Unalaska, Alaska
Multi-Jurisdictional Hazard Mitigation Plan Update

April 2018

Prepared for:

City of Unalaska and Qawalangin Tribe of Unalaska

LeMay Engineering & Consulting, Inc.

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City of Unalaska
Hazard Mitigation Plan

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Acronyms/Abbreviations

°F	Degrees Fahrenheit
ACCIMP	Alaska Climate Change Impact Mitigation Program
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
AIDEA	Alaska Industrial Development and Export Authority
AK	Alaska
ANA	Administration for Native Americans
ANCSA	Alaska Native Claims Settlement Act
ARC	American Red Cross
AVEC	Alaska Village Electric Cooperative
AVO	Alaska Volcano Observatory
BIA	Bureau of Indian Affairs
CCP	Citizen Corps Program
CDBG	Community Development Block Grant
CFR	Code of Federal Regulations
CFP	Community Forestry Program
CGP	Comprehensive Grant Program
City	City of Unalaska
CUTOD	Community & Utility Towers Overlay District
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
Denali	Denali Commission
DHS	Department of Homeland Security
DHS&EM	Division of Homeland Security and Emergency Management
DHSS	Department of Health and Social Services
DGGS	Division of Geological and Geophysical Survey
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
DPS	Director of Public Safety
DSS	Division of Senior Services
EOC	Emergency Operations Center
EMPG	Emergency Management Performance Grant

EPA	Environmental Protection Agency
EQ	Earthquake
ER	Erosion
EWP	Emergency Watershed Protection Program
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FL	Flood
FMA	Flood Mitigation Assistance
FP&S	Fire Prevention and Safety
ft	Feet
FY	Fiscal Year
g	Gravity
GF	Ground Failure
GIS	Geospatial Information System
Hazus-MH	Hazard United States – Multi-Hazard Software
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HSGP	Homeland Security Grant Program
HUD	Housing and Urban Development
IBHS	Institute for Business and Home Safety
IHBG	Indian Housing Block Grant
IHLGP	Indian Home Loan Guarantee Program
INAP	Indian And Native American Programs
IRS	Internal Revenue Service
Kts	Knots
LEG	Legislative Energy Grant
LEPC	Local Emergency Planning Committee
LSA	Unalaska Little South America
M	Magnitude
MAP	Mitigation Action Plan
MGL	Municipal Grants and Loans
MMI	Modified Mercalli Intensity
MPH	Miles Per Hour
msl	Mean Sea Level
NAHASDA	Native American Housing Assistance and Self Determination Act
NFIP	National Flood Insurance Program
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NRF	National Response Framework
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
OC	Ounalashka Corporation
PCR	Parks Culture & Recreation Center
PDM	Pre-Disaster Mitigation
PGA	Peak Ground Acceleration

RCASP	Remote Community Alert Systems
RL	Repetitive Loss
RFC	Repetitive Flood Claim
SAFER	Staffing for Adequate Fire and Emergency Response
SBA	U.S. Small Business Administration
SHMP	Alaska State Hazard Mitigation Plan
SHSP	State Homeland Security Program
SOA	State of Alaska
Stafford Act	Robert T. Stafford Disaster Relief and Emergency Assistance Act
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, And Environmental
Tribe	Qawalangin Tribe of Unalaska
TS	Tsunami
UAFIGI	University of Alaska Fairbanks Geophysical Institute
UCP	City of Unalaska's Comprehensive Plan, 2020
UMA	Unified Mitigation Assistance
US or U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VFA-RFA	Volunteer Fire Assistance and Rural Fire Assistance Grant
VOL	Volcano
VSW	Village Safe Water
WARN	Warning, Alert, And Response Network
WHIP	Wildlife Habitat Incentives Program
WRCC	Western Region Climate Center
WX	Weather

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

1.1 HAZARD MITIGATION PLANNING

Local hazard mitigation planning is mainly driven by a 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 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 Code of Federal Regulations (CFR) Part 201 with subsequent updates. The planning requirements for local entities are described in detail in Section 3 and are identified in their appropriate sections throughout this MJHMP.

In October 2007 and July 2008, FEMA combined and expanded flood mitigation planning requirements with Local HMPs (44 CFR §201.6). Furthermore, all Federal hazard mitigation assistance (HMA) 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 HMPs now qualify communities for several HMA grant programs.

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 HMP. The Tribe does not have grant writers and relies on the city administration to act on it's behalf for grants management and planning capabilities. Two of the grants are authorized under the Stafford Act and DMA 2000, while the remaining one is 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 (UMA) Programs: Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) 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 HMGP may provide funds to States, Territories, Indian Tribal governments, Local governments, and eligible private non-profits following a major Presidential disaster declaration. The PDM and FMA 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 HMA Unified Programs

HMA grant program activities include:

Table 1-1 HMA Eligible Activities

Activities	HMGP	PDM	FMA
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% of the total aggregate disaster damage costs to fund HMGP projects or planning grants. The cost-share for these grants is 75% Federal/25% non-Federal. Communities that fulfill "Impoverished Community" criteria and receive FEMA Regional Administrator approval may be funded at 90% Federal/10% non-Federal.

The PDM grant program provides funds to State, 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 2016, PDM program funding totaled approximately $90 million. The cost-share for these grants is 75% Federal/25 % 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 with funding available for planning and project grants. Project grants typically use the majority of the program's total funding. States, Tribes, and Local entities apply to implement mitigation measures that potentially reduce flood losses to NFIP insured properties.

> The City of Unalaska does not currently participate in the NFIP, and, is therefore, ineligible for National Flood Insurance Act Grant Programs.

MJHMP Layout Description

The MJHMP consists of the following sections and appendices:

Introduction

Section 1 defines what a MJHMP is, delineates federal requirements and authorities, and introduces the HMA program listing the various grant programs and their historical funding levels.

Community Description

Section 2 provides a general history and background of the City of Unalaska (City) and the Qawalangin Tribe of Unalaska (Tribe), including historical trends for population, and the demographic and economic conditions that have shaped the area.

Planning Process

Section 3 describes the MJHMP update process, identifies the Planning Team members, the meetings held as part of the update process, and the key stakeholders within the City, Tribe, 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; actions the City and Tribe plan to implement to assure continued public participation; and their methods and schedule for keeping the MJHMP current.

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

MJHMP Adoption

Section 4 describes the Community's MJHMP adoption process (support documents are located in Appendix C).

Hazard Analysis

Section 5 describes the process through which the Planning Team identified, screened, and selected the hazards for profiling in this 2018 update of the MJHMP. The hazard analysis includes the nature, previous occurrences (history), location, extent, impact, and future event recurrence probability for each hazard. In addition, historical impact and hazard location figures are included when available.

Vulnerability Analysis

Section 6 identifies Unalaska's potentially vulnerable assets—people, residential and nonresidential buildings (where available), critical facilities, and critical infrastructure. The resulting information identifies the full range of hazards that the Community could face and potential social impacts, damages, and economic losses. Land use and development trends 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 Unalaska. Mitigation actions include preventive actions, property protection techniques, natural resource protection strategies, structural projects, emergency services, and public information and awareness activities. Mitigation strategies were developed in 2013 and updated in 2018.

References

Section 8 lists reference materials and resources used to prepare this MJHMP.

Appendices

Appendix A: Delineates Federal, State, and other potential mitigation funding sources. This section will aid the community with researching and applying for funds to implement their mitigation strategy.

Appendix B: Provides the FEMA Local Mitigation Plan Review Tool, which documents compliance with FEMA criteria.

Appendix C: Provides the adoption resolution for the City and Tribe.

Appendix D: Contains Unalaska's critical facilities list.

Appendix E: Contains figures which represent the hazard areas and critical facilities located within the natural hazard areas.

Appendix F: Provides public outreach information, including newsletters.

Appendix G: Contains the Benefit-Cost Analysis Fact Sheet used to prioritize mitigation actions.

Appendix H: Provides the plan maintenance documents, such as an annual review sheet, progress report form, and community natural hazard survey.

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This section describes the location, geography, history; demographics; and land use development trends of the City of Unalaska and Qawalangin Tribe of Unalaska.

2.1 LOCATION, GEOGRAPHY, AND HISTORY

"Unalaska overlooks Iliuliuk Bay and Dutch Harbor on Unalaska Island in the Aleutian Chain. It lies 800 air miles from Anchorage (a two- to three-hour flight) and 1,700 miles northwest of Seattle. The name Dutch Harbor is often applied to the portion of the city on Amaknak Island, which is connected to Unalaska Island by bridge. Dutch Harbor is actually within the boundaries of the City of Unalaska. Unalaska lies at approximately 53.873610 North Latitude and -166.536670 West Longitude. (Sec. 11, T073S, R118W, Seward Meridian and the Aleutians West Census Area.)" (Department of Community, Commerce, and Economic Development [DCCED], Division of Community and Regional Affairs [DCRA] 2017).

Figure 2-1 Unalaska Location Map

The Qawalangin Tribal website provides a brief history of present day Unalaska:

> *"The word Aleutian and the name "Aleut" was given to the native people by the first Russian explorers to visit the Aleutian Islands. Its meaning is unclear, so the present-day Natives of Unalaska and most of the Aleutian Islands prefer to call themselves Unangan, or the people of the passes. In the dialect of the eastern Aleutian Islands, the self-given term for this group of Native peoples is Unangan; in the western dialect, Unangas. Collectively, Unangax^ (with the "^" positioned directly over the "x") is the proper term for the Native people of the Aleutian region. This group of hunters, whalers, and fishers are the original inhabitants of the Aleutian Island Chain, predating the Russian settlement of the region by thousands of years.*
>
> *Resources from the sea provided a livelihood for the Unangan people and still does today, for not only the Unangan, but also many residents of Unalaska. The harsh climate and unforgiving topography of the islands created a Unangan culture both rich in art and oral tradition that lives today, and continues to grow and flourish in the present generation of Unangan People. Language, Unangan dance, and medicinal plants are being brought back and used as they always were over thousands of years. The Unangan People are mostly widely known for their ultra-fine grass basketry, sleek and efficient wood-frame iqyan (skin boats made of wood frames and marine mammal skin) and mastery in handling these skin boats at sea. The Unangan People are also well-known for their excellence as marine mammal hunters, superior skin sewing and embroidery techniques, and beautiful, streamlined bentwood hats and visors.*
>
> *Historically, the Aleutian Island of Unalaska has been home to the Unangan People, who through oral history have documented an estimated 8,000 years of trade and travel. Recent archaeological investigation in the Unalaska area gives evidence that the Unangan people have inhabited the Aleutian Islands for at least 9,000 years. Artifacts found in the archaeological site at Margaret Bay on the Island of Unalaska were ancient*

at the time the Egyptians were building the first step pyramids. By 1745, the Unangan People had come into contact with Russian explorers, fur traders and hunters who came across the Bering Straits to the Aleutian Islands such as Unalaska. There were inevitable clashes between the Russians and the native islanders, as the Russian's treatment of the Unangan was less than favorable. At this time, the explorers branded the Unangan/Unangas people with the name, "Aleut", a word of uncertain meaning and origin that has become a catchall name for various Alaska Native groups.

International commerce began in 1759 when Stephan Glotov and accompanying fur hunters spent two years on Unalaska and nearby Umnak Island. Soon under Russian control, the Unangan People were consolidated into fewer and fewer communities to accelerate the efficiency in which the Russians could take advantage of their hunting skills. The decline of the Unangan population was rapid and occurred for varied reasons, from genocide to contact diseases brought by the Russian newcomers.

According to Unalaska resident Moses Dirks, a linguist specialist and teacher of the Unangan Language at the high school in Unalaska, the word Unangan means people of the passes. The Aleutian Islands are home to the earliest known continually inhabited coastal site in North America" (Qawalangin 2012).

The City of Unalaska's Comprehensive Plan 2020 (2020 Plan) provides some historical background for their community as:

"Unalaska (Iluulux) in Aleut; (Уналашка) in Russian) is a city in the Aleutians West Census Area of the Unorganized Borough of the State of Alaska and is located on Unalaska Island and neighboring Amaknak Island in the Aleutian Islands off of mainland Alaska.

The Unangan people, who were the first to inhabit the island of Unalaska, named it "Ounalashka" meaning "Near the Peninsula". The name Unalaska is probably an English variation of this name. The regional native corporation has adopted this moniker and is known as the Ounalashka Corporation. Dutch Harbor was so named by the Russians because they believed that a Dutch vessel was the first European ship to enter the harbor" (UCP 2011).

The City covers approximately 111 square miles of land and approximately 101.3 square miles of water. Moderate maritime temperature changes occur along Alaska's Aleutian Islands. The City's maritime temperatures range from a winter low of 23 degrees Fahrenheit (°F) to a high of 56 °F. The area receives approximately 58 inches of rain and 61.2 inches of snow. (DCRA 2012, WRCC 2012).

The following is a brief sketch of the City's history:

15-20,000 Years ago	First people inhabiting the Unalaska region were those who are thought to have crossed over into Alaska from Siberia on the "Bering Land Bridge."
1741	Russian ships first reached the Aleutians. Fur hunters exploited resources, Russians enslaved Aleut inhabitants.
1759	Approximately 3,000 Unangan (Today's Aleuts) utilized 24 locations on Unalaska and Amaknak Islands.
	International commerce began – Unangan people worked with Stephan Glotov and accompanying fur hunters.

1867	Alaska was purchased by the United States (U.S.) of American and Russian control ended.
1880	The Methodist Church opened a school, clinic, and the Jesse Lee Home for Orphans.
1880s	Dutch Harbor flourished from coal and commercial trade.
1890s	The Klondike Gold Rush brought many through the Unimak Pass as the gateway to the northwest Alaska gold fields.
1900s	Seafood processing plants are believed to have existed to process herring, salmon, and whale meat.
1910	Fox farming provided economic benefits to the area as the coal trade diminished due to oil use.
1930s	The Great Depression caused the collapse of the fur industry.
1942	Military defense installations proved wise when Japanese aircraft attacked Dutch Harbor.
1950	The Aleutians renewed fish processing interest with halibut, salmon, and king crab.
1960	The king crab industry improved significantly.
1989	The Qawalangin Tribe of Unalaska has held status as a federally recognized sovereign nation of the United States since 1989.

(UCP 2011, Qawalangin 2012, DCRA 2012)

"Unalaska is a rapidly-growing and culturally-diverse community, primarily focused on fishing and fish-processing activities. Subsistence activities are important to the Unangan community and to many long-term non-Native residents, as well" (DCRA 2012).

2.2 DEMOGRAPHICS

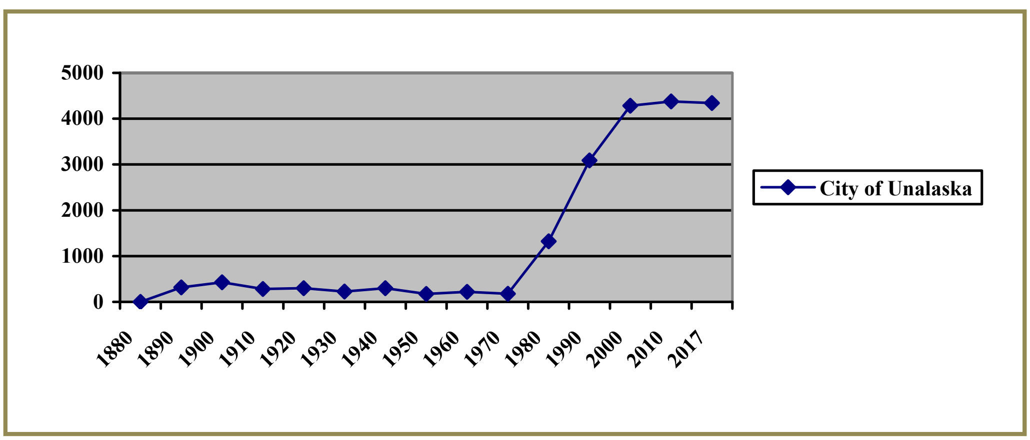

Figure 2-2 Unalaska Historic Population

The 2010 U.S. Census recorded 4,376 residents, of which the median age was 40.7, indicating a relatively young population. The population of Unalaska is expected to remain steady because over half of the population is between 10 and 44 years of age. The City population is split between various races with 39.2% White, 32.6% Asian, 6.9% Black or African American, and

2.2% Pacific Islanders with the remaining 13% as undefined nationality. The male and female composition is approximately 68.4 and 31.5 %, respectively. The 2010 U.S. Census revealed that there are 1,106 households with the average household having approximately two individuals. The most recent 2017 Department of Labor (DOL) certified population is 4,341. Figure 3-2 illustrates the historic population of the community.

2.3 ECONOMY

Unalaska's economy is primarily based on their very successful and historically established fishing industry which includes commercial fishing, fish processing, and fleet services (fuel, repairs, maintenance, trade, and transportation). Unalaska is situated within the Great Circle shipping route and is located within 50 miles from major trade routes between the Aleutian Islands to Pacific Rim and Bering Sea ports.

Commercial fish processors and fishing industry infrastructure include: Westward Seafoods, Unisea, Alyeska, Icicle, and Trident. (DCRA 2012)

Fishing processing is the principle industry in Unalaska, however, other general employment opportunities exist within the community. Table 2-1 lists the U.S. Census Industry Classifications for the City of Unalaska.

Table 2-1 Labor Industry Classification Break-out for Unalaska

Industry	Estimate	Percentage
Civilian employed population 16 years and over	3,938	100%
Agriculture, forestry, fishing and hunting, and mining	43	1.1%
Construction	52	1.3%
Manufacturing	3,254	82.6%
Wholesale trade	18	0.5%
Retail trade	73	1.9%
Transportation and warehousing, and utilities	226	5.7%
Information	4	0.1%
Finance and insurance, and real estate and rental and leasing	30	0.8%
Professional, scientific, and management, and administrative and waste management services	20	0.5%
Educational services, and health care and social assistance	77	2.0%
Arts, entertainment, and recreation, and accommodation and food services	55	1.4%
Other services, except public administration	21	0.5%
Public administration	65	1.7%

According to the 2010 U.S. Census, the median household income in Unalaska was $80,625 with a per capita income of $25,353. Approximately 11.5% were reported to be living below the poverty level. The potential work force (those aged 16 years or older) in the City was estimated to be 4,140, of which 3,938 were actively employed. In 2010, the unemployment rate was 2.1%; however, this rate included part-time and seasonal jobs, and practical unemployment or underemployment is likely to be significantly higher.

Table 2-2 identifies the City of Unalaska's Top 2010 Occupations.

Table 2-2 2010 Top Occupations, Gender, and Age Group

Occupations	Number of workers	Female	Male	Age 45 and over	Age 50 and over
Meat, Poultry, and Fish Cutters and Trimmers	335	111	218	202	148
Material Moving Workers, All Other	142	18	124	86	52
Stock Clerks and Order Fillers **GASLINE**	50	9	41	19	11
Installation, Maintenance, and Repair Workers, All Other	49	0	49	30	22
Laborers and Freight, Stock, and Material Movers, Hand **GASLINE**	48	0	45	18	14
Office Clerks, General **GASLINE**	38	32	6	20	14
Maids and Housekeeping Cleaners **GASLINE**	31	20	11	21	14
Sales and Related Workers, All Other	28	19	8	7	5
Operating Engineers and Other Construction Equipment Operators **GASLINE TOP JOB**	25	3	22	11	7
Helpers--Installation, Maintenance, and Repair Workers **GASLINE**	24	7	17	6	5
General and Operations Managers **TOP JOB**	24	6	18	16	13
Cooks, Institution and Cafeteria **GASLINE**	20	9	11	11	7
Industrial Truck and Tractor Operators	20	1	19	10	5
Security Guards **GASLINE**	17	6	11	9	3
Welders, Cutters, Solderers, and Brazers **GASLINE TOP JOB**	17	2	15	1	0
Bookkeeping, Accounting, and Auditing Clerks **GASLINE**	17	15	2	4	2
Executive Secretaries and Executive Administrative Assistants **GASLINE TOP JOB**	16	16	0	6	4
Food Batchmakers	16	8	8	5	3
Janitors and Cleaners, Except Maids and Housekeeping Cleaners **GASLINE**	16	5	11	10	7
Lifeguards, Ski Patrol, and Other Recreational Protective Service	15	8	7	1	0
Maintenance and Repair Workers, General **GASLINE TOP JOB**	15	0	14	10	4
Heavy and Tractor-Trailer Truck Drivers **GASLINE TOP JOB**	15	0	15	7	3
Billing and Posting Clerks	14	12	2	6	5
First-Line Supervisors of Retail Sales Workers	14	6	8	5	3
Elementary School Teachers, Except Special Education **TOP JOB**	13	12	1	6	4

GASLINE: means the occupation has been identified as a core occupation involved in the gas line project.

TOP JOB: means the occupation is projected to have a high growth rate and numerous openings, and has an above average wage.

: means the occupation has been identified as green.

(Census 2010)

Figure 2-3 depicts the 2010 U.S. Census Pie Chart indicating the number of Resident Workers by Industry.

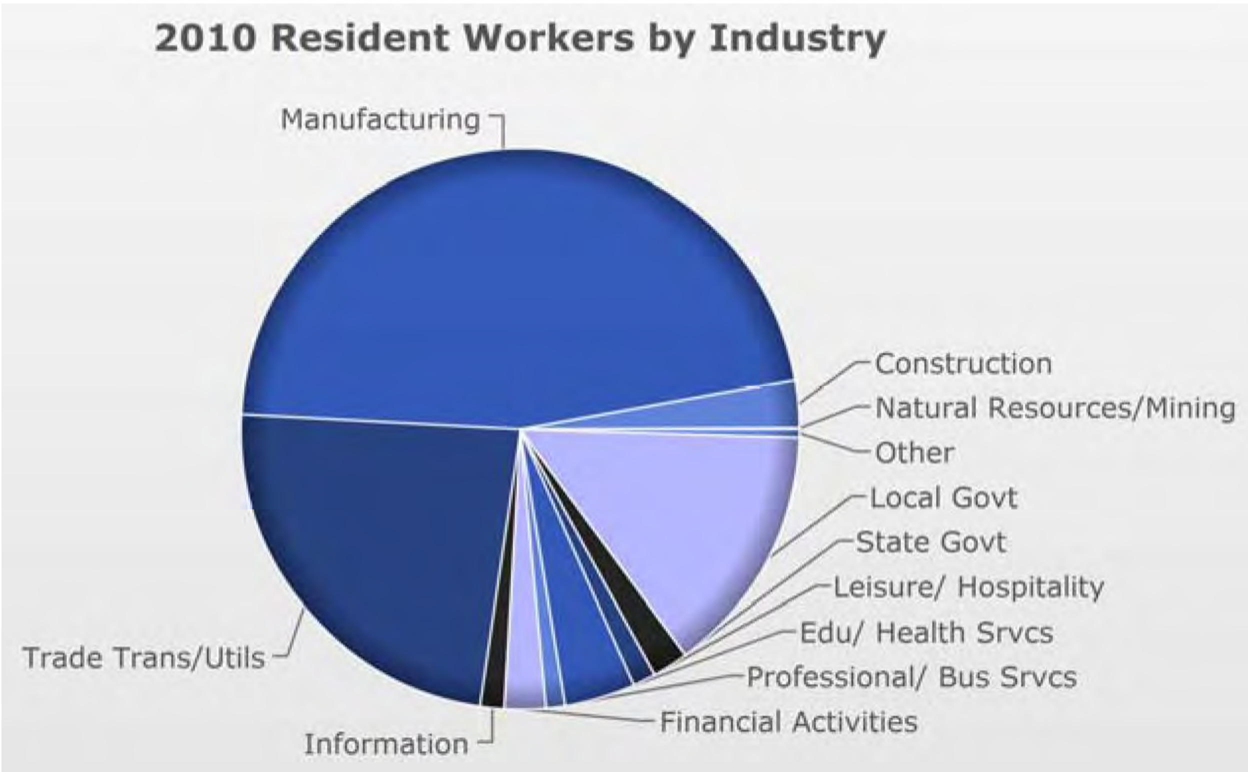

Figure 2-3 **Resident Works by Industry** (Census 2010)

Figure 2-4 depicts a photographic collage of Unalaska.

Figure 2-4 Collage of Aerial Photographs –Unalaska (Unalaska 2012)

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This section provides an overview of the planning 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 MJHMP. 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, 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 five-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?
Source: FEMA, October 2011.

3.1 PLANNING PROCESS OVERVIEW

The State of Alaska, Division of Homeland Security and Emergency Management (DHS&EM) provided funding and project oversight to LeMay Engineering & Consulting, Inc. to facilitate and guide Planning Team development and the MJHMP Update development.

Updates to this 2018 MJHMP include:

1. A review of the local hazards that could potentially impact the City and Tribe of Unalaska.
2. An examination of the progress towards minimizing or eliminating those hazards.
3. A reevaluation of the community's vulnerability to local hazards.
4. Revised community demographic and economic information.
5. An update on mitigation goals and projects developed and implemented in the 2013 HMP.
6. New mitigation goals and projects.

The update process began in November 2017 with Planning Director Bil Honka and Planner Thomas Roufos consulting the Tribe and organizing a Planning Team to begin the MJHMP update process.

The Planning Team held its first meeting on December 18, 2017. During the meeting, Jennifer LeMay explained how the MJHMP differed from other emergency plans and is required to be updated every five years, and she described the steps of the update process. The Planning Team then reviewed the information given in the 2013 HMP to determine what information was required for the update. This included reviewing and updating information about applicable City and Tribe resources and capabilities, hazards affecting Unalaska, and mitigation strategies. The Planning Team also discussed the City's and Tribe's role such as: acting as an advocate for the planning process, assisting with gathering information, and supporting public participation opportunities. The Planning Team further discussed the hazards that most affect Unalaska and worked to verify and update potential impacts to residential and critical facilities, and to identify and prioritize mitigation actions for potential future mitigation project funding.

After the meeting, LeMay Engineering & Consulting, Inc. compiled the information gathered from the Planning Team data into a Draft MJHMP Update that was emailed to the Planning Team and posted within the Community for review.

A public meeting was held on March 12, 2018, to review the Draft MJHMP Update, discuss revisions, and record public comments on the Draft MJHMP Update. No public comments were submitted.

In summary, the following five-step process took place from November 2017 through May 2018.

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 MJHMP.
2. Monitor, evaluate, and update the MJHMP: The Planning Team developed a process to ensure the MJHMP was monitored to ensure it was used as intended while fulfilling community needs. The team then developed a process to evaluate the MJHMP 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 HMP's five-year update.

3. Assess risks: The Planning Team identified the hazards specific to Unalaska, and with the assistance of a hazard mitigation planning consultant (LeMay Engineering & Consulting, Inc.), developed the risk assessment for the identified hazards. The Planning Team updated 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 addressed 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 and updated mitigation actions from the 2013 HMP. Subsequently, the Planning Team identified and prioritized the actions for implementation.

3.2 HAZARD MITIGATION PLANNING TEAM

Table 3-1 identifies the Planning Team.

Table 3-1 Hazard Mitigation Planning Team

Name	Title	Organization	Key Input
Bil Homka, AICP	Director of Planning	City of Unalaska	Planning Team Lead: data input and MJHMP review.
Thomas Roufos	Planner	City of Unalaska	Planning Team Member: data input and MJHMP review.
James Price	GIS Administrator	City of Unalaska	Planning Team Member: data input and MJHMP review.
Tom Robinson	President	Qawalangin Tribe of Unalaska	Planning Team Member: data input and MJHMP review.
Chris Price	Environmental Director	Qawalangin Tribe of Unalaska	Planning Team Member: data input and MJHMP review.
Nicole Johnson	Tribal Administrator	Qawalangin Tribe of Unalaska	Planning Team Member: MJHMP review.
Peggy McLaughlin	Director of Ports and Harbors	City of Unalaska	Planning Team Member: data input and MJHMP review.
Jennifer Shockley	Deputy Police Chief	City of Unalaska	Planning Team Member: data input and MJHMP review.
Clay Darnell	Director Finance	City of Unalaska	Planning Team Member: data input and MJHMP review.
Roger Blakeley	Director of Parks, Culture, and Recreation	City of Unalaska	Planning Team Member: data input and MJHMP review.
Albert Burnham	Recreation Manager	City of Unalaska	Planning Team Member: data input and MJHMP review.
Nichole Gordon	Director of Operation’s Assistant	Ounalashka Corporation	Planning Team Member: data input and MJHMP review.

Table 3-1 Hazard Mitigation Planning Team

Name	Title	Organization	Key Input
Marjie Veeder	Clerk	City of Unalaska	Planning Team Member: data input and MJHMP review.
Tom Cohenour	Director of Public Works	City of Unalaska	Planning Team Member: data input and MJHMP review.
Robert Lund	Public Works	City of Unalaska	Planning Team Member: data input and MJHMP review.
Erin Reinders	Assistant City Manager	City of Unalaska	Planning Team Member: data input and MJHMP review.
Scott Brown	Deputy Port Director	City of Unalaska	Planning Team Member: data input and MJHMP review.
JR Pearson	Department of Public Utilities	City of Unalaska	Planning Team Member: data input and MJHMP review.
Debra Hanson Zueger	Risk Manager	City of Unalaska	Planning Team Member: data input and MJHMP review.
Jennifer LeMay, PE, PMP	Planner	LeMay Engineering & Consulting, Inc.	Temporary Team Member: Responsible for MJHMP development, lead writer, project coordination.
Brent Nichols, CFM	State Hazard Mitigation Officer	DHS&EM	Temporary Team Member: Responsible for providing technical assistance and reviewing the Draft MJHMP Update.

3.3 PUBLIC INVOLVEMENT & OPPORTUNITIES FOR INTERESTED PARTIES TO PARTICIPATE

Table 3-2 lists the community's public involvement initiatives to encourage participation and insight for the MJHMP update effort. Even though Unalaska community members and residents (i.e., the public) were invited to participate in the planning process and public meetings, only people employed by the City, Tribe, and Ounalashka Corporation chose to participate in the process and attended public meetings. The public is defined as any tribal or community member.

Table 3-2 Public Involvement Mechanisms

Mechanism	Description
Public Meeting (December 18, 2017)	The community held a public meeting to discuss the hazard mitigation updating process. Data needs were requested from the community for the MJHMP Update.
Newsletter Distribution (March 7, 2018)	The City and Tribe distributed a newsletter describing the availability of the Draft MJHMP Update for review and comment. The newsletter encouraged the Community to provide comments or input and to attend the upcoming public hearing. The newsletter was posted in public locations around Unalaska.
Public Hearing (March 12, 2018)	The Planning Team held a public meeting and reviewed the Draft MJHMP Update, specifically the mitigation actions, and sought public feedback as to how the Draft MJHMP Update may be revised to best meet the needs of the community.

The Planning Team was formed in early December, 2017 and began directing MJHMP data acquisition efforts for the update. The Planning Team met on December 18, 2017, and Jennifer LeMay explained the MJHMP update project and the essential role of community members in the process.

