&EM administers FEMA mitigation grants to mitigate future disaster damages such as those that may affect infrastructure including elevating, relocating, or acquiring hazard-prone properties. (http://www.ak-prepared.com/plans/mitigation/mitigati.htm)

  DHS&EM also provides mitigation funding resources for mitigation planning on their Web site at http://www.ak-prepared.com/plans/mitigation/localhazmitplan.htm.

- Division of Senior Services (DSS): Provides special outreach services for seniors, including food, shelter and clothing. (http://www.hss.state.ak.us/dsds/seniorInfoResources.htm)

- Division of Insurance (DOI): Provides assistance in obtaining copies of policies and provides information regarding filing claims. (http://www.dced.state.ak.us/insurance/)

- Department of Military and Veterans Affairs (DMVA): Provides damage appraisals and settlements for VA-insured homes, and assists with filing of survivor benefits. (http://veterans.alaska.gov/links.htm)

- DCRA within the DCCED. DCRA administers the HUD/CDBG, FMA Program, and the Climate Change Sub-Cabinet's Interagency Working Group's program funds and administers various flood and erosion mitigation projects, including the elevation, relocation, or acquisition of flood-prone homes and businesses throughout the State. This department also administers programs for State "distressed" and "targeted" communities. (http://www.commerce.state.ak.us/dca/)

- Department of Environmental Conservation (DEC). The DEC primary roles and responsibilities concerning hazards mitigation are ensuring safe food and safe water, and pollution prevention and pollution response. DEC ensures water treatment plants, landfills, and bulk fuel storage tank farms are safely constructed and operated in communities. Agency and facility response plans include hazards identification and pollution prevention and response strategies. (http://dec.alaska.gov/)

- The Division of Water's Village Safe Water (VSW)Program works with rural communities to develop sustainable sanitation facilities. Communities apply each year to VSW for grants for sanitation projects. Federal and state funding for this program is administered and managed by the State of Alaska's VSW program. VSW provides technical and financial support to Alaska's smallest communities to design and construct water and wastewater systems. In some cases, funding is awarded by VSW through the Alaska Native Tribal Health Consortium (ANTHC), who in turn assist communities in design and construct of sanitation projects.
- Municipal Grants and Loans Program. The Department of Environmental Conservation / Division of Water administer the Alaska Clean Water Fund (ACWF) and the Alaska Drinking Water Fund (ADWF). The division is fiscally responsible to the Environmental Protection Agency (EPA) to administer the loan funds as the EPA provides capitalization grants to the division for each of the loan funds. In addition, it is prudent upon the division to administer the funds in a manner that ensures their continued viability.
- Under EPA's Clean Water State Revolving Fund (CWSRF) program, each state maintains a revolving loan fund to provide independent and permanent sources of low-cost financing for a wide range of water quality infrastructure projects, including: municipal wastewater treatment projects; non-point source projects; watershed protection or restoration projects; and estuary management, [and stormwater management] projects. (http://yosemite.epa.gov/R10/ecocomm.nsf/6da048b9966d22518825662d00729a35/7b68c420b668ada5882569ab00720988!OpenDocument)

  Alaska's Revolving Loan Fund Program, prescribed by Title VI of the Clean Water Act as amended by the Water Quality Act of 1987, Public Law 100-4. DEC will use the ACWF account to administer the loan fund. This Agreement will continue from year-to-year and will be incorporated by reference into the annual capitalization grant agreement between EPA and the DEC. DEC will use a fiscal year of July 1 to June 30 for reporting purposes. (http://www.epa.gov/region10/pdf/water/srf/cwsrf_alaska_operating_agreement.pdf)

- Department of Transportation and Public Facilities (DOT/PF) personnel provide technical assistance to the various emergency management programs, to include mitigation. This assistance is addressed in the DHS&EM-DOT/PF Memorandum of Agreement and includes but is not limited to: environmental reviews, archaeological surveys, and historic preservation reviews.
  - DOT/PF and DHS&EM coordinate buy-out projects to ensure that there are no potential right-of-way conflicts with future use of land for bridge and highway projects, and collaborate on earthquake mitigation.
  - Additionally, DOT/PF provides the safe, efficient, economical, and effective State highway, harbor, and airport operation. DOT/PF uses it's Planning, Design and Engineering, Maintenance and Operations, and Intelligent Transportation Systems

resources to identify hazards, plan and initiate mitigation activities to meet the transportation needs of Alaskans, and make Alaska a better place to live and work. DOT/PF budgets for temporary bridge replacements and materials necessary to make the multi-modal transportation system operational following natural disaster events.

- DNR administers various projects designed to reduce stream bank erosion, reduce localized flooding, improve drainage, and improve discharge water quality through the stormwater grant program funds. Within DNR,
  - The Division of Geological and Geophysical Survey (DGGS) is responsible Alaska's mineral, land, and water resources use, development, and earthquake mitigation collaboration.

    Their geologists and support staff are leaders in researching Alaska's geology and implementing technological tools to most efficiently collect, interpret, publish, archive, and disseminate information to the public. Information is available at: (http://www.dggs.dnr.state.ak.us/index.php?menu_link=publications&link=publications_search#)
  - The DNR's Division of Forestry (DOF) participates in a statewide wildfire control program in cooperation with the forest industry, rural fire departments and other agencies. Prescribed burning may increase the risks of fire hazards; however, prescribed burning reduces the availability of fire fuels and therefore the potential for future, more serious fires. (http://forestry.alaska.gov/pdfs/08FireSuppressionMediaGuide.pdf)
  - DOF also manages various wildland fire programs, activities, and grant programs such as the FireWise Program (http://forestry.alaska.gov/fire/firewise.htm), Community Forestry Program (CFP) (http://forestry.alaska.gov/community/), Assistance to Fire Fighters Grant (AFG), Fire Prevention and Safety (FP&S), Staffing for Adequate Fire and Emergency Response Grants (SAFER), and Volunteer Fire Assistance and Rural Fire Assistance Grant (VFA-RFA) programs (http://forestry.alaska.gov/fire/vfarfa.htm). Information can be found at http://forestry.alaska.gov/fire/current.htm.

Other Funding Resources

The following provide focused access to valuable planning resources for communities interested in sustainable development activities.

- FEMA, http://www.fema.gov - includes links to information, resources, and grants that communities can use in planning and implementation of sustainable measures.
- American Planning Association (APA), http://www.planning.org - a non-profit professional association that serves as a resource for planners, elected officials, and citizens concerned with planning and growth initiatives.
- Institute for Business and Home Safety (IBHS), http://ibhs.org - an initiative of the insurance industry to reduce deaths, injuries, property damage, economic losses, and human suffering caused by natural disasters.
- American Red Cross (ARC). Provides for the critical needs of individuals such as food, clothing, shelter, and supplemental medical needs. Provides recovery needs such as

furniture, home repair, home purchasing, essential tools, and some bill payment may be provided.

- Crisis Counseling Program. Provides grants to State and Borough Mental Health Departments, which in turn provide training for screening, diagnosing and counseling techniques. Also provides funds for counseling, outreach, and consultation for those affected by disaster. (http://dialoguemakers.org/Resourses4states+Nonprofits.htm)
- Denali Commission. Introduced by Congress in 1998, the Denali Commission is an independent federal agency designed to provide critical utilities, infrastructure, and economic support throughout Alaska. With the creation of the Denali Commission, Congress acknowledged the need for increased inter-agency cooperation and focus on Alaska's remote communities. Since its first meeting in April 1999, the Commission is credited with providing numerous cost-shared infrastructure projects across the State that exemplifies effective and efficient partnership between federal and state agencies, and the private sector.
(http://www.denali.gov/index.php?option=com_content&view=section&id=1&Itemid=3)
    - The Energy Program primarily funds design and construction of replacement bulk fuel storage facilities, upgrades to community power generation and distribution systems, alternative-renewable energy projects, and some energy cost reduction projects. The Commission works with the Alaska Energy Authority (AEA), Alaska Village Electric Cooperative (AVEC), Alaska Power and Telephone and other partners to meet rural communities' fuel storage and power generation needs.
    - The goal of the solid waste program at the Denali Commission is to provide funding to address deficiencies in solid waste disposal sites which threaten to contaminate rural drinking water supplies.
- Lindbergh Foundation Grants. Each year, The Charles A. and Anne Morrow Lindbergh Foundation provides grants of up to $10,580 (a symbolic amount representing the cost of the Spirit of St. Louis) to men and women whose individual initiative and work in a wide spectrum of disciplines furthers the Lindberghs' vision of a balance between the advance of technology and the preservation of the natural/human environment.
(http://www.lindberghfoundation.org/docs/index.php/our-grants)
- Rasmuson Foundation Grants. The Rasmuson foundation invests both in individuals and well-managed 501(c)(3) organizations dedicated to improving the quality of life for Alaskans.

  The Foundation seeks to support not-for-profit organizations that are focused and effective in the pursuit of their goals, with special consideration for those organizations that demonstrate strong leadership, clarity of purpose and cautious use of resources.

  The Foundation trustees believe successful organizations can sustain their basic operations through other means of support and prefer to assist organizations with specific needs, focusing on requests which allow the organizations to become more efficient and effective. The trustees look favorably on organizations which demonstrate broad community support, superior fiscal management and matching project support.
(http://www.rasmuson.org/index.php)

- Resurrection Bay Conservation Alliance. In 2005, the Resurrection Bay Conservation Alliance (RBCA), based in Seward Alaska, formed to advance the environmental integrity of our community. We focus on watershed issues like air and water pollution, protection and restoration of habitat, reducing bear and human conflicts, pursuing new energy sources, and weighing in on development proposals.

  The RCBA's Resurrection Bay Watershed Conservation Program's mission is to protect and enhance the Resurrection Bay watershed through monitoring, habitat assessment, public education, and advocacy of science-based resource management.

  Watershed program goals include:

  - Promote community awareness and understanding of local ecosystems and associated conservation issues.
  - Protect the Resurrection Bay watershed through education, outreach, partnerships, and citizen science.
  - Monitor compliance with the Clean Water Act and other state and federal environmental regulations to ensure the protection of watershed resources.
  - Develop projects to monitor and enhance the health of the Resurrection Bay Watershed.

  (http://rbca-alaska.org/page6/page31/page31.html.)

Appendix D

FEMA's Local Mitigation Plan Review Tool

To be inserted after KPB Review and Approval.

Appendix E

KPB Meeting Minutes Accepting HMP

Insert KPB Assembly Meeting Minutes which designate SBCFSA HMP Acceptance.

Appendix F

Public Outreach

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Replace this page with applicable correspondence
(Public Notices, Advertisements, etc.)

Meeting Notes

700 G Street, Suite 500
Anchorage, AK 99503
Phone: 907.261.9706
Fax: 907.562.1297

SUBJECT: SBCFSA Mitigation Action Plan Project Selection Process

DATE/TIME: March 13, 2013, 10:00 a.m. to 12:16 p.m.

LOCATION: Teleconference

ATTENDEES:

URS Corporation

- URS Alaska: Scott Simmons
- URS CO: Richard Chamberlain, Kim Pirri
- URS GA: Jon Philipsborn
- URS MD: Shame Parsons

Seward Bear Creek Flood Service Area

- Bill Williamson, Chairman
- Randy Stauffer, Vice Chairman

City of Seward

- Jim Hunt, City Manager
- Donna Glenz, Planner

Kenai Peninsula Borough

- Dan Mahalak, Water Resource Manager
- Dan Bevington, Floodplain Administrator
- Marcus Mueller, Land Management Officer
- Brenda Ahlberg, Community & Fiscal Projects Manager

PRESENTATION SUMMARY

Introduced mitigation project selection process: review potential projects and categorize as consider or select for implementation within the Mitigation Action Plan (MAP). Identify any projects that are currently in-process or that have been completed by partner SBCFSA, Kenai Peninsula Borough, City of Seward, State or Federal agencies.

KEY POINTS

1. Section 7, Mitigation Strategy
2. Select Mitigation Goals
3. Review, consider, and select from listed potential mitigation projects/actions

COMMENTS

- Explained the Mitigation Strategy development process
- Introduced Mitigation Goals purpose and reached consensus on suggested goals for the City
- Reviewed the Mitigation Project Consideration Sheet,
- Identified ongoing or existing City mitigation initiatives
- Selected mitigation initiatives for implementation and refinement within the Mitigation Action Plan Matrix.
- Explained how the information discussed would be implemented and expanded within the Mitigation Action Plan Matrix and returned to the community for review.

- Matrix will include:
    - Initiative Priority
    - Responsible Entity
    - Potential Funding Sources
    - Timeframe for implementation
    - Benefit /Cost and Technical Feasibility narrative description
- Teleconference Follow-up
- A second newsletter will be developed once the Mitigation Strategy is finalized and incorporated into the Draft HMP. The newsletter should be posted or distributed throughout the community to inform the community that the HMP is available for public review and comment.

ACTION ITEMS:

- Refine suggested wording for participant review
- Insert information into HMP's MAP for April 1 delivery (SBCFSA MAP Workgroup meeting)
- Develop and forward Newsletter #2 to fulfill FEMA public participation and HMP review criteria

SEWARD BEAR CREEK FLOOD SERVICE AREA (SBCFSA) HAZARD MITIGATION PLAN (HMP) MITIGATION STRATEGY FOR REVIEW

April 2013 **Newsletter**

This newsletter discusses the preparation of the SBCFSA Hazard Mitigation Plan's Mitigation Strategy. It has been prepared to inform interested agencies, stakeholders, and the public about the project and to solicit comments.

HMP Development

The SBCFSA selected URS Corporation Alaska to convert their Flood Hazard Mitigation Plan to a Local Hazard Mitigation Plan (HMP) to fulfill FEMA's stringent criteria. The new HMP update is expanded to include an all-hazards analysis, risk assessment and vulnerability analysis – essential information which will qualify the SBCFSA for numerous project funding grant opportunities. The plan identifies natural hazards that affect the community including earthquake, erosion, flood, ground failure, severe weather, and wildland fire. The HMP also identifies the people and facilities potentially at risk and ways to mitigate hazards. The project also includes a comprehensive floodplain impact assessment for all SBCFSA watersheds. The public participation and planning process has been documented as part of the project.

What is Hazard Mitigation?

Across the United States, natural disasters have increasingly caused injury, death, property damage, and business and government service interruptions. The toll on individuals, families, and businesses can be very high. The time, money, and emotional effort required to respond to and recover from these disasters take public resources and attention away from other important programs and problems.

The people and property in the State of Alaska are at risk from a variety of hazards that have the potential for causing human injury, property damage, or environmental harm.

The purpose of hazard mitigation is to implement projects that eliminate the risk or reduce the severity of hazards on people and property. Mitigation programs may include short-term and long-term activities to reduce the hazards, reduce exposure to hazards, or reduce the effects of hazards. Mitigation could include education, and construction projects. Hazard mitigation activity examples include relocating buildings, developing or strengthening building codes, and educating residents and building owners.

Why Do We Need A Hazard Mitigation Plan?

Local and Tribal governments as well as special service areas are only eligible to receive grant money for mitigation programs by preparing and adopting a hazard mitigation plan. Each of these entities must have an approved mitigation plan to receive grant funding from the Federal Emergency Management Agency (FEMA) for eligible mitigation projects.

The Planning Process

There are very specific federal requirements that must be met when preparing a hazard mitigation plan. These requirements are commonly referred to as the Disaster Mitigation Act of 2000, or DMA2000 criteria. Information about the criteria may be found on the Internet at: http://www.fema.gov/mitigation-planning-laws-regulations-guidance.

The DMA2000 requires the plan to document the following topics:

- Planning process
- Hazard identification
- Risk assessment
- Goals
- Mitigation programs, actions, and projects
- A resolution from the community adopting the plan

FEMA has prepared Planning Guidance which is available at: http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=4859, and "How to" Guides that explain in detail how each of the DMA2000 requirements is met. These guides are available at http://www.fema.gov/hazard-mitigation-planning-resources. The SBCFSA Hazard Mitigation Plan will follow those guidelines.

The planning process kicked-off in September 2012 by establishing a local planning committee and holding a public meeting. The planning committee examined the full spectrum of hazards listed in the State Hazard Mitigation Plan and identified those hazards the HMP would address.

After the first public meeting, SBCFSA participating members and URS began identifying critical facilities, compiling the hazard profiles, assessing capabilities, and conducting the risk assessment for the identified hazards. Critical facilities are facilities that are critical to the SBCFSA's recovery in the event of a disaster. After collection of this information, URS helped to determine which critical facilities and estimated populations are vulnerable to the identified hazards in the SBCFSA.

A mitigation strategy was the next component of the plan to be developed. Understanding the community's local capabilities and using information gathered from the public, Planning Team, and the expertise of the consultants and agency staff, a mitigation strategy was developed. The mitigation strategy is based on an evaluation of the hazards, and the assets at risk from those hazards. Mitigation goals and a list of potential actions or projects were developed as the foundation of the mitigation strategy.

Mitigation goals are defined as general guidelines that explain what a community wants to achieve in terms of hazard and loss prevention. Goals are positively stated future situations that are typically long-range, policy-oriented statements representing community-wide visions. Mitigation actions and projects are undertaken in order to achieve the SBCFSA and participating member's stated objectives. On March 15, 2013, the Planning Team identified approximately 45 projects and actions that focus on six categories: prevention, property protection, public education and awareness, natural resource protection, emergency services, and structural projects. A representative sample of the Planning Team's newly identified mitigation actions are listed below and explained in more detail within the HMP.

The selected projects and/or actions will potentially be implemented over the next five years as funding becomes available. A HMP maintenance plan was also developed to guide the review and future update processes. It outlines how the SBCFSA will monitor progress on achieving the projects and actions that will help meet the stated goals and objectives, as well as outlining continuous public involvement.

The draft HMP will be available in the SBCFSA, City of Seward, and Kenai Peninsula Borough Offices for public review and comment. Comments should be made via email, fax, or phone to Scott Simmons (listed below) and be received no later than April 17, 2013. The plan will be provided to the Kenai Peninsula Borough for their preliminary approval and returned to the SBCFSA for updating once all comments have been processed.

The Planning Committee

The plan was developed with the assistance from a Planning Team consisting of a cross section of the SBCFSA's participating members. Planning Team members include the SBCFSA Board, City of Seward, Kenai Peninsula Borough staff, and URS Corporation.

Sample of the SBCFSA's Mitigation Actions. Review the draft HMP for a complete list.		
Adopt the Risk MAP coastal velocity zone mapping studies into the floodplain code.	Harden and/or retrofit existing levees to qualify for USACE certification.	Seek funding for sediment and debris management to remove excessive stream bed sediment load, gravel, and glacial debris.
Obtain an exemption to the Alaska Department of Natural Resources (DNR) Material Sales Fees on navigable rivers and streams for sediment and debris management, stream channel maintenance, and flood control or other flood mitigation projects.	Develop Bridge Maintenance with KPB, DOT/PF, and ARRC for all stream crossings throughout the flood service area to include: sediment removal under bridges.	Develop and implement programs to coordinate maintenance and mitigation activities to reduce risk to public infrastructure from severe winter storms (snow load, ice, and wind).
Evaluate each watershed to develop land use plans for removing and storing creek bed load to: • Perform periodic sediment management/bed load removal as necessary. • Identify and permit fill areas for future flood-free development sites. • Identify storage sites that limit gravel transportation costs.	Apply for grant funding to assist critical facilities, public infrastructure, and residential properties with elevating flood threatened structures at least two feet above the identified Base Flood Elevation (BFE). *(Current FEMA minimum is 1 ft. above BFE.)*	Install wire matting, debris catchment structure, cliff stabilization etc. to prevent Lowell Canyon Creek diversion tunnel obstruction and diversion dam overtopping from landslide debris, woody vegetation, trees, etc.
Construct debris basins or other debris catchment devices to retain debris to prevent downstream drainage structure clogging.	Acquire and maintain NOAA/NWS stream flow and rainfall measuring gages.	

We encourage you to learn more about the SBCFSA's Hazard Mitigation Plan. The purpose of this newsletter is to keep you informed and to allow you every opportunity to voice your opinion regarding this important project. If you have any questions, comments, or requests for more information, please contact:

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Appendix G
Benefit–Cost Analysis Fact Sheet

Benefit-Cost Analysis Fact Sheet

Hazard mitigation projects are specifically aimed at reducing or eliminating future damages. Although hazard mitigation projects may sometimes be implemented in conjunction with the repair of damages from a declared disaster, the focus of hazard mitigation projects is on strengthening, elevating, relocating, or otherwise improving buildings, infrastructure, or other facilities to enhance their ability to withstand the damaging impacts of future disasters. In some cases, hazard mitigation projects may also include training or public-education programs if such programs can be demonstrated to reduce future expected damages.

A Benefit-Cost Analysis (BCA) provides an estimate of the “benefits” and “costs” of a proposed hazard mitigation project. The benefits considered are avoided future damages and losses that are expected to accrue as a result of the mitigation project. In other words, benefits are the reduction in expected future damages and losses (i.e., the difference in expected future damages before and after the mitigation project). The costs considered are those necessary to implement the specific mitigation project under evaluation. Costs are generally well determined for specific projects for which engineering design studies have been completed. Benefits, however, must be estimated probabilistically because they depend on the improved performance of the building or facility in future hazard events, the timing and severity of which must be estimated probabilistically.

All Benefit-Costs must be:

- Credible and well documented
- Prepared in accordance with accepted BCA practices
- Cost-effective (BCR ≥ 1.0)

General Data Requirements:

- All data entries (other than Federal Emergency Management Agency [FEMA] standard or default values) MUST be documented in the application.
- Data MUST be from a credible source.
- Provide complete copies of reports and engineering analyses.
- Detailed cost estimate.
- Identify the hazard (flood, wind, seismic, etc.).
- Discuss how the proposed measure will mitigate against future damages.
- Document the Project Useful Life.
- Document the proposed Level of Protection.
- The Very Limited Data (VLD) BCA module cannot be used to support cost-effectiveness (screening purposes only).
- Alternative BCA software MUST be approved in writing by FEMA HQ and the Region prior to submittal of the application.

Damage and Benefit Data

- Well documented for each damage event.
- Include estimated frequency and method of determination per damage event.
- Data used in place of FEMA standard or default values MUST be documented and justified.

- The Level of Protection MUST be documented and readily apparent.
- When using the Limited Data (LD) BCA module, users cannot extrapolate data for higher frequency events for unknown lower frequency events.

Building Data

- Should include FEMA Elevation Certificates for elevation projects or projects using First Floor Elevations (FFEs).
- Include data for building type (tax records or photos).
- Contents claims that exceed 30 percent of building replacement value (BRV) MUST be fully documented.
- Method for determining BRVs MUST be documented. BRVs based on tax records MUST include the multiplier from the County Tax Assessor.
- Identify the amount of damage that will result in demolition of the structure (FEMA standard is 50 percent of pre-damage structure value).
- Include the site location (i.e., miles inland) for the Hurricane module.

Use Correct Occupancy Data

- Design occupancy for Hurricane shelter portion of Tornado module.
- Average occupancy per hour for the Tornado shelter portion of the Tornado module.
- Average occupancy for Seismic modules.

Questions to Be Answered

- Has the level of risk been identified?
- Are all hazards identified?
- Is the BCA fully documented and accompanied by technical support data?
- Will residual risk occur after the mitigation project is implemented?

Common Shortcomings

- Incomplete documentation.
- Inconsistencies among data in the application, BCA module runs, and the technical support data.
- Lack of technical support data.
- Lack of a detailed cost estimate.
- Use of discount rate other than FEMA-required amount of 7 percent.
- Overriding FEMA default values without providing documentation and justification.
- Lack of information on building type, size, number of stories, and value.
- Lack of documentation and credibility for FFEs.
- Use of incorrect Project Useful Life (not every mitigation measure = 100 years).

Appendix H

Plan Maintenance Documents

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Annual Review Questionnaire

PLAN SECTION	QUESTIONS	YES	NO	COMMENTS
PLANNING PROCESS	Are there internal or external organizations and agencies that have been invaluable to the planning process or to mitigation action			
	Are there procedures (e.g., meeting announcements, plan updates) that can be done more efficiently?			
	Has the Task Force undertaken any public outreach activities regarding the MHMP or implementation of mitigation actions?			
HAZARD PROFILES	Has a natural and/or human-caused disaster occurred in this reporting period?			
	Are there natural and/or human-caused hazards that have not been addressed in this HMP and should be?			
	Are additional maps or new hazard studies available? If so, what have they revealed?			
VULNERABILITY ANALYSIS	Do any new critical facilities or infrastructure need to be added to the asset lists?			
	Have there been changes in development patterns that could influence the effects of hazards or create additional risks?			
MITIGATION STRATEGY	Are there different or additional resources (financial, technical, and human) that are now available for mitigation planning within the			
	Are the goals still applicable?			
	Should new mitigation actions be added to the a community's Mitigation Action Plan?			
	Do existing mitigation actions listed in a community's Mitigation Action Plan need to be reprioritized?			
	Are the mitigation actions listed in a community's Mitigation Action Plan appropri-ate for available resources?			

Mitigation Action Progress Report

Progress Report Period: ____________ to ____________
(date) (date)

Project Title: ____________ Project ID# ____________

Responsible Agency: ____________

Address: ____________

City: ____________

Contact Person: ____________ Title: ____________

Phone #(s): ____________ email address: ____________

List Supporting Agencies and Contacts:

____

____

Total Project Cost: ____________

Anticipated Cost Overrun/Underrun: ____________

Date of Project Approval: ____________ Start date of the project: ____________

Anticipated completion date: ____________

Description of the Project (include a description of each phase, if applicable, and the time frame for completing each phase): ____________

____

____

____

Milestones	Complete	Projected Date of Completion

Plan Goal (s) Addressed:

Goal: ______________________________

Indicator of Success: ______________________________

____

____

____

Project Status

- ☐ Project on schedule
- ☐ Project completed
- ☐ Project delayed*

*explain: ______________________________

____

- ☐ Project canceled

Project Cost Status

- ☐ Cost unchanged
- ☐ Cost overrun*

*explain: ______________________________

____

- ☐ Cost underrun*

*explain: ______________________________

____

Summary of progress on project for this report:

A. What was accomplished during this reporting period?

____

____

____

____

B. What obstacles, problems, or delays did you encounter, if any?

____

____

____

____

C. How was each problem resolved?

____

____

____

____

Next Steps: What is/are the next step(s) to be accomplished over the next reporting period?

Other Comments:

Appendix I
Climate Change Analysis

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I. Climate Change

I.1 Background

It is now widely accepted that global climate change is occurring; that regions are impacted differently depending on regional characteristics; and that the effects of climate change are already being felt in certain areas across the globe (e.g., Intergovernmental Panel on Climate Change [IPCC] 2007, IPCC 2012, National Climate Assessment [NCA] 2013, etc.). The arctic regions are particularly sensitive to climate change and have been experiencing increased effects already, with, for example, air temperatures increasing at nearly twice the global average, and the surface of the Arctic Ocean warming (e.g., IPCC 2007, United Nations Environmental Programme (UNEP) 2013, etc.). As a resulting consequence, the effects of climate change are already having an impact in arctic regions. The State of Alaska is no exception to this, with observed changes including “species shifts, permafrost thaw, coastal erosion, wetland drying, glacial and sea ice recession, and an increase in fire frequency and intensity” (University of Alaska-Fairbanks [UAF] Scenarios Network for Alaska & Arctic Planning [SNAP] 2012b). In an acceptance of the threat of global climate change, the State of Alaska established cabinets (e.g., “Climate Change Sub-Cabinet”) to advise the Office of the Governor, and commissioned multiple studies (e.g., Alaska Climate Impact Assessment Commission (ACIAC) 2008, Adaptation Advisory Group (AAG) 2010, etc.) in order to better comprehend the potential impact of climate change on State citizens, communities, and resources – natural, economic, and cultural.

Furthermore, given the relationship between greenhouse gas emissions from global manmade and land use change (e.g., IPCC, National Aeronautical and Space Administration (NASA), etc.), climate change is expected to continue into the future as a result of continued and increasing trends in global emissions. As a result, “temperatures and precipitation are expected to increase across the state (of Alaska) throughout the next century”, which includes higher temperatures predicted for every month, particularly in the winter, and “statewide trends in Alaska call(ing) for future increases in precipitation, shorter and warmer winters, (and) substantial decreases in snow cover and ice cover” (UAF SNAP 2012b).

I.2 Seward Bear Creek Flood Service Area

Based on this and other evidence, the Seward Bear Creek Flood Service Area (SBCFSA) deemed it prudent to consider what climate change impacts are most relevant to consider for the SBCFSA, and how climate change may affect local conditions in the future, including hazard characteristics (type, frequency, intensity). Future climate change, in the form of changes in amounts of precipitation, changes in temperature, sea level rise, and changes in the intensity and frequency of storms, can both create new hazards as well as change the scale of existing hazards.

Impacts of climate change constitute and pose both direct and indirect impacts on the SBCFSA. For example, the impact from increased precipitation or a rise in sea level could directly lead to increased riverine or coastal flooding. An increase in temperatures, however, may result in greater ice or snow melt from ice fields or glaciers, or effect seasonal snow melt, thus impacting flooding in a different manner. Increased temperatures may also increase the risk of forest fires by drying out trees and making them more susceptible to igniting.

By assessing the potential impacts from climate change on the Kenai Peninsula and the SBCFSA when possible, planners and decision makers will be able to consider how future climate scenarios may impact local hazards as well as local vulnerability and risk to hazards in decisions moving forward. This information, though not guaranteed as future projections are based on best available data, scientific research and understanding, and models, and are not certain to occur, could influence planning decisions towards where future development should occur; direct limited resources to key areas of concern; identify areas that will be increasingly within harm's way in advance so that mitigation measures can be taken to avoid negative consequences; and present opportunities for smart and sustainable planning and growth given a more robust understanding of future scenarios and conditions.

Hazards within the SBCFSA have long been documented in Hazard Mitigation Plans, other plans, and papers. Due to the unique topography of the SBCFSA – a narrow basin surrounded by mountains and glaciers that ends on an alluvial fan – and the many streams and rivers that confluence in the valley that drains into Resurrection Bay, flooding is consistently the predominant hazard of concern for the SBCFSA and surrounding region. Some streams are glacier fed; others originate in lakes and/or sources further up the valley. As it relates to climate change, this is important as different factors contribute to flooding in different drainages, and climate change effects (i.e., changes in precipitation and temperature) will impact each differently. This HMP researched existing information, and utilized projected data from modeled future climate change scenarios in order to better understand the potential impacts of climate change on hazards within the SBCFSA.

I.3 Methodology

This HMP uses best available data and scientific literature in order to gain an understanding of what research exists on current and projected climate change impacts and effects within the Kenai Peninsula Borough and the SBCFSA. In addition to considering best available existing studies and reports, this study also used downscaled historical and projected monthly climate data for precipitation and temperature in order to consider future precipitation and temperature trends within and surrounding the SBCFSA and the effects that each would have on hazards. This downscaled data was acquired from the UAF/SNAP. "Downscaling takes known information at large scales to make projections at local scales" (UAF SNAP 2012). UAF/SNAP used selected global climate models which are developed by research organizations and submitted to the IPCC on regular intervals to determine the current state of scientific consensus regarding global climate change. Additional information as to the specific global climate models used by UAF/SNAP can be found on their website at http://www.snap.uaf.edu/downscaling.php (UAF/SNAP 2012).

For the purpose of the climate change analysis performed in this HMP, in addition to using current data (2012), data was chosen for five future scenarios: 2022, 2032, 2052, 2060, and 2100. These dates were chosen to show future climate change scenarios to be considered for both near- and long-term planning purposes.

For each year, projected precipitation and temperature data were produced by UAF/SNAP for three separate emissions scenarios as depicted in Figure I-1: B1, A1B, and A2. As stated above, the degree to which climate change is occurring is directly linked to the amount of greenhouse gas (ghg) emissions from human activities and land use changes entering into the atmosphere. Thus, differing amounts of future ghg emissions will produce different future climate change scenarios which will result in varying degrees of related impacts (i.e. greater or smaller degree of change in temperature or precipitation, etc.). Each of the three emissions scenarios represents a different future in which the world will generate a different amount of ghg emissions.

> *"In 2000, the Intergovernmental Panel on Climate Change (IPCC) used data from the Earth Institute at Colombia University to prepare the Special Report on Emissions Scenarios, which outlined a range of possible emission futures. In order to represent a range of possibilities, SNAP uses model outputs based on three of these (emission scenarios): B1, A1B, A2" (UAF SNAP).*

The three scenarios are summarized by UAF SNAP as follows:

> *The B1 scenario represents a more integrated and more ecologically friendly world:*
>
> - *Rapid economic growth as in A1B, but with rapid changes towards a service and information economy.*
> - *Population rising to 9 billion in 2050 and then declining as in A1.*
> - *Reductions in material intensity and the introduction of clean and resource efficient technologies.*
> - *An emphasis on global solutions to economic, social and environmental stability.*
>
> *The A1B scenario represents a world characterized by:*
>
> - *Rapid economic growth.*
> - *A global population that reaches 9 billion in 2050 and then gradually declines.*
> - *The quick spread of new and efficient technologies.*
> - *A convergent world - income and way of life converge between regions.*
> - *Extensive social and cultural interactions worldwide.*
> - *A balanced emphasis on all energy sources.*
>
> *The A2 scenario represents a more divided world characterized by:*
>
> - *A world of independently operating, self-reliant nations.*
> - *Continuously increasing population.*
> - *Regionally oriented economic development.*
> - *Slower and more fragmented technological changes and improvements to per capita income."*

Though the descriptions of the scenarios do not state a specific rise in ghg emissions, they each describe a future world of differing ghg emission production. To look into each scenario a bit further, the B1 scenario represents the best case scenario in terms of limiting ghg emissions. In addition to a peaking global population mid-century, as the most ecologically friendly scenario, ghg emissions would have already begun to level off by 2050 and would rapidly decline thereafter to roughly half of what they are in 2020 by 2100. The A2 scenario represents a world in which global population as well as global ghg emissions continue to rise unabated. Global ghg emissions steadily increase from 2020 to 2050 followed by a sharp increase from 2050 to 2100. The third scenario, A1B, represents a world in which the global population also peaks mid-century, and after an initial increase in emissions from 2020 to 2050, global emissions level off and decline to just above 2020 global ghg emissions by the year 2100 (IPCC 2000).

To summarize, as can be seen in Figure I-1 below, the B1 scenario is associated with a "low growth" emission scenario; the A2 scenario is associated with a "high growth" emission scenario; and the A1B scenario is associated with the "moderate growth" emission scenario (Riebeek 2010).