The Planning Team verified the seven natural hazards from the 2013 HMP: earthquake, erosion, flood, ground failure (avalanche, landslide, and rockfall), tsunami, volcano, and severe weather, which periodically impact Unalaska. The Planning Team also verified transportation and utility disruptions were still a hazard that could occur from various natural and manmade events. Additionally, the Planning Team identified climate change as another manmade hazard that could affect the community.

LeMay Engineering & Consulting described the specific information needed from the Planning Team to update the critical facility vulnerability and population risk assessments, including the location, value, and occupancy. The Planning Team also identified the progress made toward each of the mitigation actions from the 2013 HMP and determined additional mitigation projects that would benefit the community.

The risk assessment was updated after the community asset data was collected by the Planning Team over the winter of 2017/2018, which identified the assets that are exposed and vulnerable to specific hazards.

A newsletter was prepared and delivered on March 7, 2018 describing the process to date and announcing the availability of the Draft MJHMP Update for public review and comment. The Planning Team held a public meeting on March 12, 2018 to review the Draft MJHMP Update for accuracy – ensuring it meets the City's and Tribe's needs. The meeting was productive.

3.4 INCORPORATION OF EXISTING PLANS AND OTHER RELEVANT INFORMATION

During the update process, the Planning Team reviewed and incorporated information from existing plans, studies, reports, and technical reports into the MJHMP Update. The following were available on the City, Tribe, and State websites and were reviewed and used as references for the jurisdiction information and hazard profiles in the risk assessment of the MJHMP (Table 3-3). The tribe has no current ongoing planning efforts to integrate into the MJHMP.

Table 3-3 Documents Reviewed

Existing plans, studies, reports, ordinances, etc.	Contents Summary (How will this information improve mitigation planning?)
City of Unalaska, Alaska, Recommended Community Development Plan, November, 1977	Explains the City's historic land-use initiatives and natural hazard impacts.
Unalaska Comprehensive Plan 2020, February 22, 2011	Explains the City's current land use initiatives and natural hazard impacts.
Unalaska Comprehensive Plan 2020 – Housing Plan, February 22, 2011	Defined the City's housing trends, goals, and initiatives.
Unalaska Land Use Plan: 2015	Explains the City's current land use trends and plans for future development.

Table 3-3 Documents Reviewed

Existing plans, studies, reports, ordinances, etc.	Contents Summary (How will this information improve mitigation planning?)
Unalaska Economic Development Plan, March 2004	Defines the City's future economic goals.
Unalaska Community Visions for the Future 1991-2000	Defines the City's vision for future development.
Aleutians West Coastal Resource Service Area, Volume II, Resource Inventory and Analysis, Appendix C, Coastal Management Plan, Mitigation Opportunities in Unalaska, State Review Draft, Prepared June 2008 by LaRoche + Associates	Explains the City's coastal environment and desired initiatives.
Unalaska Road Improvement Master Plan	Defines the City's road conditions and threats.
Earthquakes in Alaska, USGS Open-File Report 95-624, by Peter Haeussler and George Plafker	Defines the location's earthquake threat potential.
DNR/DGGS, Preliminary Volcano-Hazard Assessment for Makushin Volcano, Alaska, Report of Investigation 2000-4	Defines the area's volcanic threat.
State of Alaska, Department of Commerce, Community and Economic Development Community Profile	Provides historical and demographic information.
State of Alaska Hazard Mitigation Plan, 2013	Defines statewide hazards and their potential locational impacts.
City of Unalaska Hazard Mitigation Plan, 2013	Defines natural hazard and their potential impacts through the year 2013.

A complete list of references list is provided in Section 8.

3.5 PLAN MAINTENANCE

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

The following three process steps are addressed in detail here:

1. Implementation into existing planning mechanisms;
2. Continued public involvement; and
3. Monitoring, reviewing, evaluating, and updating the MJHMP.

3.5.1 Implementation 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 MJHMP is community-adopted and receives FEMA's final approval, each Planning Team Member ensures that the MJHMP, in particular each Mitigation Action Project, is incorporated into existing planning mechanisms whenever possible. Each member of the Planning Team has the responsibility of 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 the community to increase awareness of the MJHMP 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 City and Tribe are dedicated to involving the public directly in the continual reshaping and updating the MJHMP. A paper copy of the MJHMP and any proposed changes will be available at the City and Tribal Offices. The contact information of the Planning Team Leaders, to whom people can direct their comments or concerns, will also be available at the City and Tribal Offices.

The Planning Team will mail out a natural hazard survey to the community in their water bills every March (see Appendix H). Survey results will be kept in the annual MJHMP files and evaluated during each five-year review.

3.5.3 Monitoring, Reviewing, Evaluating, and Updating the MJHMP

The requirements for monitoring, reviewing, evaluating, and updating the MJHMP, 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 five-year cycle)?
Source: FEMA, October 2011.

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

The following three process steps are addressed in detail here:

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

3.5.3.1 Monitoring the MJHMP

This MJHMP was prepared as a collaborative effort. To maintain momentum and build upon previous hazard mitigation planning efforts and successes, the City and Tribe will continue to use the Planning Team to monitor, evaluate, and update the MJHMP. Each authority identified in the Mitigation Action Plan (MAP) matrix (Table 7-8) will be responsible for implementing the Mitigation Action Plan and determining whether their respective actions were effectively implemented. The Director of Planning and Tribe Environmental Director will serve as the primary points of contact and will coordinate local efforts to monitor, evaluate, revise, and tabulate MJHMP actions' status.

3.5.3.2 Reviewing the MJHMP

The City and Tribe will review their success for achieving the HMP's mitigation goals and implementing the Mitigation Action Plan's activities and projects during the annual review process.

During each annual review, each agency or authority administering a mitigation project will submit a Progress Report (Appendix H) to the Planning Team. The report will include the current status of the mitigation project, including any project changes, a list of identified implementation problems (with appropriate strategies to overcome them), and a statement of whether or not the project has helped achieve the appropriate goals identified in the MJHMP.

3.5.3.3 Evaluating the MJHMP

The Annual Review Questionnaire (Appendix H) provides the basis for future MJHMP 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 MJHMP 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:

- Determine authorities, outside agencies, stakeholders, and residents' participation in MJHMP implementation success.
- Identify notable risk changes for each identified and newly considered natural or human-caused hazards.
- Consider land development activities and related programs' impacts on hazard mitigation.
- Mitigation Action Plan implementation progress (identify problems and suggest improvements as necessary).
- Evaluate MJHMP local resource implementation for MJHMP identified activities.

3.5.3.4 Updating the MJHMP

In addition to the annual review, the Planning Team will update the HMP every five years. The following section explains how the MJHMP will be reviewed, evaluated, and implementation successes described.

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 for approval within 5 years in order to continue to be eligible for mitigation project grant funding.

ELEMENT D. Planning Process (Continued)
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 City and Tribe will annually review the HMP as described in Section 3.5.3.2 and update the MJHMP every five years (or when significant changes are made) by having the Planning Team review all Annual Review Questionnaires (Appendix H) to determine the success of implementing the HMP's Mitigation Action Plan.

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

No later than the beginning of the fourth year following MJHMP adoption, the Planning Team will undertake the following activities:

- Request grant assistance from DHS&EM to update the MJHMP (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 to the Planning Team.
- Develop a chart to identify those MJHMP sections that need improvement, the section and page number of their location within the MJHMP, and describe the proposed changes.
- Thoroughly 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 reasons for the delay.
    - Describe how each action's priority status has changed since the MJHMP was originally developed and subsequently approved by FEMA.
    - Determine whether or not the project has helped achieve the appropriate goals identified in the MJHMP.
    - 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 to change the proposed implementation date/duration timeline for delayed actions the City of Unalaska still desires to implement.
    - Prepare a "new" MAP matrix for the City of Unalaska.

- Prepare a new Draft MJHMP Update.
- Submit the Draft MJHMP Update to DHS&EM and FEMA for review and approval.

3.5.3.5 Formal State and FEMA *MJHMP* Review

Completed HMPs do not qualify the City and Tribe of Unalaska for mitigation grant program eligibility until they have been reviewed and adopted by the City and Tribal Councils, and received final approval from the State and FEMA.

The City and Tribe will submit the Draft MJHMP Update to the DHS&EM for initial review and preliminary approval. Once any corrections are made, DHS&EM will forward the MJHMP to FEMA for their review and conditional approval.

Once the plan has fulfilled all FEMA criteria, the City and Tribe will pass an MJHMP Adoption Resolution. A copy will be sent to FEMA for final MJHMP approval.

FEMA's final approval assures the City and Tribe are eligible for applying for appropriate mitigation grant program funding. LeMay Engineering & Consulting, Inc. will send a final copy of the FEMA approved MJHMP to the City and Tribe.

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4.1 ADOPTION BY LOCAL GOVERNING BODIES AND SUPPORTING DOCUMENTATION

The requirements for the adoption of this MJHMP 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 City and Tribe of Unalaska are represented in this MJHMP and meet the requirements of Section 409 of the Stafford Act and Section 322 of DMA 2000, and 44 CFR §201.6(c)(5).

The Unalaska City Council and Qawalangin Tribe of Unalaska adopted the MJHMP on ______, 2018 and submitted the final MJHMP Update to FEMA for formal approval.

A scanned copy of the vote record and the City' and Tribe's formal adoption are included in Appendix C.

The Qawalangin Tribe of Unalaska will continue to comply with all applicable Federal statutes and regulations during the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c), and will amend its plan whenever necessary to reflect changes in tribal or Federal laws and statutes as required in 44 CFR 13.11(d).

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This section identifies and profiles the hazards that could affect the City of Unalaska.

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 and terrorism-related hazards are beyond the scope of this MJHMP. 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 then eliminated from consideration.

Hazard profiling is accomplished by describing hazards in terms of their nature, history, magnitude, frequency, location, extent, and probability. Hazards are identified through historical and anecdotal information collection, existing plans, studies, and map reviews, and study area hazard map preparations when appropriate. Hazard maps are used to define a hazard's geographic extent as well as define the approximate risk area boundaries.

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 December 18, 2017, the Planning Team reviewed possible natural hazards that could affect the Aleutians West Census Area, including two manmade and technological hazards that could affect the community. They then evaluated and screened the comprehensive list of potential hazards based on a range of factors, including prior knowledge or perception of their threat and the relative risk presented by each hazard, the ability to mitigate the hazard, and the known or expected availability of information on the hazard (Table 5-1). The Planning Team determined that seven natural hazards and two manmade hazards posed a significant threat to Unalaska: earthquake, erosion, flood, ground failure, tsunami, volcanic eruption, severe weather, transportation and utility disruptions, and climate change.

Table 5-1 Identification and Screening of Hazards

Hazard Type	Should It Be Profiled?	Explanation
Natural Hazards		
Earthquake	Yes	Periodic, unpredictable occurrences. Unalaska experienced no damage from the 2003 Denali Earthquake, but experienced severe structural damage from the earthquake and its aftershocks, tsunamis, seiches, and flooding throughout the Resurrection Bay from the 1964 Good Friday Earthquake. Unalaska has experienced over 3,700 earthquake impacts within 100 miles of the community since 1973 with 116 that exceeded M 5.0 intensity.
Erosion	Yes	Unalaska experiences storm surge, coastal ice run-up, and coastal wind erosion along the shoreline and riverine erosion along the area's river, streams, and creek embankments from high water flow, riverine ice flows, wind, surface runoff, and boat traffic wakes.
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 Flows, Rockfalls, Permafrost, Subsidence)	Yes	Ground failure occurs throughout Alaska from avalanches and landslides. However, subsidence and permafrost do not exist on Unalaska Island. Unalaska experiences avalanches, landslides, and rockfalls periodically in known locations.
Tsunami & Seiche	Yes	This hazard has historically threatened infrastructure.
Volcano	Yes	Volcanic eruptions occur within the Aleutian Islands, sending volcanic debris throughout the area and adversely impacting Unalaska.
Severe Weather	Yes	Annual weather patterns, severe cold, heavy rain, freezing rain, snow accumulations, storm surge, and wind are the predominant 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 damage roofs and move houses off their foundations. Complex weather systems are the most severe, bringing extreme cold, wind, freezing rain, storm surge, and flooding.
Wildland/Urban Interface Fire	No	This hazard does not exist for Unalaska.
Technological and Manmade Hazards		
Transportation and Utility Disruptions	Yes	Unalaska is vulnerable to disruptions in utility services, communications, and shipping as a result of natural hazards. While these disruptions are a secondary hazard, the remote location of the community and the dependence on supplies from outside sources makes a disruption in transportation or utility services highly consequential.
Climate Change	Yes	Unalaska experiences impacts from dropping sea levels, ocean acidification, and warmer summers.

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 Unalaska's residents and critical facilities); and
- Probability of future events.

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).

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's chance of occurring (1/1=100%). • History of events is greater than 33% 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 year's chance of occurring (1/3=33%). • History of events is greater than 20% but less than or equal to 33% 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 year's chance of occurring (1/5=20%). • History of events is greater than 10% but less than or equal to 20% likely per year. • Event could "Possibly" occur.
1 - Unlikely	• Event is possible within the next 10 years. • Event has up to 1 in 10 year's chance of occurring (1/10=10%). • History of events is less than or equal to 10% likely per year. • Event is "Unlikely" but is possible to occur.

Probability is determined based on historic events, using the criteria identified above, to provide the likelihood of a future event.

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

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% 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% 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% 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% of property is severely damaged.

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

5.4 NATURAL HAZARDS

5.4.1 Earthquake

5.4.1.1 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), 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 feet, but up to 100 feet), flow failures (massive flows of soil, typically hundreds of feet, 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/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 rock falls, rockslides, and soil slides. Debris flows are created when surface soil on steep slopes becomes 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 from place to place depending 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 5-4, the MMI Scale consists of 12 increasing levels of intensity 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*) (MMI 2006).

Magnitude (M) is the measure of the earthquake's 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 Magnitude/Intensity/Ground-Shaking Comparisons

<table>
<tr><th>Magnitude</th><th>Intensity</th><th>PGA (% g)</th><th>Perceived Shaking</th></tr>
<tr><td rowspan="2">0 – 4.3</td><td>I</td><td><0.17</td><td>Not Felt</td></tr>
<tr><td>II-III</td><td>0.17 – 1.4</td><td>Weak</td></tr>
<tr><td rowspan="2">4.3 – 4.8</td><td>IV</td><td>1.4 – 3.9</td><td>Light</td></tr>
<tr><td>V</td><td>3.9 – 9.2</td><td>Moderate</td></tr>
<tr><td rowspan="2">4.8 – 6.2</td><td>VI</td><td>9.2 – 18</td><td>Strong</td></tr>
<tr><td>VII</td><td>18 – 34</td><td>Very Strong</td></tr>
<tr><td rowspan="3">6.2 – 7.3</td><td>VIII</td><td>34 – 65</td><td>Severe</td></tr>
<tr><td>IX</td><td>65 – 124</td><td>Violent</td></tr>
<tr><td>X</td><td rowspan="3">124 +</td><td rowspan="3">Extreme</td></tr>
<tr><td rowspan="2">7.3 – 8.9</td><td>XI</td></tr>
<tr><td>XII</td></tr>
</table>

(MMI 2006)

5.4.1.2 History

The U.S. Geological Survey (USGS) database lists 3,711 earthquakes that have occurred within 100 miles (161 km) of Unalaska since 1973. Their average M is approximately M 3.3. Unalaska experiences shaking from more distant earthquakes, but this analysis was limited to events within 100 miles of the City.

Table 5-5 lists 116 of these historical earthquakes which exceeded M 5.0 (listed by order of magnitude). Highlighted text within Table 5-5 indicates those that exceeded M 5.9. **Note: 20 exceeded M 6.0 (orange highlight).*

Table 5-5 Historical Earthquakes for Unalaska

Date / Time (UTC)	Latitude	Longitude	Depth (km)	Magnitude
02/27/1987 08:31	53.47	-167.291	10	6.9
03/24/1980 03:59	52.969	-167.67	33	6.9
02/19/2003 03:32	53.645	-164.643	19	6.6
10/13/2009 05:37	52.754	-166.997	24	6.5
11/19/1993 01:43	54.287	-164.164	30.3	6.5
02/06/1974 04:04	53.799	-164.672	2	6.5
10/13/2009 20:21	52.604	-167.118	14	6.4
05/19/1989 02:21	54.305	-165.574	104	6.3
11/30/1975 20:30	52.599	-167.184	24	6.3
08/10/2012 18:37	52.633	-167.421	13	6.2
11/20/2005 12:53	53.843	-164.093	30	6.2
10/31/1985 19:33	53.249	-166.936	30	6.2
05/25/1979 16:45	52.611	-167.019	23	6.2
07/20/1997 00:30	52.562	-167.484	14.4	6.1
01/25/1982 05:29	53.222	-165.719	60	6.1
03/24/1980 04:02	52.6	-167.453	33	6.1
02/13/1992 02:38	53.597	-165.734	44.2	6
07/19/1986 22:32	53.521	-167.301	33	6
07/19/1986 06:53	53.6	-167.171	33	6
04/11/1986 17:22	54.164	-167.883	33	6
09/01/2006 12:04	53.97	-166.392	75.6	5.9
09/23/1984 17:06	53.577	-165.424	33	5.9
09/12/1982 09:22	52.64	-166.941	33	5.9
04/20/1974 08:22	52.974	-167.375	42	5.9
01/03/1998 23:02	54.224	-164.177	10	5.8
09/01/1979 05:27	53.978	-165.204	69	5.8
03/09/1986 13:49	54.256	-167.864	33	5.7
06/12/1984 11:09	53.648	-165.218	43.1	5.7
07/19/1986 04:31	53.352	-165.882	33	5.6
12/27/1983 23:05	54.191	-164.14	52.8	5.6
10/15/2009 00:13	52.853	-166.75	20	5.5
03/01/2002 06:57	52.697	-166.695	33	5.5
05/09/2001 15:47	53.641	-164.319	42	5.5
08/08/1996 17:10	53.061	-167.094	43.7	5.5
09/12/1982 16:50	52.819	-167.053	33	5.5
11/09/1981 16:45	53.221	-165.747	33	5.5
04/20/1976 07:59	53.534	-165.465	46	5.5
07/26/2016 19:46	52.8329	-166.774	17	5.4
05/25/2000 05:10	52.633	-167.066	33	5.4

Table 5-5 Historical Earthquakes for Unalaska

Date / Time (UTC)	Latitude	Longitude	Depth (km)	Magnitude
05/11/1999 04:22	53.591	-165.404	50.8	5.4
11/19/1993 03:58	54.283	-164.154	33	5.4
04/04/1993 17:21	53.443	-164.52	33	5.4
10/20/1991 01:17	53.819	-166.923	33	5.4
10/19/1991 04:59	53.736	-167.234	33	5.4
03/16/1987 17:20	53.355	-167.248	10	5.4
12/03/2009 01:56	53.693	-165.518	63	5.3
10/13/2009 07:41	52.719	-167.166	39.1	5.3
01/10/2007 10:01	53.669	-167.724	27.9	5.3
12/26/1994 03:08	53.65	-164.508	33	5.3
10/09/1991 15:39	53.516	-165.906	33	5.3
12/22/1988 10:42	53.983	-166.244	76.3	5.3
07/01/1988 12:48	52.931	-166.771	33	5.3
06/09/1986 02:17	54.142	-168.132	33	5.3
08/24/1982 04:09	53.645	-165.437	33	5.3
01/16/1973 09:57	54.12	-165.543	81	5.3
12/14/2015 21:12	52.835	-167.924	46.67	5.2
08/20/2010 16:40	54.156	-166.159	108.1	5.2
08/07/2008 07:27	53.486	-167.47	32.1	5.2
12/28/2005 00:03	53.374	-164.459	36.3	5.2
01/19/2002 19:52	54	-167.264	123.7	5.2
10/21/2001 14:40	52.721	-166.723	33	5.2
03/02/1997 17:39	53.543	-166.593	57.2	5.2
11/20/1993 11:54	54.306	-164.19	33	5.2
11/19/1993 03:22	54.29	-164.264	33	5.2
06/10/1992 01:24	53.581	-165.423	33	5.2
07/19/1986 05:04	53.339	-165.859	33	5.2
09/12/1982 11:59	52.642	-166.848	33	5.2
03/28/1976 06:55	52.701	-167.153	36	5.2
01/04/1976 08:44	52.891	-166.758	40	5.2
05/24/2017 06:35	53.3072	-164.454	10	5.1
07/15/2014 22:13	52.8809	-167.601	29.95	5.1
08/29/2013 00:54	54.123	-165.348	108.5	5.1
01/25/2012 00:45	52.654	-167.049	41.4	5.1
10/03/2010 08:10	52.73	-167.004	36.5	5.1
10/03/2003 23:36	52.682	-167.022	33	5.1
10/04/2002 14:16	53.354	-168.794	101.8	5.1
11/14/2001 02:50	53.915	-164.083	40.5	5.1
01/16/1998 13:47	54.14	-165.943	134.2	5.1

Table 5-5 Historical Earthquakes for Unalaska

Date / Time (UTC)	Latitude	Longitude	Depth (km)	Magnitude
10/25/1995 10:19	52.766	-167.087	33	5.1
04/01/1995 07:12	53.613	-164.438	33	5.1
09/01/1994 01:17	52.77	-166.987	33	5.1
04/11/1987 16:22	53.406	-167.213	33	5.1
07/20/1986 01:59	53.53	-167.344	33	5.1
07/26/1985 07:04	52.776	-166.62	33	5.1
05/21/1985 22:20	53.815	-166.89	70.7	5.1
01/06/1985 17:04	54.397	-166.18	130.9	5.1
09/06/1983 04:01	54.086	-164.111	49.3	5.1
09/12/1982 09:28	53.016	-167.104	33	5.1
11/14/1981 00:43	54.067	-164.538	66.4	5.1
07/04/1979 18:57	52.835	-167.123	33	5.1
05/01/1975 18:47	52.709	-167.033	17	5.1
01/06/1975 23:12	54.303	-165.78	102	5.1
09/04/2013 10:04	53.0455	-166.745	10.12	5
08/23/2010 02:53	53.469	-164.523	35.7	5
10/13/2009 07:46	52.663	-167.183	38	5
09/09/2005 05:47	52.554	-167.251	34.6	5
02/20/2003 15:10	53.405	-167.414	75.2	5
04/30/1999 16:35	53.846	-164.125	52.4	5
04/20/1994 16:08	52.906	-166.8	33	5
03/20/1993 11:21	53.545	-166.049	33	5
10/19/1991 04:09	53.695	-167.137	33	5
09/24/1991 20:05	53.996	-164.297	33	5
12/11/1988 05:18	53.324	-166.963	66.9	5
09/01/1987 00:14	53.77	-167.208	33	5
09/26/1986 04:09	54.066	-165.204	33	5
07/28/1986 05:02	52.862	-166.59	33	5
07/19/1986 11:31	53.617	-167.408	33	5
07/30/1984 22:03	53.681	-165.581	33	5
09/16/1982 06:46	52.953	-167.026	33	5
06/07/1981 17:52	53.833	-165.135	33	5
01/12/1981 16:33	52.833	-166.793	15	5
03/24/1980 04:41	52.886	-167.714	33	5
02/19/1976 22:01	53.471	-164.5	33	5
11/20/1974 00:09	53.6	-165.253	57	5
02/28/1974 19:19	53.01	-166.664	33	5
01/19/1974 08:53	52.936	-167.977	59	5

(USGS 2017)

North America's strongest recorded earthquake occurred on March 27, 1964, in Prince William Sound measuring M 9.2 and was felt by many residents throughout Alaska. Unalaska experienced severe ground motion from this historic event.

Figure 5-1 depicts the location of earthquakes greater than M 5.9 within 150 to 180 miles of Unalaska.

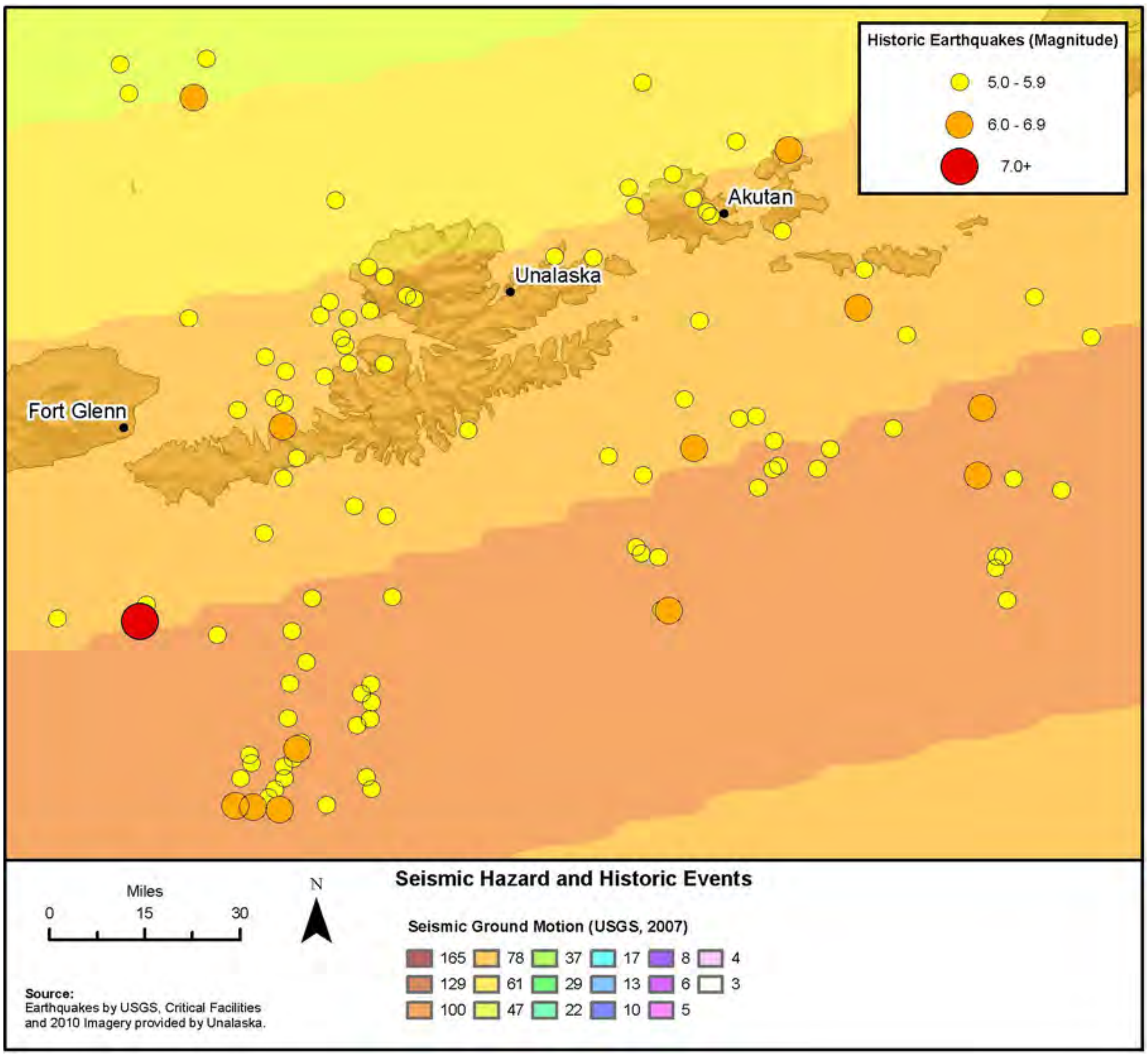


Figure 5-1 Earthquakes Adjacent to Unalaska (USGS 2018)

The largest recorded earthquakes that occurred within 100 miles of the City were measured M 6.9 at 43 miles and 79 miles from the City, occurring in 1987 and 1980, respectively. These earthquakes did not cause any significant damage to critical facilities, residences, non-residential buildings, or infrastructure.

Planning Team members stated that Unalaska experienced no ground shaking from the November 3, 2002 M 7.9 Denali Earthquake.

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

Location

The entire geographic area of Alaska is prone to earthquake effects; Unalaska has experienced 3,711 earthquakes since 1973 with an average of nearly one earthquake per day.

Figure 5-2 shows the locations of active and potentially active faults in Alaska.

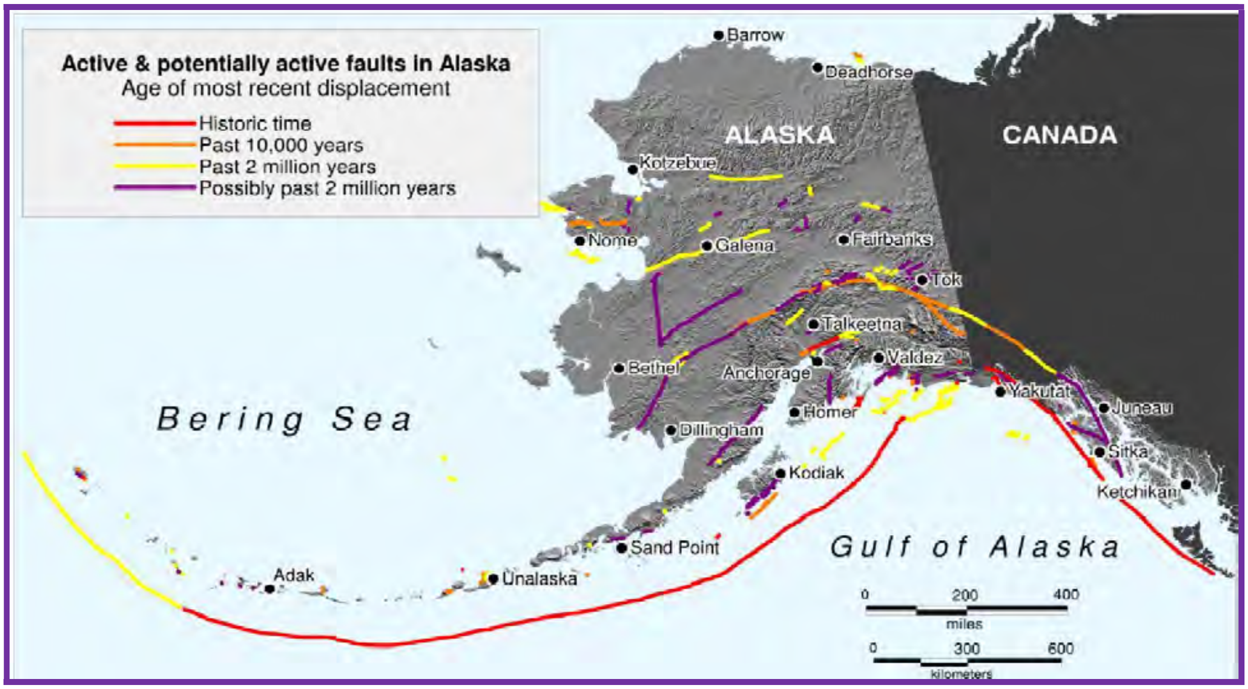


Figure 5-2 Active and Potentially Active Faults in Alaska

The Department of Geological and Geophysical Survey (DGGS) Neotectonic Map of Alaska (Figure 5-3) 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, M 7.9 Denali fault earthquake ruptured three faults, including the Susitna Glacier fault, which was previously undiscovered."* (DGGS 2009).