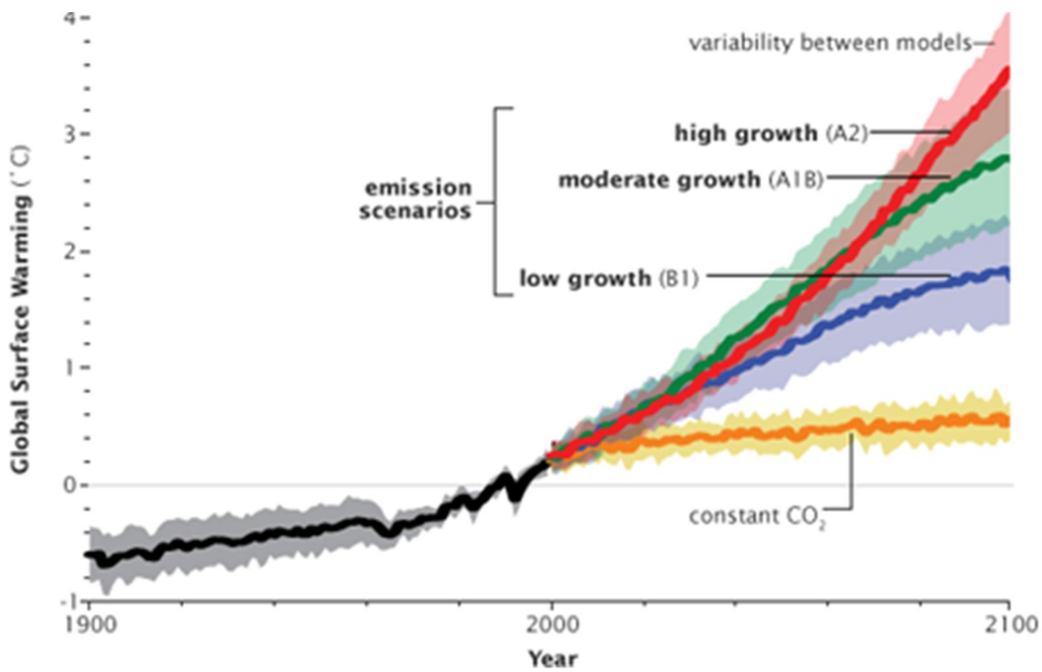

Figure I-1 IPCC emissions scenarios (Riebeek 2010).

In order to focus efforts of this HMP to be most useful for SBCFSA and other planners, the decision was made to use the A1B scenario as the basis for future modeling of climate change impacts and effects of the SBCFSA. This decision was made as the A1B scenario was considered to provide the most likely emission scenario for the time period considered in this HMP and therefore present the most likely climate change effects and impacts for SBCFSA. Future projections made using the A1B emission scenario will provide planners and decision makers with useful information to consider for future planning purposes.

One of the many challenges faced when attempting to understand and quantify potential impacts of climate change is the inability to accurately predict outcomes at a local level. Modeling inefficiencies, high costs, and lack of data, all contribute to the challenges of downscaling global climate change scenarios to a local level. That said, it is still possible to draw broad conclusions from best available data and models so that planners and decision makers can better understand the potential impacts of climate change on an area or region. This HMP attempts to do just that using the data obtained from UAF/SNAP. No information reported on projected future climate change impacts and effects should be taken to be certain outcomes. All projections made are based off of best available scientific data, models, and reports, and are used to develop climate change scenarios for the SBCFSA so as to consider hazards, and thus hazard mitigation strategies, for potential future climate change.

I.4 Results

Due to the current nature of hazards within the SBCFSA, as discussed in the main body of this HMP, as well as research conducted on potential climate change, the following impacts of climate change were assessed:

- Change in temperature
- Change in precipitation
- Sea level rise

This section describes results of future temperature change and precipitation change within the Kenai Borough Peninsula and SBCFSA and surrounding region based on mapping and analysis using data obtained from UAF/SNAP for current year (2012) and future years 2022, 2032, 2052, 2060, and 2100, and using the A1B emissions scenario. In addition this section discusses sea level rise and the potential impacts to the SBCFSA of future sea level rise.

Temperature

Using temperature data obtained from UAF/SNAP for current year (2012) and future years (2022, 2032, 2052, 2060, and 2100) this HMP attempts to depict potential changes in average annual temperature as a result of potential climate change in the SBCFSA and surrounding areas. Maps K-1 and K-2 represent the findings of changes in temperature in the Kenai Peninsula Borough (KPB) and SBCFSA, respectively, based on the A1B climate change emissions scenario for all six time periods (current and future). The maps portrayed in Maps K-1 and K-2 represent average annual projected temperature for each year considered. The maps use colors to display the variation in temperature across KPB (Map K-1) and across a more localized SBCFSA and surrounding region (Map K-2). The light blue represents areas with the relative *low* average annual temperature, whereas the dark red color represents areas with the relative *high* average annual temperature.

Map K-1 is included to provide an overall reference of future average annual temperature trends for the entire Borough. On each of these maps it is easy to decipher the higher altitudes, as the light and dark blues represent mountains and glaciers within KPB. Throughout each map, the highest average annual temperatures can be seen on the coastal areas in the south and southeastern portion of the Borough. Potential impacts of climate change can be seen when viewing the range of average annual projected temperature listed below each map (for Maps K-1 and K-2, the top number represents the highest average annual temperature and the bottom number represents the lowest average annual temperature based on the data analyzed for the area within the region displayed on the map). Though there is a decrease in 2022 for both the average high and average low annual temperatures, the overall trend from current year (2012) is increasing average annual temperatures from 2012 through 2100. In 2012, the lowest average annual temperature is 7.2 degrees Fahrenheit (°F) and the highest average annual temperature is 42.4 °F. By 2100, the lowest average annual temperature is 13.3 °F while the highest average annual temperature is 47.3 °F.

Map K-2 provides a more focused look of the projected changes in temperature in the SBCFSA and surrounding areas. As was the case in Map K-1, the six maps in Map K-2 display an overall increasing trend in average annual temperatures: the lowest and highest average annual temperatures for current year (2012) are 24.1 and 41.7 °F, respectively. Though both lowest and highest average annual temperatures decrease in the 2022 scenario, the overall trend from 2022 to 2100 is for an increase in both. In the 2100 scenario the lowest average annual temperature is projected to be 29.0 °F while the highest average annual temperature is projected to be 46.5 °F.

Table I-1 defines the average annual projected temperature in degree Fahrenheit at Exit Glacier and in Downtown City of Seward for current and future climate change scenarios.

Table I-1 Total Annual Projected Temperature

Year	Exit Glacier (°F)	Downtown City of Seward (°F)
2012	25.6	40.2
2022	24.9	39.5
2032	26.4	41.0
2052	26.3	41.0
2060	29.2	43.8
2100	30.5	45.1

As an example of how changes in temperature will potentially occur within the SBCFSA and in surrounding areas, Table I-1 displays average annual projected temperature (°F) at two locations over the six time periods considered. The first location represents where average annual temperature is at, or close to, the lowest in the area surrounding the SBCFSA. This location is at Exit Glacier. The second location represents where average annual temperature is at, or close to, the highest within the SBCFSA. This location is in Downtown City of Seward. In both locations, a general trend of increasing average annual temperatures can be seen. Though average annual temperatures drop in the 2022 scenario, they increase by 2032, and then again by 2060, and again by 2100.

At the location near Exit Glacier, average annual temperature is projected to reach 30.5 °F by 2100, an increase of 4.9 °F over current (2012) average annual temperature. At the location in Downtown City of Seward, average annual temperature is projected to reach 45.1 °F by 2100, also an increase of 4.9 °F over current (2012) average annual temperature.

Precipitation

Using precipitation data obtained from UAF/SNAP for current year (2012) and future years (2022, 2032, 2052, 2060, and 2100) this HMP also attempted to depict potential changes in total annual precipitation as a result of potential climate change in the SBCFSA and surrounding areas. Maps K-3 and K-4 represent the findings of changes in precipitation in KPB and SBCFSA, respectively, based on the A1B climate change emissions scenario for all six time periods (current and future). The maps portrayed in Maps K-3 and K-4 represent total annual projected precipitation (in inches) for each year considered. The maps use colors to display the variation in precipitation across KPB (Map K-3) and across a more localized SBCFSA and surrounding region (Map K-4). The light blue represents areas with the relative least amount of precipitation, whereas the pink and purple represent areas with the relative greatest amount of precipitation. Similar to the temperature maps, a range of precipitation (in inches) is given below each map in Maps K-3 and K-4. The top number represents the highest total annual precipitation and the bottom number represents the lowest total annual precipitation based on the data analyzed for the area within the region displayed on the map.

Map K-3 is included to provide an overall reference of future precipitation trends for the entire Borough. There is a noticeable difference in precipitation between the north and western parts of the Borough and the southeastern quadrant of the Borough. As can be seen in the range of total annual projected precipitation listed below each map, both the low (bottom number) and the high (top number) increase from current year (2012) through the future scenarios leading up to year 2100. The year 2012 has a total annual precipitation range from a low of 11.8 inches to a high of 343.8 inches. As seen in Map K-3, the low and high increase until the future scenario in year 2100 where the total annual precipitation range is from a low of 15.1 inches to a high of 445.3 inches.

Map K-4 provides a more focused look of the projected changes in precipitation on the SBCFSA and surrounding areas. As was the case in Map K-3, the six maps display an overall increasing trend in total annual precipitation: the low values for total annual projected precipitation for current year and 2022 are the same at 12.6 inches but increase after 2022 to 15.9 inches in 2100, while the high value decreases initially from 244.0 inches in 2012 to 238.0 inches in 2022 before peaking in 2062 at 302.9 inches and then slightly decreasing from there to 297.7 inches by 2100 (though remaining significantly higher than in 2012).

Table I-2 defines the SBCFSA's total annual projected precipitation for current and future climate change scenarios in two identified locations in or surrounding the SBCFSA (above Bear Lake and in Downtown City of Seward).

Table I-2 Average Annual Projected Precipitation

Year	Above Bear Lake *(Inches)*	Downtown City of Seward *(Inches)*
2012	238.8	75.8
2022	233.3	73.8
2032	242.6	75.9
2052	261.7	81.9
2060	297.1	94.8
2100	291.6	92.1

As an example of how changes will potentially occur within the SBCFSA, Table I-2 displays total annual projected precipitation (in inches) at two locations over the six time periods considered. The first location represents where total annual precipitation is at, or close to, the highest within the SBCFSA. This location is high in the mountains directly east of Bear Lake. The second location represents where total annual precipitation is at, or close to, the lowest within the SBCFSA. This location is in Downtown City of Seward. In both locations, a general trend of increased total annual precipitation can be seen from the current year (2012) throughout the different climate change scenarios (years) modeled. At the location near Bear Lake, total annual projected precipitation peaks in 2060 at a high of 297.1 inches per year, an increase of 58.3 inches per year from current year (2012). At the location in Downtown City of Seward, total annual projected precipitation peaks in 2060 at a high of 94.8 inches per year, an increase of 19.0 inches per year from current year (2012).

Sea Level Rise

In many parts of the world, including parts of Alaska, sea level rise is a well-documented effect of climate change (IPCC 2007, NCA 2013). Both the IPCC and the NCA attribute global sea level rise (SLR) to ocean warming and ice sheet loss, and present that there is a "highly significant correlation between observations of global mean SLR and increasing global mean temperature (IPCC 2007, Parris et al. 2012). Given the location of the SBCFSA (surrounding the top of Resurrection Bay) as well as the fact that part of Seward, including the airport, rests on an alluvial fan, this HMP attempted to consider the potential impacts of SLR on the SBCFSA. In doing so, SLR was considered based on the potential for SLR to occur, but also the potential extent of inundation if SLR were to occur. For the first, best available data on historical and current change in sea level was reviewed. For much of southern Alaska, including Seward, data has shown that sea level is actually falling, in part due to vertical land rise from tectonics and post-glacier land rise (Parris et al. 2012, UAF/SNAP 2012b). In addition, recent historical mean sea level (msl) trends for Seward, as documented by NOAA (NOAA 2012) echoes that sentiment by documenting a slight decrease in sea level in recent years.

Though research shows that sea level at Seward is decreasing, this HMP also considered what height of sea level rise would impact the SBCFSA if it were to occur. The decision to look at these potential impacts was made in part to allow planners to see the vulnerability of low lying areas within the SBCFSA to sea level rise, or coastal storm surge. Using data obtained from Center of Remote Sensing of Ice Sheets (CReSIS) at the University of Kansas, potential SLR ranging from 1meter to six meters was analyzed to assess the relative extent of coastal flooding that would occur within the SBCFSA. Based on an assessment of the projected inundation, it was determined that not until a SLR of three meters would the impact of SLR be felt within the SBCFSA. Map K-5 provides four maps of the City of Seward, focusing on the area around the Seward Airport. Maps represent the extent of flooding that would occur based on a SLR of three-meters, four-meters, five-meters, and six-meters. As can be seen in each of the maps, the extent of flooding starts and focuses at the Seward Airport and extends west and east as the degree of SLR increases.

I.5 Conclusion

As was represented in the literature review conducted, models from UAF/SNAP present data that supports both annual average temperatures and total annual precipitation are expected to increase in the SBCFSA and surrounding region. This is relevant information for SBCFSA and other planners and decision makers as these future impacts of climate change could potentially affect the severity of hazards within the SBCFSA.

Increases in temperature and precipitation could produce a variety of secondary effects throughout the SBCFSA. For example, historically “increases in wildfire activity in Alaska from 1950 to 2003 have been linked to increased temperatures” (IPCC 2012). Models have shown that warming temperatures could further increase the risk of fires in future decades in the southeastern part of Alaska (UAF/SNAP 2012b). In addition, warming temperatures presents a scenario in which the speed of glacier melt increases. Throughout southeast Alaska, and around the globe, glaciers are expected to experience a trend of accelerated melting (UAF/SNAP 2012b). The shrinking of Harding Icefield, home of over 30 outflowing glaciers directly west of the SBCFSA, has been documented in recent years (National Park Service [NPS] 2013). Of greater prominence has been the recording of the retreat of Exit Glacier, part of Harding Icefield, and a direct source of the Resurrection River which flows through the SBCFSA and into Resurrection Bay (Tuttle 2011). Continued rising temperatures and shorter, warmer cold seasons could accelerate the melting of regional glaciers potentially increasing flooding and sedimentation. Regarding SLR, as is stated above, based on historic and projected trends there is currently no threat to the SBCFSA from SLR. That said, planners could utilize the provided SLR maps to better understand the existing vulnerability within low-lying areas of the SBCFSA to coastal flooding from storm surges or other events producing a SLR of three-to six-meters.

Review of existing scientific data and research, along with the use of future climate change scenario modeling at the regional level has projected a warmer and wetter SBCFSA in the time period between 2012 and 2100. Warming temperatures and increased precipitation within and surrounding the SBCFSA could have several implications for the future state of hazards in the region. Specifically as it relates to the effects of climate change on flooding, Appendix J discusses the results of flood models and mapping used to analyze the potential influence of future climate change (projected future temperature and precipitation data using the same projected future climate change scenarios discussed above) on flooding for the major streams and rivers within the SBCFSA.

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Appendix J
Hazus Data and Narratives

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J. Hazus Scenarios

J.1 Earthquake

J.1.1 Hazard Scenario Development Methodology

The earthquake loss analysis for the SBCFSA makes use of the FEMA Hazus software. Hazus provides the options to model probabilistic or deterministic earthquake events. Probabilistic hazard modeling makes use of regional earthquake data to approximate earthquake characteristics associated with different recurrence intervals (return periods). Deterministic events are specific user-defined events based on historical events or user-entered locations and earthquake parameters. This can include events definition based on point locations and intensity parameters or more sophisticated scenarios from earthquake models.

For the SBCFSA, a scenario based on the 1964 Good Friday Earthquake was used. A scenario was developed by the USGS for the 1964 earthquake using the Shakemap data format. The USGS Earthquake Hazards Program manages the Shakemap Program (http://earthquake.usgs.gov/earthquakes/shakemap/) with regional seismic network operators. ShakeMap provides near-real-time maps of ground motion and shaking intensity following significant earthquakes. The Hazus model developers have worked with Shakemap to establish data standards to allow Shakemap data to be imported directly into Hazus. Specifically, Shakemap provides earthquake event GIS layers for Peak Ground Acceleration, Peak Ground Velocity, and Spectral Response (0.3 and 1.0 sec period). Map J-1 shows a representation of the 1964 Earthquake scenario from the Shakemap program.

This 1964 event scenario was entered into Hazus by using the 4 maps provided by the Shakemap Program. Hazus also required the Magnitude to be entered. Although the actual magnitude was 9.2, Hazus only allows a maximum value of 9.0, which used for this scenario.

J.1.2 Inventory

By default, Hazus Level 1 analysis for earthquake makes use of census tract data based on Hazus general building stock (GBS) data. Hazus GBS data provides structure counts and structure replacement values for over 30 different occupancy types (structure usage). The current GBS data within Hazus (Major Release 2.1) is based in 2000 Census data for most residential structures and 2006 Dunn and Bradstreet data for other occupancy types. Table J-1 summarizes the total structure counts and structure replacement values for groupings of occupancy types for the entire census tract that covers the SBCFSA.

Table J-1 delineates Hazus Major Release 2.1, building inventory estimates for the SBCFSA using the 2000 Census Tract 02122001300.

Table J-1 Hazus Major Release 2.1, SBCFSA Building Inventory Estimates

Occupancy Type	Total Structure Count	Total – Structure Replacement Values[1]	Total – Content Replacement Values[1]
Residential	3622	$358,760,000	$179,580,000
Commercial and Industrial	143	$108,840,000	$116,840,000
Other[2]	29	$14,620,000	$15,970,000
Total	3,794	$482,220,000	$312,390,000

Source: Hazus Major Release 2.1, General Building Stock data for Census Tract 02122001300.
[1] 2006 Dollars from RSMeans, rounded to nearest $10,000.
[2] Other occupancy types include Government, Education, Religion, and Agriculture.

The census tract that covers the SBCFSA also includes land area outside of the study area. However, a comparison of the GBS values for only the census blocks within the study area versus the entire tract found that over 99% of the structures and structure replacement values in the census tract fall within the SBCFSA. Therefore, loss estimates for the entire census tract could be applied to only the SBCFSA without the need for any prorating.

J.1.3 Hazus Results

While the Hazus GBS data was enhanced for the flood analysis to included structure specific data, the study scope did not allow as detailed an analysis for earthquake. Instead, a Hazus earthquake analysis was conducted using the default Hazus GBS inventory data with the US Geological Survey's (USGS) 1964 earthquake Shakemap scenario. Table J-2 summaries the number of damaged structures and estimated structure and contents losses based on Hazus GBS data. The table also shows the relative percent of each value as compared to the value in Table J-1 that represents the entire GBS inventory value.

Table J-2 Hazus GBS-based SBCFSA Losses - 1964 Earthquake Scenario

Occupancy Type	Damaged Structure Counts	Total Loss to Structures[1]	Total Loss to Contents[1]
Residential	3493 (96%)	$106,470,000 (30%)	$29,020,000 (16%)
Commercial and Industrial	143 (100%)	$100,940,000 (93%)	$39,320,000 (34%)
Other[2]	29 (100%)	$11,630,000 (80%)	$4,750,000 (30%)
Total	3,665 (97%)	$219,040,000 (45%)	$73,090,000 (23%)

Source: Hazus Major Release 2.1, General Building Stock data for Census Tract 02122001300, percent values are based on comparison with total inventory values from Hazus GBS data.
[1] 2006 Dollars for replacement values, rounded to nearest $10,000.
[2] Other occupancy types include Government, Education, Religion, and Agriculture.

This table shows that Hazus predicts that almost all structures (97%) will have some level of damage from an event as severe as a repeat of the 1964 earthquake. This is especially true for non-residential structures, which will have greater than 80% structural losses. The key structure characteristic that drives the level of damage is construction type (called building type in Hazus). Hazus GBS assumes most non-residential structures will be built with materials other than wood, such as concrete blocks, masonry, or steel. Because of the severity of the 1964 event, all of these non-wood materials are predicted to have close to complete structural failure, resulting in close to complete loss. Residential structures are predicted to perform better, since a majority of the structures are built from wood, which can better resist damage from earthquake shaking. Very few residential structures, except manufactured housing (mobile homes), are expected to have extensive or complete failure according to the Hazus analysis. Contents losses are about half as severe (in terms of percent loss) of structural loss, because Hazus model parameters assumes many contents can be salvaged from a damaged structure.

Although Hazus earthquake analysis was not conducted on the individual structure data developed for the flood analysis (see Section J.2.4 of this Appendix for more detailed discussion), the percentages from Table J-2 can be applied to the individual structure data to provide a rough estimate of what earthquake losses might be based on this better structure data. Table J-3 shows the total inventory values based on the Hazus user-defined facilities data developed for flood analysis. Table J-4 applies the percent losses from Table J-2 to the values in Table J-3 to estimate losses based on individual structure information.

Table J-3 Hazus SBCFSA User-Defined Facilities (UDF) Building Inventory Estimates

Occupancy Type	Total Structure Count	Total – Structure Replacement Values[1]	Total – Content Replacement Values[1]
Residential	1919	$418,710,000	$209,350,000
Commercial and Industrial	376	$233,420,000	$247,440,000
Other[2]	52	$118,260,000	$139,100,000
Total	2,347	$770,390,000	$595,890,000

Sources: KPB Parcel Data, KPB Building Data, KPB aerial photography, RSMeans 2012 Residential Cost Data and Light Commercial Cost Data, Hazus default data for region, field survey, publically available aerial and street level photography
[1] 2012 Dollars from RSMeans 2012 Residential Cost Data and Light Commercial Cost Data, rounded to nearest $10,000.
[2] Other occupancy types include Government, Education, Religion, and Agriculture.

Table J-4 SBCFSA Estimated Earthquake Losses

Occupancy Type	Total Structure Count	Total – Structure Replacement Values[1]	Total – Content Replacement Values[1]
Residential	1842 (96%)	$124,260,000 (30%)	$33,830,000 (16%)
Commercial and Industrial	376 (100%)	$216,480,000 (93%)	$83,270,000 (34%)
Other[2]	52 (100%)	$94,070,000 (80%)	$41,370,000 (30%)
Total	2,270 (97%)	$434,810,000 (56%)	$158,470,000 (27%)

Sources: Applied percent losses from Hazus GBS Earthquake Analysis to UDF Building Inventory values to all value except totals.
[1] 2012 Dollars, rounded to nearest $10,000.
[2] Other occupancy types include Government, Education, Religion, and Agriculture.

These UDF-based earthquake loss estimates show a much higher total loss ($593.28 million vs. $292.13 million) than the Hazus GBS-based losses. This is mostly due to the greater number and dollar value of the non-residential occupancy types in the UDF data. With Hazus predicting high damage levels to these non-residential structures, this produces a slightly more than doubling in the loss estimate based on UDF data. While an actual Hazus earthquake analysis with structure specific data may result in slightly lower losses (since some of the non-residential structures are made of wood), the estimate shown on Table J-4 gives a worse-case scenario of the severity that a repeat of the 1964 earthquake might cause in the SBCFSA.

J.2 Flood

For the Seward-Bear Creek Flood Service Area LHMP Annex assessment, fifteen watersheds were evaluated for riverine flood hazards.

J.2.1 Watershed Descriptions

A brief description of each watershed is provided below. All of the studied streams, along with their approximate watersheds, are show on Map K-8.

Bear Creek

Bear Creek serves as the outlet for Bear Lake and is a left bank tributary to Lost Creek, which is subsequently tributary to Salmon Creek. The Bear Creek watershed is approximately 6.5 square miles. The watershed is mostly undeveloped, although some residential development exists along the creek south and west of Bear Lake. The Bear Creek study reach extends approximately 1.2 miles from Bear Lake, across Seward Highway, then downstream to the confluence with Lost Creek. Northwest Hydraulic Consultants, Inc. (NHC) prepared a HEC-RAS hydraulic model for Bear Creek during their work for an update of the Flood Insurance Study (FIS) for the Kenai Peninsula Borough (KPB) in 2008 (NHC, 2008), which URS obtained for use in this assessment.

Box Canyon Creek

Box Canyon Creek is a left bank tributary to Resurrection River. The Box Canyon Creek watershed is approximately 14.7 square miles of undeveloped, forested, and mountainous terrain. The study area for Box Canyon Creek includes a 0.9 mile reach of Box Canyon Creek that starts at the confluence with Clear Creek, crosses Glacier Road, and terminates at the Resurrection River. Based on information provided by the SBCFSA, this study assumes a failure of the left levee near Clear Creek that forms an approximately 1.8 mile long split flow path through Clear Creek that terminates at the Resurrection River. This system was evaluated as a single unit, so the results presented for Box Canyon Creek in Section 2.5 include the impacts of flooding on both the main stem of Box Canyon Creek and the split flow path through the Clear Creek watershed.

Clear Creek

Clear Creek is a right bank tributary to Salmon Creek. The Clear Creek watershed consists of approximately 2.87 square miles of predominantly undeveloped land. There is sparse large-lot residential development in the area just west of Seward Highway, which is located near the confluence with Salmon Creek. The Clear Creek study reach includes approximately 0.9 miles of channel that terminates at the confluence with Salmon Creek. This study reach along Clear Creek was evaluated independently of the split flow from Box Canyon Creek described in Section J.2.1.2. Results presented for Clear Creek in Section J.2.5 include only the flooding impacts due to flooding from Clear Creek.

Fourth of July Creek

Fourth of July Creek discharges directly into the east side of Resurrection Bay. The Fourth of July Creek watershed is approximately 25.7 square miles. The watershed is undeveloped land that includes both forested terrain near the outfall and glacial land, including Godwin Glacier, in the upper watershed. The Fourth of July Creek study reach extends upstream approximately 1.6 miles from the outfall at Resurrection Bay.

Grouse Creek

Grouse Creek is a left bank tributary of Lost Creek. The Grouse Creek watershed is approximately 6.2 square miles of predominantly undeveloped, forested land with sparse residential development at the south end of the watershed, near the confluence with Lost Creek. The Grouse Creek study reach includes an approximately 0.6 mile channel that parallels Seward Highway on the west side and terminates at the confluence with Lost Creek. NHC prepared a HEC-RAS hydraulic model for Grouse Creek for the KPB FIS update in 2008 (NHC, 2008). URS obtained that model for used in this assessment.

Japanese Creek

Japanese Creek is a right bank tributary to Resurrection River. The Japanese Creek watershed is approximately 4.3 square miles and contains a mixture of rock outcrop and forested terrain. The majority of the Japanese Creek watershed is undeveloped; however, there is a developed area located southeast of Japanese Creek near it’s confluence with Resurrection River. The Japanese Creek study reach extends approximately 0.4 mile upstream from the Dimond Boulevard crossing, located just upstream from the Resurrection River floodplain.

Kwechak Creek

Kwechak Creek is a left bank tributary of Salmon Creek. The Kwechak Creek watershed is approximately 7.0 square miles of predominantly undeveloped land that includes a mixture of forested terrain and glacial land, including Bear Lake Glacier, on the east side of the watershed. There is a developed area on the west side of the watershed, near the confluence with Salmon Creek, consisting mostly of large-lot residential development. The Kwechak Creek study reach extends approximately 2.5 miles upstream from the terminus at Salmon Creek. NHC developed a HEC-RAS hydraulic model for Kwechak Creek for the KPB FIS update in 2008 (NHC, 2008), which URS obtained for use in this assessment.

Lost Creek

Lost Creek is a right bank tributary of Salmon Creek. The Lost Creek watershed is approximately 9.3 square miles of undeveloped, forested terrain, with a small pocket of large-lot residential development near the confluence with Grouse Creek. The watershed includes Lost Lake, a recreational lake located in the upper watershed that has a surface area of approximately 0.7 square mile. The Lost Creek study reach is approximately 0.6 miles long and terminates at the confluence with Grouse Creek.

Lowell Creek

Lowell Creek discharges directly into the west side of Resurrection Bay. The current Lowell Creek watershed, which terminates just below the diversion dam for the Lowell Creek Flood Control Project, is approximately 4.2 square miles of predominantly undeveloped land, with a mix of forested and glacial terrain.

Lowell Creek conveyed flows directly through the City of Seward along what is now Jefferson Street until 1940, when construction of the Lowell Creek Flood Control Project was completed and successfully diverted flows to an outfall into Resurrection Bay just south of the City. The project included construction of the Lowell Creek Dam, a concrete diversion tunnel through Bear Mountain known as the Lowell Creek Tunnel, and a new concrete outfall to Resurrection Bay. A map of the Lowell Creek Flood Control Project area is shown on Figure J-1. Hydraulic modeling results were obtained from the U.S. Army Corps of Engineers for use in this assessment. See Section J.2.2.3 for a description of the Lowell Creek analysis.

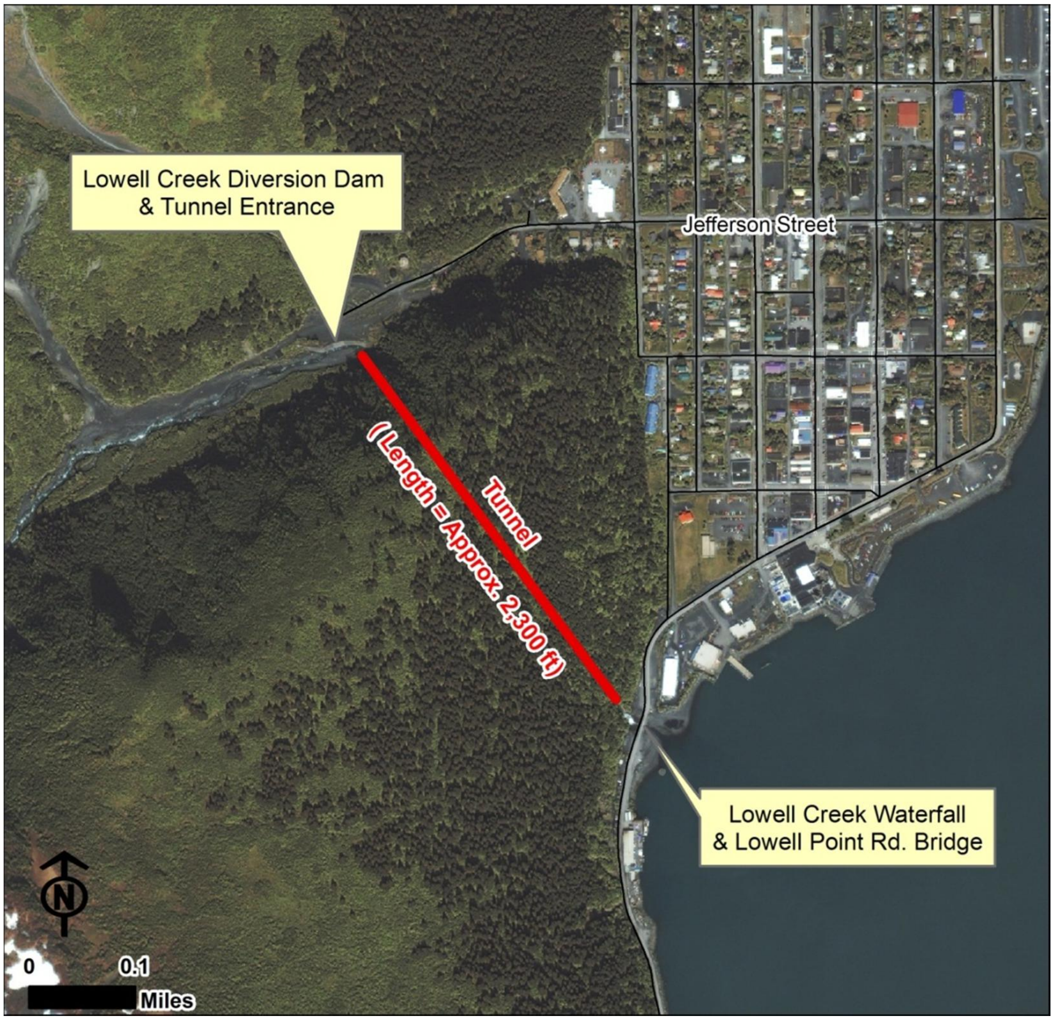

Figure J-1 Aerial View of the Lowell Creek Flood Control Project

Resurrection River

The Resurrection River flows predominantly northwest to southeast and discharges directly into the north end of Resurrection Bay. The Resurrection River watershed is approximately 221 square miles of glacial terrain which includes the watersheds for Salmon Creek, and Japanese Creek, which are tributary to the river. There are developed areas on both sides of the river, with the largest area to the west, including the Seward Airport, which is located on the west bank of the river adjacent to Resurrection Bay. The Resurrection River study reach extends approximately 3.1 miles upstream from the outfall at Resurrection Bay. NHC developed a HEC-RAS hydraulic model for Resurrection River for the KPB FIS update in 2008 (NHC, 2008). URS obtained that model for use in this assessment.

Salmon Creek

Salmon Creek is a left bank tributary to Resurrection River. The Salmon Creek watershed is approximately 37.0 square miles and includes the watersheds for Clear Creek, Sometimes Creek, Lost Creek, Grouse Creek, Bear Creek, and Kwechak Creek, which are tributary to Salmon Creek. The majority of the Salmon Creek watershed is undeveloped with the exception of commercial and residential developments along Seward Highway. The Salmon Creek study reach includes approximately 6.3 miles of the main channel as well as multiple split flow paths. NHC developed a HEC-RAS hydraulic model for Salmon Creek for the KPB FIS update in 2008 (NHC, 2008), which URS obtained for use in this analysis.

Sawmill Creek

Sawmill Creek discharges directly into the northeast corner of Resurrection Bay. The Sawmill Creek watershed is approximately 11.4 square miles with a mixture of forested and glacial terrain. There is residential development near the Nash Road crossing. The Sawmill Creek study reach terminates at the outfall to Resurrection Bay and includes 1.7 miles of the main channel and one split flow path. NHC developed a HEC-RAS hydraulic model for Sawmill Creek for the KPB FIS update in 2008 (NHC, 2008), which URS obtained for use in this assessment.

Scheffler Creek

Scheffler Creek discharges directly into the west side of Resurrection Bay. The Scheffler Creek watershed is bounded by the Japanese Creek and Lowell Creek watersheds and is approximately 1.8 square miles. The upstream portion of the watershed is predominantly glacial and the downstream portion is a mixture of forested and developed land near the Resurrection Bay. The developed land includes residential and commercial developments, including a marina near the outfall. The Scheffler Creek study reach is approximately 0.9 miles long and flow through the Lagoon and Fish Ditch before terminating at the outfall to Resurrection Bay.

Sometimes Creek

Sometimes Creek is a right bank tributary of Lost Creek. The Sometimes Creek watershed is approximately 2.3 square miles of predominantly undeveloped land. The majority of the watershed consists of undeveloped forested land; however there is residential development at the downstream end of the watershed near the Lost Creek confluence. The Sometimes Creek study reach extends approximately 0.5 miles upstream from the confluence with Lost Creek.

Spruce Creek

Spruce Creek discharges directly into the west side of Resurrection Bay near the Lowell Point Water Treatment Plant. The Spruce Creek watershed is approximately 9.7 square miles of forested, mountainous terrain, including the south face of Bear Mountain. There are several structures at the downstream end of the watershed, including a fire department and the municipal water treatment plant. The Spruce Creek study reach extends approximately 0.4 miles upstream from the outlet at Resurrection Bay.

J.2.2 Current Day Hazard Methods

The following section describes the methods used to estimate the flood hazards and resulting damages for the current day scenario.

J.2.2.1 Hydrology

Two hydrological analysis methods were used for this assessment, based on the availability of existing flood hazard modeling for a given stream. The two methods are described below.

Regional Regression Equations

Hydrologic analyses of the several of the studied streams were performed using regional regression equation methods as published in *"Estimating the Magnitude and Frequency of Peak Streamflows for Ungaged Sites on Streams in Alaska and Conterminous Basins in Canada, Water Resources Investigations Report 03-4188"* (WRIR 03-4188) by the USGS (USGS, 2003). See Table J.2-1 for a listing of the streams where this method was used. The regional regression equations were used to calculate peak flow rates for the 10-, 50-, 100-, and 500-year frequency storm events. Input parameters for the equations include: drainage area (square miles), area of lakes and ponds (percentage), mean annual precipitation (inches), and mean minimum January temperature (degrees Fahrenheit). Mean annual precipitation and mean minimum January temperatures were taken from the reference date provided in WRIR 03-41888. The drainage area and area of lakes and ponds for each watershed were estimated using GIS techniques and the 2009 LiDAR data and USGS Quadrangle maps. Peak flow rates for each stream can be found in Table J-5. The watersheds are shown on Map K-8.