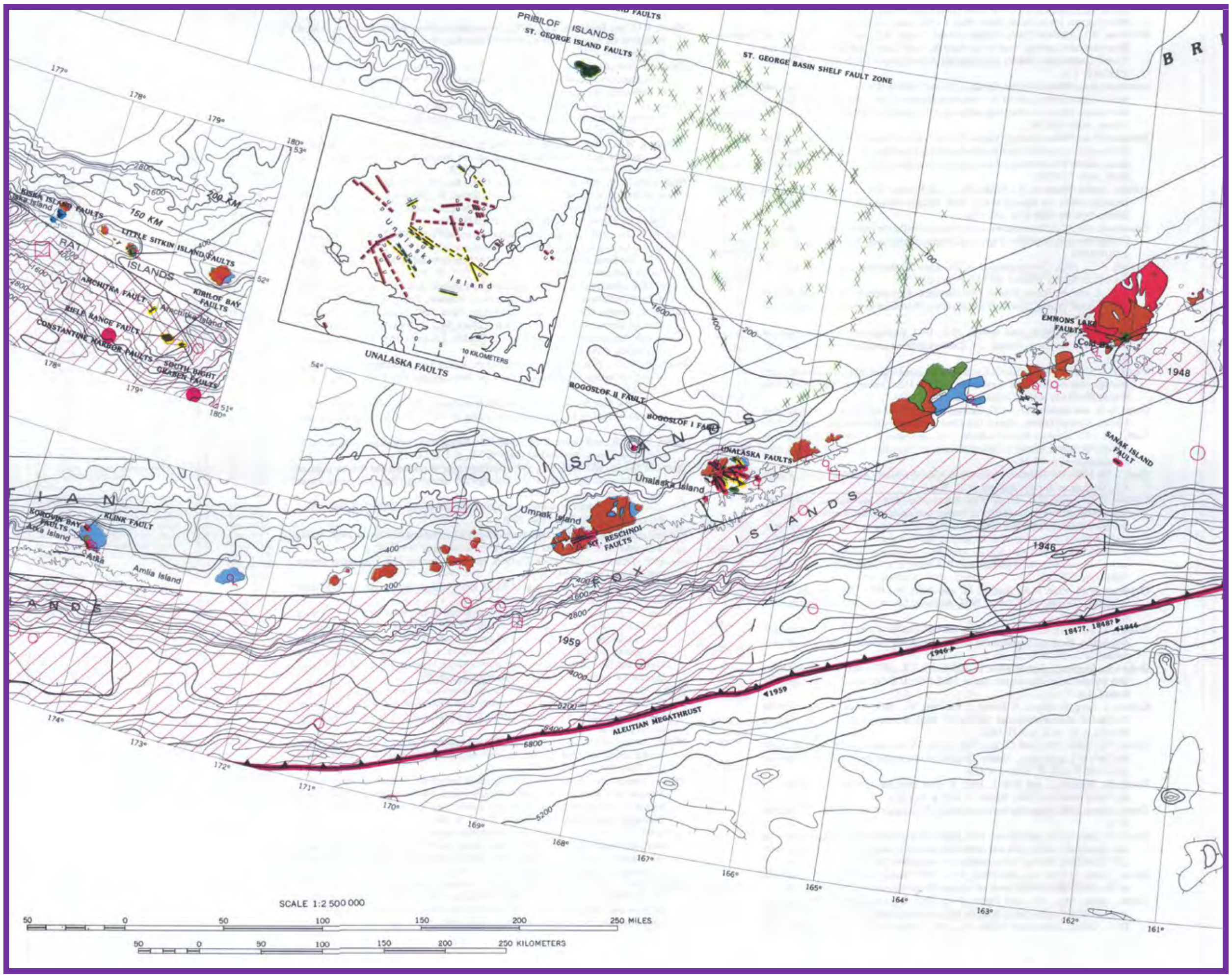


Figure 5-3 Western Aleutian Island Area (from "Neotechtonic Map of Alaska") (DGGS 2009)

Extent

Based on historic earthquake events and the criteria identified in Table 5-3, the magnitude and severity of earthquake impacts in the City are considered "critical." Injuries and/or illnesses may result in permanent disability; critical facilities could expect to be shut-down for at least two weeks; and more than 25% of property is severely damaged with potential long-term damage to transportation, infrastructure, and the economy.

Impact

Unalaska is located in close proximity to the "Ring of Fire" which is more seismically active than the majority of the State. Impacts to the community such as significant ground movement that may result in infrastructure damage can be expected. Minor shaking may be seen or felt based on past events. Impacts to future populations, residences, critical facilities, and infrastructure are anticipated to remain the same.

Probability of Future Events

Unalaska has received 116 earthquakes that exceeded M 5.0 within the last 44 years, of which, 20 exceeded M 6.0. This is a significant threat where aircraft and marine infrastructure damages could result in isolation of the Community from emergency response and critically needed assistance.

While it is not possible to predict when an earthquake will occur, Figure 5-4 was generated using the USGS Earthquake Mapping model and indicates that Unalaska has a 2% probability of experiencing a ground acceleration of 0.80-1.20 *g* within the next 50 years.

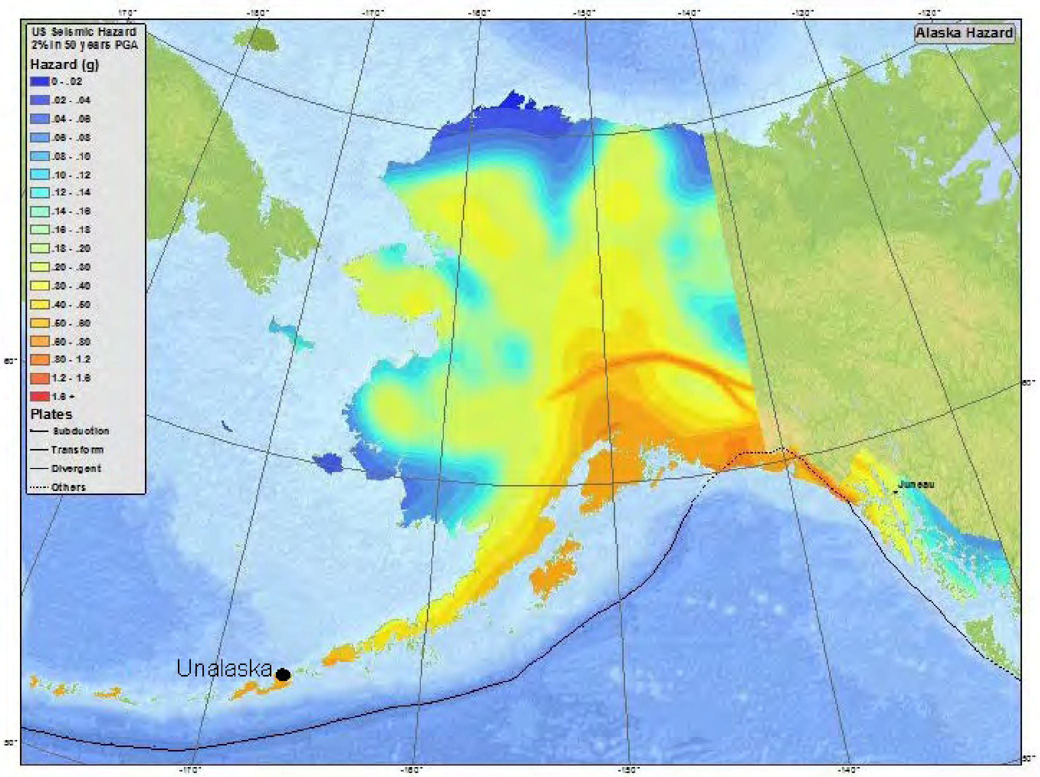


Figure 5-4 Unalaska Earthquake Probability (USGS 2017)

Based on historical earthquake data and the USGS model in Figure 5-4, earthquake recurrence probability is rated "Highly Likely." An event which exceeds M 5.0 is probable within the calendar year with a 1 in 1 year's chance of occurring (1/1=100%) as the history of earthquake events is greater than 33% likely per year.

5.4.2 Erosion

5.4.2.1 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. 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. Coastal erosion is a major erosion threat to Unalaska as it threatens the embankment, structures, and utilities of its residents.

Coastal erosion, sometimes referred to as tidal, bluff, or beach erosion, may other times encompass different categories altogether. For this profile, tidal, bluff and beach erosion are nested within the term erosion.

Coastal erosion is the attrition of land resulting in loss of beach, shoreline, or dune material from natural activity or human influences. Coastal erosion occurs over the area roughly from the top of the bluff out into the near-shore region to about the 30-foot water depth. It is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time. Bluff recession is the most visible aspect of coastal erosion because of the dramatic change it causes to the landscape. As a result, this aspect of coastal erosion usually receives the most attention.

The forces of erosion are embodied in waves, currents, and winds on the coast. Surface and ground water flow, and freeze-thaw cycles may also play a role. Not all of these forces may be present at any particular location. Coastal erosion can occur from rapid, short-term daily, seasonal, or annual natural events such as waves, storm surge, wind, coastal storms, and flooding, or from human activities including boat wakes and dredging. The most dramatic erosion often occurs during storms, particularly because the highest energy waves are generated under storm conditions.

Coastal erosion may also be due to multi-year impacts and long-term climatic change such as sea-level rise, lack of sediment supply, subsidence, or long-term human factors such as aquifer depletion or the construction of shore protection structures and dams.

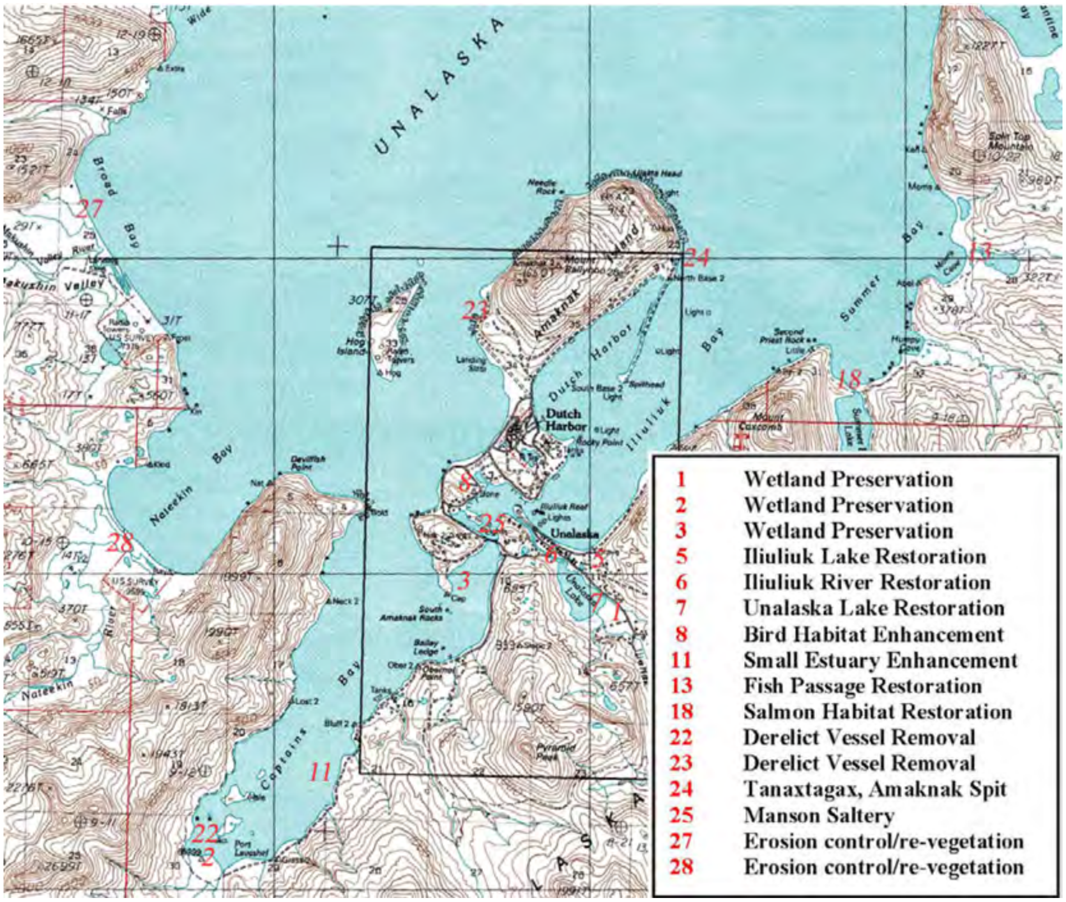
Riverine erosion results from the force of flowing water and ice formations in and adjacent to river channels. This erosion affects the bed and banks of the channel and can alter or preclude any channel navigation or riverbank development. In less-stable braided channel reaches, erosion and material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

Attempts to control erosion using shoreline protective measures such as groins, jetties, seawalls, or revetments can lead to increased erosion; however, the Community feels that "no action leads to increased damages."

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.

5.4.2.2 History

The Aleutians West Coastal Resource Service Area, Volume II, Resource Inventory and Analysis, Appendix C, Coastal Management Plan, Mitigation Opportunities in Unalaska (2008 Coastal Management Plan), State Review Draft, prepared June 2008 by LaRoche and Associates, summarized Unalaska's environmentally-impacted areas and potential mitigation opportunities that could reverse existing hazard impacts. The Coastal Management Plan identified erosion-impacted areas on Map 1, photographs, and through project narratives. The Coastal Management Program was discontinued in 2011, but statuses from the proposed projects are summarized below.



"Map 1. Index to Mitigation Project Locations." (CMP 2008)

"3.1 Coastal Development Mitigation Opportunities

Project 6. Iliuliuk River Restoration

Goal: [R]estore and enhance the riverine and riparian functions (fish spawning habitat, erosion control, flood retention, recreation/subsistence use) that have been lost over time by incremental development activity and heavy use.

Figure 7. Upper Iliuliuk River. May 14, 2008.

<u>Description</u>: This project encompasses the length of the Iliuliuk River from the outlet of Unalaska Lake to its discharge into Illiuliuk Harbor, spanning a linear distance of approximately 3,000 feet. This is an important anadromous fish system in the Unalaska Bay area, and due to its location within the village of Unalaska is of high value for recreational and subsistence users (ADFG Anadromous Stream No. 302-31-10500).

Figure 8. Middle Iliuliuk River - erosion and trampling. May 14, 2008.

Figure 9. Middle Iliuliuk River facing upstream. May 13, 2008.

Storm water run-off controls (paving, storm drain, oil separators) have been installed to help address problems with sedimentation. However, many opportunities still exist. The project would involve restoring and enhancing the wetland and riparian functions of the site by correcting problems with shoreline trampling, erosion, and sedimentation. Public access that is designed to control and manage access points, such as a constructed trail or elevated boardwalk, could be incorporated into the project.

Objectives: [M]aintain and enhance traditional access while reducing impacts to shoreline associated with existing skiff docks; stabilize and revegetate the river banks and adjacent uplands; restore river substrates for pink salmon spawning; increase shallow water emergent vegetation.

Figure 10. Iliuliuk River facing downstream toward mouth. May 13, 2008.

Implementation Issues/Feasibility: Depending on the access route that is selected, implementation of this project could require that access to the land along the riverbanks be obtained through an arrangement with the landowners or one of the formal land acquisition or other preservation mechanisms previously described. If access is provided along the base of Haystack Mountain, acquisition would not be necessary as the City of Unalaska owns the land. The type of acquisition or preservation mechanism will have significant impact on feasibility.

Implementation would require coordination with the Army Corps of Engineers because it involves alteration of shorelines, placement of fill, and modification of drainage.

Many examples of controlled public access with elevated walkways using low-impact development techniques such as pin foundations exist in Alaska. The Kenai River Management Plan provides a good example" (CMP 2008).

The Iliuliuk River Restoration Project (Project 16) was completed in 2016 as part of a larger Lakes and Rivers Restoration Project contracted through the City's Public Works Department. There was not a boardwalk installed due to public pushback. Other projects, including the storm water run-off control described below, have had some progress made toward them as well.

"Project 19. Areawide Stormwater Run-off Control

Goal: [R]estore water quality and aquatic functions that have been impaired over time due to storm water run-off and associated problems with erosion and sedimentation.

Description: The single-most commonly identified issue for the community of Unalaska is the lack of storm water run-off control and associated problems with erosion and sedimentation. In areas of unstable soils or steep slopes, heavy accumulations of snow or intense rainfall contribute to erosion, mudslides, landslides, debris flow, and avalanches. The City of Unalaska encompasses 116 square miles of land with 38 miles of road maintained by the City. There are currently storm drains along Unalaska Lake, Summer Bay Road and Ballyhoo Road. Although progress has been made to pave roads and install catch basins to manage storm water run-off and sedimentation, the majority of the road system remains un-paved and surface water run-off flows directly into the rivers, lakes and nearshore marine waters.

Numerous opportunities exist at varying scales to address this area-wide problem including paving, ditching, installation of catch basins and sediment traps, and retention ponds as well as "Low Impact Development" approaches such as re-vegetation with native plant species.

Objectives: Perform an evaluation of water quality and functions that are impacted by storm water run-off in various locations. Develop a formal project plan, including designs and cost estimates in consultation with resource agencies. Design, construct, and implement appropriate techniques to manage and control storm water run-off.

Implementation Issues/Feasibility: The feasibility of an areawide storm water management system would vary considerably with the techniques employed. A suite of options at different scales of geography and complexity would have a greater chance of being implemented over time.

This project is ongoing as of 2018.

Project 20. Beach Stabilization/Re-vegetation - Areawide

Goal: [R]estore the functional values of the beach areas that were lost by the development of adjacent roadways.

Description: Most of the roads in the Unalaska area (Airport Road, Captains Bay Road, Front Street, Summer Bay Road, etc.) follow the coastline often impinging on the back-beach zone. The compacted roadbed material does not provide a good substrate for natural colonization of vegetation, and therefore remains mostly unvegetated and is an area of active erosion. Also, the absence of vegetation allows the storm water sediment to be transported and discharged into receiving waters.

The project would consist of stabilizing and re-vegetating the beach area. A coastal engineering evaluation of the project would be required to develop an appropriate project design. The project should also include access management plans that provide access to the beaches at specified areas while preventing trampling and damage to developing vegetation. The project locations also present opportunities for an interpretive signage component.

The City conducted a similar project along Front Beach which has been successful although opportunities remain for additional enhancements in this location.

Figure 25. Front Street vegetated back beach berm. May 13, 2008.

Objectives: [C]reate a vegetated sea berm that mimics natural sea berms where practicable; create access point to the beach for recreation and subsistence use; install interpretive signage at access points.

Implementation Issues/Feasibility: A formalized restoration, enhancement and management plan, including engineering designs and cost estimates would be developed in consultation with resource agencies. Implementation would require coordination with the Army Corps of Engineers because it would involve placement of fill and alteration of shorelines" (CMP 2008).

Since 2013, the City has worked to plant Beach Wildrye along many beaches, including Front Street. The City has installed armor stone and revegetated areas along Ballyhoo and Captains Bay Road.

Project 24. Tanaxtagax, Amaknak Spit Site

Goal: [E]xcavate and curate the Amaknak Spit Site (UNL-00055).

Description: The Amaknak Spit Site (UNL-00055) is near the town of Unalaska, on Unalaska Island. The site is situated at the base of Amaknak, or Dutch Harbor Spit, a mile-long spindle of land stretching southward from the site to form a natural breakwater protecting the port of Dutch Harbor from the Bering Sea. The site and most of the surrounding land is owned by the Ounalashka Corporation.

The site has research history dating back to the 1970s, and thus has a number of synonyms in the literature – Uhlaktha Spit, Tanaxtagax, site "A", and Amaknak Spit. The AHRS lists the site as UNL-00055 or Tanaxtagax. This term may be related to the Unangan word tanasxa meaning "field' or "kitchen gardens", probably associated with the use of the rich organic sediments or midden sites around Unalaska Bay as gardens beginning in the Russian era. Tanaxtagax was a prehistoric Unagan village beginning as early as 3,000 BP.

The site has been documented and some restoration has occurred. However, due to erosion and deterioration, the site needs to excavated and artifacts curated. The mitigation project would fund the excavation. The project could be facilitated by the Museum of the Aleutians.

Objectives: [E]xcavate the Amaknak Spit Site (UNL-00055) and curate recovered artifacts.

Implementation Issues/Feasibility: The project is relatively straightforward and well defined as a result of previous studies. The site and most of the surrounding land is owned by the Ounalashka Corporation. The Museum of the Aleutians could coordinate appropriate agencies.

Figure 31. Tanaxtagax Interpretive Sign. May 14, 2008.

This project has not been implemented and is outside the jurisdiction of this MJHMP.

3.2 Utility and Transportation Mitigation Opportunities

Project 27. Erosion Control and Re-vegetation - Broad Bay

Goal: [R]estore the ground cover and the beach profile at Broad Bay.

Description: Broad Bay is located on the west side of Unalaska Bay at the mouth of the Makushin River. The area is zoned "subsistence tidelands" with adjacent "marine dependent industrial." Furthermore, the AWCRSA Coastal Management Plan has designated a portion of this area for recreational and subsistence use as follows: Broad Bay - The area within 1000 feet of either side of the ordinary high-water mark of the Makushin River. The designated area extends 300 feet offshore and 250 feet inland as measured from mean high water.

Figure 33. Broad Bay. May 13, 2008.

This project would involve contouring and reseeding with native plant materials, if practicable, to restore the ground cover and the beach profile.

Objectives: [S]tabilize and revegetate the river banks, riparian areas and adjacent uplands; develop a motorized vehicle management plan which may include an educational signage component.

Implementation Issues/Feasibility: The project is relatively straightforward. The challenge will be to maintain the restored areas and implement a motorized vehicle management plan in a remote area.

Project 28. Erosion Control and Re-vegetation - Nateekin Bay

Goal: [R]estore the ground cover and the beach profile at Nateekin Bay.

Description: Nateekin Bay is located on the west side of Unalaska Bay at the mouth of the Nateekin River. The area is zoned "developable tidelands" with adjacent "marine dependent industrial". Furthermore, the AWCRSA Coastal Management Plan has designated a portion of this area for recreational subsistence use as follows: Nateekin Bay - The area within 1000 feet of either side of the ordinary high-water mark of the Nateekin River. The designated area extends 300 feet offshore and 250 feet inland as measured from mean high water.

Figure 34. Nateekin Bay. May 13, 2008

This project would involve contouring and reseeding with native plant materials, if practicable, to restore the ground cover and the beach profile.

Objectives: [S]tabilize and revegetate the river banks, riparian areas and adjacent uplands; develop a motorized vehicle management plan which may include an educational signage component.

Implementation Issues/Feasibility: The project is relatively straightforward. The challenge will be to maintain the restored areas and implement a motorized vehicle management plan in a remote area"

(CMP 2008).

Unalaska experiences periodic flooding from rain and snow melt runoff as depicted in a community located media release.

> *"Rain and snowmelt eroded the banks of a creek flowing out of the Pyramid Valley and flooded the crab pot yard maintained by Offshore Systems, Inc. at the end of Captains Bay Road this morning. OSI's operating facilities manager, Craig Rice, said the moved earth divided the stream into three channels, which quickly swelled and flooded the pot yard and part of the road" (KIAL 2007).*

The original Russian inhabitants attempted to develop a plantation to grow Sitka Spruce in Unalaska. These trees are now located in a local park placed in the National Historic Landmarks Program under National Register Number 78000513. These trees are now threatened by flood and contamination:

"Statement of Significance (as of designation - June 2, 1978):

This is the site of the oldest recorded afforestation project (1805) on the North American continent, representing a Russian attempt to make the colony at Unalaska self-sufficient in timber. The number of trees originally planted is not known; however, in 1834, 24 trees stood. As of 1975, six original trees remained, and there are hundreds of new seedlings.

Condition:

Adjacent construction has altered the topography of the surrounding land; drainage provisions are inadequate, and the site is frequently flooded. Seepage from underground fuel tanks and a diesel fuel spill have tainted runoff and surrounding soils. The three remaining Sitka Spruce trees, which would normally live 400-500 years, are endangered by the flooding and contamination.

Recommendation/Change since 1978:

The City is attempting to arrange with the private land owner for cleanup of the pollution. The City and owner should also install a new drainage system and consult with the USFS to restore the habitat. The City historical commission and parks department should educate the public on the ecological repercussions of construction and contaminants in the area.

(NHLP 1978)

As of 2018, the City has not implemented this project as this area is outside City limits and is low on their priority list.

Research shows that the Army Corp of Engineers (USACE) did not contact the City of Unalaska; however, they did send research correspondence to the President of the Qawalangin Tribe of Unalaska during their USACE's 2009 Baseline Erosion Assessment.

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

Location

The 1977 Unalaska Recommended Community Development Plan states,

"I. Background for Planning

A. Physical Setting

2. Geology and Natural Features.

b. Erosion and Landslides. Creeping and sliding of the soil mantle is characteristic of the Unalaska soil types and is found extensively throughout the area. It results from a combination of the steep slopes and the high moisture content of the soil. Flows and landslide scars are particularly present on glacially-steepen[e]d valley walls. Landslides are recorded throughout the area and most often occur as small, isolated portions of steep slopes tumbling or sliding downward as a result of excessive water saturation, snow loading, avalanche or man's alteration of natural conditions. Areas which may be subject to slides are easily identified by their steep, smooth faces and slopes, and should be avoided when selecting potential development sites. Several such slide areas are *present along Captains Bay Road, at points along the Pyramid Creek Road, and at several locations on Amaknak Island. Many of the early military access roads, not having been maintained over the years, show evidence of small scale landslide activity.*

Marine erosion and deposition are evident throughout the area. Steep hillsides and occasional cliffs indicate earlier and present-day wave erosion in less-protected areas of the coastline. Exposed utility pipes and the eroded north end of the airport runway indicate heavy wave erosion on the north and westerly sides of Amaknak Island. Wave-cut rock benches, visible at low tide, are found along the moderately protected shores, but are not found on the protected shores. Beach deposits of boulders, gravel, and sand are found at the heads of all but the most protected bays. Beach berms often exist along stretches of open coastline as is the case adjacent to the present landfill site on Iliuliuk Bay. Storm waves wash material up onto the beach, building the higher flat areas which normally are not inundated by tidal action.

Wave action also constructs spits and bars. The two major spits in the community are the spit at Dutch Harbor extending nearly to the center of Iliuliuk Bay, and the spit upon which most of the mainland Unalaska community is built, between Iliuliuk River and Iliuliuk Bay. These formations exist in a state of natural balance and any interference with either of the forces which created and maintain them or with their existing condition will tend to disrupt the balance and could lead to their possible destruction or substantial change in the existing balanced condition" (URCDP 1977).

Shannon and Wilson, Inc's. Unalaska Road Improvement Master Plan, February 2010 explains that the City has approximately 26 miles of roads with nearly 6.6 that are paved. The entire road system experiences severe pot-holing and rutting. However, the short-paved section has damages unique to asphalt surfaces. Asphalt surfaces also experience joint failure, raveling, and fatigue (alligator) cracking.

- *On most of Airport Beach Road and all of East Broadway Avenue, the asphalt pavement was constructed by placing two panels of asphalt pavement. The longitudinal joints constructed in the 2004 project have raveled despite the fact that the contractor cut the joints and all of the joint densities.*
- *The South Channel Bridge has raveled due to rapid cooling and inadequate compaction.*
- *Fatigue cracking, also known as alligator cracking, is a series of interconnecting cracks caused by the fatigue of the asphalt pavement under repeated traffic loading. The cracks gradually propagate over time and chunks of asphalt can become dislodged from the paved surface. The divots gradually grow from frost and water erosion and can lead to potholes.*

(Unalaska 2010)

Since the Road Improvement Master Plan was last updated, the City has repaved and improved many road surfaces.

Extent

A variety of natural and human-induced factors influence the erosion process within the community. Coastal orientation and proximity to ocean waves, currents, and storm surges 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 coastal erosion include:

- Shoreline type;
- Geomorphology;
- Structure types along the shoreline;
- Amount of encroachment in the high hazard zone;
- Proximity to erosion inducing coastal structures;
- Nature of the coastal topography;
- Density of development;
- Elevation of coastal dunes and bluffs; and
- Shoreline exposure to wind and waves.

Climate change may also play a part in increasing coastal erosion. Altered weather patterns may increase wave action during normal and winter storm conditions.

The City's 1977 Community Development Plan indicated,

> ***f. Special Soil Conditions.***
>
> *Special attention needs to be given to such activities as stripping of vegetation, road construction, and other potential erosion-causing activities. The generally steep gradients prevalent in the Unalaska community, coupled with soil characteristics conducive to sliding, sloughing and soil fluctuation and high moisture content of the soils makes the soils prone to quick erosion and sliding. Evidence exists throughout the area of past road building efforts, mostly by the military, where slides have occurred. Old military maps of the area are covered with notations alerting to the presence of mud, rock, and snow slides. The City should be especially aware of this problem and develop road building standards which, through minimizing slope and angle of roadway cuts, reduces the slide hazard. While this may add to the initial cost in construction and may even preclude some areas from being developed or delay their development for some years, the long-term benefits will be realized in lower maintenance costs and possible preservation of properties" (URCDP 1977).*

Based on the 2008 Coastal Management Plan, past erosion events, and the criteria identified in Table 5-3, the magnitude and severity of erosion impacts in Unalaska are considered "limited" with potential for critical facilities to be shut down for more than a week, and more than 10% 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 sedimentation of river deltas and hinder channel navigation—affecting marine transport. Other impacts include reduction in water quality due to high sediment loads, loss of native aquatic habitats, damage to public utilities (fuel headers and electric and water/wastewater utilities), and economic impacts associated with the costs of trying to prevent or control erosion sites.

The Alaska Department of Natural Resources, Coastal Processes and Erosion Responses, October 6-7, 2009, University of Alaska-sponsored Seminar Presentation Figure 5-5 depicts Alaska Department of Transportation and Public Facilities' Harvey Smith's photo in Unalaska of a revetment slope armored by precast concrete dolosse is topped by a rock splash apron at the airport in Unalaska.

Figure 5-5 Precast Concrete Dolosse (DNR 2009)

Probability of Future Events

Based on historical impacts 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 year's chance of occurring) as the history of events is greater than 20% but less than or equal to 33% likely per year.