FEMA Models

Six of the studied streams in the City of Seward and surrounding KPB area were modeled as part of NHC's work on the KPB FIS Update in 2008 (NHC, 2008). In Table J-5, the Hydrology Method for these streams is shown as "FEMA". Peak flow rates from the obtained models were adopted for use in this assessment for Current Day conditions. NHC used the regional regression equations described above to estimate the peak flows, then adjusted the flows to account for the effects of surge-release floods and other anomalous events. Peak flow rates for each stream can be found in Table J-5. The watersheds are shown on Map K-8.

Note: Lowell Creek is not shown in this table because it was analyzed differently, as described in Section J.2.2.2.

Table J-5 FEMA Peak Flow Rates for Current Conditions

Watershed	Hydrology Method	Current Peak Flow (cfs)			
		10-Year	50-Year	100-Year	500-Year
Bear Creek	FEMA	440	610	690	880
Box Canyon Creek	Regional Regression Equations	2,174	2,992	3,342	4,216
Clear Creek	Regional Regression Equations	552	764	855	1,082
Fourth of July Creek	Regional Regression Equations	3,540	4,870	5,440	6,860
Grouse Creek	FEMA	740	1,020	1,140	1,450
Japanese Creek	Regional Regression Equations	897	1,220	1,360	1,700
Kwechak Creek	FEMA	1,190	2,140	2,780	5,160
Lost Creek	Regional Regression Equations	1,372	1,905	2,134	2,709
Resurrection River	FEMA	19,230	26,190	29,160	36,570
Salmon Creek	FEMA	2,650	5,170	7,120	15,730
Sawmill Creek	FEMA	1,460	2,350	2,860	4,590
Scheffler Creek	Regional Regression Equations	418	572	673	799
Sometimes Creek	Regional Regression Equations	441	612	685	869
Spruce Creek	Regional Regression Equations	1,050	2,020	2,240	2,790

Note: cfs = cubic feet per second

J.2.2.2 Hydraulics

As with the hydrology, two hydraulic analysis methods were used for this assessment, based on the availability of existing flood hazard modeling for a given stream. The two methods are described below.

Original Models

The USACE's Hydrologic Engineering Center's River Analysis System (HEC-RAS) version 4.1.0 and its steady flow analysis capability was used to route frequency flood events through the study reaches described above. The USACE's HEC-GeoRAS extension was used within ArcGIS to build geometry data for the HEC-RAS hydraulic models using the 2009 LiDAR data that was obtained from SBCFSA. Manning's roughness coefficients (n-values) used in the analysis were taken from similar FEMA models (see next section) and were verified using aerial photography. The steady flow data were calculated using the regional regression equation analysis described in Section J.2.2.1.

The HEC-RAS results were exported into ArcGIS, where floodplain boundaries and depth grids were processed using the HEC-GeoRAS extension. The depth grids were then imported into Hazus to estimate potential flood damages during each flood event. The 100- and 500-year depth grids for all studied streams are show on Maps K-9 and K-10 respectively. The calculated depth grids for each stream, individually, are shown on Maps K-11 to K-58.

FEMA Models

The six HEC-RAS models that were obtained from FEMA were used to evaluate flood hazards along those streams. The geometry in the FEMA models was based on 2006 LiDAR data and survey field survey information. Given the highly-dynamic morphology of the streams in the SBCFSA area, where bed load is transported in even the most routine flood events, HEC-GeoRAS was used to update the ground geometry for each stream to reflect the 2009 LiDAR data. In some cases, cross sections were added or extended to facilitate development of complete depth grids. The steady flow file and all other inputs remained unchanged. The 100- and 500-year depth grids for all studied streams are show on Maps K-9 and K-10 respectively. The calculated depth grids for each stream, individually, are shown on Maps K-11 to K-58.

Lowell Creek

No hydrologic or hydraulic modeling for Lowell Creek was performed for this project. Hydraulic analyses for Lowell Creek were performed by the U.S. Army Corps of Engineers (USACE) as part of the *"Lowell Creek Inundation Study, Seward, Alaska"*, dated January 2012 (USACE, 2012). URS obtained water surface depth data points from USACE for the three flood scenarios described below. Depth grids were created from the water surface depth points and were imported into Hazus to estimate potential flood damages for each scenario. The calculated depth grids are shown on Maps K-59 to K-61. These depth grids were developed assuming all non-zero water depth values represented a modeled flood depth. This assumption resulted in the depth grids having a slightly wider spatial extent than the mapping shown in the USACE's report (USACE, 2012), because lower flood depth values were mapped.

Flood Scenario 1

The first flood scenario for Lowell Creek considered the 100-year peak flow in Lowell Creek, estimated to be 2,000 cubic feet per second (cfs), with the Lowell

Creek Tunnel entrance completely blocked. The blockage of the Lowell Creek Tunnel caused the diversion dam to overtop, and flow was conveyed through Seward. (USACE, 2012).

Flood Scenario 2

The second flood scenario for Lowell Creek considered the Probable Maximum Flood (PMF), estimated to be 7,600 cfs, with the Lowell Creek Tunnel fully operational. During this event, approximately 3,000 cfs was conveyed through the tunnel, while approximately 4,600 cfs overtopped the diversion dam to be conveyed through Seward (USACE, 2012).

Flood Scenario 3

The third flood scenario for Lowell Creek considered the PMF causing a landslide, with the diversion dam and tunnel fully operational. Per the USACE, it was assumed that the landslide formed a temporary reservoir that collected water and failed during the peak of the runoff hydrograph. This worst-case scenario resulted in a peak flow of 3,200 cfs through the tunnel and 15,800 cfs overtopping the diversion dam and flowing through Seward (USACE, 2012).

J.2.3 Climate Change Hazard Methods

The following section describes the methods used to estimate the flood hazards and resulting damages for the future year scenarios.

J.2.3.1 Hydrology

As described in Appendix I, climate change will have a significant influence on flooding in future years. Using the temperature and precipitation data obtained from UAF SNAP for 2012 and for future years (2022, 2032, 2050, 2062, and 2099/2100), as inputs for the regional regression equations described in Section J.2.2.2, flows were calculated for each combination of return period, year, and emission scenario (A1B, A2, B1). Although, as described in Appendix I, Emission Scenario A1B was selected for the full hazard analysis, flows were calculated for all emission scenarios to provide a general understanding of the impacts of the three scenarios.

The resulting flows were then used to calculate a scale factor that would be applied to the current day flow data to give the final peak flow data for each flood scenario. Rather than direct application of the future flows from the regression equations, a scale factor was need because the FEMA flows described in Section J.2.2.1 above were not based solely on the regional regression equations. Additionally, because both sets of current day flows were based on the reference data included in WRIR 03-4188, which is older than 2012 but was used for consistency with typical current day methods, the 2012 climate change data was used as a baseline to develop the scale factors, so that the scale factors would be based entirely on the same source temperature and precipitation data.

The scale factor was calculated by dividing the projected flows for each future year flood scenario by the projected 2012 flow data for that flood scenario. The resulting ratio was then multiplied by the current peak flow data to calculate the final peak flow value for each scenario, as shown in Equations 1 and 2.

$$Scale\ Factor\ (SF) = \frac{Q_{2xxx}}{Q_{2012}} \qquad (Equation\ 1)$$

where:
Q_{2xxx} = flow rate for a given future year, flood event, and scenario, as calculated using regression equations and climate change data
Q_{2012} = flow rate for 2012 for a given flood event and scenario, as calculated using regression equations and climate change data

$$Q_{final} = Q_{current} \times (SF) \qquad (Equation\ 2)$$

where:
Q_{final} = final flow rate for a given future year, flood event, and scenario
$Q_{current}$ = current flow rate for a given flood event as described in Section 2.2.1
(SF) = Scale Factor calculated using Equation 1

The peak flow rates for current conditions and all future scenarios are shown in Tables J-6, J-7, and J-8.

Note: Lowell Creek is not shown in these tables because it was analyzed differently, as described in Section J.2.2.2.

Table J-6 Peak Flow Rates for Current Conditions and Future Conditions: Emissions Scenario A1B

Watershed	Hydrology Method	Current Flow Data				Future Flow Data																			
		Current Peak Flow (cfs)				2022 Peak Flow (cfs)				2032 Peak Flow (cfs)				2050 Peak Flow (cfs)				2062 Peak Flow (cfs)				2100 Peak Flow (cfs)			
		10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year
Bear Creek	FEMA	440	610	690	880	515	710	801	1,015	512	706	796	1,008	545	746	840	1,058	806	1,081	1,204	1,485	641	867	971	1,211
Box Canyon Creek	RRE	2,174	2,992	3,342	4,216	2,565	3,511	3,910	4,896	2,553	3,490	3,886	4,863	2,702	3,672	4,080	5,084	4,039	5,368	5,905	7,194	3,184	4,273	4,723	5,821
Clear Creek	RRE	552	764	855	1,082	648	892	995	1,251	645	887	990	1,243	684	935	1,041	1,302	1,019	1,362	1,502	1,836	803	1,085	1,201	1,486
Fourth of July Creek	RRE	3,540	4,870	5,440	6,860	4,109	5,628	6,271	7,857	4,100	5,607	6,245	7,819	4,362	5,929	6,588	8,209	6,415	8,530	9,390	11,448	5,079	6,820	7,544	9,305
Grouse Creek	FEMA	740	1,020	1,140	1,450	867	1,190	1,326	1,675	860	1,179	1,314	1,659	914	1,245	1,385	1,740	1,362	1,815	1,999	2,457	1,082	1,454	1,609	1,999
Japanese Creek	RRE	897	1,220	1,360	1,700	1,051	1,423	1,582	1,963	1,046	1,414	1,571	1,949	1,111	1,492	1,655	2,044	1,658	2,178	2,391	2,886	1,294	1,718	1,896	2,317
Kwechak Creek	FEMA	1,190	2,140	2,780	5,160	1,392	2,491	3,227	5,948	1,387	2,478	3,210	5,913	1,473	2,617	3,382	6,201	2,180	3,787	4,847	8,695	1,726	3,028	3,894	7,066
Lost Creek	RRE	1,372	1,905	2,134	2,709	1,619	2,236	2,498	3,148	1,609	2,220	2,479	3,123	1,706	2,339	2,606	3,268	2,549	3,419	3,773	4,626	2,023	2,738	3,035	3,763
Resurrection River	FEMA	19,230	26,190	29,160	36,570	22,814	30,894	34,291	42,672	22,718	30,727	34,096	42,410	24,026	32,305	35,769	44,294	36,156	47,522	52,098	63,056	28,355	37,634	41,461	50,778
Salmon Creek	FEMA	2,650	5,170	7,120	15,730	3,110	6,038	8,292	18,190	3,093	5,998	8,236	18,059	3,285	6,330	8,671	18,925	4,885	9,209	12,493	26,668	3,871	7,366	10,041	21,678
Sawmill Creek	FEMA	1,460	2,350	2,860	4,590	1,705	2,732	3,316	5,286	1,699	2,718	3,298	5,255	1,805	2,869	3,474	5,508	2,671	4,154	4,980	7,725	2,113	3,319	3,998	6,274
Scheffler Creek	RRE	418	572	673	799	488	665	780	920	486	661	776	915	516	697	816	958	770	1,018	1,179	1,352	600	802	934	1,084
Sometimes Creek	RRE	441	612	685	869	519	717	800	1,008	516	711	794	999	548	751	836	1,047	815	1,092	1,205	1,476	645	873	967	1,199
Spruce Creek	RRE	1,050	2,020	2,240	2,790	1,218	2,334	2,582	3,195	1,215	2,325	2,570	3,179	1,291	2,455	2,709	3,334	1,916	3,562	3,891	4,684	1,498	2,815	3,091	3,767

Notes: 1. cfs = cubic feet per second 2. RRE = Regional Regression Equations

Table J-7 Peak Flow Rates for Current Conditions and Future Conditions: Emissions Scenario A2

Watershed	Hydrology Method	Current Flow Data				Future Flow Data																			
		Current Peak Flow (cfs)				2022 Peak Flow (cfs)				2032 Peak Flow (cfs)				2050 Peak Flow (cfs)				2062 Peak Flow (cfs)				2100 Peak Flow (cfs)			
		10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year
Bear Creek	FEMA	440	610	690	880	340	475	540	696	478	658	742	941	535	728	818	1,027	492	673	757	956	720	963	1,073	1,325
Box Canyon Creek	RRE	2,174	2,992	3,342	4,216	1,667	2,311	2,593	3,309	2,348	3,208	3,574	4,484	2,655	3,583	3,973	4,936	2,431	3,297	3,664	4,575	3,571	4,735	5,212	6,367
Clear Creek	RRE	552	764	855	1,082	428	596	670	857	597	820	915	1,152	674	915	1,017	1,267	619	844	940	1,177	901	1,202	1,326	1,626
Fourth of July Creek	RRE	3,540	4,870	5,440	6,860	2,792	3,863	4,331	5,516	3,821	5,220	5,816	7,293	4,312	5,818	6,452	8,015	3,982	5,397	5,998	7,484	5,691	7,555	8,322	10,176
Grouse Creek	FEMA	740	1,020	1,140	1,450	567	788	884	1,138	805	1,101	1,227	1,551	899	1,216	1,349	1,691	827	1,123	1,249	1,573	1,221	1,621	1,785	2,197
Japanese Creek	RRE	897	1,220	1,360	1,700	699	957	1,071	1,353	964	1,303	1,449	1,802	1,096	1,461	1,617	1,991	1,007	1,349	1,496	1,850	1,455	1,909	2,098	2,542
Kwechak Creek	FEMA	1,190	2,140	2,780	5,160	927	1,677	2,188	4,104	1,288	2,300	2,980	5,499	1,448	2,554	3,294	6,023	1,333	2,363	3,054	5,611	1,932	3,351	4,292	7,719
Lost Creek	RRE	1,372	1,905	2,134	2,709	1,045	1,462	1,645	2,113	1,488	2,051	2,291	2,891	1,673	2,277	2,533	3,167	1,532	2,096	2,336	2,935	2,265	3,029	3,343	4,108
Resurrection River	FEMA	19,230	26,190	29,160	36,570	14,604	20,044	22,420	28,451	20,757	28,067	31,166	38,865	23,648	31,557	34,874	43,053	21,552	28,911	32,023	39,740	31,884	41,816	45,868	55,667
Salmon Creek	FEMA	2,650	5,170	7,120	15,730	2,041	4,011	5,548	12,395	2,874	5,564	7,642	16,783	3,227	6,174	8,442	18,372	2,964	5,699	7,809	17,077	4,342	8,164	11,080	23,706
Sawmill Creek	FEMA	1,460	2,350	2,860	4,590	1,141	1,848	2,258	3,661	1,578	2,523	3,062	4,886	1,780	2,809	3,394	5,366	1,640	2,601	3,150	5,002	2,370	3,679	4,414	6,865
Scheffler Creek	RRE	418	572	673	799	327	451	532	638	450	611	717	847	511	686	801	937	471	635	743	872	677	894	1,037	1,193
Sometimes Creek	RRE	441	612	685	869	339	474	533	683	477	657	734	926	537	731	813	1,016	494	675	752	944	723	967	1,066	1,310
Spruce Creek	RRE	1,050	2,020	2,240	2,790	824	1,594	1,775	2,233	1,129	2,157	2,386	2,957	1,286	2,425	2,670	3,275	1,182	2,239	2,470	3,044	1,695	3,148	3,441	4,155

Notes: 1. cfs = cubic feet per second 2. RRE = Regional Regression Equations

Table J-8 Peak Flow Rates for Current Conditions and Future Conditions: Emissions Scenario B1

Watershed	Hydrology Method	Current Flow Data				Future Flow Data																			
		Current Peak Flow (cfs)				2022 Peak Flow (cfs)				2032 Peak Flow (cfs)				2050 Peak Flow (cfs)				2062 Peak Flow (cfs)				2100 Peak Flow (cfs)			
		10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year	10-Year	50-Year	100-Year	500-Year
Bear Creek	FEMA	440	610	690	880	389	542	615	790	334	471	536	694	555	758	852	1,072	451	624	705	898	540	737	829	1,043
Box Canyon Creek	RRE	2,174	2,992	3,342	4,216	1,921	2,661	2,981	3,786	1,646	2,300	2,586	3,313	2,744	3,721	4,131	5,141	2,225	3,056	3,411	4,295	2,664	3,610	4,008	4,989
Clear Creek	RRE	552	764	855	1,082	488	680	763	972	419	589	663	852	691	943	1,049	1,310	563	778	871	1,100	673	917	1,020	1,274
Fourth of July Creek	RRE	3,540	4,870	5,440	6,860	3,139	4,345	4,868	6,179	2,702	3,773	4,242	5,431	4,397	5,968	6,629	8,253	3,608	4,957	5,534	6,970	4,290	5,816	6,460	8,045
Grouse Creek	FEMA	740	1,020	1,140	1,450	651	904	1,013	1,297	560	784	882	1,140	937	1,272	1,413	1,772	760	1,045	1,167	1,482	911	1,237	1,373	1,723
Japanese Creek	RRE	897	1,220	1,360	1,700	792	1,084	1,212	1,525	676	935	1,049	1,332	1,117	1,499	1,661	2,050	911	1,237	1,378	1,721	1,083	1,452	1,610	1,988
Kwechak Creek	FEMA	1,190	2,140	2,780	5,160	1,054	1,907	2,484	4,642	907	1,656	2,165	4,080	1,491	2,644	3,415	6,254	1,218	2,186	2,837	5,258	1,454	2,575	3,325	6,092
Lost Creek	RRE	1,372	1,905	2,134	2,709	1,206	1,686	1,894	2,422	1,036	1,461	1,647	2,124	1,739	2,378	2,648	3,314	1,405	1,946	2,178	2,761	1,688	2,307	2,568	3,216
Resurrection River	FEMA	19,230	26,190	29,160	36,570	16,973	23,265	25,978	32,800	14,412	19,938	22,352	28,483	24,314	32,635	36,114	44,668	19,601	26,642	29,642	37,119	23,496	31,510	34,872	43,160
Salmon Creek	FEMA	2,650	5,170	7,120	15,730	2,338	4,591	6,342	14,106	2,010	3,981	5,519	12,381	3,339	6,421	8,789	19,152	2,713	5,282	7,268	16,031	3,249	6,240	8,542	18,621
Sawmill Creek	FEMA	1,460	2,350	2,860	4,590	1,292	2,092	2,554	4,126	1,111	1,815	2,223	3,623	1,823	2,895	3,503	5,548	1,489	2,393	2,910	4,664	1,779	2,821	3,413	5,407
Scheffler Creek	RRE	418	572	673	799	368	508	599	716	315	438	519	626	519	701	820	961	423	578	680	806	503	679	795	932
Sometimes Creek	RRE	441	612	685	869	389	544	610	779	334	471	530	683	556	760	846	1,058	451	625	699	885	540	738	821	1,028
Spruce Creek	RRE	1,050	2,020	2,240	2,790	932	1,805	2,007	2,517	797	1,557	1,738	2,198	1,302	2,472	2,726	3,353	1,062	2,041	2,263	2,816	1,263	2,396	2,642	3,251

Notes: 1. cfs = cubic feet per second 2. RRE = Regional Regression Equations

As shown in the tables, the highest flows along each stream occur in the 2062 scenario year, which reflects the peak of the A1B Emissions Scenario. Flows then go down in the 2100 scenario year, as the emissions are reduced in the A1B Emissions Scenario.

Additionally, the flows for the most frequent flood events in the 2062 scenario year (eg. the 10-year flood event) often correlate to the flows for the extreme or least frequent flood events (the 100- and 500-year) in the current year scenario. For example the Current Day 500-year flood flow along Bear Creek is approximately 880 cfs, which the 2062 10-year flood flow is approximately 806 cfs. So, in future years, the most common floods will have nearly the same magnitude as today's extreme events.

J.2.3.2 Hydraulics

The HEC-RAS models that were used to model the current flood events were also used to model the future flood events. The future flows were input into the model for each scenario year. The geometry files for several models were modified to accommodate significant flow increases from the future events. All n-values and hydraulic structure geometry remained the same.

The HEC-RAS results were exported into ArcGIS, where floodplain boundaries and depth grids were processed using the HEC-GeoRAS extension. The depth grids were then imported into Hazus to estimate potential flood damages during each flood event.

For Salmon Creek, because the current year (2012) hydraulic analysis indicated that this stream would have the most significant general flooding impact, HEC-RAS models were completed for every combination of return period, year, and emission scenario (A1B, A2, and B1).

Based on review of the flow data presented in Tables J-6, J-7, and J-8, the 2022 and 2062 scenario years represent the upper and lower bounds, respectively, of the flows for the future years. While HEC-RAS models were generated for every scenario year, depth grids were only generated for the 2022 and 2062 years, to limit the number of Hazus runs needed to estimate damages.

The calculated depth grids for the 2022 and 2062 scenario years for all studied streams are shown on Maps K-11 to K-58.

J.2.4 Inventory

For this analysis, several different sources were examined to determine the most appropriate structure inventory data for flood analysis. For example, Table J-9 shows how 2010 U.S. Census data and more detailed data from the Alaska Department of Labor (DOL) can be used to derive 2012 population. The table delineates population data for the study's population areas within the SBCFSA (i.e. City of Seward, Bear Creek, and Lowell Point) and also provides an estimate of number of residential structures and their estimated replacement value.

Table J-9 Census-Based Population and Residential Building Inventory Estimates

Location	Population		Residential Structures	
	2010 Census	DCCED 2012	Total Structure Count	Total Replacement Value of Structures[1]
City of Seward	2,693	2,733	947	$181,824,000
Bear Creek	1,956	1,958	720	$134,064,000
Lowell Point	80	71	71	$9,230,000
Total	4,729	4,762	1,738	$325,118,000

Sources: The SBCFSA, U.S. Census 2010, and 2011 Alaska Department of Labor.
[1] 2010 Dollars. The 2010 US Census estimates residential building values at City of Seward: $192,000, Bear Creek: 186,200, and Lowell Point: $130,000.

However, these estimates do not include all non-residential structures, structure contents values, and also do not provide detail at a resolution greater than the Census designated areas.

A second data source considered for the flood analysis was default census block-level structure data provided with the FEMA Hazus software. This default inventory data, referred to in the Hazus documentation as Level 1 General Building Stock (GBS) data, provides structure counts and structure replacement values for over 30 different occupancy types, where occupancy type related to usage of the structure (residential, commercial, etc.) The current data at the census block-level within Hazus (Major Release 2.1) is based in 2000 Census data for most residential structures and 2006 Dunn and Bradstreet data for other occupancy types. Table J-10 summarizes the total structure counts and structure replacement values for the entire SBCFSA census tract.

Table J-10 Hazus Major Release 2.1 SBCFSA Building Inventory Estimates

Occupancy Type	Total Structure Count	Total Replacement Value of Structures[1]	Total Replacement Value of Contents[1]
Residential	3622	$358,755,000	$179,584,000
Commercial and Industrial	143	$108,843,000	$116,838,000
Other[2]	29	$14,618,000	$15,971,000
Total	3,794	$482,216,000	$312,393,000

Source: Hazus Major Release 2.1, General Building Stock data for Census Tract 02122001300.
[1] 2006 Dollars from RSMeans.
[2] Other occupancy types include Government, Education, Religion, and Agriculture.

These default Hazus GBS values have several issues that provide challenges for flood analysis. First, these values represent the land area of a census block, not individual structures. For many flood scenarios with detailed flood boundaries, census blocks are too generalized to provide site-specific flood loss estimates. Second, the residential structure counts have not been updated since the 2000 census and are based on default relationships between population and structure counts. When compared with Table J-9, the residential structure counts are more than doubled, which appears excessive. Third, the basis for replacement values was 2006 RSMeans publications, which does not reflect the changes to housing costs since the 2008 recession. For all these reasons, the decision was made to conduct all flood analysis using data for individual structures.

J.2.4.1 Current Day

The flood loss analysis was conducted using the FEMA Hazus model for individual structures. Known as a User-defined Facilities (UDF) analysis, the Hazus model requires detailed information on each structure to establish the relationships used to model flood losses. Table J-11 summarizes the data required for UDF analysis and the sources used for this analysis.

Table J-11 Hazus User Defined Facilities (UDF) Data Requirements

Data type	Description	Sources
Occupancy type	Usage of the structure (residential, commercial, etc.) based on Hazus categories	KPB Parcel and Building Data, Field survey, KPB and publically available aerial and street level photography
Stories	Number of stories	KPB Parcel and Building Data, Publically available street level photography
Finished floor area	Square footage of finished floor area in the structure	KPB Parcel and Building Data, Hazus default data for region
Construction type	Structure primary construction material (wood, concrete, etc.) based on Hazus categories	KPB Parcel and Building Data, Hazus default data for region
Foundation Type	Structure foundation type (basement, crawlspace, etc.) based on Hazus categories	KPB Parcel and Building Data, Hazus default data for region
First Floor Height	First floor (finished) height above grade	Field survey, Publically available street level photography, Hazus default data for region
Location	Location of structure (given as latitude and longitude)	KPB Parcel and Building Data, KPB and publically available aerial photography
Replacement Costs	Replacement cost for structure and structure contents	RSMeans 2012 Residential Cost Data and Light Commercial Cost Data
Depth-Damage Functions (DDFs)	Relationships for structure and structure contents of estimates damages versus flood depth based on Hazus categories	Hazus default data with categories selected based on occupancy type, stories, and foundation type

Developing UDF data for Hazus had three major steps:

1. Adjusting structure locations
2. Obtaining structure data from KPB sources
3. Deriving additional structure data from other sources

Step 1: Structure Locations

The first step was to establish the structure locations. Existing KPB data had address points established in the center of tax parcels. These points were edited (some additions and deletions) and moved over building locations based on aerial photography. Where possible, these structure points had associated tax parcel ID numbers to link to other KPB tax and parcel data tables.

Step 2: Structure data based on KPB data

The second step of the UDF data development was converting the available structure characteristic data into the formats required by Hazus. Many data types, such as occupancy type, stories, finished floor area, construction type, and foundation types, had fields in KPB data tables that were similar to Hazus categories. For a majority of structures, the KPB data tables provided the information needed to establish the Hazus categories. Where there were data gaps, information from the available data were used to estimate default values for similar structures.

For example, finished floor area data were not available for around 300 structures, representing 13% of the total structures. Default values were established based on the finished floor area of the known structures. Table J-12 summarizes some of these finished floor area assumptions.

Table J-12 Default Values for Finished Floor Area

Finished floor category	Default finished floor area
Residential single family with 1 story	1,100 square feet
Residential single family with 1 1/2 stories	1,600 square feet
Residential single family with 2 stories	2,000 square feet
Mobile Home (assume single wide)	800 square feet
Apartment	2,600 square feet
Temporary Lodging	2,700 square feet
Small Commercial and Industrial	1,700 square feet
Government	2,400 square feet
Educational	30,000 square feet

For some structures with missing data, neighboring structures were used to estimate the missing data, such as stories or foundation type.

Step 3: Structure data from other sources

There were some data types, such as first floor heights and replacement costs, which were not in KPB data tables and had to be derived for other sources. Some typical first floor heights were established by a combination of field survey and use of publicly-available street level photography. Around 81 structures (3% of total structures) had first floor height directly estimated. For those structures that did not have the first floor height directly estimated, some default values (Table J-13) were established based on combinations of occupancy and foundation type.

Table J-13 First Floor Height Above Grade - Default Values

Occupancy and foundation type combination	Default first floor height above grade	Description
Any structure with a basement or slab foundation	0 feet	Structures with basements or slab foundations are assumed to begin having flood damage when flood waters touch any part of the foundation walls.
Residential structures with pier, crawlspace, or solid wall foundations	2 feet	Field survey and street level aerial photography found for residential structures with these foundation types that the average first height above grade was 2 feet.
Non-residential structures	0 feet	Hazus default values assume most non-residential structures in the area have either slab or basement foundations. This was spot checked during field survey and from street level aerial photography.

Replacement costs were estimated using the replacement cost guides from RSMeans, specifically the 2012 Residential Cost Data and Light Commercial Cost Data publications. Table J-14 summarizes the structure replacement values provided by RSMeans.

Table J-14 Replacement Value Ranges (RSMeans)

Replacement Value Category	Range of Replacement Value per Square Foot (adjusted for Seward Area) from RSMeans 2012
Residential single family with 1 story (regular)	$100 - $178
Residential single family with 1 1/2 stories (regular, includes split level)	$90 - $199
Residential single family with 2 stories (regular)	$98 - $157
Residential single family with 1 story (log)	$114 - $198
Residential single family with 2 stories (log)	$111 - $176
Mobile Home (assume single wide)	$69*
Apartment	$162 - $187
Temporary Lodging	$175 - $190
Nursing Home	$217 - $245
Retail Commercial	$108 - $163
Wholesale Commercial	$104 - $129
Repair Services	$122 - $172
Office Commercial	$177 - $282
Banks	$235 - $289
Medical	$452 - $493
Restaurants	$222 - $261
Industrial	$131 - $154
Religion	$180 - $321
Government	$180 - $286
Educational	$188 - $199
**Mobile home replacement value based on the Pacific region in 2011 Manufactured Housing survey by the U.S. Commerce Department's Census Bureau.*	

Table J-15 summarizes from the UDF data total structure counts and structure replacement values for groupings of structures types for the study area.

Table J-15 Hazus User Defined Facilities Building Inventory Estimates for SBCFSA

Occupancy Type	Total Structure Count	Total Structure Replacement Value[1]	Total Contents Replacement Value[1]
Residential	1919	$418,708,000	$209,354,000
Commercial and Industrial	376	$233,424,000	$247,439,000
Other[2]	52	$118,258,000	$139,097,000
Total	2,347	$770,390,000	$595,890,000

Sources: KPB Parcel Data, KPB Building Data, KPB aerial photography, RSMeans 2012 Residential Cost Data and Light Commercial Cost Data, Hazus default data for region, field survey, publically available aerial and street level photography
[1] 2012 Dollars from RSMeans 2012 Residential Cost Data and Light Commercial Cost Data.
[2] Other occupancy types include Government, Education, Religion, and Agriculture.

Some items should be noted when comparing Table J-15 with the two previous estimates of structure counts and replacement values in Tables J-9 and J-10. The residential structure count of 1,919 is much closer to the 1,738 value in Table J-9 than the 3,622 estimate from Hazus default GBS in Table J-10. The UDF residential replacement values were greater than either of the other two tables, which is surprising when compared to the Hazus GBS values with their much greater residential structure counts. For non-residential structures, the Hazus UDF had much higher counts and replacement values than the Hazus GBS values.

J.2.4.2 Future Land Use

To represent future land use scenarios, additional points were added to the UDF data in locations (as described in Appendix I) where growth is expected over the next 10 years. An additional 425 structures were added to the UDF data as summarized in Table J-16.

Table J-16 Additional Future Structures Modeled with Hazus UDFs for SBCFSA

Occupancy Type	Total Structure Count	Total Replacement Value of Structures1	Total Replacement Value of Contents1
Residential	414	$100,227,000	$50,113,000
Commercial and Industrial	11	$8,464,000	$12,696,000
Other[2]	0	$0	$0
Total	425	$108,691,000	$62,809,000

Notes: 1. 2012 Dollars from RSMeans 2012 Residential Cost Data and Light Commercial Cost Data.
2. Other occupancy types include Government, Education, Religion, and Agriculture.

The additional residential structures are assumed to be 2,000 square foot single family residences and the additional non-residential structures are 5,000 square foot industrial structures. See Appendix I for more information on future land use assumptions.

Critical facility data were used to develop the SBCFSA's Vulnerability Exposure Analysis as summarized in Tables 6-9, 6-10, and 6-11.

Appendix K provides maps that depict colored hazard impact areas. The various color codes define the extent of the impact area. Critical facilities are depicted as point locations within the planning area; and subsequently indicate their relative location within an identified potential hazard impacted area.

Tables 6-9, 6-10, and 6-11 tabulate this potential loss estimation data. Section 6.7.1 Exposure Analysis – Hazard Narrative Summaries provides an explanatory description of the tabulated exposure analysis.

J.2.5 Hazus Results

Using the depth grids and UDF data described in the previous sections, Hazus runs were completed for riverine flood hazards to estimate the total number of structures impacted by flooding (e.g. all of the structures that get wet), the number from that total that experience damage, and then the aggregate cost of structure and building damages.

All Streams except Salmon Creek & Lowell Creek

For all studied streams except Salmon Creek and Lowell Creek, Hazus runs were completed for the current year (2012) and for the 2022 and 2062 scenario years under the A1B Emissions Scenario using current and future land development data. As damages are directly correlated with flood flow, curve fit techniques based on the calculated damages for the 2022 and 2062 scenario years were used to estimate total damages for the 2032, 2050, and 2100 scenario years. The results of the Hazus runs for all streams except Salmon Creek and Lowell Creek are presented in Table J-17.

As shown in Table J-17, there are no damages along Fourth of July Creek, Japanese Creek, or Spruce Creek in any year/event scenario. Additionally, along Sometimes Creek, there are no flood damages in any year/event scenario until the 2062 scenario year, when there are damages due to the 100- and 500-year events. Then, in 2100, because flows go down, there are no damages along Sometimes Creek except for the 500-year event.

The table also shows that several streams do not experience damaging floods except in the most extreme events or in the later scenario years.

As can be expected, the highest damages are correlated with the highest flows, so the highest damages along each stream occur in the 2062 scenario year for the 500-year flow event.