5.4.3 Flood

5.4.3.1 Nature

Flooding is the accumulation of water where usually none occurs or the overflow of excess water from a stream, river, lake, reservoir, glacier, or coastal body of water 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.

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

Four primary types of flooding occur in the City: rainfall-runoff, snowmelt, storm surge, and ice override 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-runoff 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 magnitude of flooding.

Storm Surges, or coastal floods, occur 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 communities and villages along the Bristol Bay coast, the Bering Sea coast, the Arctic coast, and the Beaufort Sea coast 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. As shorefast ice forms along the coast before winter, the risk of coastal flooding abates, but, later freeze-ups greatly increase the risk of erosion, storm surge flooding, and ice override events.

Ice Override is a phenomenon that occurs when motion of the sheet ice is initiated by wind stress acting on the surface of ice that is not confined. Onshore wind, coupled with conditions such as a smooth gradual sloping beach and high tides can cause ice sheets to slide up or "override" the beach and move inland as much as several hundreds of feet. Ice override typically occurs in fall and early winter (though events have been reported at other times) and is usually associated with coastal storms and storm surge but may also happen in calm weather.

Override advances are slow enough to allow people to move out of its path, and therefore, poses little immediate safety hazard. Intact sheets of ice up to several feet thick moving into buildings or across roads and airports can however cause structural damage and impede travel. Shoreline protection in the form of bulkheads or other structures to break-up the ice can limit the movement of ice. In at least one occasion, a bulldozer was able to break-up the ice and prevent damage.

Timing of events

Many floods are predictable based on rainfall patterns. Most of the annual precipitation is received from April through October with August 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 ice-jam floods.

5.4.3.2 History

The 2008 Coastal Management Plan summarized Unalaska's environmentally-impacted areas and identified potential mitigation opportunities that could reverse existing hazard impacts. As with erosion, the Coastal Management Plan identified the City's flood-impacted areas within their project narratives as well as a few photos to highlight extent:

Project 5. Iliuliuk Lake Restoration

> *Goal: restore and enhance lacustrine wetland functions that were lost by isolation from Unalaska Lake.*

<u>Description</u>: Two sections of Unalaska Lake that were isolated by the development of Broadway Road are potential sites for mitigation. The larger section is known as Iliuliuk Lake. New culverts were installed, improving both circulation and fish passage. However, flooding was a significant problem during a 2007 storm event. This project would involve restoring and enhancing the wetland functions and values by correcting problems with water circulation, drainage, and adding riparian cover.

Figure 5. Iliuliuk Lake facing west from Dutton Road. November 29, 2007.

Figure 6. Iliuliuk Lake facing west from Dutton Road. May 12, 2008.

<u>Objectives</u>: increase water circulation, shoreline area and riparian cover; restrict access to portions of lake; remove trash and debris; preserve the site.

<u>Implementation Issues/Feasibility</u>: Implementation of this project would require that access to the land surrounding the lake be obtained through an arrangement with the landowners or one of the formal land acquisition or other preservation mechanisms previously described. The type of acquisition or preservation mechanism will have significant impact on feasibility.

Implementation would require coordination with the Army Corps of Engineers because it involves alteration of shorelines, placement of fill, and modification of drainage.

Construction of this project would not require any special equipment, skills or expertise that is not locally available" (CMP 2008).

As of 2018, this project was not implemented and is no longer a priority.

Additionally, various other projects had additional flood mitigation concerns or identified initiatives:

- Project 6, Iliuliuk River Restoration;
- Project 8, Bird Habitat Enhancement/Lake Ilulaq;
- Project 18, Summers Bay Salmon Habitat Restoration;
- Project 27, Erosion Control/Re-vegetation - Broad Bay;
- Project 28, Erosion Control/Re-vegetation - Nateekin Bay; and
- Project 29, Area Wide Invasive Species Control – Vegetation.

The US Army Corp of Engineers reported "There is no river gauge in the community. Insignificant floods were reported for 1985 and 1991. Most floods are rainfall-related flood events. (USACE 2011).

The USACE provided limited flood impact data for Table 5-6.

Table 5-6 Historic Flood Events (NWS)

Location	Date	Event Type	Magnitude
Unalaska	1985	Flood	11 inches of rain in 24 hours
Unalaska	1991	Heavy Rainfall Flood	Iliuliuk River flooded public works area
Unalaska	2007	Winter Storm/Flood	Impacted neighborhoods.

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

No additional flooding events since the 2013 plan update.

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

Location

The Planning Team indicated that Unalaska has minor flooding impacts; most of which occur from rainfall and snowmelt run-off. Water collects in low terrain depressions and may rise to just below a structures first step with no water intrusion on the first floor. The City's typical minor flood locations are:

- Iliuliuk River;
- Iliuliuk Lake;
- Lake Ilulaq;
- Summers Bay;
- Captain's Bay;

- Broad Bay; and
- Nateekin Bay.

(Unalaska 2017)

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 features existing in the watershed includ 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; and
- Location related to the base flood elevation as indicated with Unalaska's certified high-water mark.

Impact

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

- 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 released 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.

Impacts and problems also related to flooding are deposition and stream bank erosion (erosion is discussed in detail in Section 5.4.2). 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 a challenge for navigational purposes, and prevents access to historical boat and barge landing areas. Deposition also reduces channel capacity, resulting in increased flooding or bank erosion. Stream bank erosion involves the removal of material from the stream bank. When bank erosion is excessive, it becomes a concern because it results in loss of streamside vegetation, loss of fish habitat, and loss of land and property (BKP 1988).

Probability of Future Events

Based on previous occurrences, and criteria in Table 5-2, there is a 1 in 1 year's chance of occurring (1/1=100%) in the valley. History of events is greater than 33%. There is no data identifying a 500-year (0.2% chance of occurring in a given year) flood threat in Unalaska.

5.4.4 Ground Failure

5.4.4.1 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.

Landslides are a 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, landslides often occur with other natural hazards, thereby exacerbating conditions, such as:

- 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; and
- 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 six landslide types, distinguished by material type and movement mechanism including:

- **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.
- **Debris Flows** arise from saturated material that generally moves rapidly down a slope. A debris flow usually mobilizes from other types of landslides 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.
- **Lateral Spreads** are a type of landslide that generally occurs on a 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.
- **Falls** are the free-fall movement of rocks and boulders detached from steep slopes or cliffs.
- **Topples** are rocks and boulders that rotate forward and may become falls.
- **Complex** is any combination of landslide types.

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. (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 2013 State Hazard Mitigation Plan provides additional ground failure information defining mass movement types as well as topographic and geologic factors which influence ground failure and may pertain to Unalaska.

5.4.4.2 History

There are few written records defining ground failure impacts. However, the 2016 DHS&EM Disaster Cost Index lists one historical ground failure event affecting Unalaska:

> ***"49. Unalaska, December 13, 1985*** *A severe windstorm caused mudslides, road and port damage, and damage to public buildings. Public disaster assistance supplemented insurance settlements to assist in recovery." (DHS&EM 2016)*

The NWS also records one ground failure event that caused property damage for the Dutch Harbor area (Alaska Zone 185):

> **Debris Flow**, February 13, 2006. *An intense storm rapidly moved from the north Pacific into the Bering Sea on February 13th. This storm had an intense pressure gradient in advance of its associated front that produced extreme wind across the central Aleutians to the Alaska Peninsula and the Bristol Bay coast to the Pribilof Islands. Reports received from the vessel Stimson in Akutan were of wind peaking at 123 knots that resulted in the vessel "tipping over" in the harbor. The vessel Redeemer reported winds peaking at 120 knots where they were moored in Dutch Harbor. Along with the high wind, heavy rain occurred. This followed a prolonged period of extremely cold conditions with above average snow. Several landslides occurred. One landslide completely destroyed a building and its contents and another pushed a building off its foundation.* (NWS 2017)

The Planning Team also stated that many rockfall events occur on a nearly annual basis. Within the last five years, many rockfalls have occurred along Captains Bay Road, Ballyhoo Road, and Summer Bay Road. One of these events included a pick-up truck sized bolder falling onto Captains Bay Road.

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

Location

There are various ground failure locations on Unalaska Island. Sources include Makushin Volcano, glacial impacts, and island development. Steep, nearly vertical terrain is the most common landslide or snow avalanche location type. These locations are generally located adjacent to the road system which surrounds Unalaska's bays and coves.

The City's 1977 Community Development Plan describes ground failure events such as creeping and sliding soil, flows, landslides, avalanches, and development:

> *"Creeping and sliding of the soil mantle is characteristic of the Unalaska soil types and is found extensively throughout the area. It results from a combination of the steep slopes and the high moisture content of the soil. Flows and landslide scars are particularly present on glacially-steepen[e]d valley walls. Landslides are recorded throughout the area and most often occur as small, isolated portions of steep slopes tumbling or sliding downward as a result of excessive water saturation, snow loading, avalanche or man's*

alteration of natural conditions. Areas which may be subject to slides are easily identified by their steep, smooth faces and slopes, and should be avoided when selecting potential development sites. Several such slide areas are present along Captains Bay Road, at points along the Pryamid Creek Road and at several locations on Amaknak Island. Many of the early military access reads, not having been maintained over the years, show evidence of small scale landslide activity." (URCDP 1977).

(See MJHMP Figure 5-6).

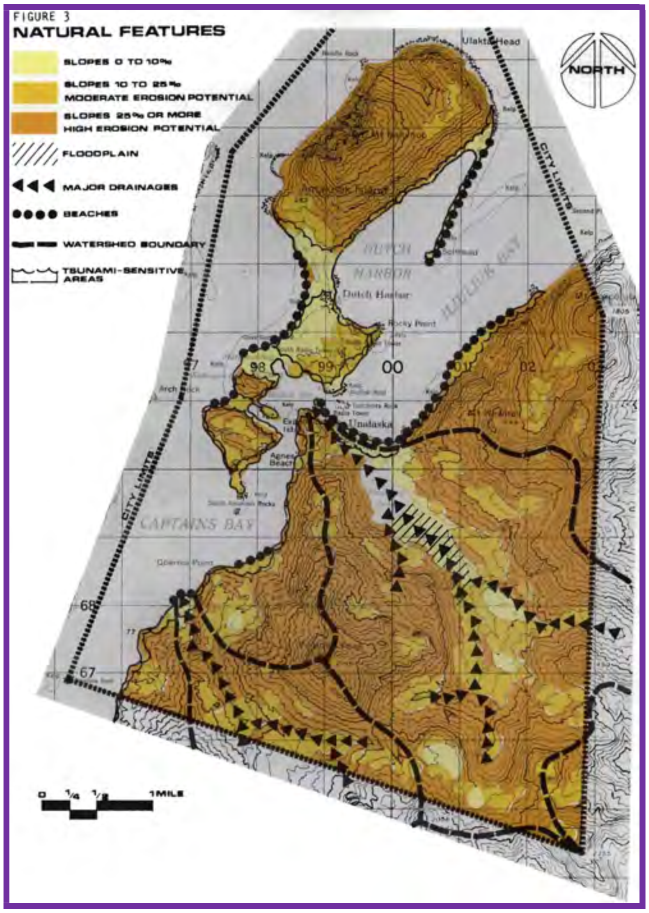


Figure 5-6 Natural Features Map *(URCDP 1977)*

According to permafrost and ice conditions map (Figure 5-7) developed for the National Snow and Ice Data Center/World Data Center for Glaciology located in the State Hazard Mitigation Plan (DHS&EM 2013), permafrost is not present on Unalaska Island.

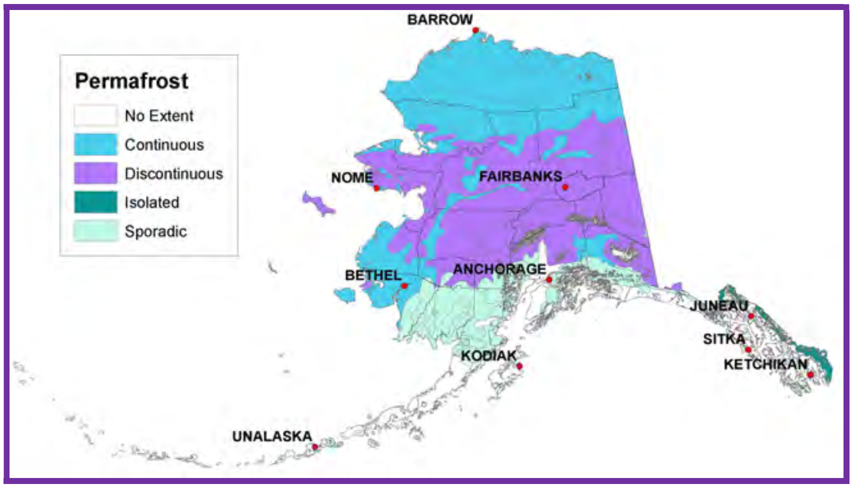


Figure 5-7 Permafrost and Ground Ice Map of Alaska (Brown et al 2001)

Extent

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

Based on research and the Planning Team's knowledge of past ground failure events and the criteria identified in Table 5-3, the extent of ground failure impacts in Unalaska are considered limited. Impacts would not occur quickly but over time with warning signs. Therefore, this hazard would not likely cause injuries or death, neither would it shut-down critical facilities and services. However, 10% of property could be severely damaged.

Impact

Impacts associated with ground failure include surface subsidence, infrastructure, building, and/or road damage. Ground failure does not typically pose a sudden and catastrophic hazard; however, landslides and avalanches may. Ground failure damage may occur from improperly-designed and constructed buildings that settle as the ground subsides, resulting in structure loss or expensive repairs. It may also impact buildings, communities, pipelines, airfields, as well as road and bridge design costs and location. To avoid costly damage to these facilities, careful planning and location and facility construction design is warranted.

The 2008 Coastal Management Plan describes potential impacts as:

> *"The single-most commonly identified issue for the community of Unalaska is the lack of storm water run-off control and associated problems with erosion and sedimentation. In areas of unstable soils or steep slopes, heavy accumulations of snow or intense rainfall contribute to erosion, mudslides, landslides, debris flow, and avalanches. The City of Unalaska encompasses 116 square miles of land with 38 miles of road maintained by the City. There are currently storm drains along Unalaska Lake, Summer Bay Road, and Ballyhoo Road. Although progress has been made to pave roads and install catch basins to manage storm water run-off and sedimentation, the majority of the road system remains un-paved and surface water run-off is directly into the rivers, lakes and nearshore marine waters.*

Numerous opportunities exist at varying scales to address this area-wide problem including paving, ditching, installation of catch basins and sediment traps, and retention ponds as well as "Low Impact Development" approaches such as re-vegetation with native plant species" (CMP 2008).

Probability of Future Events

Even though there are few written records defining ground failure impacts for Unalaska, the Planning Team has anecdotal evidence of their recurring landslide, rockfall, avalanche, and ground failure damages throughout the community – to structures, roads, harbor areas, and the airport. The Planning Team stated the probability for ground failure follows the criteria in Table 5-2; the future damage probability resulting from ground failure is likely in the next three years (event has up to 1 in 3 year's chance of occurring) as the history of events is greater than 20% but less than 33% likely per year.

5.4.5 Tsunami and Seiche

5.4.5.1 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 one to three 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 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 local events generated by 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.

5.4.5.2 History

Unalaska is in close proximity to historic tsunamigenic events that have occurred along the Aleutian Trench. The West Coast/Alaska Tsunami Warning Center (WC/ATWC) lists the following earthquake-generated tsunamis with observed or measured tsunami waves in Dutch Harbor (Table 5-7).

Table 5-7 Historic Aleutian Tsunamis –Waves at Dutch Harbor

Date	Location	Earthquake Moment Magnitude (MW)	Wave Height (meters)	Source	
				Latitude	Longitude
November 10, 1938	Alaska Peninsula	8.2	0.1	54.48	-158.37
April 1, 1946	Near Unimak Island, Eastern Aleutian Islands, AK	8.6	Unknown	25.8	-163.5
March 9, 1957	South of Andreanof Islands, Central Aleutian Islands, AK	8.3	Unknown	51.5	-175.7
March 27, 1964	Prince William Sound	9.2	0.35	61.05	-147.48
February 4, 1965	Rat Islands, Western Aleutian Islands, AK	8.7	<0.1	51.29	-178.49
May 7, 1986	Central Aleutian Islands, AK	8.0	0.15	51.52	-166.54
February 21, 1991	Bering Sea	6.7	0.15	58.43	-175.45
June 10, 1996	Central Aleutian Islands, AK	7.9	0.6	51.56	-177.63

On January 23, 2018, a 7.9 magnitude earthquake occurred near Kodiak, and a tsunami warning was issued. A buoy in Unalaska predicted a 30-foot tsunami wave, but the wave was a few inches in reality.

The 1964 tsunami tide gauge recorded the following tsunami wave heights (Figure 5-8):

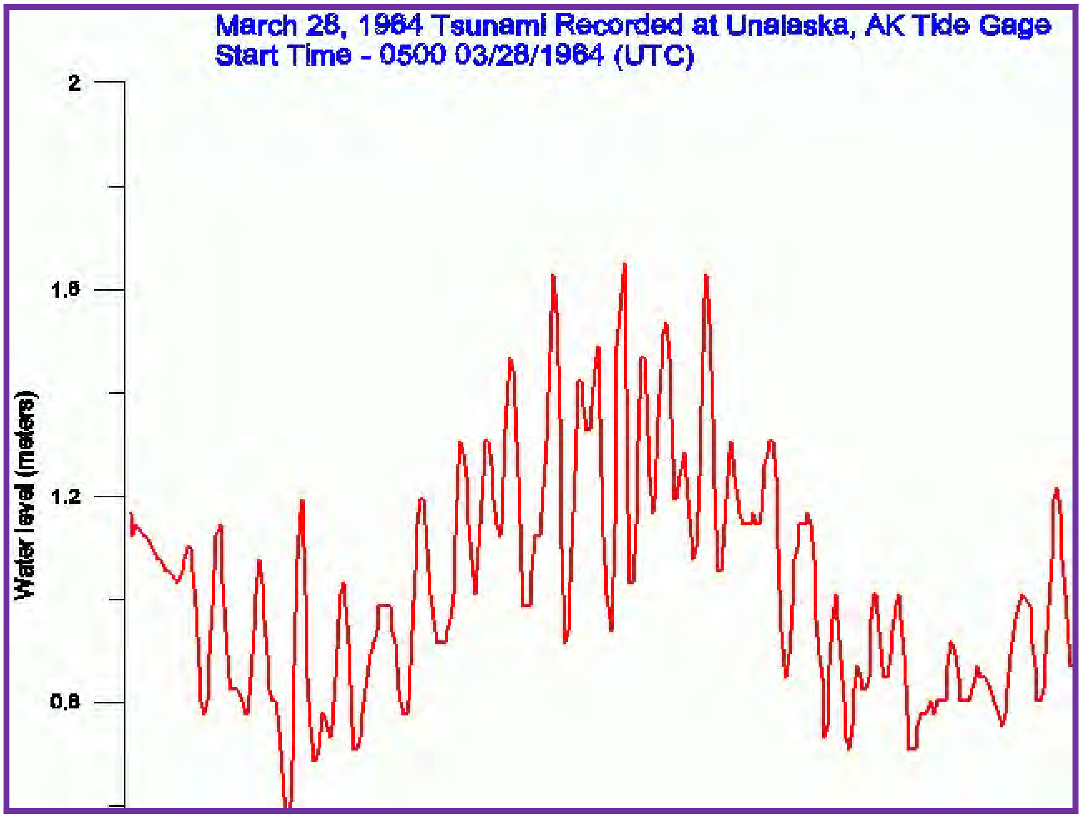


Figure 5-8 Unalaska Tide Gauge – 1964 Great Alaska Earthquake

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

Location

The State of Alaska, the University of Alaska Fairbanks, Geophysical Institute (UAF/GI), and the National Oceanic and Atmospheric Administration's (NOAA) Pacific Marine Environmental Laboratory indicate that Unalaska has a minor tsunami impact threat. Many believe their relatively-protected location on the northern side of the island – away from Aleutian Trench-created tsunami sources would protect them from severe impacts. However, the UAF/GI conducted tsunami models that demonstrates the harbor and airport areas may receive significant water current impacts with whirlpools as depicted in Figure 5-9, the UAF/GI's "specific scenario" model sequence - 65 minutes to 105 minutes series.

The photos provide a relative scale for this particular model where blue indicates a water level at -2 meters, and red depicts a +2-meter water level. These photos do not depict a worst-case scenario for Unalaska. However, they depict potential whirlpools developing adjacent to the narrow passages between Amaknak and Unalaska Islands.

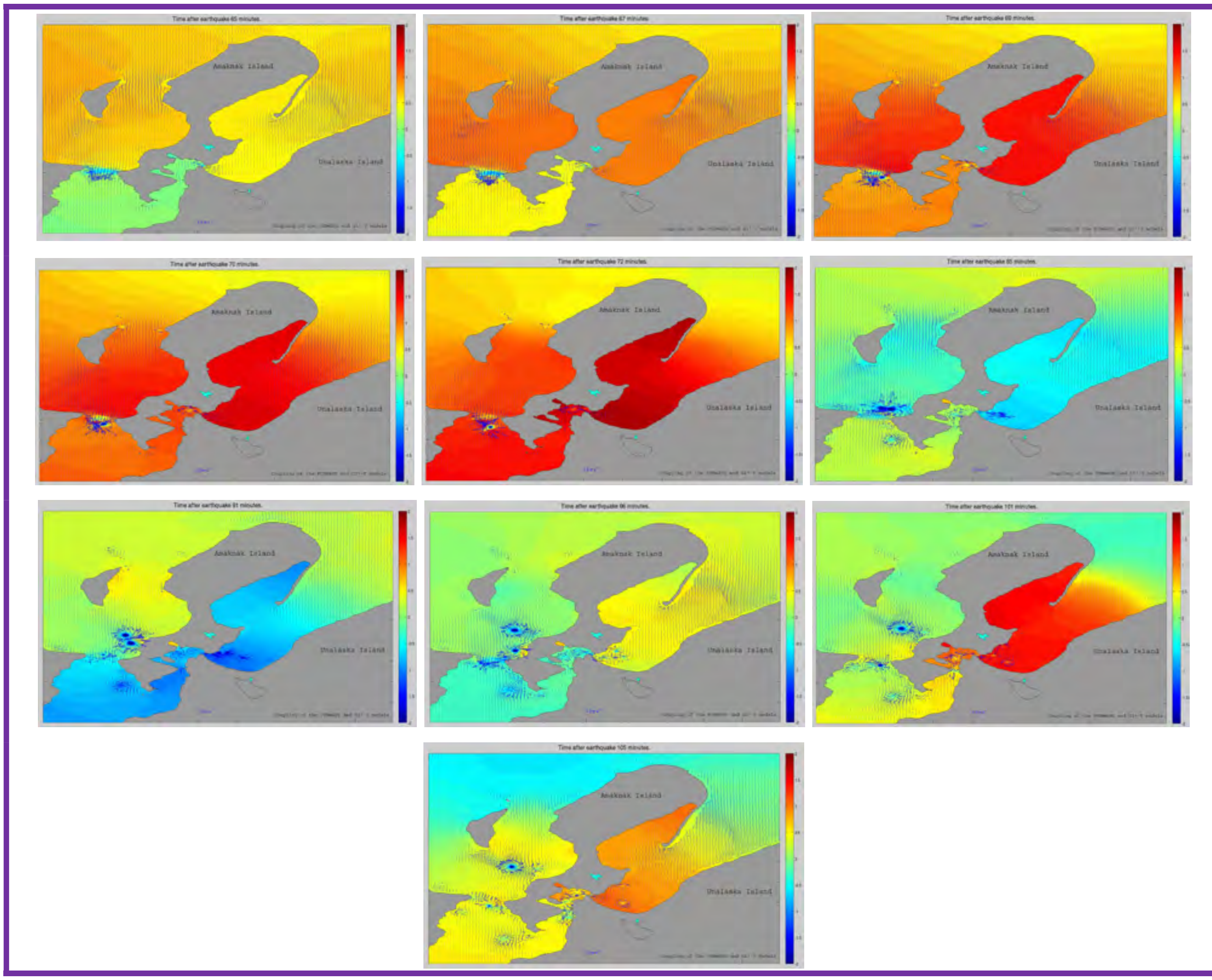


Figure 5-9 UAF/GI Impact Model Sequence Photos (UAF/GI 2012)

Extent

Based on historic earthquake events, UAF/GI, the University of Washington, and the Pacific Marine Environmental Laboratory information, and the criteria identified in Table 5-3, the magnitude and severity of earthquake impacts to Unalaska are considered "Limited" with injuries and/or illnesses that do not result in permanent disability; complete critical facility shut-down for more than one week, and more than 10% of property could be severely damaged.

Impact

UAF GI's Dr. Elena Sulemani and Dmitry Nicolski indicate there is a high potential of Unalaska receiving future tsunami impacts.

Dr. Elena Sulemani stated:

> *"I think that the NOAA's Short-Term Inundation Forecast for Tsunami (SIFT) modeling summary gives a [sound] estimate of the tsunami threat to Unalaska. Based on our recent modeling results, there could be a wave of about 2-meter-high coming into the Unalaska [B]ay from a tsunami source located along the Aleutian Trench" (UAF/GI 2012).*

Dmitry Nicolski further postulated:

> *"Some local landslide-generated tsunamis might produce higher runup values, but there is little known about them in this region. The tsunami currents could be extremely dangerous especially in passages between Amaknak and Unalaska Islands" (UAF/GI 2012).*

Yong Wei postulated that Unalaska could have a substantial tsunami impact in his Joint Institute for the Study of Atmosphere and Ocean (JISAO), University of Washington and NOAA Center for Tsunami Research (NCTR), NOAA/PMEL presentation at the American Society of Civil Engineers "Solutions to Coastal Disasters 2008: Tsunamis" conference.

> *"Being the most populous area in the Aleutians, Unalaska is considered as one of the Alaskan coastal communities with high potential for tsunamis. As part of NOAA's SIFT, a Stand-by Inundation Model based on the MOST model is applied in this study to assess the tsunami impact for Unalaska. The model validation using historical tsunami events show excellent agreement between the model computation and observations, which gives rise to the accuracy of the inundation model. This study provides inclusive tsunami impact assessment for Unalaska subject to a total of 2,681 distant and local tsunamis scenarios in the Pacific at different level of earthquake magnitude M of 7.5, 7.8, 8.2, 8.7, and 9.3. This study also investigates the impact caused by the hypothetical scenarios initiated in Unalaska gap and Shumagin gap at different level of earthquake magnitude M of 7.5, 8.0, 8.5, and 9.0. The computational maximum tsunami runup suggests the current definition of a Tsunami Safe Zone in Unalaska, areas above 50 feet, is conservative" (UW 2011).*

Probability of Future Events

The City's 1977 Community Development Plan stated:

> *"Tsunamis, seismic sea waves, are sometimes generated by earthquake activity and crustal movements. These are often generated along the Aleutian Chain and can have disastrous effects throughout the Pacific Basin. Earthquakes occurring elsewhere in the Pacific [R]im can cause tsunami waves to reach Unalaska Island also. However, since the community is located on the north, or Bering Sea, side of the chain, there is very little, if any, probability that a substantial tsunami wave of rapid and destructive force could affect Unalaska. The major consideration in Unalaska with respect to the tsunami problem is the rapid rising of ocean waters sometimes associated with tsunami activity rather than the destructive tidal wave of rapid movement and great height as occurred in 1964 in Valdez and Kodiak. In low-lying areas at or adjacent to sea level elevation, even a two or three-foot increase in sea level could cause flooding. The tsunami watch station at Unalaska is part of the Alaska Regional Warning System, which monitors tsunamic activity throughout the state." (UCDP 1977).*

The DGGS Makushin Volcano Assessment, Report of Investigation, 2000-4 stated that it is unlikely the volcano will generate a tsunami:

> *"No tsunamis have been produced at Makushin Volcano during the relatively small eruptions of the last few hundred years, and tsunamis are very unlikely to be produced by typical eruptions of Makushin Volcano in the future. However, if an unusually large eruption, similar to the caldera-forming eruptions of about 8,000 years ago, were to occur again, tsunami waves might be produced. During the prehistoric eruptions, pyroclastic flows and surges traveled from the volcano to the sea, especially on the north*

flank, where the sea is closest (McConnell and others, 1997). Slightly older debris avalanches also reached the sea on the north flank of Makushin Volcano (Bean 1999). No geologic deposits of tsunamis produced by eruptions of Makushin were identified during field studies (Bean, 1999)" (DGGS 2000).

The City of Unalaska has a minor tsunami impact history. While it is not possible to predict when a tsunami will occur, Dr. Elena Sulemani, University of Alaska Fairbanks' tsunami threat assessment supports NOAA's SIFT model. Therefore, following the criteria delineated in Table 5-2, a distant source tsunami is "Possible" to occur, but the recurrence interval is unknown. Too many factors determine when the next event will occur, as supported by known bathymetric conditions surrounding Unalaska Island.

5.4.6 Volcanic Hazards

5.4.6.1 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 one to two 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 six 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 the 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 the 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 City of Unalaska 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 2012a, USGS 2002).

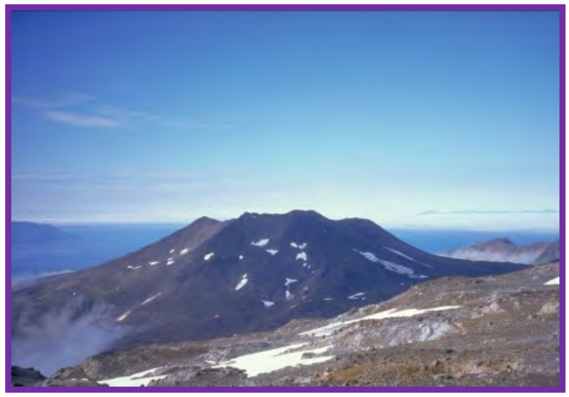


Figure 5-10 Makushin Volcano
(AVO 2012b)

The Aleutian Islands consist of a volcanic chain (14 large and 55 smaller volcanic islands). Makushin Volcano is on Unalaska Island and visible from the City of Unalaska. AVO provides information about Makushin Volcano (Figure 5-10):

> *From Miller and others (1998): "Makushin V is a broad, truncated stratovolcano, 1,800 meters high and 16 kilometers in basal diameter, which occupies most of the triangular northwest extension of Unalaska Island. A breached summit caldera, about three kilometers across, contains a small cinder cone, eroded remnants of other cones, and several fumaroles. The volcano is capped by an icefield of about 40 square kilometers; subsidiary glaciers descend the larger flanking valleys to elevations as low as 305 meters.*
>
> *… Based on geomorphic analysis, Arce (1983) infers that the sequence of Holocene events… as follows: construction of Sugarloaf cone, activity at Tabletop Mountain, construction of Makushin cone, and lastly, construction of the Wide Bay cone and activity on the Pt. Kadin vents" (AVO 2012b).*

The Preliminary Volcano-Hazard Assessment for Makushin Volcano, Alaska, Summary of Hazards states,

> *"Makushin Volcano is a 2,036-meter-high stratovolcano on Unalaska Island. The volcano is located 28 kilometers west of the towns of Dutch Harbor and Unalaska, the largest population centers in the Aleutian Islands and the principal fishing, shipping, and air-transportation hub for westernmost Alaska. Explosive eruptions of Makushin Volcano have occurred at least 17 times since the late 1700s, when written records began. These historic eruptions have been relatively small, sending ash three to 10 kilometers above the volcano summit and depositing ash mainly on the flanks of the volcano. Geologic studies show that larger explosive eruptions occurred more than two dozen times during the last several thousand years, generating more widespread ash layers. In addition, a*

series of very large eruptions about 8,800 to 8,000 years ago produced a four-kilometer-diameter crater at the summit of the volcano and generated not only numerous pyroclastic flows and surges that traveled down valleys to the sea on the east, west, and north flanks of the volcano, but a debris avalanche and lateral blast that entered the sea on the north flank of Makushin Volcano.

If future eruptions are similar in size to those of the last few hundred to few thousand years, the most likely volcanic hazard would be plumes of volcanic ash that could extend several kilometers to 10 kilometers or more into the atmosphere. Such ash plumes would constitute a hazard both to aircraft landing at the Dutch Harbor airport and to passenger and cargo jets that fly over the eastern Aleutian Islands and northern Pacific Ocean on long-distance international air routes. Currently, as many as a hundred flights a day cross above or near Makushin Volcano. Ashfall from future eruptions could also disrupt airport operations, shipping, fishing, and other commercial activities at Dutch Harbor. Such eruptions might be accompanied by floods, mudflows, and small pyroclastic flows and surges that would be dangerous for humans and property within about 10 kilometers of the volcano, particularly in low-lying areas.

If eruptions as large as those of 8,000 years ago were to occur, volcanic ash falls would be much thicker and more extensive than any seen in the area in historic time, and highly mobile pyroclastic flows, surges, or lateral blasts might affect areas tens of kilometers from the volcano, including the towns of Dutch Harbor and Unalaska. Such huge eruptions could also significantly disrupt air travel over the north Pacific area for days and perhaps weeks. However, based on the volcano's pattern of past behavior, eruptions of this magnitude are very rare, and therefore, unlikely to recur in the near future. (DGGS 2000)

Table 5-8 lists the AVO's identified volcanos in Alaska along the Aleutian Chain.

Table 5-8 Volcanos in Alaska

Volcano Names			
Akutan Volcano	Davidof Volcano	Kiska Volcano	Semisopochnoi Volcano
Amak Volcano	Dutton Volcano	Koniuji Volcano	Shishaldin Volcano
Amukta Volcano	Fisher Volcano	Korovin Volcano	Tanaga Volcano
Aniakchak Volcano	Gareloi Volcano	Little Sitkin Volcano	Ugashik-Peulik Volcano
Bobrof Volcano	Great Sitkin Volcano	Makushin Volcano	Ukinrek-Maars Volcano
Bogoslof Volcano	Herbert Volcano	Okmok Volcano	Uliaga Volcano
Buldir Volcano	Isanotski Volcano	Pavlov Volcano	Veniaminof Volcano
Carlisle Volcano	Kagamil Volcano	Pogromni Volcano	Vsevidof Volcano
Chagulak Volcano	Kanaga Volcano	Seguam Volcano	Westdahl Volcano
Cleveland Volcano	Kasatochi Volcano	Segula Volcano	Yunaska Volcano

(AVO 2012)

5.4.6.2 History

The City's 1977 Comprehensive Development Plan states, "Makushin Volcano has erupted 14 times since 1700 A.D., the last major eruption occurring in 1938. Ash eruptions have occurred as recently as 1951. Makushin and other nearby volcanoes are still engaged in the island-building process" (Unalaska 1977).

The AVO 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 and satellite imagery.

The DHS&EM's 2016 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.*

The AVO's Service Review, Mount Redoubt Volcanic Eruptions, March – April 2009 (Figure 5-11) states,

> *"Mount Redoubt volcano in continuous eruption on March 31, 2009. Plume height is no more than 15,000 feet above sea level. The small amount of ash in the plume is creating a haze layer downwind of the volcano and dustings of fine ash are falling out of the plume. View is from the northwest.*

Figure 5-11 2009 Eruption Cloud- 15,000 ft. (AVO 2009b)

> *On March 22, 2009, Mount Redoubt Volcano, 106 miles southwest of Anchorage, Alaska, began a series of eruptions after persisting in Orange or "Watch" status since late January 2009. Plume heights were observed at or above 60,000 feet during two of the six significant eruptions. Ashfall occurred over south-central Alaska, including in Anchorage, with amounts ranging from a trace to one-half inch in depth.*

The Redoubt eruptions also disrupted air traffic in the region. Hundreds of commercial flights were cancelled, and cargo companies were significantly impacted. This resulted in employees being placed on unpaid leave during periods when airport operations were shut down. Anchorage is Alaska's major population center; its airport serves as a critical strategic transportation hub as the third busiest cargo airport in the world.

The impacts of the unrest at Mount Redoubt Volcano continued through spring and into the summer. The threat of continuing eruptions and lahars (volcanic mud flows composed of water, ash, mud, and debris) necessitated the removal of millions of gallons of oil from Chevron's nearby Drift River Terminal. Residents, emergency management, and health officials remained on alert until Mount Redoubt Volcano was downgraded to Yellow or "Advisory" status on June 30, 2009, and finally to Green or "Normal" status on September 29, 2009." (AVO 2009b)

Recent volcano eruption impacts demonstrate modern community vulnerability to volcanic ash dispersal and travel distance. This includes an event in 2017 when the City experienced flight disruptions due to an ash cloud from Bogoslof Volcano erupting.

The Tribe also noted that in 2017, ash from Bogoslof Volcano erupting fell into the river they subsistence fish from and caused a siltation issue which resulted in a lack of fish.

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 5-9 lists the AVO's identified Aleutian Chain volcano's historical eruption dates with explanatory symbols to designate the data's accuracy.

Table 5-9 Aleutian Volcano Eruption Events

Aleutian Volcanoes and Their Respective Eruption Dates				
Akutan	**Cleveland**	**Kasatochi**	**Pavlof**	**Ugashik-Peulik**
10: 1765-1953	8: 1774-2010	4: 1760-1899	10: 1762-1903	2: 1814-1852
30: 1848-1992	26: 1828-2017	1: 2008	37: 1817-2007	**Ukinrek-Maars**
Amak	**Fisher**	**Kiska**	**Pavlof Sister**	1: 1977
2: 1700-1796	3: 1795-1830	3: 1907-1987	1: 1762	**Veniaminof**
Amukta	**Gareloi**	4: 1962-1990	**Seguam**	4: 1852-1987
5: 1770-1997	6: 1760-1996	**Korovin**	3: 1827-1927	18: 1830-2013
4: 1786-1996	10: 1791-1989	10: 1829-2005	6: 1786-1993	**Vsevidof**
Aniachak	**Great Sitkin**	3: 1973-1998	**Semisopochnoi**	5: 1784-1957
1: 1931	7: 1760 -1987	**Little Sitkin**	4: 1772-1830	**Westdahl**
Bogoslof	9: 1750-1974	3: 1776-1900	2: 1873-1987	3: 1820-1979
4: 1908-1951	**Kagamil**	**Makushin**	**Shishaldin**	7: 1795-1991
9: 1796-2016	1: 1929	14: 1790-1993	30: 1775-2009	**Wrangell**
Carlisle	**Kanaga**	10: 1769-1995	26: 1824 2014	12: 1760-1930
1: 1987	5: 1763-1996	**Okmok**	**Tanaga**	**Yunaska**
	6: 1786-2012	3: 1878-1936	3: 1763-1829	3: 1817-1929
		14: 1817-2008	1: 1914	3: 1824-1937

Key:
Eruption
Questionable eruption
Non-eruptive activity

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

Location

Figure 5-12 depicts the AVO monitoring program's active and inactive volcanoes.

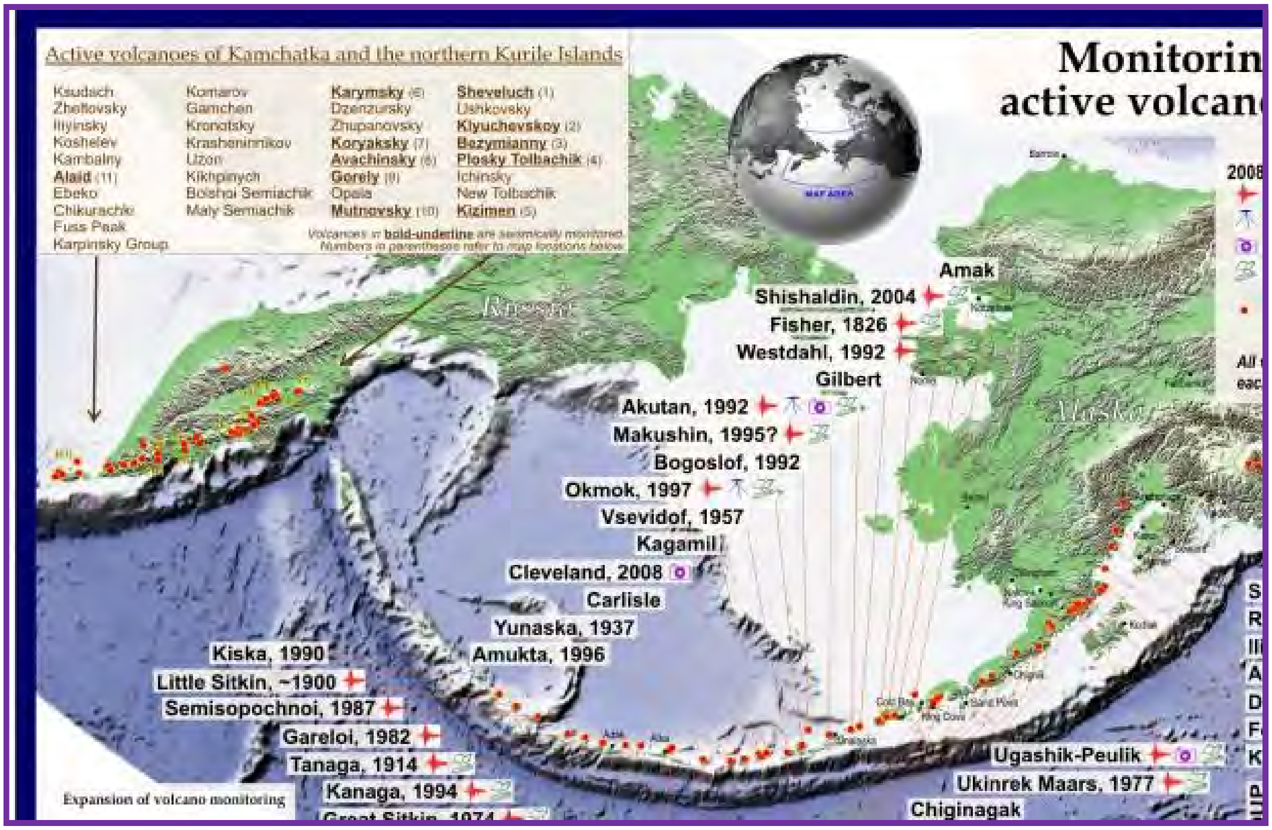


Figure 5-12 AVO's Volcano Monitoring Status Map (AVO 2008)

The AVO publishes individual hazard assessments for each active volcano in Alaska. Table 5-10 lists a representative sample of their preliminary reports and hazard assessments.

Table 5-10 List of Published Aleutian Volcano Hazard Assessments

Volcano Names			
Akutan Volcano	Gareloi Volcano	Makushin Volcano	Shishaldin Volcano
Aniakcahak Volcano	Great Sitkin Volcano	Okmok Volcano	Tanaga Island Volcanic Cluster
Fisher Volcano	Kanaga Volcano	Pavlof 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 5-13 indicates the most likely volcanoes to impact Unalaska.

Figure 5-13 Alaska's Seismically Monitored 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).*

Many of the volcanoes in Alaska are capable of producing eruptions that can affect Unalaska. Residents are concerned that significant volcanic ash falls and even large tephra particles could impact Unalaska. 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. Large tephra could cause further damage from direct impact damages.

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 three 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 5-14 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. "Volcanologists discovered that [this] 1912 [Katmai] eruption was actually from Novarupta, not Mount Katmai" (USGS 1998).

Figure 5-14 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 2009 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 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 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 two millimeters 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.

Figure 5-15 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.

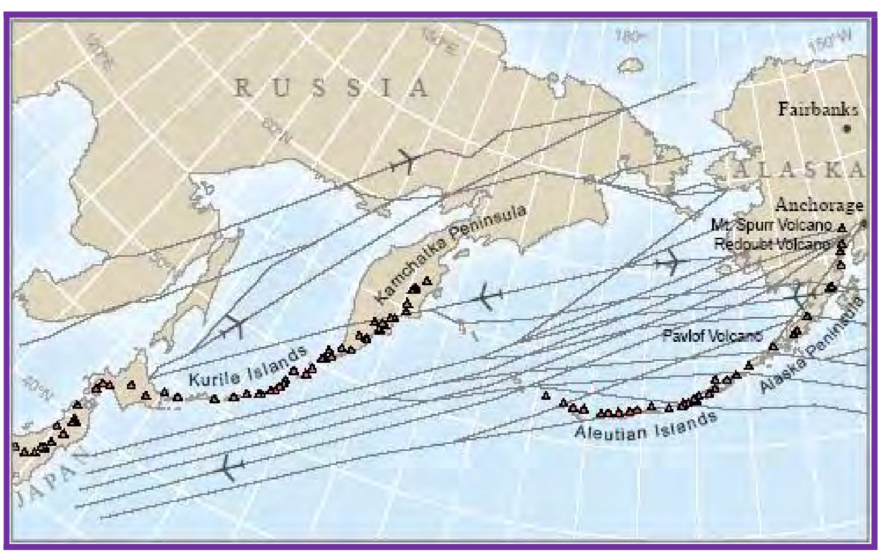


Figure 5-15 North Pacific Air Travel Routes (USGS 2001)

Figure 5-16, DGGS Makushin Hazard Assessment (Report of Investigation 200-4, Figure 8), explains how an explosive Makushin Volcano eruption's plumes could impact airline flight routes:

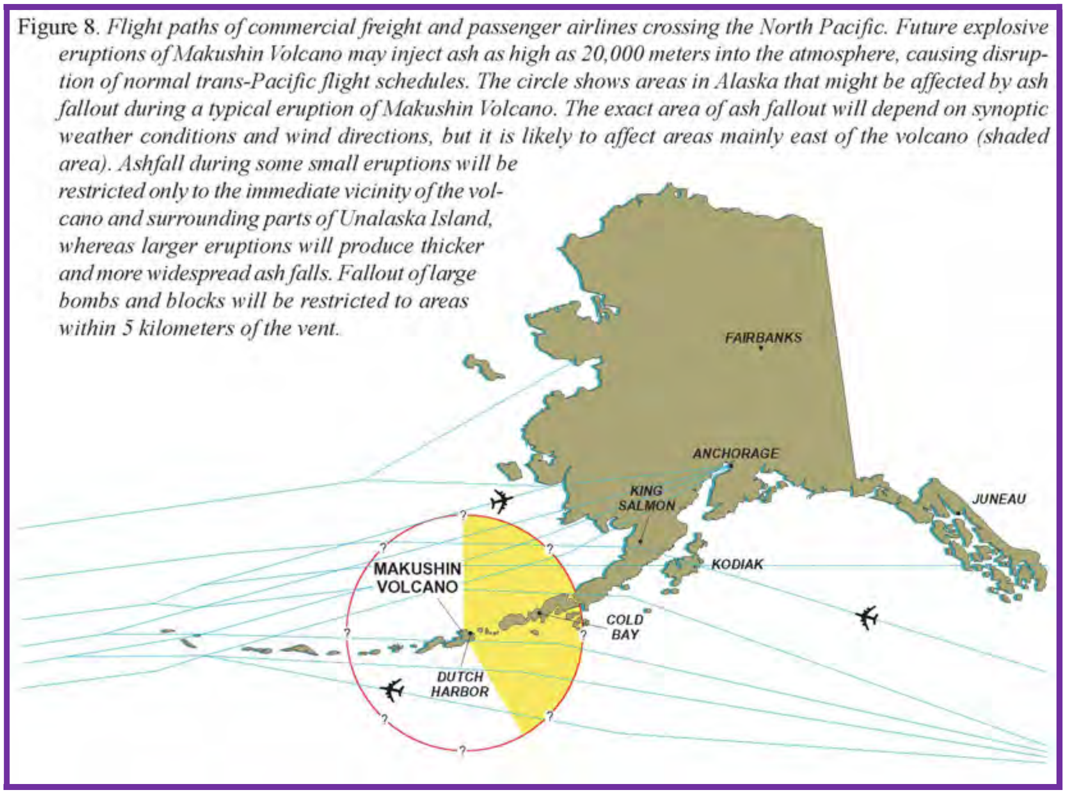


Figure 8. *Flight paths of commercial freight and passenger airlines crossing the North Pacific. Future explosive eruptions of Makushin Volcano may inject ash as high as 20,000 meters into the atmosphere, causing disruption of normal trans-Pacific flight schedules. The circle shows areas in Alaska that might be affected by ash fallout during a typical eruption of Makushin Volcano. The exact area of ash fallout will depend on synoptic weather conditions and wind directions, but it is likely to affect areas mainly east of the volcano (shaded area). Ashfall during some small eruptions will be restricted only to the immediate vicinity of the volcano and surrounding parts of Unalaska Island, whereas larger eruptions will produce thicker and more widespread ash falls. Fallout of large bombs and blocks will be restricted to areas within 5 kilometers of the vent.*

Figure 5-16 Unalaska/Makushin Volcano Flight Proximity (DGGS 2000)

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.

Unalaska 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 Bering Sea; however, Unalaska has only a minimal tsunami impact threat from volcanic activity. A much more likely impact would be prolonged traffic disruptions (air or boat) preventing essential community resupply e.g. food and medicine delivery, and medical evacuation service capabilities to full service hospitals.

A massive eruption anywhere on earth, as depicted in Figure 5-17, could severely affect the global climate; radically changing Unalaska's risk from weather events for weeks, months, or years.

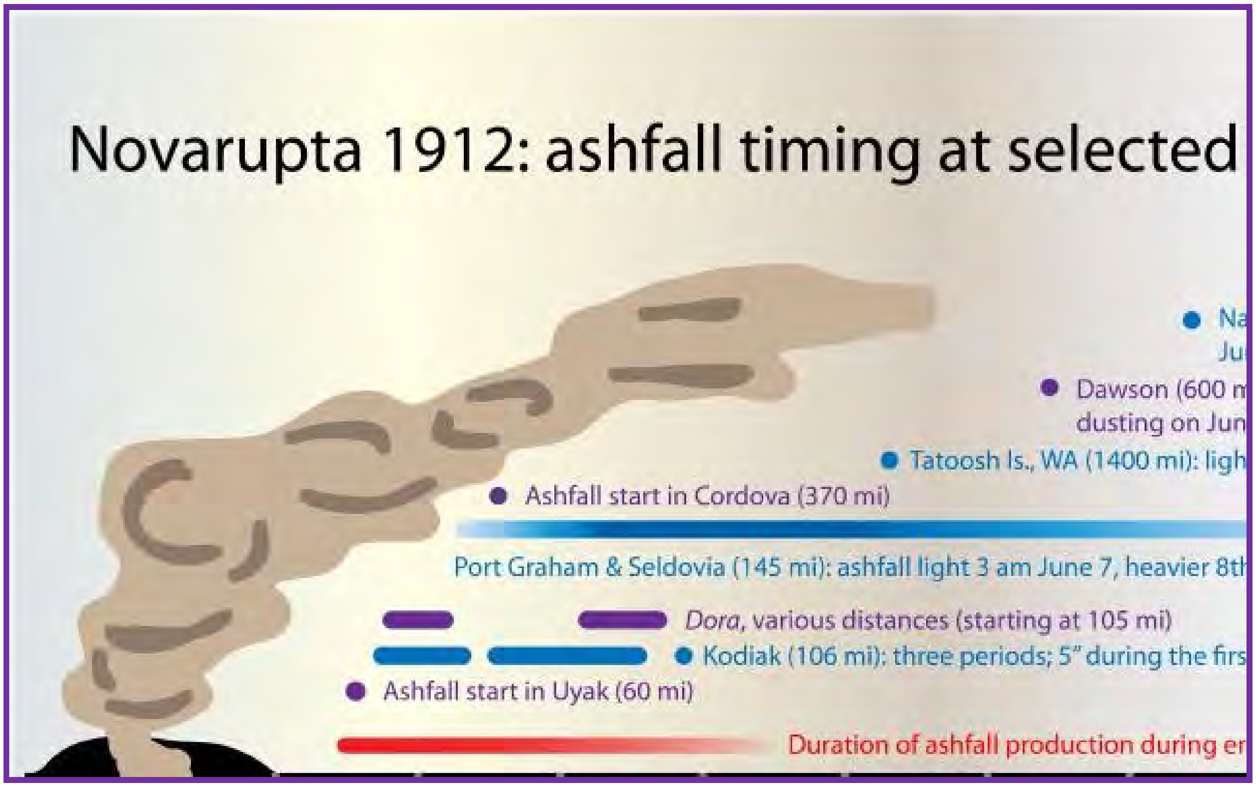


Figure 5-17 Novarupta's Historic Ashfall Timeline (AVO 2012)

Based on historic volcanic activity impacts and the criteria identified in Table 5-3, the magnitude and severity of impacts in Unalaska 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

As the Preliminary Volcano-Hazard Assessment for Makushin Volcano, Alaska, Summary of Hazards states,

> *"If eruptions as large as those of 8,000 years ago were to occur, volcanic ash falls would be much thicker and more extensive than any seen in the area in historic time, and highly mobile pyroclastic flows, surges, or lateral blasts might affect areas tens of kilometers from the volcano, including the towns of Dutch Harbor and Unalaska. Such huge eruptions could also significantly disrupt air travel over the north Pacific area for days and perhaps weeks. However, based on the volcano's pattern of past behavior, eruptions of this magnitude are very rare, and therefore, unlikely to recur in the near future. (DGGS 2000)*

Such an ash fall event would undoubtedly be devastating to Unalaska by straining its resources as well as transportation (air, ocean, land, and rail routes); especially if other hub communities are also significantly affected by a volcanic eruption. Residents 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 Unalaska 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, it is “Likely” for a volcanic eruption to occur within the next three years. The event has up to 1 in 3 year’s chance of occurring (1/3=33%). History of events is greater than 20% but less than or equal to 33% likely per year. Vulnerability depends on the type of activity and current weather, especially wind patterns.

5.4.7 Severe Weather

5.4.7.1 Nature

Severe weather occurs throughout Alaska with extremes experienced by Unalaska that include thunderstorms, lightning, hail, heavy and drifting snow, freezing rain/ice storm, extreme cold, and high winds.

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 Unalaska.

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 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 winds 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 Unalaska.

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.

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 the 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 °F. 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 5.4.3.

5.4.7.2 History

Unalaska is continually impacted by severe weather events. Hurricane force wind, storm surge, and cold typically have disastrous results. For example, *The Village*, A Rural Blog posted an Anchorage Daily News entry on December 5, 2009, stating that a 125-mph wind event toppled a 110-foot gantry crane at an American President Lines, LTD shipping facility in Dutch Harbor (ADN 2009). DHS&EM's Disaster Cost Index records the following severe weather disaster events which affected the area:

49. Unalaska, December 13, 1985: *A severe windstorm caused mudslides, road and port damage, and damage to public buildings. Public disaster assistance supplemented insurance settlements to assist in recovery.*

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.*

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)

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 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… Federal declaration was made December 2006 including assistance for Public Assistance and Hazard Mitigation but not including Individual Assistance.*

00-191, Central Gulf Coast Storm declared February 4, 2000 by Governor Murkowski, then FEMA declared (DR-1316) on February 17, 2000: *On February 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 December 21, 1999. The declaration was expanded on February 8 to include the 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 was $15.66 million.*

12-236, 2011 West Coast Storm declared by Governor Parnell on December 5, 2011 then FEMA declared December 22, 2011 (DR-4050). *On November 7, 2011 the National Weather Service (NWS) issued the first of several coastal flood warnings for the* *western coastline of Alaska from Hooper Bay to the North Slope. The NWS warned of "a rapidly intensifying storm…expected to be an extremely powerful and dangerous storm…one of the worst on record." Over the next three days additional warnings in response to the 942 millibar low-pressure system were issued for coastal villages as the storm moved northerly from the Aleutian Islands into the Bering and Chukchi Seas. The west coast was impacted with hurricane force winds exceeding 85 MPH, high tidal ranges, and strong sea surges up to 10-ft above mean sea level. Before the first storm had passed, a second equally-low pressure system (e.g., 942 millibar) impacted the western coastline from the Yukon-Kuskokwim Delta south to Bristol Bay. This combined weather extended the incident period for the state to November 13, 2011. The FEMA declaration was limited to the incident period from November 8 – 10, 2011.*

AK-15-256, 2015 December Bering Sea Storm declared by Governor Walker on January 29, 2016 then FEMA declared on February 17, 2016 (DR-4257): *Beginning December 12, 2015 and continuing for several days, the low-pressure system reached 933 millibars moving northeast from the Central and Western Aleutian Islands past the Pribilof Islands, and into the Yukon-Kuskokwim Delta region. These communities were impacted by hurricane force winds exceeding 100 MPH and gusts of up to 122 MPH, high tidal ranges, and strong sea surges up to 10 feet above mean sea level. Island communities also experienced extreme wave heights of 40–50 feet. This combined weather system began on December 15, 2015 and extended the incident period to December 19, 2015. As a result of this storm, the Cities of Adak and St. George issued local disaster declarations and requested State assistance.*

The Western Regional Climate Center (WRCC) provides weather data throughout the Pacific Northwest. The WRCC's daily comparative average and extreme data are on Figures 5-18, 19, and 20.

Figure 5-18 provides average and extreme temperature data for the closest community to Unalaska – Cold Bay. 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.

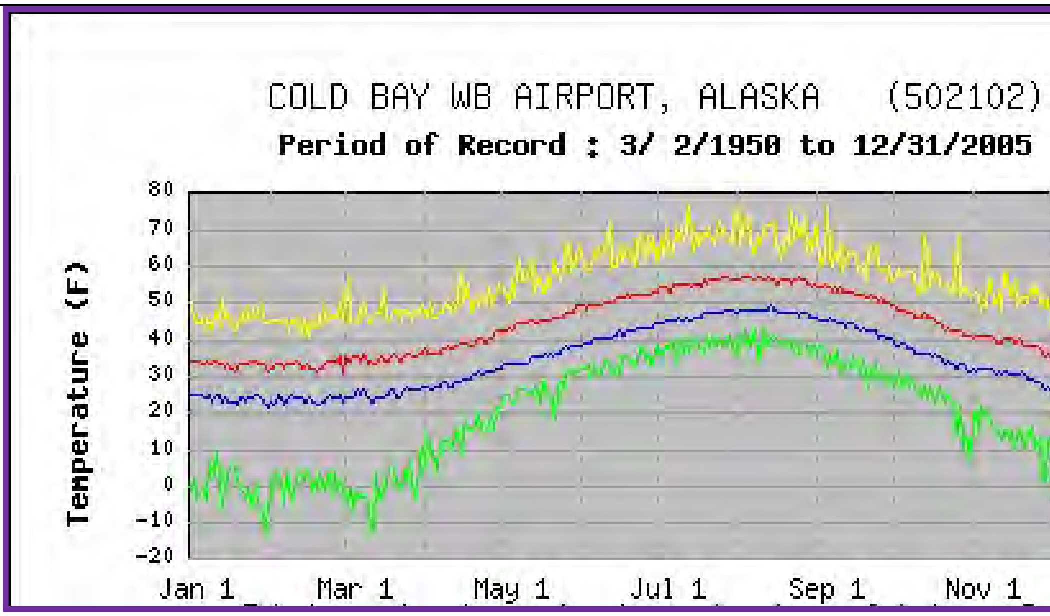


Figure 5-18 Cold Bay's Temperature Extremes (WRCC 2012)

Figure 5-19 displays the area's daily precipitation extremes.

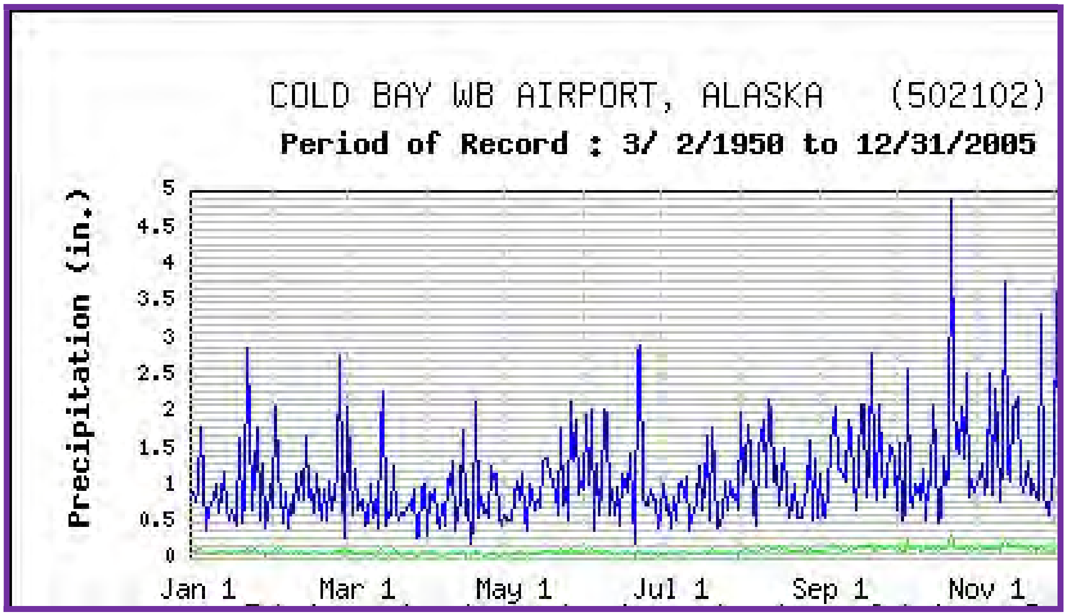


Figure 5-19 Cold Bay's Precipitation Extremes (NWS 2012)

Figure 5-20 displays the area's daily snowfall extremes.