Table J-17 Hazus-Estimated Damages

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Structures Damaged	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
Bear Creek							
2012 (Current Day)	10	440	There were no building damages in the 10-year event.				
	50	610	2	1	$1,577	$236	$1,813
	100	690	5	2	$9,015	$1,877	$10,892
	500	880	7	4	$51,063	$18,999	$70,061
2022	10	515	1	0	$0	$0	$0
	50	710	5	2	$10,014	$2,241	$12,254
	100	801	6	2	$14,307	$3,802	$18,109
	500	1,015	8	4	$66,332	$24,742	$91,074
2032	10	512	There were no building damages in the 10-year event.				
	50	706	Not Estimated				*$4,537*

Table J-17 Hazus-Estimated Damages

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Structures Damaged	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
	100	796	Not Estimated				*$22,276*
	500	1,008	Not Estimated				*$75,863*
2050	10	545	There were no building damages in the 10-year event.				
	50	746	Not Estimated				*$11,988*
	100	840	Not Estimated				*$32,218*
	500	1,058	Not Estimated				*$89,799*
2062	10	806	6	2	$14,595	$3,907	$18,502
	50	1,081	8	6	$71,864	$26,915	$98,779
	100	1,204	8	7	$91,298	$34,549	$125,846
	500	1,485	9	8	$141,683	$55,429	$197,112
2100	10	641	There were no building damages in the 10-year event.				
	50	867	Not Estimated				*$38,897*
	100	971	Not Estimated				*$65,842*
	500	1,211	Not Estimated				*$131,782*
Box Canyon Creek							
2012 (Current Day)	10	2,174	32	19	$514,313	$881,150	$1,395,462
	50	2,992	41	22	$606,397	$1,020,480	$1,626,878
	100	3,342	44	24	$666,675	$1,203,360	$1,870,035
	500	4,216	47	29	$772,279	$1,484,950	$2,257,230
2022	10	2,565	35	19	$551,501	$938,612	$1,490,113
	50	3,511	45	25	$691,345	$1,283,832	$1,975,177
	100	3,910	46	28	$737,315	$1,403,279	$2,140,593
	500	4,896	48	32	$816,632	$1,572,986	$2,389,618
2032	10	2,553	Not Estimated				*$1,553,520*
	50	3,490	Not Estimated				*$1,922,887*
	100	3,886	Not Estimated				*$2,078,749*
	500	4,863	Not Estimated				*$2,463,976*
2050	10	2,702	Not Estimated				*$1,612,352*
	50	3,672	Not Estimated				*$1,994,723*
	100	4,080	Not Estimated				*$2,155,282*
	500	5,084	Not Estimated				*$2,550,771*
2062	10	4,039	46	28	$745,537	$1,423,587	$2,169,125
	50	5,368	53	38	$938,767	$1,776,821	$2,715,588
	100	5,905	54	38	$1,001,378	$1,865,201	$2,866,580
	500	7,194	60	44	$1,236,333	$2,129,670	$3,366,003
2100	10	3,184	Not Estimated				*$1,802,221*

Table J-17 Hazus-Estimated Damages

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Structures Damaged	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
	50	4,273	Not Estimated				*$2,231,224*
	100	4,723	Not Estimated				*$2,408,737*
	500	5,821	Not Estimated				*$2,841,500*
Clear Creek							
2012 (Current Day)	10	552	27	21	$1,058,932	$4,548,128	$5,607,060
	50	764	31	27	$1,246,625	$5,154,617	$6,401,242
	100	855	33	30	$1,348,252	$5,396,084	$6,744,336
	500	1,082	35	32	$1,531,715	$5,922,858	$7,454,573
2022	10	648	29	24	$1,156,348	$4,849,768	$6,006,116
	50	892	33	31	$1,377,846	$5,484,270	$6,862,116
	100	995	33	31	$1,462,791	$5,725,360	$7,188,151
	500	1,251	37	32	$1,647,243	$6,255,076	$7,902,319
2032	10	645	Not Estimated				*$5,963,422*
	50	887	Not Estimated				*$6,880,974*
	100	990	Not Estimated				*$7,195,880*
	500	1,243	Not Estimated				*$7,851,786*
2050	10	684	Not Estimated				*$6,132,086*
	50	935	Not Estimated				*$7,032,169*
	100	1,041	Not Estimated				*$7,340,756*
	500	1,302	Not Estimated				*$7,983,422*
2062	10	1,019	33	31	$1,482,740	$5,781,619	$7,264,359
	50	1,362	39	32	$1,695,922	$6,428,483	$8,124,405
	100	1,502	41	34	$1,750,443	$6,632,672	$8,383,115
	500	1,836	44	36	$1,901,297	$7,079,636	$8,980,933
2100	10	803	Not Estimated				*$6,594,225*
	50	1,085	Not Estimated				*$7,458,292*
	100	1,201	Not Estimated				*$7,752,809*
	500	1,486	Not Estimated				*$8,364,766*
Fourth of July Creek							
There are no building damages along Fourth of July Creek in any year/event scenario.							
Grouse Creek							
2012 (Current Day)	10	740	2	2	$73,622	$38,426	$112,049
	50	1,020	2	2	$90,699	$59,620	$150,319
	100	1,140	3	3	$143,400	$82,822	$226,221
	500	1,450	3	3	$214,593	$140,048	$354,641
2022	10	867	3	3	$162,681	$88,460	$251,141

Table J-17 Hazus-Estimated Damages

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Structures Damaged	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
	50	1,190	5	5	$257,044	$161,426	$418,470
	100	1,326	5	5	$301,187	$206,589	$507,776
	500	1,675	6	6	$423,335	$329,034	$752,369
2032	10	860	Not Estimated				*$244,821*
	50	1,179	Not Estimated				*$423,631*
	100	1,314	Not Estimated				*$490,643*
	500	1,659	Not Estimated				*$638,843*
2050	10	914	Not Estimated				*$277,258*
	50	1,245	Not Estimated				*$457,206*
	100	1,385	Not Estimated				*$523,699*
	500	1,740	Not Estimated				*$668,645*
2062	10	1,362	5	5	$307,495	$202,037	$509,532
	50	1,815	6	6	$415,116	$291,858	$706,973
	100	1,999	6	6	$429,344	$308,975	$738,319
	500	2,457	7	6	$478,485	$376,067	$854,552
2100	10	1,082	Not Estimated				*$372,041*
	50	1,454	Not Estimated				*$554,857*
	100	1,609	Not Estimated				*$619,169*
	500	1,999	Not Estimated				*$751,844*
Japanese Creek							
There are no building damages along Japanese Creek in any year/event scenario.							
Kwechak Creek							
2012 (Current Day)	10	1,190	17	12	$422,674	$269,685	$692,359
	50	2,140	21	14	$501,855	$320,290	$822,145
	100	2,780	27	19	$631,050	$382,166	$1,013,216
	500	5,160	40	28	$880,222	$516,334	$1,396,556
2022	10	1,392	20	13	$439,539	$281,193	$720,731
	50	2,491	25	16	$557,287	$348,117	$905,404
	100	3,227	31	21	$684,240	$405,393	$1,089,633
	500	5,948	46	32	$948,840	$565,214	$1,514,054
2032	10	1,387	Not Estimated				*$742,866*
	50	2,478	Not Estimated				*$928,848*
	100	3,210	Not Estimated				*$1,053,434*
	500	5,913	Not Estimated				*$1,514,019*
2050	10	1,473	Not Estimated				*$757,647*
	50	2,617	Not Estimated				*$952,485*

Table J-17 Hazus-Estimated Damages

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Structures Damaged	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
	100	3,382	Not Estimated				*$1,082,744*
	500	6,201	Not Estimated				*$1,563,007*
2062	10	2,180	23	15	$536,127	$335,395	$871,522
	50	3,787	34	22	$741,831	$434,189	$1,176,020
	100	4,847	37	27	$853,230	$500,959	$1,354,189
	500	8,695	58	40	$1,211,983	$757,576	$1,969,559
2100	10	1,726	Not Estimated				*$800,687*
	50	3,028	Not Estimated				*$1,022,550*
	100	3,894	Not Estimated				*$1,170,081*
	500	7,066	Not Estimated				*$1,710,446*
Lost Creek							
2012 (Current Day)	10	1,372	9	8	$317,133	$567,260	$884,394
	50	1,905	9	9	$366,497	$648,787	$1,015,284
	100	2,134	11	10	$412,391	$689,588	$1,101,978
	500	2,709	13	10	$456,352	$758,837	$1,215,189
2022	10	1,619	9	9	$339,014	$605,928	$944,942
	50	2,236	11	10	$420,382	$704,402	$1,124,784
	100	2,498	11	10	$440,914	$738,469	$1,179,383
	500	3,148	14	12	$492,688	$808,035	$1,300,723
2032	10	1,609	Not Estimated				*$954,586*
	50	2,220	Not Estimated				*$1,099,841*
	100	2,479	Not Estimated				*$1,161,409*
	500	3,123	Not Estimated				*$1,314,453*
2050	10	1,706	Not Estimated				*$977,657*
	50	2,339	Not Estimated				*$1,128,178*
	100	2,606	Not Estimated				*$1,191,656*
	500	3,268	Not Estimated				*$1,348,900*
2062	10	2,549	12	10	$444,774	$743,516	$1,188,290
	50	3,419	14	12	$517,929	$834,186	$1,352,115
	100	3,773	15	15	$592,887	$881,642	$1,474,529
	500	4,626	15	15	$727,145	$958,964	$1,686,109
2100	10	2,023	Not Estimated				*$1,053,084*
	50	2,738	Not Estimated				*$1,223,042*
	100	3,035	Not Estimated				*$1,293,638*
	500	3,763	Not Estimated				*$1,466,666*
Lowell Creek							

Table J-17 Hazus-Estimated Damages

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Structures Damaged	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
See Table J-19 for Lowell Creek results.							
Resurrection River							
2012 (Current Day)	10	19,230	10	8	$59,762	$143,019	$202,781
	50	26,190	21	19	$172,668	$320,641	$493,308
	100	29,160	25	23	$277,688	$741,105	$1,018,794
	500	36,570	30	28	$543,318	$1,127,737	$1,671,055
2022	10	22,814	19	17	$459,626	$359,998	$819,624
	50	30,894	34	32	$854,971	$1,053,638	$1,908,608
	100	34,291	36	34	$1,005,982	$1,238,168	$2,244,150
	500	42,672	47	43	$1,357,047	$1,791,508	$3,148,555
2032	10	22,718	Not Estimated				*$896,398*
	50	30,727	Not Estimated				*$1,804,754*
	100	34,096	Not Estimated				*$2,186,743*
	500	42,410	Not Estimated				*$3,129,663*
2050	10	24,026	Not Estimated				*$1,044,789*
	50	32,305	Not Estimated				*$1,983,626*
	100	35,769	Not Estimated				*$2,376,542*
	500	44,294	Not Estimated				*$3,343,277*
2062	10	36,156	39	37	$1,124,368	$1,373,879	$2,498,247
	50	47,522	54	46	$1,563,824	$2,080,301	$3,644,125
	100	52,098	62	52	$1,758,582	$2,371,472	$4,130,054
	500	63,056	75	69	$2,339,380	$3,195,608	$5,534,988
2100	10	28,355	Not Estimated				*$1,535,733*
	50	37,634	Not Estimated				*$2,588,058*
	100	41,461	Not Estimated				*$3,021,960*
	500	50,778	Not Estimated				*$4,078,630*
Salmon Creek							
See Table J-18 for Salmon Creek results.							
Sawmill Creek							
2012 (Current Day)	10	1,460	3	1	$12,819	$42,670	$55,489
	50	2,350	4	3	$17,783	$60,723	$78,506
	100	2,860	5	4	$54,102	$77,567	$131,669
	500	4,590	7	5	$68,529	$100,394	$168,923
2022	10	1,705	3	1	$14,529	$48,940	$63,469
	50	2,732	5	4	$33,160	$218,580	$251,740
	100	3,316	5	5	$49,067	$271,319	$320,386

Table J-17 Hazus-Estimated Damages

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Structures Damaged	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
	500	5,286	8	6	$157,417	$570,207	$727,624
2032	10	1,699	Not Estimated				*$18,556*
	50	2,718	Not Estimated				*$264,385*
	100	3,298	Not Estimated				*$385,134*
	500	5,255	Not Estimated				*$690,191*
2050	10	1,805	Not Estimated				*$46,006*
	50	2,869	Not Estimated				*$297,167*
	100	3,474	Not Estimated				*$418,930*
	500	5,508	Not Estimated				*$718,169*
2062	10	2,671	5	4	$30,896	$210,034	$240,930
	50	4,154	7	6	$88,445	$304,272	$392,717
	100	4,980	8	6	$150,302	$543,855	$694,157
	500	7,725	9	6	$174,262	$658,691	$832,952
2100	10	2,113	Not Estimated				*$123,526*
	50	3,319	Not Estimated				*$389,090*
	100	3,998	Not Estimated				*$512,394*
	500	6,274	Not Estimated				*$786,592*
Scheffler Creek							
2012 (Current Day)	10	418	There were no building damages in the 10-year event.				
	50	572	1	0	$0	$0	$0
	100	673	1	0	$0	$0	$0
	500	799	1	0	$0	$0	$0
2022	10	488	There were no building damages in the 10-year event.				
	50	665	1	0	$0	$0	$0
	100	780	1	0	$0	$0	$0
	500	920	2	2	$34,311	$12,317	$46,628
2032	10	486	There were no building damages in the 10-, 50-, or 100-year events.				
	50	661					
	100	776					
	500	915	Not Estimated				*$43,407*
2050	10	516	There were no building damages in the 10-, 50-, or 100-year events.				
	50	697					
	100	816					
	500	958	Not Estimated				*$47,360*
2062	10	770	1	0	$0	$0	$0
	50	1,018	3	2	$39,303	$15,403	$54,706

Table J-17 Hazus-Estimated Damages

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Structures Damaged	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
	100	1,179	3	2	$43,630	$19,074	$62,703
	500	1,352	3	2	$54,567	$24,853	$79,419
2100	10	600	There were no building damages in the 10- or 50-year events.				
	50	802					
	100	934	Not Estimated				*$45,323*
	500	1,084	Not Estimated				*$53,840*
Sometimes Creek							
2012 (Current Day)	10	441	There were no building damages in any event.				
	50	612					
	100	685					
	500	869					
2022	10	519	There were no building damages in any event.				
	50	717					
	100	800					
	500	1,008					
2032	10	516	There were no building damages in any event.				
	50	711					
	100	794					
	500	999					
2050	10	548	There were no building damages in any event.				
	50	751					
	100	836					
	500	1,047					
2062	10	815	There were no building damages in the 10- or 50-year events.				
	50	1,092					
	100	1,205	1	1	$43,543	$18,362	$61,906
	500	1,476	1	1	$44,439	$18,810	$63,250
2100	10	645	There were no building damages in the 10-, 50-, or 100-year events.				
	50	873					
	100	967					
	500	1,199	Not Estimated				*$61,877*
Spruce Creek							
There are no building damages along Spruce Creek in any year/event scenario.							

Notes: 1. All damage estimates are in 2012 dollars based on RSMeans data. 2. Damages for years 2032, 2050, and 2100 were estimated using curve fit techniques based on the calculated results for 2022 and 2062. These values are shown in italicized text and highlighted in yellow.

Salmon Creek

As described in previous sections, Salmon Creek experiences the most impactful riverine flooding in the SBCFSA area. Therefore, Hazus runs were completed for every combination of return period, year, and emission scenario (A1B, A2, and B1). The results of the Hazus runs for Salmon Creek are presented in Table J-18.

As with the other streams, the worst total damages of 173 structures for $21,837,716 are experienced during the 500-year flood event in the 2062 scenario year of the A1B emissions scenario, while the damages for the event in the A2 and B1 emissions scenarios are somewhat lower at 157 structures for $17,093,243 and 149 structures for $16,337,729, respectively. As the A2 and B1 emissions scenarios do not exhibit the early peak, the worst damages in those scenarios are experienced during the 500-year flood event in the 2100/2099 emissions scenarios, with 165 structures at $20,362,628 and 165 structures at $17,622,084.

Table J-18 Hazus-Estimated Damages for Salmon Creek

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Damaged Structures	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
Current Day							
2012	10	2,650	50	39	$1,201,994	$4,678,107	$5,880,101
	50	5,170	79	63	$1,916,410	$6,277,339	$8,193,748
	100	7,120	121	84	$2,526,043	$7,233,455	$9,759,498
	500	15,730	190	147	$4,552,961	$11,525,986	$16,078,947
Emissions Scenario A1B							
2022	10	3,110	54	43	$1,350,014	$5,039,112	$6,389,125
	50	6,038	87	66	$2,195,976	$6,638,966	$8,834,943
	100	8,292	137	94	$2,890,635	$7,862,389	$10,753,024
	500	18,190	189	152	$4,982,299	$12,057,142	$17,039,440
2032	10	3,093	54	43	$1,346,070	$5,029,430	$6,375,500
	50	5,998	86	65	$2,159,665	$6,601,573	$8,761,237
	100	8,236	135	94	$2,877,167	$7,834,631	$10,711,798
	500	18,059	188	152	$4,957,522	$11,983,643	$16,941,165
2050	10	3,285	54	43	$1,390,920	$5,156,896	$6,547,816
	50	6,330	87	67	$2,233,323	$6,718,267	$8,951,590
	100	8,671	139	96	$2,945,279	$8,021,013	$10,966,292
	500	18,925	191	160	$5,176,179	$12,497,319	$17,673,498
2062	10	4,885	70	56	$1,759,905	$5,944,580	$7,704,485
	50	9,209	112	90	$2,933,085	$8,085,164	$11,018,249
	100	12,493	163	119	$3,764,598	$9,732,067	$13,496,665
	500	26,668	219	173	$6,654,296	$15,183,420	$21,837,716
2100	10	3,871	60	49	$1,611,533	$5,506,283	$7,117,816

Table J-18 Hazus-Estimated Damages for Salmon Creek

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Damaged Structures	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
	50	7,366	97	80	$2,580,128	$7,217,738	$9,797,866
	100	10,041	152	106	$3,328,203	$8,682,594	$12,010,798
	500	21,678	185	152	$5,690,036	$13,371,759	$19,061,795
Emissions Scenario A2							
2022	10	2,041	43	32	$965,355	$4,049,912	$5,015,266
	50	4,011	68	56	$1,705,781	$5,748,591	$7,454,372
	100	5,548	101	70	$2,166,837	$6,551,755	$8,718,592
	500	12,395	176	131	$4,001,350	$10,079,940	$14,081,290
2032	10	2,874	53	43	$1,286,295	$4,864,428	$6,150,724
	50	5,564	85	65	$2,094,242	$6,457,303	$8,551,545
	100	7,642	132	91	$2,748,077	$7,564,192	$10,312,269
	500	16,783	189	154	$4,883,597	$12,022,067	$16,905,664
2050	10	3,227	54	43	$1,378,055	$5,119,962	$6,498,017
	50	6,174	92	68	$2,223,104	$6,700,165	$8,923,269
	100	8,442	144	99	$2,924,508	$7,945,190	$10,869,698
	500	18,372	195	160	$5,037,929	$12,151,574	$17,189,503
2062	10	2,964	54	43	$1,315,321	$4,944,308	$6,259,629
	50	5,699	89	68	$2,142,086	$6,529,342	$8,671,428
	100	7,809	134	93	$2,779,915	$7,648,574	$10,428,489
	500	17,077	191	157	$4,925,706	$12,167,537	$17,093,243
2099	10	4,342	65	52	$1,646,185	$5,713,532	$7,359,717
	50	8,164	108	87	$2,745,059	$7,668,165	$10,413,224
	100	11,080	162	116	$3,520,755	$9,219,811	$12,740,566
	500	23,706	207	165	$6,126,847	$14,235,781	$20,362,628
Emissions Scenario B1							
2022	10	2,338	46	34	$1,073,118	$4,364,925	$5,438,043
	50	4,591	76	61	$1,839,196	$6,024,966	$7,864,162
	100	6,342	108	72	$2,309,257	$6,831,469	$9,140,726
	500	14,106	176	131	$4,336,781	$10,833,560	$15,170,341
2032	10	2,010	42	31	$954,205	$4,013,579	$4,967,785
	50	3,981	68	55	$1,674,310	$5,706,193	$7,380,504
	100	5,519	101	70	$2,161,775	$6,540,655	$8,702,430
	500	12,381	176	131	$3,991,287	$10,068,966	$14,060,253
2050	10	3,339	54	43	$1,401,534	$5,187,114	$6,588,648

Table J-18 Hazus-Estimated Damages for Salmon Creek

Scenario Year	Recurrence Interval (yr)	Outlet Discharge (cfs)	Number of Wet Structures	Number of Damaged Structures	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
	50	6,421	93	69	$2,251,495	$6,757,934	$9,009,430
	100	8,789	146	100	$2,998,656	$8,113,306	$11,111,963
	500	19,152	200	169	$5,301,949	$12,648,722	$17,950,671
2062	10	2,713	52	42	$1,237,968	$4,735,148	$5,973,116
	50	5,282	83	63	$2,013,403	$6,337,681	$8,351,084
	100	7,268	128	88	$2,661,628	$7,361,030	$10,022,658
	500	16,031	187	149	$4,714,327	$11,623,402	$16,337,729
2100	10	3,249	54	43	$1,381,483	$5,129,127	$6,510,610
	50	6,240	92	69	$2,232,567	$6,720,810	$8,953,378
	100	8,542	145	99	$2,932,663	$7,992,966	$10,925,628
	500	18,621	197	165	$5,178,293	$12,443,791	$17,622,084

Notes: 1. All damage estimates are in 2012 dollars based on RSMeans data. 2. For the A1B and B1 scenarios, the results are for year 2100. For the A2 scenario, the data is for the year 2099, per the data provided by UAF SNAP.