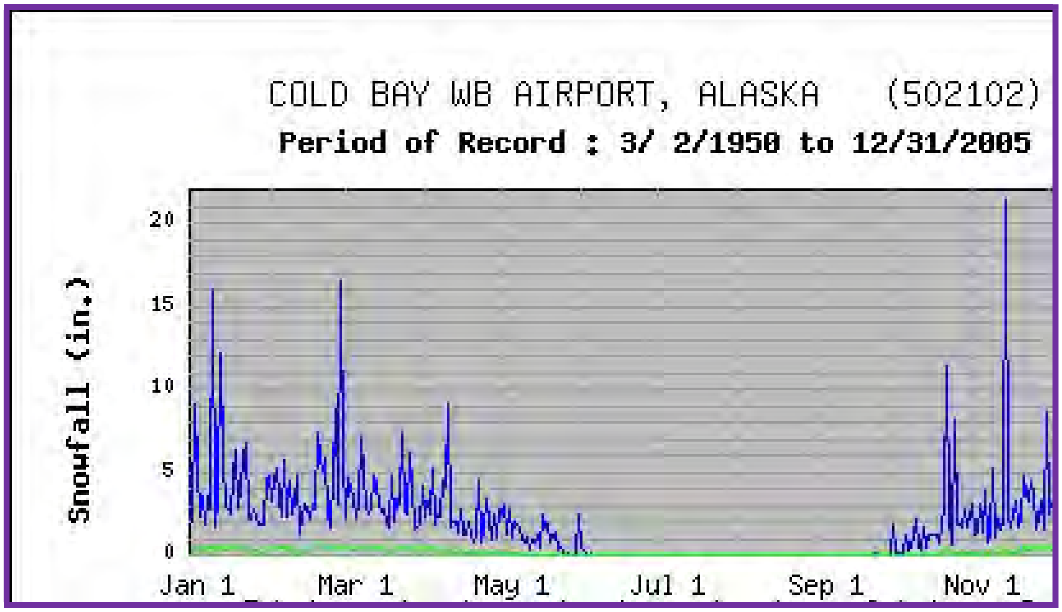


Figure 5-20 Cold Bay's Snowfall Extremes (WRCC 2012)

Unalaska is continually impacted by severe weather as depicted in Table 5-11, which highlights 29 of over 120 major storm events the NWS identified for Unalaska's Weather Zone (AKZ185). Each weather event may not have specifically impacted the area around Unalaska. These storm events are listed due to their close proximity to listed communities or by location within the identified zone.

Table 5-11 Severe Weather Events

Location	Date	Event Type	Magnitude
Central Aleutians	10/14/2006	High Wind	A storm produced a strong southeast wind of 75 MPH across the central and eastern Aleutians.
Central Aleutians	10/27/2006	High Wind	A strong system crossed the Western Aleutian Islands with wind gusts up to 86 MPH near Adak.
Central Aleutians	12/1/2006	High Wind	A strong north Pacific storm crossed the central Aleutians with strong wind gusts up to 77 MPH.
Central Aleutians	12/26/2006	Blizzard	Blizzard conditions occurred across most of the central and eastern Bering Sea and over the south-central region of Alaska.
Central Aleutians	1/3/2007	Blizzard	A storm produced snow and strong wind across most of the western Aleutian Islands.
Central Aleutians	1/29/2007	Blizzard	Snow over the central Aleutians combined with wind, resulting in a blizzard for that region.
Central Aleutians	9/17/2007	High Wind	A storm crossed the Aleutians; mariners reported wind gusts to 90 MPH.
Central Aleutians	12/27/2007	Blizzard	Strong winds and snow resulted in a blizzard across portions of the central Aleutians.
Central Aleutians	1/12/2008	High Wind	Hurricane force winds blew through the Aleutian Islands. Snow combined with the strong wind at 69 MPH.
Central Aleutians	12/17/2008	Blizzard	A strong north to northwest wind around the west side of the low coupled with snow, resulting in a blizzard in Adak.
Central Aleutians	1/12/2009	Blizzard	Strong winds and snow in advance of the front produced blizzard conditions.

Table 5-11 Severe Weather Events

Location	Date	Event Type	Magnitude
Central Aleutians	2/20/2009	High Wind	A storm produced high wind gusts of 74 MPH.
Central Aleutians	2/24/2009	High Wind	A storm produced hurricane force winds of 78 MPH.
Central Aleutians	11/29/2009	High Wind	The Gulf of Alaska produced high winds across the Aleutians and blizzard conditions from the Pribilof Islands to the Bering Sea coast with high winds up to 76 MPH.
Central Aleutians	2/7/2010	Blizzard	Blizzards occurred across the central Aleutians to the Pribilof Islands and along the Bering Sea coast of the Kuskokwim Delta.
Central Aleutians	3/1/2010	High Wind	Hurricane force gusts to 65 MPH occurred.
Central Aleutians	3/4/2010	Blizzard	High wind and blizzard conditions occurred.
Central Aleutians	3/11/2010	Blizzard	Blizzard conditions occurred.
Central Aleutians	3/30/2010	Blizzard	Strong wind and snow resulted in blizzard conditions.
Central Aleutians	1/8/2011	High Wind	Strong wind occurred across Adak. The peak gust during this event was 77 MPH.
Central Aleutians	1/17/2011	High Wind	High winds peaked at 74 MPH.
Central Aleutians	1/26/2011	Blizzard	The peak winds in the Eastern Aleutians was 78 MPH.
Central Aleutians	4/6/2011	High Wind	A storm impacted Alaska from the Aleutian Islands to south central Alaska. Wind gusts ranged from 72 - 78 MPH.
Central Aleutians	10/28/2011	High Wind	A moderately strong storm moved across the eastern Aleutians producing strong gusty northwest winds at 70 MPH.
Central Aleutians	11/18/2011	High Wind	A high wind of 76 MPH along with blizzard conditions and a storm surge resulted in minor coastal flooding.
Central Aleutians	12/13/2011	High Wind	A strong wind peaked at 81 MPH.
Central Aleutians	1/27/2012	Blizzard	A strong wind spread snow across the central Aleutian Island to the Pribilof Islands.
Central Aleutians	1/31/2012	Blizzard	There was a strong northwest wind and snow that resulted in blizzard conditions.
Central Aleutians	4/3/2012	Blizzard	A strong storm moved across the central Aleutian Islands, producing blizzard conditions.
Central Aleutians	11/1/2012	High Wind	An intense storm moving from the North Pacific into the Gulf of Alaska combined with a strong high-pressure in the Bering Sea, resulting in a strong north wind across the Eastern Aleutians. Dutch Harbor reported peak winds up to 74 MPH.
Central Aleutians	11/2/2012	High Wind	An intense storm in the Gulf of Alaska combined with strong high-pressure in the Bering Sea to produce strong north wind in Dutch Harbor gusting to 81 MPH.
Central Aleutians	2/7/2014	High Wind	Strong northwest winds blew across the Eastern Aleutians with a measured peak gust of 114 MPH on the APL crane in Dutch Harbor. The wind in Dutch Harbor resulted in damage.
Central Aleutians	11/11/2015	High Wind	Hurricane force wind gusts occurred with a peak gust of 83 MPH.
Central Aleutians	11/11/2015	High Wind	Damage at Akutan was reported by the local emergency manager; construction materials at a new fourplex were blown away.
Central Aleutians	11/11/2015	High Wind	Multiple damage reports from law enforcement and local emergency management included roofs damaged. A streetlight post and several traffic signs were blown down. Dumpsters and conex container were rolled over or moved. There were several houses and one vehicle with glass damage.
Central Aleutians	1/6/2016	High Wind	Dutch Harbor experienced a peak gust up to 82 knots.

Table 5-11 Severe Weather Events

Location	Date	Event Type	Magnitude
Central Aleutians	10/30/2016	High Wind	Unalaska Airport measured a wind gust at 79 knots.
Central Aleutians	12/23/2016	High Wind	A peak gust of 74 knots was measured on a secondary wind sensor on the Unalaska Airport runway.
Central Aleutians	11/26/2016	High Wind	Dutch Harbor recorded a peak wind of 85 knots. Over six consecutive hours of winds above 73 MPH were recorded.
Central Aleutians	1/22/2017	Avalanche	Police at Dutch Harbor had no reports of structural damage; however, there were many vehicles stuck in the snow. A travel advisory was issued to try to keep people off the roads. Road crews worked late into Sunday night to clear the roads before the morning commute.

(NWS 2017)

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

Location

Unalaska experiences periodic severe weather impacts. The most common to the area are high winds and severe winter storms. Table 5-11 depicts weather events that have impacted the area since 2006 and are provided as a representative sample.

Extent

Unalaska is vulnerable to the severe weather effects and experiences severe storm conditions with moderate snow depths; wind speeds exceeding 90 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 is considered limited where injuries do not result in permanent disability, complete shut-down of critical facilities occurs for more than one week, and more than 10% of property is severely damaged.

Impact

The intensity, location, and the land's topography influence a severe weather event's impact within a community. Hurricane force winds, rain, snow, and storm surge can be expected to impact the entire Unalaska Island.

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 loss of business can have severe economic impacts on Unalaska.

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 functioning of a community's infrastructure 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 highly likely a severe storm event will occur in the next year (event has up to 1 in 1 year’s chance of occurring) as the history of events is greater than 33% likely per year.

5.5 TECHNOLOGICAL AND MANMADE HAZARDS

Unalaska decided to identify technological and manmade hazards that could potentially impact Unalaska. However, they determined that only Transportation and Utility System Disruptions and Climate Change need to be profiled within the MJHMP.

5.5.1 Transportation System Disruptions

Transportation and utility system disruptions are a potential or subsequent impact of each of the identified natural hazards; their ramifications are far-reaching and much broader than direct damage and direct service loss.

It is important to remember, in considering any of the other hazards profiled in this MJHMP, that transportation and utility system disruptions should be viewed in addition to other impacts. The probability, duration, extent, and risk associated with system disruptions are described below, and in some cases quantified. Electric power outages are dealt with in more detail than other disruptions because loss of electric power has the most widespread effects on other utilities.

5.5.1.1 Nature

Road, airport, and harbor closures are the most significant disruptive events to Unalaska. All are subject to disruption from the various hazards profiled in this MJHMP: earthquake, erosion, flood, ground failure, (avalanche and landslide), volcano, severe weather, hazardous materials incidents, and climate change.

The ramifications of transportation system disruption range from effects on life, health, and safety (emergency vehicle mobility, access to hospitals, evacuation routes, and vital supplies if transport is unavailable for extended time periods); to the economic effects of delays, lost commerce, and lost time.

Utility System Disruptions

Similarly, utility system disruptions can affect the Community at the commerce and recreation levels as well as at the impacting fundamental health and safety. Analyzing potential utilities disruptions is complicated because utilities like electric power, potable water, wastewater, natural gas, and telecommunications are all networks, consisting of nodes (centers where something happens) and links (connections between nodes). Networks typically have various built-in redundancy levels, and the amount and nature of alternate pathways determines the robustness of the system and their sustainability to a particular disturbance. (Goettel 2005)

The City's water treatment plant is by nature located in a flood-prone area in Pyramid Valley. Floodwater inundation can cause raw water to circumvent and contaminate source wells and filtration and treatment systems. Earthquakes can damage water storage, treatment, and transport systems. Water systems are also extremely vulnerable to power outages. Storage tanks are usually located 60 to 200 feet above the water source network, and water is pumped into these tanks using electricity. Storage tanks typically contain a water supply for one to two days. Long duration power outages can result in a drinking and cooking water shortage –a basic public health requirement. The City has worked to mitigate this hazard by installing a back-up power system at the water treatment plant; however, should the system become damaged or malfunction, this threat would persist.

Wastewater management is also crucial for public health, and wastewater systems are similarly vulnerable to floods, earthquake damages, and power outages. Floods may cause collection pipes to overflow that in-turn could cause inflow that exceeds treatment plant capacity, resulting in untreated or partially treated wastewater releases. Treatment plants are often located in low-lying areas, which facilitate collected wastewater gravity flow to the plant. However, this means that treatment plants are often found in flood zones. Wastewater pipes and plants are subject to earthquake damage, and loss of power can result in plant shutdown with subsequent releases of untreated or partially treated water. (Goettel 2005) Public health hazards can be posed by wastewater and sewage backed-up, as well as by untreated or incompletely treated wastewater releases.

Telecommunication Systems

Telecommunications systems (including telephone, broadcast radio, and satellite systems) are generally somewhat less vulnerable to hazards than other services, given that few nodes (stations) are located in flood zones or landslide areas. Buried lines have more ability to stretch than do gas and water lines, and can usually accommodate several feet of ground movement before failing. Above-ground lines are vulnerable to utility pole failure, but disruptions are about 10 times less common than electrical line failures – partly because the much lower communications line voltage makes them much less vulnerable to arcing or shorting out if lines come very close to one another. (Goettel 2005) Telecommunications failures can have devastating impacts to Unalaska due to its isolated location. Routine emergency response (fire, police, and ambulance) as well as disaster-response rely on immediate electricity for timely communications.

Electrical power plants and transmission lines are vulnerable to most of the hazards covered in this MJHMP. Earthquake, flood, volcano, and severe weather events are all power, transmission, and distribution line threats. Unalaska has only one small generating plant. Electric power is pivotal to modern life. Residential, commercial, and public facilities all rely heavily on electricity. Emergency facilities such as hospitals and emergency response centers typically are equipped with backup generators for critical life-support and communications functions. Nonetheless, there are significant consequences to long-term and widespread electrical power outages. Other utility systems, discussed above, also depend on electricity for normal operations; subsequently, electric power loss can have serious secondary effects. (Goettel 2005)

5.5.1.2 History

System disruptions typically result from a primary hazard event and are treated as a secondary hazard.

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

Location

Unalaska has and relies upon modern infrastructure. Transportation and utility systems are the basis of everyday life in rural areas of Alaska.

The City has identified critical system networks and links which may experience critical failure from these technological hazards. To that end, the City has stated that they have or are working to acquire emergency generators, bury utility lines where appropriate, and ensure fuel availability for their critical infrastructure's sustainability. The City owns the electric utility who considers mitigating power line failure projects, developing plans for fuel distribution, and waste-water treatment alternatives.

Extent

The extent of transportation or utility service disruptions directly depends on the nature and magnitude of a hazard's impacts. Minor hazard events may cause minor disruptions, while significant hazard events may cause long-term transportation and utility failures.

Impact

The intensity, location, topography, and the age of an infrastructure all influence damages experienced. For example, earthquakes, floods, hurricane force winds, rain, and snow in and of themselves may not adversely affect a critical facility. However, combine any of these events in any combination could create catastrophic impacts. Compounded hazard impacts would potentially cripple the City's response capabilities.

These impacts can range from inconvenience – a few days with no transportation capability; to disastrous – heavy, debilitating damages with no capability to communicate their plight beyond Unalaska Island.

Utility functionality would directly determine the rapidity for response, construction, and repairs because communication and computer systems, and emergency response equipment is essential for modern operational capability.

The City's transportation or utility system malfunctions would be hampered, even closed down completely, stopping the flow of supplies and disrupting emergency and medical services.

Accumulations of snow or ash can cause roof collapse and other hazard impacts could further impact recovery processes.

Probability of Future Events

Inclement weather, topography, and human influence are the usual causes for transportation and utility system failure events. Increased usage (portrayed by heavy traffic periods or increased utility needs such as winter heating) can exacerbate or accelerate these systems' failure rates. Consequently, Unalaska may periodically experience episodic utility failure.

Based on previous occurrences and the criteria identified in Table 5-2, it is possible a technological and manmade hazard will occur in the next five years (event has up to 1 in 5 year's chance of occurring) as the history of events is greater than 10% likely per year but less than or equal to 20% likely per year.

5.5.2 Climate Change

5.5.2.1 Description

For this MJHMP, climate change refers to the long-term variation in atmospheric composition and weather patterns on a global scale. Global climate change may occur gradually due to small variations or rapidly due to large catastrophic forces. Greenhouse gasses, especially carbon dioxide and methane, are commonly regarded as the most significant factors influencing the Earth's current climate.

Significant atmospheric variations may also be influenced by more than one event. For instance, an asteroid impact and a major eruption over a longer time period. For scientists studying climate change, both hazards imply different time periods. Therefore, the time period estimates for previous climate change events tend to vary and cannot be accurately applied to current predictive climate change models, which now must account for human activity. This is significant because hazard mitigation planning relies greatly upon the historical record.

5.5.2.2 Location

Climate change is a global event. Therefore, the entire community of Unalaska is vulnerable to climate change.

5.5.2.3 Extent

Through studies of the historical record, it is known climate change affects water acidity, atmospheric composition, precipitation, weather patterns, and temperatures. Climate change has the potential to aggravate natural disasters along the coastline and rivers, particularly flooding and erosion. Ongoing climate change will continue to exacerbate these issues.

5.5.2.4 History and Local Impact

The community of Unalaska is being impacted by more moderate temperatures and changing seasonal timing. The community's economy relies heavily on commercial fishing and crabbing, which may be impacted by a changing climate. Some residents also rely on subsistence practices to supplement store bought goods; a changing climate may cause residents to alter their subsistence practices. Residents provided the following observations during community meetings in December 2017 and March 2018:

- The sea level in the community is rising.
- Drier weather is occurring in summer months.
- Wind storms are more aggressive and back to back.
- High winds combined with heavy rain can affect surface water supply, increasing turbidity, and resulting in the system being shut down for up to two days.
- Harmful algal bloom used to be predictable in May and now it not predictable.
- Temperatures are warmer throughout the year. Residents are concerned about less snowfall occurring at higher elevations, which will affect the City's water supply.
- Shells of muscles and other crustaceans crumble in hand, and blue mollusk shells are much softer. Residents believe ocean acidification is affecting local sea life.
- Less water in rivers carries less sediment.
- The fisheries are being affected by ocean acidification. In 2016, a federal fisheries disaster was declared.

The complete local impact of climate change on Unalaska is difficult to quantify because there is not much conclusive data about the impacts of climate change on the region. Additionally, issues often correlated with climate change may have other factors that may be contributing to the issue. Due to this, the best information about the local impact of climate change is the testimonies provided by Unalaska residents.

5.5.2.5 Probability of Future Events

Given the Earth's history of climate change, the current observed changes in the atmosphere, and the community's observations, it is credible that a disaster event attributed to climate change will occur in the next 10 years as the probability is less than or equal to 10% likely per year.

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This section outlines the vulnerability analysis process for determining potential losses for the community from various hazard impacts.

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; and
8. Future Development.

This section provides an overview of the vulnerability analysis for current assets and 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 hazard vulnerability of Unalaska's infrastructure. The City and Tribe are co-located within the City of Unalaska. The Tribe does not own land within the City but provides operational funding to Tribal facilities within the City. Additionally, the population of the Tribe lives within the City.

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	50	50	50	50
Erosion	< 10	~ 10	< 10	< 5
Flood	< 10	~ 10	< 10	< 5
Ground Failure	< 5	< 5	< 5	< 5
Tsunami/Seiche	< 5	< 5	< 5	< 5
Volcano	50	50	50	50
Weather	50	50	50	50
Climate Change	0	10	0	0

6.2 LAND USE AND DEVELOPMENT TRENDS

6.2.1 Land Use

The Unalaska Comprehensive Plan 2020 (UCP) describers their land use capability as:

> *"Since most of the available land area in Unalaska suitable for the development of business and industry is owned by the Ounalashka Corporation (OC), it will always be essential to involve that organization in striving to meet the growing demand for appropriate land area to accommodate the needs of local businesses and industries…*

Owners of appropriate land area in Unalaska, including OC and others, should be supported and encouraged in their efforts to make available land for the future development needs of businesses and industry." (UCP 2011).

The City of Unalaska has completed several plans to ensure the adequate maintenance and supply of the City's drinking water. These plans are listed in UCP and include:

The Unalaska Water System Master Plan was prepared in 2017 by HDR Alaska, Inc. which describes the City's goals and accomplishments:

- City of Unalaska National Pollutant Discharge Elimination System
  - Quality Assurance Plan, prepared in 2004 by CH2MHILL, and updated in 2009 by City staff;
  - City of Unalaska Water Treatment Public Water System PWS Wellhead Protection Management Plan, prepared in 2005 by City staff, and updated in 2009;
  - City of Unalaska Icy Creek Reservoir Dam Emergency Action Plan Standard Operating Procedures, prepared in 2005 by City staff, and updated in 2008.
- City of Unalaska Water Treatment Plant Phase I Analysis Design
  - Recommendations Report, prepared by HDR in 2008; and Cost of Service/Rate Design Study Water Utility, City of Unalaska, prepared in 2009 by the Financial Engineering Company.

The UCP further defines existing land use as:

Description of Existing Zones

As noted by the existing Land Use Maps presented on the following … pages, land in Unalaska is currently used for a multitude of purposes. Please note that the first Land Use Map presents land uses for the entire City. The second Land Use Map presents an enlarged view of land uses in the most developed parts of the City to enable better viewing within this Comprehensive Plan.

The classifications of land uses include the following. The classifications are the same as those used in the City's Zoning Ordinance in order to present consistent definitions for both land uses and zoning classifications.

- *Communication & Utility Towers Overlay District (CUTOD) – The Communication and Utility Towers Overlay District is a special land use classification area that contains communication towers and public utility towers that enhance the safety and welfare of the community.*
- *General Commercial – General Commercial land uses include, primarily, general retail sales, service, and repair activities. This land use classification also includes professional offices, certain commercial/lighter industrial and warehousing offices, and structures that are not dependent on direct access to a waterbody.*
- *Single-Family/Duplex Residential – Single-Family/Duplex Residential land uses include one- and two-family residential dwellings, served with public sewer and water.*

- *Moderate Density Residential – Moderate-Density Residential land uses include intermediate density multi-family residential dwellings with up to four residential dwelling units per lot, served with public sewer and water.*
- *High-Density Residential – High-Density Residential land uses include single-, two-, and multiple-family dwelling units, served with public sewer and water.*
- *Marine-Dependent Industrial – Marine-Dependent/Industrial land uses include those land uses and structures whose primary purposes require direct access to a water body and/or can be carried out on, in, or adjacent to a water body only.*

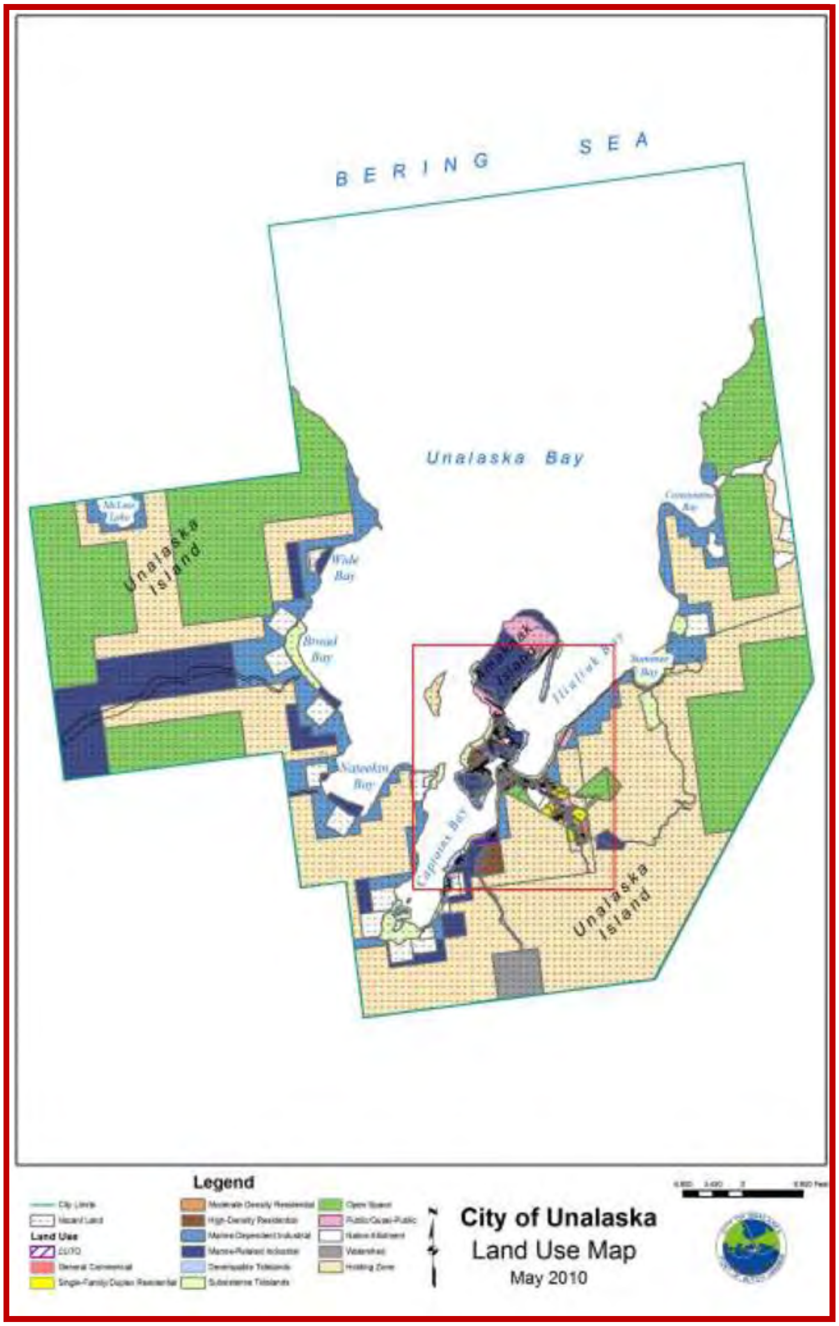

Figure 6-1 Unalaska Area Land Use Map 1 (UCP 2011)

- *Marine-Related Industrial – Marine-Related/Industrial land uses include those industrial land uses and structures that are not dependent on direct access to a water body.*
- *Developable Tidelands – Developable Tidelands land uses include tide and submerged lands that have been identified as developable subject to guidelines and restrictions.*

- *<u>Subsistence Tidelands</u> – Subsistence, as defined in Title 8, Section 803, of the 1980 Alaska National Interest Lands Conservation Act, "is the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption, as food, shelter, fuel, clothing, tools, or transportation…for barter or sharing for personal or family consumption and for customary trade."*

  The Subsistence Tidelands land uses include tide and submerged lands that have been identified as important to fish and wildlife habitats, recreation and personal use subsistence activities, and water quality and circulation characteristics.
- *<u>Open Space</u> – Open-Space land uses include the community's scenic resources, parks, recreation, and subsistence activities.*
- *<u>Public/Quasi-Public</u> – Public/Quasi-Public land uses include public and quasi-public educational, recreational, health, utility, administrative, and institutional land uses and structures.*
- *<u>Native Allotment</u> – Native Allotment land uses include land that has been conveyed to individual Alaskan Natives under the Native Allotment Act of 1906, 34 Stat. 197, as amended.*
- *<u>Watershed</u> – Watershed land uses include potable water reserves available to the city.*
- *<u>Holding</u> – Land uses classified as Holding are those lands within the City of Unalaska that are suitable and intended for future development but for which the landowner has no proposed land use plans. The Holding areas are not intended to prohibit future development, but to provide both the City and the landowner flexibility in determining the future use of those lands.*

The UCP describes the OC land holdings throughout Unalaska Island,

> *"Formed in 1973 under the Alaska Native Claims Settlement Act (ANCSA), the OC is the Native village corporation of Unalaska, Alaska.*
>
> *As noted on OC's Web site, OC was incorporated with an original 269 Unangan shareholders, OC's shareholder base now represents about 400 original shareholders and original shareholders' descendants. Under ANCSA, OC is entitled to 115,000 acres of land on Unalaska, Amaknak, and Sedanka Islands. To date, the U.S. Bureau of Land Management has conveyed approximately 112,000 acres. Selection and conveyance of remaining land depends on development plans. Much of the land OC owns is undevelopable given the terrain of the islands (and current development standard), but the land within the City limits was well chosen by early leadership. Site work done during World War II set the stage for development in later years.*
>
> *OC is a for-profit corporation. Its business is land leasing and development. OC is the major land owner in Unalaska. OC leases land to commercial and residential interests – some short-term and some long-term. Commercial tenants*

include firms in the fishing industry and firms that support it, as well as firms in international shipping, sand and gravel extraction, retail, etc. It is the Board of Directors' policy to lease only. Lease terms range from month-to-month rentals for apartments and units in Kashega Ministorage to very long-term leases of 50+ years."

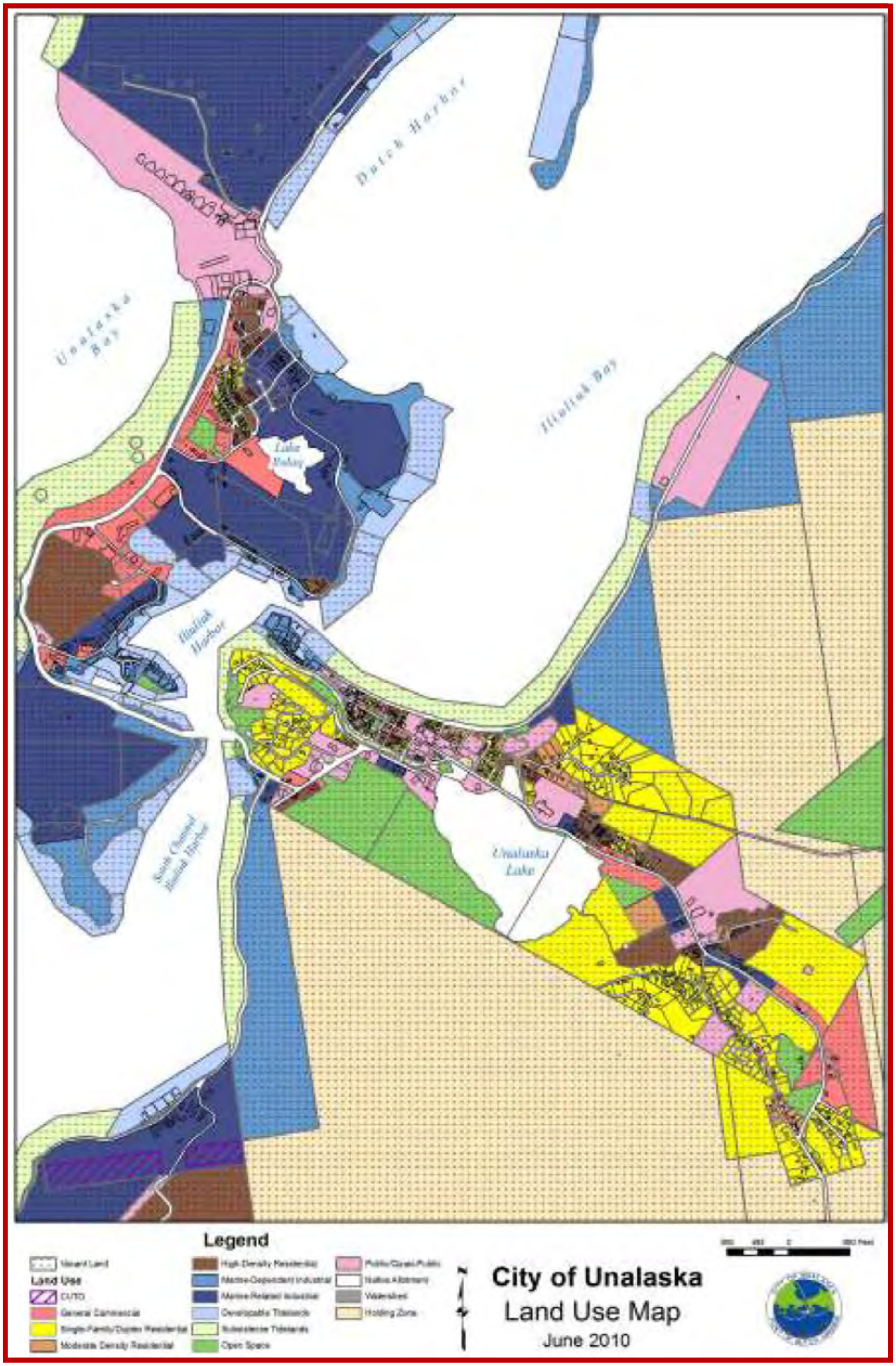

Figure 6-2 Unalaska Area Land Use Map 2 (UCP 2011)

The UCP provides detailed "Existing Land Use Calculations" presented below in Table 6-2.

> *"The most significant finding presented in the chart is that the City of Unalaska has sufficient land area to accommodate any anticipated growth in the community for the foreseeable future, assuming that an adequate amount of the undeveloped land area is made available for development and is developable given contemporary construction limitations" (UCP 2011).*

The Planning Team explained, *"this table includes the entire land area within the corporate boundary, only a small fraction of which is developed."*

Table 6-2 provides a general land-use breakout:

Table 6-2 Existing Land Use Break-Out

Percentage Used	Land Use Description
0.50	*Developable Tidelands*
2.13	*Subsistence Tidelands*
0.19	*General Commercial*
1.01	*Residential areas include single or duplex, moderate-density, or high-density housing*
43.47	*Holding Zone (cannot be developed unless planned and approved for specific use)*
17.58	*Marine Industrial areas include Marine – Dependent or Marine – Related Industrial*
0.99	*Watershed*
30.00	*Open Space*
1.03	*Public and Quasi Public lands*
3.11	*Restricted Deeds and Native Allotments*
100%	***Total***

(UCP 2020a)

The largest land use in the City (90.95%) is predominately classified as either a "Holding Zone" (43.47%) or as "Open Space" (30.00%) followed by industrial classifications. This leaves very little space for residential, commercial, or future development (0.5%).

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 critical facility and infrastructure assets and associated values throughout the City of Unalaska are addressed in Section 6.3.1.3. and Appendix D.

6.3.1.1 Population and Building Stock

Population data for Unalaska was obtained from the 2010 U.S. Census and the DCRA. The U.S. Census reports the City's total population for 2010 as 4,376, and 2017 DOL estimates for Unalaska reported a population of 4,341 (Table 6-3).

Table 6-3 Estimated Population and Building Inventory

Population		Residential Buildings	
2010 Census	2017 DOL Estimate	Total Building Count	Total Value of Buildings[1]
4,376	4,341	1,106	$209,918,800

Sources: U.S. Census 2010, and 2017 DOL Population Estimate.
[1] US Census listed the median housing unit value at $189,800.

Estimated replacement values for those structures, as shown in Table 6-3, were obtained from the 2010 U.S. Census and 2017 DCCED/DCRA certified estimate. A total of 1,106 housing units were considered in this analysis along with the U.S. Census estimated structure values.

6.3.1.2 Existing Infrastructure

The City of Unalaska has benefited from numerous funding opportunities to assist them with upgrading their infrastructure. The 1990s brought several housing construction and upgrade projects: several airport, dock, and harbor facility improvements; a new Airport Highway Channel Bridge along with landfill and baler upgrades, and the Iliuliuk Family & Health Services Clinic construction.

The years 2000 to 2010 brought a new hydro-electric project to Pyramid Creek, wastewater treatment plant upgrades, an Airport Master Plan Study, landfill leachate analysis, landfill cell development, roads rehabilitation, and a new chemical storage building. The following decade is bringing airport safety improvements, repurposing or demolition of old airport buildings, power house expansion, and waste water treatment plant improvements.

The City's Comprehensive Development Plan states,

> *"**Electrical Production***
>
> *The City of Unalaska has been very proactive in planning and upgrading their electrical power needs for current and future requirements. In 2002, the City started design on a new 16,000 square foot Powerhouse. The New Powerhouse Project consisted of two phases. Phase I consisted of installing two new Wartsila 12V32 Generator Sets in Bay One with a total capacity of 10.4 MW. On December 17, 2010, Phase I was put into service increasing the City's electrical capacity from 7.5 MW to 13.2 MW. Phase II consists of adding 10.4 MW or more capacity in Bay 2. In 2007, the City bought a new C280 Caterpillar Generator Set with a capacity of 4.4 MW. In March of 2011, the City installed the C280 Generator Set.*
>
> ***Electrical Distribution***
>
> *The City of Unalaska has also been proactive in upgrading their Electrical Distribution System. From 2007 – 2010, the City spent approximately $250,000 per year for Electrical Distribution System upgrades. These upgrades consisted of replacing damaged or aging transformers, section cans, switch gear and underground primary and secondary lines. The City developed an electrical line testing procedure where six-foot sections of underground electrical lines were removed and sent in for testing and analysis which evaluated its life expectancy. This information was used by the City for planning future line replacement" (UCP 2011.)*

6.3.1.3 *Existing Critical Facilities*

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 Unalaska 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 City 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; and
- Utilities, such as electric generation, communications, water and waste water treatment, and landfills.

Note: The Critical Facilities list is provided as Appendix D, Table D-1. However, this information is not available to the general public. Contact the City of Unalaska, Director of Public Safety if you have a valid need to access this information.

Figures 6-3, 6-4, and 6-5 depict the City's road system and infrastructure locations.

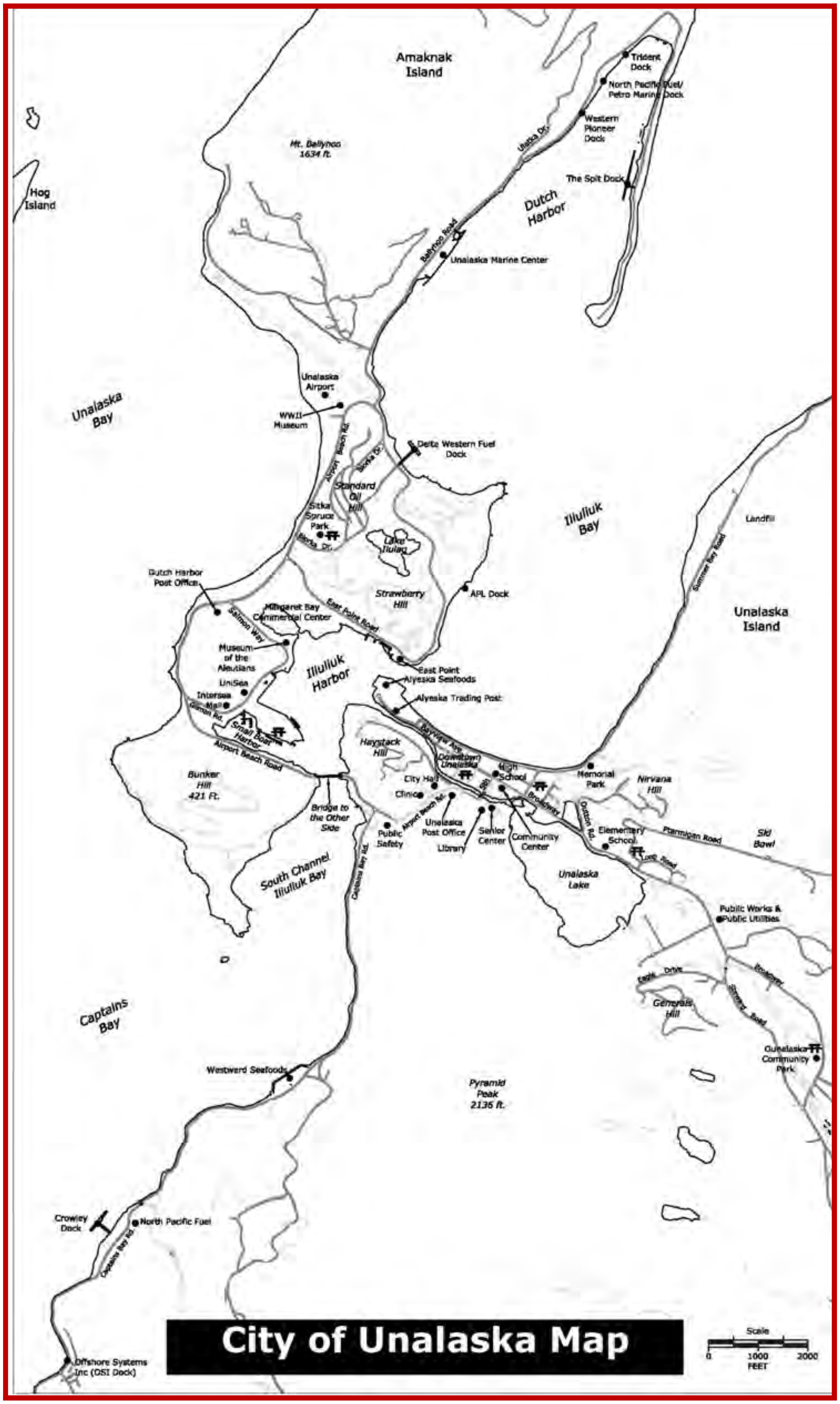

Figure 6-3 City of Unalaska Map 1 (Unalaska 2009)

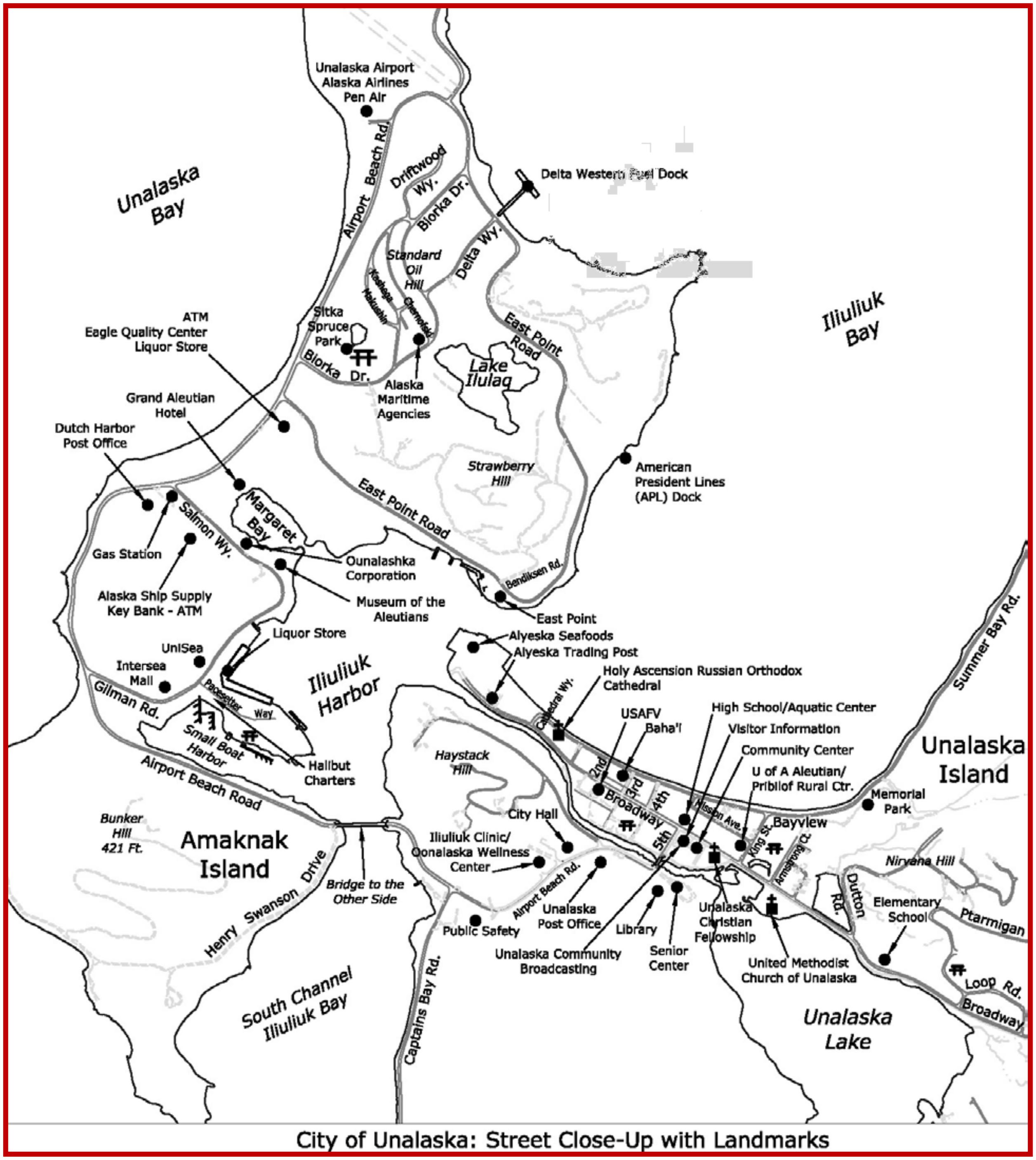

Figure 6-4 City of Unalaska Map 2 (Unalaska 2009)

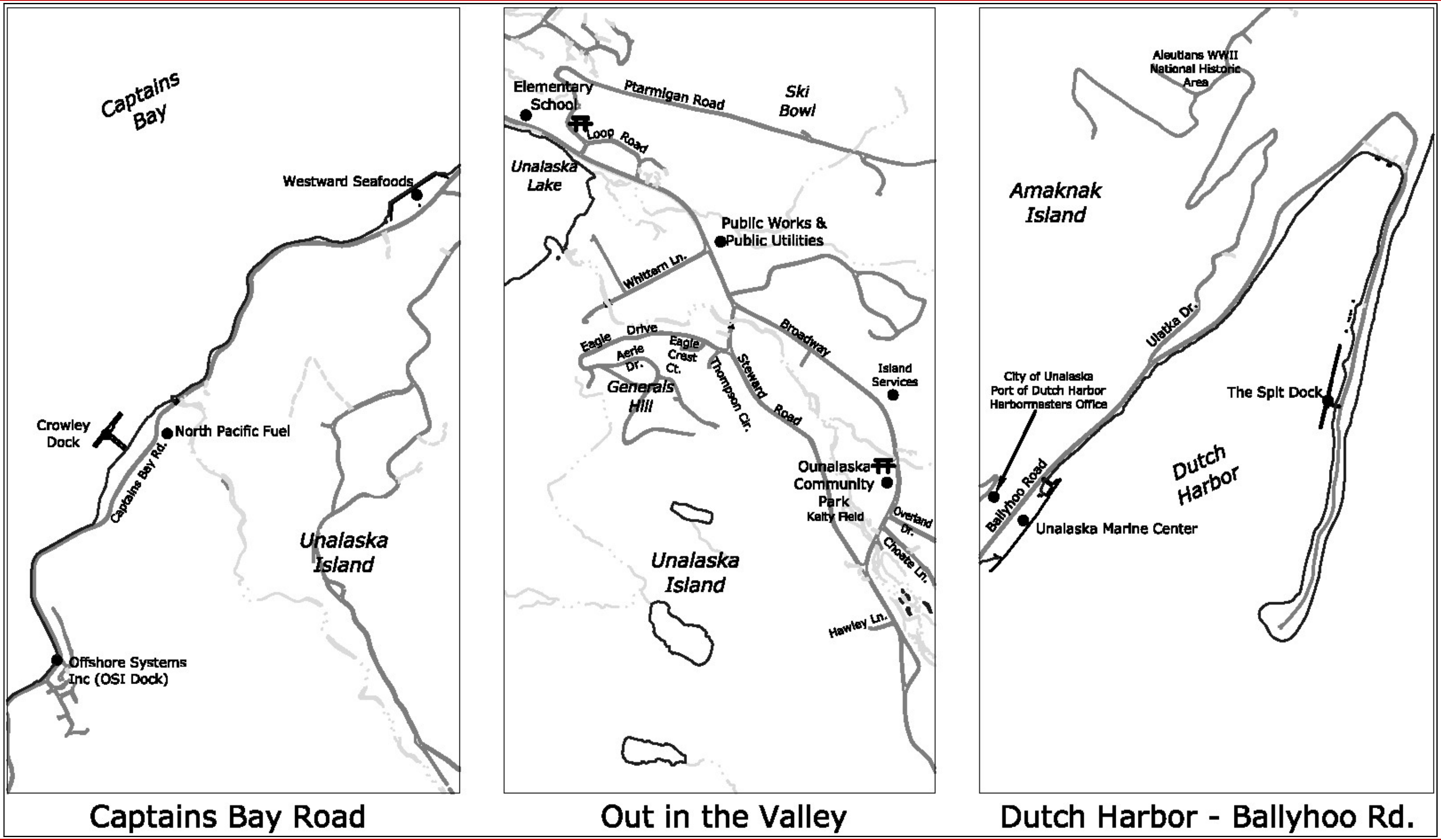

Figure 6-5 City of Unalaska Map 3 (Unalaska 2009)

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.

6.4.1 NFIP Participation

Unalaska does not participate in the NFIP; neither do they have a repetitive flood property inventory that meets NFIP criteria as the loss thresholds are substantially below FEMA values.

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 considering probability or damage levels.

The methodology used a two-pronged effort. First, the City of Unalaska provided a copy of their extensive GIS database and raster images. This information allowed the Planning Team to identify and locate critical facilities and infrastructure relevant to each facility's hazard 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 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, 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, critical facilities, and infrastructure to the identified hazards. It was beyond the scope of this MJHMP to develop a more detailed or comprehensive risk assessment (including annualized losses, people injured or killed, shelter requirements, loss of facility/system function, and economic losses).

6.7 VULNERABILITY EXPOSURE ANALYSIS

The City of Unalaska provided extensive area wide GIS data which formed the basis for the City's critical facility hazard exposure analysis. Tables 6-5 and Table 6-6 tabulates potential loss estimation data. Section 6.7.1 Exposure Analysis – Hazard Narrative Summaries provides an explanatory description of the tabulated exposure analysis.

Appendix D contains a detailed critical facility list that was used to develop the City's Vulnerability Exposure Analysis as summarized in Tables 6-5 and 6-6.

Appendix E provides figures (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 City; and subsequently indicate their relative location within an identified potential hazard impacted area.

Table 6-5 Potential Hazard Exposure Analysis – Critical Facilities

			Government		Emergency Response		Educational		Medical		Community	
Hazard Type	**Hazard Area**	**Methodology**	*** #Bldgs./ # Occ**	**Value ($)**	*** #Bldgs./ # Occ**	**Value ($)**	*** #Bldgs. / # Occ**	**Value ($)**	*** #Bldgs ./ # Occ**	**Value ($)**	*** #Bldgs./ # Occ**	**Value ($)**
Earthquake	Severe	>40-60% (g)	6/125	9,098,690	4/25	14,568,669	6/504	29,466,700	3/80	7,016,000	20/>560	>99,987,330
Erosion	--	Within 300 ft of erosion areas	3/55	4,954,935	--	--	--	--	--	--	--	--
Flood	--	Descriptive	3/55	4,954,935	--	--	--	--	--	--	--	--
Ground Failure	Moderate	>14-32 degrees	--	--	--	--	--	--	--	--	--	--
	High	>32-56 degrees	2/45	4,954,935	--	--	--	--	--	--	6/Unknown	> 1,547,100
Tsunami	Inundation Elevation	Low (100 ft)	6/120	9,098,690	3/25	4,822,599	6/482	29,466,700	3/80	7,016,000	14/380	70,431,575
		Moderate (50 ft)	6/120	9,098,690	2/10	668,669	6/482	29,466,700	1/40	1,709,400	14/380	70,431,575
		High (30 ft)	5/70	3,898,690	2/10	668,669	6/482	29,466,700	1/40	1,709,400	14/380	70,431,575
Volcanic	--	Descriptive	6/125	9,398,090	4/25	14,568,669	6/504	29,466,700	3/80	7,016,000	19/>560	>99,987,330
Severe Weather	--	Descriptive	6/125	9,398,090	4/25	14,568,669	6/504	29,466,700	3/80	7,016,000	19/>560	>99,987,330

Note: Table 6-5 assumes 100% of critical facilities are vulnerable. Vulnerability percentages from Table 6-1 are applied in the descriptive narrative in Subsection 6.7.1.

Table 6-6 Potential Hazard Exposure Analysis – Critical Infrastructure

			Highway		Bridges		Transportation Facilities		Utilities	
Hazard Type	**Hazard Area**	**Methodology**	**Miles**	**Value ($)**	**No.**	**Value ($)**	*** #Bldgs./ # Occ**	**Value ($)**	*** #Bldgs. / # Occ**	**Value ($)**
Earthquake	Severe	>40-60% (g)	41	3,813,330	4	41,846,933	10/450	$160,907,321	13/26	185,060,000
Erosion	--	Within 300 ft of erosion areas	--	--	--	--	--	--	--	--
Flood	--	Descriptive	--	--	--	--	--	--	--	--
Ground Failure	Moderate	>14-32 degrees	--	--	--	--	--	---	--	-
	High	>32-56 degrees	0.5	Unknown	--	--	--	--	--	--
Tsunami	Inundation Elevation	Low (100 ft)	Unknown	Unknown	2	30,024,907	9/410	143,737,321	3/12	7,979,807
		Moderate (50 ft)	Unknown	Unknown	2	30,024,907	9/410	143,737,321	3/12	7,979,807
		High (30 ft)	Unknown	Unknown	4	41,846,933	10/450	$160,907,321	--	--
Volcanic	--	Descriptive	41	3,813,330	4	41,846,933	10/450	$160,907,321	11/26	100,085,000
Severe Weather	--	Descriptive	41	3,813,330	4	41,846,933	10/450	$160,907,321	11/26	100,085,000

6.7.1 Exposure Analysis – Hazard Narrative Summaries

Earthquake

Unalaska and its surrounding area can expect to experience significant earthquake ground movement that may result in infrastructure damage. Intense shaking may be seen or felt based on past events. Although all structures are exposed to earthquakes, buildings constructed with wood have slightly less vulnerability to the effects of earthquakes than those with masonry.

Based on earthquake probability (PGA) maps produced by the USGS, the entire area is at risk of experiencing moderate to significant earthquake impacts as a result of its proximity along the Aleutian section of the "Ring of Fire," which possesses numerous volcanoes and a seismically active location.

The probability is high (see Section 5.4.1) that impacts to the community such as severe ground movement may result in infrastructure damage and personal injury.

The entire existing, transient, and future Unalaska population, residential structures, and critical facilities are exposed to the effects of "severe" earthquake events. For the purpose of this vulnerability assessment, it is estimated that 50% of the population, residences, and facilities would be affected. This includes approximately:

- 2,171 people in 553 residences (approximate value: $104,959,400)
- 125 people in six government facilities (approximate value: $9,098,690)
- 25 people in four emergency response facility (approximate value: $14,568,669)
- 504 people in six educational facilities (approximate value: $29,466,700)
- 80 people in three care facilities (approximate value: $7,016,000)
- >560 people in 20 community facilities (approximate value: >$99,987,330)
- 41 asphalt and gravel miles (approximate value: $3,813,330)
- four bridges (approximate value: $41,846,933)
- 450 people in ten transportation facilities (approximate value: $160,907,321)
- 26 people in 13 utilities (approximate value: $185,060,000)

Impacts to future populations, residential structures, critical facilities, and infrastructure are anticipated at the same historical impact level. See map in Appendix E.

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 (beaches, docks, harbors, and electric and water/wastewater utilities), and economic impacts associated with costs trying to prevent or control erosion sites. Only a building's or facility's location can lessen its vulnerability to erosion on Unalaska Island.

Based on local knowledge, areas within the City affected by erosion are located adjacent to the Illiuliuk River, storm water run-off, and beach areas from storm surge damage (Section 5.4.2). For the purpose of this vulnerability assessment, it is estimated that 5% of the population, residences, and three government facilities would be affected. This includes approximately:

- 112 people in 56 residences (approximate value: $10,495,940)
- 55 people in three government facilities (approximate value: $454,935)

Impacts to future populations, residential structures, critical facilities, and infrastructure are anticipated at the same impact level. See map in Appendix E.

Flood

Typical flood impacts associated with flooding is water damage to structures and contents, roadbed erosion and damage, boat strandings, 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 5.4.3).

No detailed 100-year flood analysis has been prepared for Unalaska. The USACE Floodplain Manager does not provide flood information or a 100-year floodplain map for Unalaska. Based on historical impacts, residential structures and government facilities are susceptible to flooding. For the purpose of this vulnerability assessment, it is estimated that 5% of the population, residences, and three government facilities would be affected. This includes approximately:

- 112 people in 56 residences (approximate value: $10,495,940)
- 55 people in three government facilities (approximate value: $454,935)

Impacts to future populations, residential structures, critical facilities, and infrastructure are anticipated at the same impact level. See map in Appendix E.

Ground Failure

Impacts associated with ground failure include surface subsidence, infrastructure, structure, and/or road damage. The potential ground failure impacts from avalanches, landslides, and subsidence can be widespread. Potential debris flows and landslides can impact transportation, utility systems, and water and waste treatment infrastructure along with public, private, and business structures located adjacent to steep slopes, along riverine embankments, or within alluvial fans or natural drainages. Response and recovery efforts will likely vary from minor cleanup to more extensive utility system rebuilding. Utility disruptions are usually local and terrain-dependent. Damages may require reestablishing electrical, communication, and gas pipeline connections occurring from specific breakage points. Initial debris clearing from emergency routes and high traffic areas may be required. Water and wastewater utilities may need treatment to quickly improve water quality by reducing excessive water turbidity and reestablishing waste disposal capability.

USGS elevation datasets were used to determine the ground failure hazard areas within Unalaska. Risk was assigned based on slope angle. A slope angle of less than 14 degrees was assigned a low risk, a slope angle between 14 and 32 degrees was assigned a medium risk, and a slope angle greater than 32 degrees was assigned a high risk.

Ground failure hazards periodically cause structure and infrastructure displacement due to ground shifting, sinking, and upheaval. According to mapping completed by the DGGS, Unalaska has no permafrost (see Section 5.4.4).

There have been periodic landslides and other ground failure incidents in Unalaska.

For the purpose of this vulnerability assessment, it is estimated that 5% of the population, two government facilities, six community facilities, and 0.5 highway miles would be affected. This includes approximately:

- 45 people in two government facilities (approximate value: $454,935)
- Six community facilities (approximate value: >$77,355)
- 0.5 highway miles (approximate value: Unknown)

Impacts to future populations, residential structures, critical facilities, and infrastructure are anticipated at the same impact level. See map in Appendix E.

Tsunami and Seiche

The UAF/GI indicates there is a minimal threat from distant source tsunamis; however, they indicated an Aleutian Trench generated tsunami could generate a two-meter-high tsunami that could come into Unalaska Bay. (UAF/GI 2012)

Potentially threatened facilities located within the **30 ft elevation**. For the purpose of this vulnerability assessment, it is estimated that 5% of the total dollar amount is lost.

- 70 people in five government facilities (approximate value: $194,935)
- Ten people in two emergency response facilities (approximate value: $33,434)
- 482 people in six educational facilities (approximate value: $1,473,335)
- 40 people in one medical facility (approximate value: $85,470)
- 380 people in 14 community facilities (approximate value: $3,521,579)
- Unknown highway facilities (approximate value: Unknown)
- Two bridges (approximate value: $1,501,246)
- 410 people in nine transportation facilities (approximate value: $7,186,866)
- 12 people in three utility facilities (approximate value: $398,991)

Impacts to future populations, residential structures, critical facilities, and infrastructure are unpredictable due to several complex factors, such as tsunami generating source, distance from community and originating direction of source wave. See map in Appendix E.

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.

Using information provided by the AVO, the entire existing and future Unalaska population, residences, and critical facilities are equally at risk from the effects of a volcanic eruption (see Section 5.4.6). For the purpose of this vulnerability assessment, it is estimated that 50% of the population, residences, and facilities would be affected. This includes approximately:

- 2,171 people in 553 residences (approximate value: $104,959,400)
- 125 people in six government facilities (approximate value: $9,098,690)
- 25 people in four emergency response facility (approximate value: $14,568,669)
- 504 people in six educational facilities (approximate value: $29,466,700)
- 80 people in three care facilities (approximate value: $7,016,000)
- >560 people in 20 community facilities (approximate value: >$99,987,330)
- 41 asphalt and gravel miles (approximate value: $3,813,330)
- four bridges (approximate value: $41,846,933)
- 450 people in ten transportation facilities (approximate value: $160,907,321)
- 26 people in 13 utilities (approximate value: $185,060,000)

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

Severe Weather

Impacts associated with severe weather events includes roof collapse, trees and power lines falling, damage to light aircraft and sinking small boats, injury and death resulting from snow machine or vehicle accidents, overexertion while shoveling all due to heavy snow. 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. Additional impacts may occur from secondary weather hazards or complex storms such as extreme high winds combined with freezing rain, high seas, and storm surge. Section 5.4.7 provides additional detail regarding severe weather 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 severe weather damage.

Based on information provided by the City of Unalaska and the National Weather Service, the entire existing, transient, and future Unalaska population, residential structures, and critical facilities are exposed to future severe weather impacts. For the purpose of this vulnerability assessment, it is estimated that 50% of the population, residences, and facilities would be affected. This includes approximately:

- 2,171 people in 553 residences (approximate value: $104,959,400)
- 125 people in six government facilities (approximate value: $9,098,690)
- 25 people in four emergency response facility (approximate value: $14,568,669)
- 504 people in six educational facilities (approximate value: $29,466,700)
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- 450 people in ten transportation facilities (approximate value: $160,907,321)
- 26 people in 13 utilities (approximate value: $185,060,000)

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

6.8 FUTURE DEVELOPMENT

The City's Comprehensive Plan describes their Future Land Use goals as:

> ***"Future Land Uses***
>
> *As noted by the previous sections of this chapter of the Comprehensive Plan:*
>
> - *The City of Unalaska has a tremendous amount of developable, undeveloped land;*
> - *An abundance of land is being held for future planning and development, land currently classified in a Holding Zone by the City's Zoning Ordinance;*
> - *The City has an established utility system, roadway system, and all other significant infrastructure to support continued growth and development of industry, general commercial, and housing;*
> - *The City has substantial plans for the continued expansion of infrastructure, and is working purposively to establish cost-effective and timely maintenance of all public facilities;*
> - *With expectations that the fishing industry will continue to grow and prosper, it appears that adequate land area is available for the continued development of needed facilities; and*
> - *While Unalaska is not without issues such as conflicting land uses, code violations, and the start of revitalization talks throughout the community, most land uses have been segregated, and future development has been planned for by zoning an adequate amount of land area to reasonably accommodate the growth needs of Unalaska, without over-zoning prematurely.*

The good news from a future planning perspective is that the community has a good existing planning foundation and, rather than wholesale planning and land use changes, the community should work to correct current land use conflicts, avoid similar conflicts in the future, and work to require compliance with all local growth and development codes.