Lowell Creek

Hazus runs were completed for the three flooding scenarios developed by the USACE and described in Section J.2.2.2 under both current and future land use development conditions. The results of the Hazus runs for Lowell Creek are shown in Table J-19.

As might be expected, the worst damages from Lowell Creek flooding would be realized during Flood Scenario 3, which is the PMF with a landslide, for both current and future land development conditions. This event would practically wipe-out downtown Seward, damaging 259 structures for $53,204,832 in total damages and 261 structures for $53,668,957 in total damages under current and future development conditions, respectively.

There is still significant damage during Flood Scenario 1, which is a more likely scenario than Scenario 3, with 133 structures damaged for a total of $17,453,823 under current conditions and with 135 structures damaged for a total of $17,509,649 under future land development conditions.

Table J-19 Hazus-Estimated Damages for Lowell Creek

Land Use Scenario	Flooding Scenario	Number of Wet Structures	Number of Damaged Structures	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
Current Day	1% Chance Flood, Tunnel Blocked	179	133	$6,256,968	$11,196,855	$17,453,823
	PMF, Tunnel Operational	221	171	$9,621,140	$19,849,234	$29,470,375
	PMF with Surge Release, Tunnel Operational	339	259	$16,400,583	$36,804,249	$53,204,832

Table J-19 Hazus-Estimated Damages for Lowell Creek

Land Use Scenario	Flooding Scenario	Number of Wet Structures	Number of Damaged Structures	Total Structure Damages	Total Contents Damages	TOTAL DAMAGES
Future Land Development	1% Chance Flood, Tunnel Blocked	181	135	$6,287,404	$11,222,246	$17,509,649
	PMF, Tunnel Operational	223	173	$9,691,566	$19,942,109	$29,633,675
	PMF with Surge Release, Tunnel Operational	341	261	$16,561,753	$37,107,205	$53,668,957

Notes: 1. All damage estimates are in 2012 dollars based on RSMeans data. 2. 1% Chance Flood = 100-year Flood, 3. PMF = Probable Maximum Flood. 4. Flooding scenarios were taken from the USACE's Lowell Creek Inundation Study, Seward, Alaska, January 2012.

J.3 Coastal

J.3.1 Hazard Scenario Development Methodology

The coastal flood loss analysis for the SBCFSA makes use of the FEMA Hazus software. The coastal flood hazard is represented as a flood depth raster based on the best available 100-yr coastal floodplain zones from FEMA. FEMA coastal floodplain modeling involves combining a number of different analyses. The flooding associated with stillwater elevation (SWEL) comes primarily from storm surge modeling. Wave setup modeling estimates the increase in water elevation shoreward of the region in which breakers form at the seashore, caused by the onshore flux of momentum against the beach. Wave runup is also modeling, which is added on top the wave setup when water from a specific wave will “run up” the face of a dune or structure. Figure J-2 illustrates how all of these analyses are combined to produce coastal flood elevation estimates.

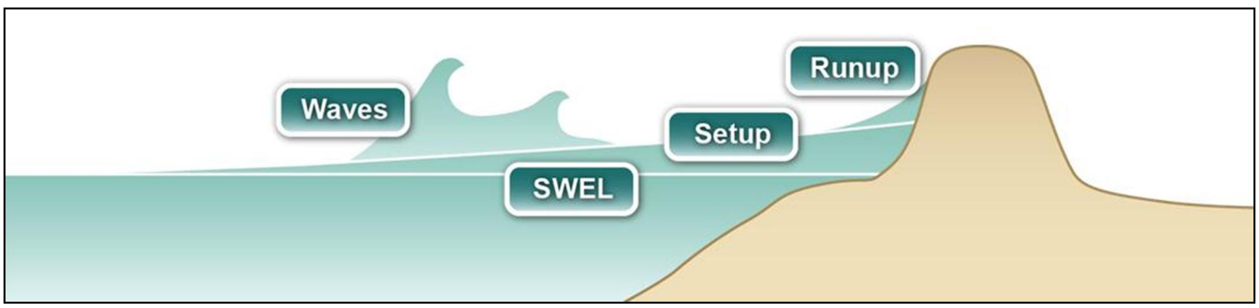

Figure J-2 Coastal Floodplain Modeling Components

For the coastal flood analysis, the latest coastal floodplain zones were obtained from the Kenai Peninsula Borough. These zones come from a draft restudy being conducted by FEMA for the Seward area and all of the Kenai Peninsula Borough. The following description of the coastal analysis comes from excerpts from the draft Flood Insurance Study (FEMA, 2012) for this restudy:

> *“A detailed coastal study was performed so that an estimate of coastal flooding at specific sites could be made. Analyses of storm surge, wave setup, and wave runup were performed in accordance with the design criteria in the Shore Protection Manual of 1973, written by the U.S. Army Corps of Engineers Coastal Engineering Research Center (USACE, 1973). The under-water and above-water topography were determined by the use of maps, U.S. Coast and Geodetic Survey navigation charts and by visual inspection.*

Wind data are sparse, but some data are available in the vicinity of each site. Therefore, wind data used for a specific site are representative of the general wind conditions. By use of the available wind data, wind frequency curves were derived for the specific sites.

Tide frequency curves were derived by use of the frequency distribution functions developed by the U.S. Army Corps of Engineers Coastal Engineering Research Center for the tide reference stations in Alaska (NOAA, 1973). The tide frequency curves and wind frequency curves were used in conjunction in order to determine the 1-percent-annual-chance event. These calculations yielded three tide/wind combinations; a 1-percent-annual-chance tide event with a low wind velocity, a 1-percent-annual-chance wind event with a lower high tide, and a tide/wind combination between the two events. The combination yielding the highest elevation was used as the 1-percent-annual-chance elevation. The 10-percent-annual-chance event was computed similarly. FEMA did not require that the 2- percent-annual-chance and 0.2- percent-annual-chance elevations be computed for the tidal areas.

Wave setup, runup, and surge were calculated for all three tide/wind combinations, and the maximum flood elevation was plotted. The computed surge is the result of wind setup only and does not take into account the surge caused by pressure differences on the open coast. Most locations in this study are substantially away from the open coast. Seward, however, is subject to the pressure-caused surges in the Gulf of Alaska as it is only separated from the gulf by the relatively small Resurrection Bay. The only way to predict these surges and their effect on Seward is through the use of hydrodynamic equations. The data for development of these equations are not available; therefore, the open-sea surge was not considered in this study. In order to determine the flood elevations, allowances were made for the irregularity of the coastline, the changes in beach slope, and the variation of beach materials. The calculated flood levels compared favorably with the observations of local residents and with previous high-water marks. Areas specified for approximate study were compared with areas of detailed study, and the approximate flood elevations were derived. Detailed coastal studies were made for Homer, Seward, Seldovia, Port Graham, English Bay, Kenai, and Nikishka.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD) except for Resurrection Bay which was converted to the North American Vertical Datum of 1988 (NAVD) as part of an update in 2009. All flood elevations shown in this FIS report and on the FIRM are referenced to NGVD except for the areas in and around the city of Seward which are referenced to NAVD.

Stillwater elevations for Resurrection Bay were taken from the prior effective FIS and adjusted to NAVD. The average conversion factor that was used to convert these data were from National Geodetic Survey (NGS) benchmarks and computed from Kenai Peninsula Borough (KPB) benchmarks using the GEOID99 ellipsoid model (Cline and Associates, 2008). The data points used to determine the conversion are listed below [Table J-19].

Table J-20 Elevation Datapoint Conversions

NGS or KPB Station	Location	NGVD29 (Feet)	NAVD88 (Feet)	Conversion from NGVD29 to NAVD88 (Feet)
BM-X-74	Seward Airport	26.45	32.64	6.19
BM E-76	Mile 7 Seward Highway	208.35	214.63	6.18
BM B-76	Mile 4 Seward Highway	64.28	70.48	6.20
KPB BM-3	Nash Road & Seward Highway	28.57	34.76	6.19
KPB BM-7	Bruno Road	151.39	157.58	6.19
			Average:	6.19

The USACE has established the 3-foot wave height as the criterion for identifying coastal high hazard zones (USACE, 1975). This was based on a study of wave action effects on structures. This criterion has been adopted by FEMA for the determination of VE zones. Because of the additional hazards associated with high-energy waves, the NFIP regulations require much more stringent floodplain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in VE zones are higher than those in AE zones. The location of the VE zone is determined by the 3-foot wave as discussed previously. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the VE zone to be established. The VE zone generally extends inland to the point where the 1-percent-annual-chance stillwater flood depth is insufficient to support a 3-foot wave."

Map K-20 shows the location of these coastal floodplain zones with elevations based on the NAVD 88 vertical datum. The location of the boundaries of these zones is identical to the current effective FIRMs (dated 1981), but elevations have gone up 6 feet due to the datum shift as described earlier.

One challenge with using the coastal floodplain boundaries is that they do not cover all of the SBCFSA. As shown on Map K-62, on the west side of Resurrection Bay the coastal floodplain zones begin in the vicinity of the Sea Life Center in downtown Seward. The coastal floodplain zones go around the north end of the Bay and go down the east side to just north of the prison near Fourth of July Creek. Therefore, for this analysis the coastal flood zones with elevation = 16 were extended to cover all of Lowell Point and all of the Fourth of July Creek area.

The coastal flood depth grid was then developed from these extended coastal floodplain zones. The elevation associated with each zone was used to create a coastal flood elevation raster. This raster was then subtracted from the ground raster to produce the coastal flood depth grid. To import the coastal depth grid into Hazus, the raster also was clipped to the land boundary (census tract) used within the Hazus analysis.

No sea level rise scenarios were developed for this study. As detailed in Appendix I in the Sea Level Rise section, most sea level rise studies predict and current trends show no rise or an actual decrease in sea levels for Resurrection Bay. Most of the "what-if" scenarios mapped for the Appendix I (3, 4, 5, and 6 meters) are less than or roughly equal to the coastal flood elevations (which range from 15 to 17 feet). Therefore, the current 100-yr coastal depth grid also provides a representation what structures would be impacted by these "what-if" sea level rise scenarios.

J.3.2 Inventory

The coastal floodplain loss analysis made use of the Hazus user-defined facilities (UDF) data described in the riverine flooding section. This includes both current and future land use UDF data. See Section J.2.4 for more details and summary tables for the UDF inventory data.

J.3.3 Hazus Results

Map K-63 and Map K-64 show the structures that are predicted to be impacted by coastal flooding based on current and future land use scenarios. Table J-21 summarizes the potential SBCFSA losses associated with each scenario.

Table J-21 Hazus UDF Potential Losses From 100-yr Coastal Flooding

Scenario	# Wet Blgs	# Bldgs Damaged	Total Bldg Damages[1]	Total Contents Damages[1]	TOTAL DAMAGES
100-yr Coastal Flood for Current Land Use	58	40	$2,671,610	$6,671,931	$9,343,541
100-yr Coastal Flood for Future Land Use	73	55	$3,594,372	$7,104,491	$10,698,863

Source: KPB Parcel Data, KPB Building Data, KPB aerial photography, RSMeans 2012 Residential Cost Data and Light Commercial Cost Data, Hazus default data for region, field survey, publically available aerial and street level photography

[1] 2012 Dollars from RSMeans 2012 Residential Cost Data and Light Commercial Cost Data

As shown on the maps, the coastal flood losses are concentrated in Lowell Point and in the dock area in Seward. Both areas have commercial structures which tend to have higher contents values and higher relative contents damages, which result in the contents damages being over twice the building damages. Some structures in Lowell Point are shown as wet, but not damaged, because the structures have been elevated on piers above the coastal flood elevation.

The future land use scenario has greater damages, because of the additional structures predicted to be built in Lowell Point. These structures are assumed to be built within a few feet of the ground. If these structures are elevated higher above ground, these damages could be avoided.

J.4 Tsunami

J.4.1 Hazard Scenario Development Methodology

The tsunami loss analysis for the SBCFSA makes use of the FEMA Hazus software. The tsunami hazard is represented as a flood depth raster based on the worse-case tsunami scenario provided in the Report Of Investigations 2010-1, Tsunami Inundation Maps of Seward and Northern Resurrection Bay, Alaska, by E.N. Suleimani et.al., 2010. In this report, there were four different tsunami scenarios modeled and mapped for Resurrection Bay. The worst case scenario tsunami inundation boundary line, shown on Map K-65 along with the 1964 Tsunami observed inundation limit (Lemke, 1967), is associated with two related scenarios. One scenario was a repeat of 1964 tsunami event using information a coseismic deformation model by Suito and Freymueller (2009). The source function used for this scenario represents the entire rupture area of the 1964 earthquake, which include slips in two locations known as the Kodiak block and the Prince William Sound (PWS) block. The second scenario represents a modified 1964 event with only the PWS block. When both scenarios were mapped, there was little difference between the two inundation limits and they were mapped using one boundary line.

The tsunami flood depth grid was developed based on this maximum tsunami inundation line. By comparing the location of the tsunami line with 2009 Seward elevation data, the study team determined that the water surface elevation was approximately 30 feet (NAVD88 vertical datum). A tsunami water surface elevation raster was developed at 30 feet using the tsunami boundary line. This raster was then subtracted from the ground raster to produce the tsunami flood depth grid. To import the depth grid into Hazus, the raster also was clipped to the land boundary (census tract) used within the Hazus analysis.

No sea level rise scenarios were developed for the tsunami analysis. As detailed in Appendix I in the Sea Level Rise section, most sea level rise studies predict no rise or an actual decrease in sea levels for Resurrection Bay. A new tsunami analysis would need to be conducted to reflect any possible sea level rise scenarios.

J.4.2 Inventory

The tsunami floodplain loss analysis made use of the Hazus user-defined facilities (UDF) data described in the riverine flooding section. This includes both current and future land use UDF data. See Section J.2.4 for more details and summary tables for the UDF inventory data.

J.4.3 Hazus Results

Map K-66 and Map K-67 show the structures that are predicted to be impacted by tsunami flooding based on current and future land use scenarios. Table J-22 summarizes the potential SBCFSA losses associated with each scenario.

Table J-22 Hazus UDF Potential SBCFSA Losses From Tsunami Flooding

Scenario	No. of Wet Structures	No. of Damaged Structures	Total – Structure Damages[1]	Total – Contents Damages[1]	TOTAL DAMAGES[1]
Tsunami Flooding for Current Land Use	318	299	$ 53,466,288	$ 92,373,968	$145,840,256
Tsunami Flooding for Future Land Use	342	323	$ 58,105,894	$ 98,692,261	$156,798,155

Source: KPB Parcel Data, KPB Building Data, KPB aerial photography, RSMeans 2012 Residential Cost Data and Light Commercial Cost Data, Hazus default data for region, field survey, publically available aerial and street level photography
[1] 2012 Dollars from RSMeans 2012 Residential Cost Data and Light Commercial Cost Data

As shown on the maps, the tsunami flood losses include structures all along Resurrection Bay from Lowell Point all the way around to outlet of Fourth of July Creek. Similar to the coastal flood damages, tsunami structure damages tend to include a high percentage of commercial structures, which have higher contents values and higher relative contents damages, which results in the contents damages being almost twice the building damages.

The future land use scenario has greater damages, because of the additional structures predicted to be built in Lowell Point and Fourth of July Creek area. Because of the estimated flood elevation for a tsunami (30 feet), it would be difficult to construct structures close to the Bay in these locations that are above this elevation.

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Appendix K
Hazus Based – Hazard Impact Maps

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