And, as previously noted, the City of Unalaska has sufficient land area to accommodate any anticipated growth in the community for the foreseeable future, assuming that an adequate amount of the undeveloped land area is made available for development and is developable given contemporary construction limitations" (UCP 2011).

The Tribe describes their Future Land Use goals as: adding future housing units and relocating the Senior Center and Headstart out of the tsunami zone above sea level.

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; and
6. Implementing the Mitigation Action Plan (MAP).

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, 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?
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.

7.1 UNALASKA'S CAPABILITY ASSESSMENT

The City's and Tribe's capability assessment reviews the technical and fiscal resources available to the community.

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.

This section outlines the resources available to Unalaska for mitigation and mitigation-related funding and training. Tables 7-1, 7-2, and 7-3 delineate the City's and Tribe's regulatory tools, technical specialists, and financial resources available for project management. Additional funding resources are identified in Appendix A.

Table 7-1 Unalaska's Regulatory Tools

Regulatory Tools (ordinances, codes, plans)	Existing?	Comments (Year of most recent update; problems administering it, etc.)
Comprehensive Plan	Yes	2020 Comprehensive Plan. Explains the City's land use initiatives and natural hazard impacts.
Land Use Plan	Yes	The City's Land Use plan explains the City's land use goals and initiatives.
Tribal Corporation Land Use Plan	Yes	Qawalangin Tribe of Unalaska Land Use Plan, 1999. Describes the Village's community development goals and initiatives.
Emergency Response Plan	Yes	
Wildland Fire Protection Plan	No	This hazard is not present within the surrounding area.
Building code	Yes	Title 17 Unalaska Municipal Code of Ordinances. IBC.
Zoning ordinances	Yes	Title 8.12 UCO. City Council Ordinance 2012-07 effective October 1, 2012.
Subdivision ordinances or regulations	Yes	Title 8.08 UCO. City Council Ordinance 2012-07 effective October 1, 2012.
Special purpose ordinances	Yes	The City can exercise this authority.

Local Resources

The City and Tribe have a number of planning and land management tools that will allow them to implement hazard mitigation activities. The resources available in these areas have been assessed by the Planning Team and are summarized below.

Table 7-2 Unalaska'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	Yes	The City has staff with land development and land management knowledge.
Engineer or professional trained in construction practices related to buildings and/or infrastructure	Yes	The City has staff with construction and building and/or infrastructure knowledge.
Planner or engineer with an understanding of natural and/or human-caused hazards	Yes	Director of Planning and the associate planner.
Floodplain Manager	No	
Surveyors	Yes	The City uses consultants when a surveyor is needed. City possesses survey-grade equipment including a Total Station and two survey-grade GPS units Staff trained in use these tools are the City Engineer and Roads Chief.
Staff with education or expertise to assess the jurisdiction's vulnerability to hazards	Yes	The City and Tribe have staff with this knowledge.
Personnel skilled in Geospatial Information System (GIS) and/or Hazards Us-Multi Hazard (Hazus-MH) software	Yes	The City and Tribe have staff with this knowledge.
Scientists familiar with the hazards of the jurisdiction	No	The City and Tribe work with U.S. Fish & Wildlife Service (USFWS) and Fish & Game (ADF&G), the West Coast/Alaska Tsunami Warning Center (WC/ATWC), and AVO.
Emergency Manager	Yes	Director of Public Safety.
Finance (Grant writers)	Yes	City Finance Officer and the Tribal Administrator.
Public Information Officer	Yes	Director of Public Safety.

Table 7-3 Financial Resources Available for Hazard Mitigation

Financial Resource	Accessible or Eligible to Use for Mitigation Activities
General funds	Can exercise this authority with voter approval.
Community Development Block Grants	Can exercise this authority with voter approval.
Capital Improvement Project Funding	Can exercise this authority with voter approval.
Authority to levy taxes for specific purposes	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 communities 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 only.
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 infrastructure to protect repetitive flood structures. ***Unalaska does not qualify for this funding source because they do not participate in the NFIP.***

Table 7-3 Financial Resources Available for Hazard Mitigation

Financial Resource	Accessible or Eligible to Use for Mitigation Activities
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 mitigation goals and potential mitigation actions to address identified potential hazard impacts for Unalaska within Section 7.2.

7.2 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).

Table 7-4 Mitigation Goals

No.	Goal Description
Multi-Hazards	
1	Promote recognition and mitigation of all natural and manmade hazards that affect the City of Unalaska (City) and Qawalangin Tribe of Unalaska (Tribe).
2	Promote cross-referencing mitigation goals and actions with other City and Tribal planning mechanisms and projects.
3	Reduce possibility of losses from all natural and manmade hazards that affect the City and Tribe.
Natural Hazards	
4	Reduce structural vulnerability to earthquake damage.
5	Reduce erosion damage and loss possibility.
6	Reduce flood damage and loss possibility.
7	Reduce ground failure damage and loss possibility.
8	Reduce tsunami impact vulnerability of population and infrastructure.
9	Reduce structural and population vulnerability to volcanic ashfall impacts.
10	Reduce structural vulnerability to severe weather damage.
Technological/Manmade Hazards	
11	Reduce population vulnerability to Utility and Transportation Disruptions.

7.3 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 developing mitigation goals, the Planning Team reviewed a comprehensive list of potential mitigation actions that were identified during this MJHMP update process.

The Planning Team assessed the potential mitigation actions to carry forward into the mitigation strategy. 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.

In December 2017, the Planning Team updated the 42 natural hazard and one manmade/ technological hazard mitigation actions for the Mitigation Action Plan (MAP) that were implemented during the five-year life cycle of the 2013 HMP. The Planning Team considered and selected two additional mitigation actions for implementation during this plan update. The Planning Team placed particular emphasis on projects and programs that reduce the effects of hazards on both new and existing buildings and infrastructure as well as facilities located in potential flood zones to comply with NFIP requirements should the City join the NFIP.

The table breaks out the project criteria as considered, selected, ongoing, and completed. The Planning Team considered projects from a comprehensive list for each hazard type. They identified numerous "ongoing" mitigation actions currently in-process or those that were listed in other planning documents. The Planning Team then selected "newly identified" actions identified through this plan development activity that would most benefit the community.

These "Considered" projects are listed in Table 7-5 below.

Table 7-5 Potential Mitigation Actions

(Ongoing and newly selected items were identified for MAP implementation)

Supports Goal No.	Hazard	Criteria *Considered* *Selected* *Ongoing* *Completed*	Action Description
Multi- Hazards			
MH 1	Promote recognition and mitigation of all-natural hazards that affect the City of Unalaska (City) and Qawalangin Tribe of Unalaska (Tribe).	S High	Identify and pursue funding opportunities to implement mitigation actions.
		C	Establish a formal role for the jurisdictional Hazard Mitigation Planning Committees to develop a sustainable process to implement, monitor, and evaluate community wide mitigation actions.
		O Low	Develop, produce, and distribute information materials concerning mitigation, preparedness, and safety procedures for all identified natural hazards.
		O Med	Based on known high-risk hazard areas, identify hazard-specific signage needs and purchase and install hazard warning signs near these areas to notify and educate the public of potential hazards.
		O High	Identify evacuation routes away from high hazard areas and develop outreach program to educate the public concerning warnings and evacuation procedures.
		S High	Develop public outreach program to train proper response to each natural hazard type, i.e. Earthquake: drop, cover, and hold-on; Structure fire: Drop and Roll, and Drop and Crawl.
		Comp	Develop outreach program to educate and encourage residents to maintain several days of emergency supplies for power outages or road closures
MH 2	Cross reference Mitigation goals and actions with other City and Tribe planning mechanisms	O High	Develop Storm Water Management Plan and coordinate within other City and Tribal planning mechanisms (2020 Plan).
		S Med	The City will aggressively manage their existing plans to ensure they incorporate mitigation planning provisions into all community planning processes such as comprehensive, capital

Table 7-5 Potential Mitigation Actions

(Ongoing and newly selected items were identified for MAP implementation)

Supports Goal No.	Hazard	Criteria *Considered* *Selected* *Ongoing* *Completed*	Action Description
Multi- Hazards			
	and projects.		improvement, and land use plans, etc. to demonstrate multi-benefit considerations and facilitate using multiple funding source consideration.
		C	Integrate the Mitigation Plan findings for enhanced emergency planning.
		C	Prohibit new construction in identified mitigatable hazard impact areas (avalanche, flood, erosion, etc.) or require building to applicable building codes for other hazard impacts (earthquake, volcanic ash, weather, etc.).
MH 3	Reduce possibility of losses from all-natural hazards that affect the City and Tribe.	O	Improve riparian cover along Unalaska's waterways (2020 Plan).
		O	Install flood and erosion mitigation actions to reduce storm water-related erosion, mudslides, landslides, debris flows, and avalanches by extending pavement and ditching along gravel roads and installing catchment basins, sediment traps, and retention ponds to control sediment entry into community waterways. (2020 Plan)
		S Med	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 and medical facilities, schools, correctional facilities, and water and sewage treatment plants, etc.).
		S Med	Identify and harden utility headers located along river embankments to mitigate potential flood, debris, and erosion damages.
		S Low	Perform hydrologic and hydraulic engineering, and drainage studies and analyses. Use information obtained for feasibility determination and project design. This information should be a key component, directly related to a proposed project.
Natural- Hazards			
EQ 4	Reduce vulnerability of structures to earthquake damage.	S Med	Evaluate critical public facility seismic performance for fire stations, public works buildings, potable water systems, wastewater systems, electric power systems, and bridges within the jurisdiction.
		O Med	Encourage City utilities to evaluate and harden vulnerable infrastructure elements for sustainability.
ER 5	Reduce possibility of damage and losses from erosion.	O	Develop erosion control measures along Iliuliuk River from Unalaska Lake to Iliuliuk Harbor. (2020 Plan)
		O	Manage Iliuliuk River access to reduce sedimentation, trampling, and erosion by restricting access through fencing and constructing access walkways or elevated boardwalks at designated riverine entry locations. (2020 Plan)
		O	Conduct areawide coastal engineering evaluation to identify the most effective embankment stabilization techniques for revegetation and controlled access for subsistence and recreational uses. (2020 Plan)
		O	Determine most effective erosion protective measure for the Tanaxtagax, Amaknak Spit Site to protect from continued damage to this historical site. Artifacts found during erosion measure implementation would need to be cataloged and curated. (2020 Plan)

Table 7-5 Potential Mitigation Actions

(Ongoing and newly selected items were identified for MAP implementation)

Supports Goal No.	Hazard	Criteria *Considered* *Selected* *Ongoing* *Completed*	Action Description
Multi- Hazards			
		O	Implement appropriate erosion control and revegetate impact areas. (2020 Plan)
		O	Install bank protection 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	Install embankment protection such as vegetation, riprap, gabion baskets, sheet piling, and walls to reduce or eliminate erosion.
		S High	Install embankment protection along Icy Dam reservoir.
FL 6	Reduce the possibility of damage and losses from flooding.	O	Improve water circulation along two sections of Unalaska Lake. (2020 Plan)
		O	Develop repetitive flood impacted structures to track damages for future NFIP requirements. (2020 Plan)
		S Med	Develop, vise, adopt, and enforce storm water ordinances and regulations to manage run-off from new development, including buffers and retention ponds.
		O	Create detention storage basins, ponds, reservoirs etc. to allow water to temporarily accumulate to reduce pressure on culverts and low water crossings allowing water to ultimately return to its watercourse at a reduced flow rate.
GF 7	Reduce possibility of damage and losses from ground failure.	S	Complete a landslide location inventory; identify threatened critical facilities and other buildings and infrastructure.
		S	Update the Storm Water Management Plan to include regulations to control runoff, both for flood reduction and to minimize saturated soils on steep slopes that can cause landslides. 2018 Update—This action will be deleted in the next update as there is no Storm Water Management Plan.
TS 8	Reduce vulnerability of population and infrastructure to tsunami impacts.	O	Increase available number of warning systems in high risk areas.
		O	Develop a public education effort to reduce the public health and safety risks for this hazard.
		O	Provide customers in the hazard area with information about what to do if there is a tsunami including the best evacuation route to avoid a tsunami.
		O	Install tsunami warning and evacuation route signs in hazard areas.
VOL 9	Reduce vulnerability of population and infrastructure to Volcanic eruption impacts.	O	Update public emergency notification procedures and develop an outreach program for ash fall events.
		O	Evaluate capability of water treatment plants to deal with high turbidity from ash fall events.
		O	Develop water plant protection or sustainability plan.
		O	Evaluate ash impact on storm water drainage systems and develop mitigation actions.
		O	Evaluate electric utility air intake filter quality and inspection processes within the facilities maintenance plan.
		S	Purchase 5,000 emergency kits, which include respirators or mask to protect people from ash. Added in 2018.
		S	Install sand filter at Pyramid Valley water treatment plant to

Table 7-5 Potential Mitigation Actions

(Ongoing and newly selected items were identified for MAP implementation)

Supports Goal No.	Hazard	Criteria *Considered* *Selected* *Ongoing* *Completed*	Action Description
Multi- Hazards			
			filter ash from water reservoir in the event of ashfall event. Added in 2018.
WX 10	Reduce vulnerability of structures to severe weather damage.	S high	Develop critical facility list needing emergency back-up power systems, prioritize, seek funding, and implement mitigation actions.
		Comp	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.
		O	Develop early warning test program partnering with NOAA, City Police, and Fire Department to coordinate tests.
		O	Review critical facilities and public facility energy efficiency, winter readiness, and electrical protection capability. Identify, prioritize and implement infrastructure upgrade or rehabilitation project prioritization and development.
		Comp	Revise requirements to place utilities underground to reduce power disruption from wind storm/tree blow down damage.
Manmade / Technological Hazards			
UTD 11	Reduce vulnerability to Utility and Transportation Disruptions.	S	Develop redundant communications capability for all critical facilities.

7.4 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 evaluated and prioritized each of the mitigation actions on December 18, 2017 to determine which actions would be included in the Mitigation Action Plan. The Mitigation Action Plan represents mitigation projects and programs to be implemented through the cooperation of multiple entities in the City and Tribe. 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 climate change).

The Planning Team reviewed the simplified social, technical, administrative, political, legal, economic, and environmental (STAPLEE) evaluation criteria (Table 7-6) and the Benefit-Cost Analysis Fact Sheet (Appendix G) to consider the opportunities and constraints of implementing each particular mitigation action. For each action considered for implementation, a qualitative statement is provided regarding the benefits and costs and, where available, the technical feasibility. A detailed cost-benefit analysis is anticipated as part of the application process for those projects that the City and Tribe chooses to implement.

Table 7-6 Evaluation Criteria for Mitigation Actions

Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE)

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 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

In December 2017, the Planning Team updated 42 natural hazards and one manmade/technological mitigation actions that were selected to carry forward into the Mitigation Action Plan (MAP) in the 2013 HMP, and selected two new natural hazard mitigation actions for the 2018 MJHMP update.

The Planning Team considered each hazard's history, extent, and probability to determine each potential action's 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.

Prioritizing the mitigation actions within the MAP Matrix (Table 7-8) was completed to provide the City and Tribe with an implementation approach. The City and Tribe chose in 2018 to keep the same priorities as the 2013 HMP.

7.5 MITIGATION ACTION PLAN

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

Unalaska'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

City of Unalaska (City)
Qawalangin 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)* *Emergency Management Performance Grant (EMPG)* *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)

Table 7-8 Unalaska's Mitigation Action Plan (MAP)

(Italicized Projects were brought forward from cross referenced – Identified Plans)

(See acronym and abbreviations list for complete titles)

Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
MH 1.1	Identify and pursue funding opportunities to implement mitigation actions.	High	City of Unalaska (City), Qawalangin Tribal Council (Tribe)	City, Tribe	(1-3 Years)	B/C: This ongoing activity is essential for the City and Tribe as there are limited funds available to accomplish effective mitigation actions. TF: This is an ongoing activity demonstrating its feasibility.	The City and Tribe are continually seeking funding to implement mitigation actions. The City funded projects to implement riverbank protection and storm drain improvements since the last plan update.
MH 1.2	Develop, produce, and distribute information materials concerning mitigation, preparedness, and safety procedures for all identified natural hazards.	Low	City LEPC, City Department of Public Safety, Tribe Environmental Department	City, Tribe	Completed	B/C: FEMA provides free publications for community education purposes. TF: This activity is an ongoing LEPC supported activity demonstrating its feasibility. Low to no cost outreach efforts makes this a very feasible project to successfully educate large populations.	The LEPC has produced and distributes a disaster preparedness guide and Tsunami inundation and evacuation map.
MH 1.3	Based on known high-risk hazard areas, identify hazard-specific signage needs, and purchase and install hazard warning signs near these areas to notify and educate the	Medium	City Department of Public Safety, Tribe Environmental Department	City, Tribe, Denali Commission, DCRA, DOF, DHS&EM Mitigation & Preparedness Sections	Completed	B/C: This project will ensure the community looks closely at their identified hazard areas to ensure they can safely evacuate their residents and visitors during a natural hazard event. TF: This is an ongoing technically	The City has posted signs about the Tsunami hazard and evacuation route, which is part of their certification as a Tsunami Ready

Table 7-8 Unalaska's Mitigation Action Plan (MAP)

(Italicized Projects were brought forward from cross referenced – Identified Plans)

(See acronym and abbreviations list for complete titles)

Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
	public of potential hazards					feasible activity using existing city resources.	community.
MH 1.4	Identify evacuation routes away from high hazard areas and develop outreach program to educate the public concerning warnings and evacuation procedures.	High	City LEPC, City Planning Department, Tribe Environmental Department	City, Tribe	Completed	B/C: This project will ensure the community looks closely at their hazard areas to ensure they can safely evacuate their residents and visitors during a natural hazard event. TF: This is technically feasible using existing city and tribal resources.	The City was recently recertified by the NWS as a Tsunami Ready community. The City has marked tsunami evacuation routes, a public warning system, and a planned response method.
MH 1.5	Develop public outreach program to train proper response to each natural hazard type, i.e. Earthquake: drop, cover, and hold-on; Structure fire: Drop and Roll, and Drop and Crawl.	High	City Department of Public Safety, City LEPC, Tribe Environmental Department	City, Tribe	Completed	B/C: Sustained emergency response, preparedness, and mitigation planning and outreach programs have minimal cost and will help build and support community capacity enabling the public to prepare for, respond to, and recover from disaster events. TF: This project is technically feasible using existing City staff.	The local fire department regularly gives presentations in schools about fire safety. The LEPC also holds public meetings and distributes information about disaster response.
MH 1.6	Develop outreach program to educate and encourage residents to maintain several days of emergency supplies for power outages or road closures	Medium	City Department of Public Safety, City LEPC, Tribe Executive Director	City, Tribe	Completed	B/C: Sustained emergency response, preparedness, and mitigation planning and outreach programs have minimal cost and will help build and support community capacity enabling the public to prepare for, respond to,	This action was completed in 2014 with the development of a 12-part series about preparation for disasters and creating an emergency kit,

Table 7-8 Unalaska's Mitigation Action Plan (MAP)

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(See acronym and abbreviations list for complete titles)

Goal/ Action ID	**Description**	**Priority** (High, Medium, Low)	**Responsible Department**	**Potential Funding Source(s)**	**Timeframe** (1-3 Years 2-4 Years 3-5 Years)	**Benefit-Costs** (BC) / **Technical Feasibility** (T/F)	**Update in 2018**
						and recover from disaster events. TF: This project is technically feasible using existing City staff.	which is shown over local media.
MH 2.1	Develop Storm Water Management Plan and coordinate within other City and Tribal planning mechanisms (2020 Plan).	High	City Planning Department, Tribe Environmental Department	City, Tribe	Will be deleted	B/C: Storm Water Management plans are an essential disaster management tool. 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. **This project is identified in the City's 2020 Plan*	The City does not have a large enough population to warrant a storm water management plan at this time. This action will be deleted in the next plan update.
MH 2.2	The City and Tribe will aggressively manage their existing plans to ensure they incorporate mitigation planning provisions into all community planning processes such as comprehensive, capital improvement, and land use plans, etc. to	Medium	City Planning Department, Tribal Administrator	City, Tribe	(3-5 Years)	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	The City has a consolidated Planning Department which works to incorporate mitigation planning into the community planning process.

Table 7-8 Unaslaska's Mitigation Action Plan (MAP)

(Italicized Projects were brought forward from cross referenced – Identified Plans)

(See acronym and abbreviations list for complete titles)

Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
	demonstrate multi-benefit considerations and facilitate using multiple funding sources.					willingness to serve their community.	
MH 3.1	Improve riparian cover along Unalaska's waterways (2020 Plan)	Medium	City Public Works Department, Tribe Executive Director	City, Tribe, ANA, NRCS, USACE	(3-5 Years)	B/C: Improving slope stability and ground cover will greatly reduce potential material losses. Improving ground cover would reduce erosion and natural vegetation would help reduce foreign material intrusion within the waterways. TF: Technically feasible as the community has the skill to implement this action using existing equipment and native materials. *This project is identified in the City's 2020 Plan.	The Community is working to improve riparian protection along its waterways.
MH 3.2	Install flood and erosion mitigation actions to reduce storm water related erosion, mudslides, landslides, debris flows, and avalanches by extending pavement and ditching along gravel roads and installing catchment	Low	City Public Works Department, USACE, NRCS	City, Tribe, FHWA, DOT/PF, USACE, NRCS	(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 facilities. TF: The Community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and	In 2016, the City Public Works Department commissioned a Lake and River restoration project, which included erosion control measures along the lower Iliuliuk River and

Table 7-8 Unalaska's Mitigation Action Plan (MAP)

(Italicized Projects were brought forward from cross referenced – Identified Plans)

(See acronym and abbreviations list for complete titles)

Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
	basins, sediment traps, and retention ponds to control sediment entry into community waterways. (2020 Plan)					equipment barged in depending on the method selected. *This project is identified in the City's 2020 Plan.	improvements to storm drains on Overland Drive, Armstrong Court, and Steward Road. The Public Works Department also has done work on the storm drains on Delta Way.
MH 3.3	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 and medical facilities, schools, correctional facilities, and water and sewage treatment plants, etc.).	Medium	City Public Utilities Department	City, Tribe, Lindbergh, HMGP, FP&S, SAFER, ANA, CCP, EMPG, EOC	(1-3 Years)	B/C: Emergency power generation is a minor cost to ensure their availability for use after a hazard strikes. TF: Installing emergency generators is technically feasible for this Community as they already have staff to maintain existing community power generation facilities. *This project typically needs to be associated with essential facility upgrades for FEMA funding.	A back-up generator and automatic disconnect switch was installed at the Pyramid Water Treatment Plant as part of a series of upgrades which were contracted for in 2014. The City is working to install, maintain, and improve back-up power systems at other critical facilities as well.
MH 3.4	Identify and harden utility headers located along river embankments to	Medium	City Public Utilities Department	City, Tribe, ANA, DOT/PF, Denali Commission,	Completed	B/C: Hardening infrastructure to reduce erosion and flood damages reduces potential future	The utilities are run underneath roadways, and receive consistent

Table 7-8 Unalaska's Mitigation Action Plan (MAP)

(Italicized Projects were brought forward from cross referenced – Identified Plans)

(See acronym and abbreviations list for complete titles)

Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
	mitigate potential flood, debris, and erosion damages.			NRCS, USACE, USDA/EWP, USDA/ECP, DCRA/ ACCIMP		damages and replacement costs. TF: The City has the technical capability to manage and conduct this project.	upgrades and improvements as part of regular maintenance.
MH 3.5	Perform hydrologic and hydraulic engineering, and drainage studies and analyses. Use information obtained for feasibility determination and project design. This information should be a key component, directly related to implementing a proposed project identified from the study.	Low	City Public Works Department, Tribe Environmental Department, USACE	City, Tribe, NRCS, USACE, USDA/EWP, USDA/ECP, DCRA/ ACCIMP	(1-3 Years)	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: The City has the technical capability to manage and conduct this project. Hiring contractors to accomplish specialized studies is expected in rural/remote Alaska.	The City commissioned a study in 2016 to look for alternative water supplies outside of Pyramid Valley or raise the dam because of the high demand of water by fish processors.
EQ 4.1	Evaluate critical public facility seismic performance for fire stations, public works buildings, potable water systems, wastewater systems, electric power systems, and bridges within the jurisdiction.	Medium	City Public Works Department, Tribe	City, Tribe, ANA, EFSP, DOT/PF	(3-5 Years)	B/C: Retrofit projects can be very cost-effective methods for bush communities as materials and shipping costs are very high. Project viability is dependent on the cost and extent of modifications. A comprehensive BCA will need to be conducted for each facility to validate this activity.	The Summer Bay bridge was recently replaced with seismic considerations in the construction, including steel piles socketed into bedrock to prevent damage in the event of soil liquefaction.

Table 7-8 Unalaska's Mitigation Action Plan (MAP)

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(See acronym and abbreviations list for complete titles)

Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
						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.	
EQ 4.2	Encourage City Utilities to evaluate and harden vulnerable infrastructure elements for sustainability.	Medium	City Public Utilities Department, Tribe	City, Tribe, ANA, EFSP, DOT/PF	Complete	B/C: This project would ensure threatened infrastructures are available for use – their loss would exacerbate potential damages and further threaten survivability. F: This project is feasible using existing staff skills, equipment, and materials.	The City recently developed master plans for electrical utilities, wastewater, and water systems, which include seismic considerations.
ER 5.1	Develop erosion control measures along Iliuliuk River from Unalaska Lake to Iliuliuk Harbor. (2020 Plan)	Medium	City, Tribe	City, Tribe, ANA, NRCS, USACE, USDA/EWP, USDA/ECP, DCRA/ACCIMP	(1-3 Years)	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. *This project is identified in the	In 2016, the Public Works Department contracted out a number of Lake and River restoration projects, which included erosion control measures along the lower Iliuliuk River. These measures included installing riprap and planting beach

Table 7-8 Unalaska's Mitigation Action Plan (MAP)

(Italicized Projects were brought forward from cross referenced – Identified Plans)

(See acronym and abbreviations list for complete titles)

Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
						City's 2020 Plan.	wildrye.
ER 5.2	Manage Iliuliuk River access to reduce sedimentation, trampling, and erosion by restricting access through fencing and constructing access walkways or elevated boardwalks at designated riverine entry locations. (2020 Plan)	Medium	City Parks and Recreation Department, Tribe Executive Director	City, Tribe, ANA, NRCS, USACE, USDA/EWP, USDA/ECP, DCRA/ACCIMP	(1-3 Years)	B/C: Pre-planning and implementing appropriate access controls will greatly reduce or delay potential damage and reduce sedimentation accumulation. Project costs would outweigh replacement costs of lost facilities. TF: The community has the skill and resources to implement this action. *This project is identified in the City's 2020 Plan.	In 2016, the Public Works Department contracted out a number of Lake and River restoration projects, which included work on the lower Iliuliuk river. Further management and improvements may be required.
ER 5.3	Conduct area-wide coastal engineering evaluation to identify the most effective embankment stabilization techniques for revegetation and controlled access for subsistence and recreational uses. (2020 Plan)	Medium	City Planning Department, Tribe Environmental Department	City, Tribe, ANA, NRCS, USACE, USDA/EWP, USDA/ECP, DCRA/ACCIMP	(3-5 Years)	B/C: Pre-planning and implementing appropriate embankment stability actions will greatly reduce or delay 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. *This project is identified in the	The City and Tribe are working toward attaining funding and conducting a study.

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Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
						City's 2020 Plan.	
ER 5.4	Determine most effective erosion protective measure for the Tanaxtagax, Amaknak Spit Site to protect from continued damage to this historical site. Artifacts found during erosion measure implementation would need to be cataloged and curated. (2020 Plan)	Medium	City Planning Department, Tribe Environmental Department, USACE	City, Tribe, ANA, NRCS, USACE	(1-3 Years)	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: Technically feasible as the community has the skill to implement this action using native materials and equipment. *This project is identified in the City's 2020 Plan.	This action is ongoing, the community is working to determine the best protection method.
ER 5.5	Implement appropriate erosion control, to revegetate impact areas. (2020 Plan)	Medium	City Public Works Department, Tribe	City, Tribe, ANA, NRCS, USACE	(1-3 Years)	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. *This project is identified in the City's 2020 Plan.	In 2016, the Public Works Department contracted out Lake and River restoration projects, which included planting Beach Wildrye and hydroseeding on the banks of the Lower Iliuliuk river to stabilize the bank.
ER 5.6	Install bank protection such as rip-rap (large	Medium	City Public Works	City, Tribe, ANA, NRCS, USACE,	(1-3 Years)	B/C: Improving embankment and slope stability will greatly reduce	The City is working to install river bank

Table 7-8 Unalaska's Mitigation Action Plan (MAP)

(Italicized Projects were brought forward from cross referenced – Identified Plans)

(See acronym and abbreviations list for complete titles)

Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
	rocks), sheet pilings, gabion baskets, articulated matting, concrete, asphalt, vegetation, or other armoring or protective materials to provide river bank protection.		Department, Tribe Executive Director	USDA/EWP, USDA/ECP, DCRA/ACCIMP		potential infrastructure and residential losses. Project costs would outweigh replacement costs of lost facilities. TF: The Community has the skill and resources to implement this action.	protection. Since the last Plan update, the Public Works Department planted vegetation along the Lower Iliuliuk River to prevent erosion. The community is working on installing more riverbank protection.
ER 5.7	Install embankment protection along Icy Dam reservoir.	High	City Public Works Department, Tribe Executive Director	City, Tribe, NRCS, USACE, USDA/EWP, USDA/ECP, DCRA/ ACCIMP	(3-5 Years)	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 and resources to implement this action.	This action has been delayed by technical problems with sediment related to the Dam and Reservoir that the Community is working to solve.
FL 6.1	Develop, revise, adopt, and enforce storm water ordinances and regulations to manage run-off from new development, including buffers and retention ponds.	Medium	City Mayor, City Council, Tribe Executive Director	City, Tribe, ANA, DEC/WSRF	(3-5 Years)	B/C: Storm water management plans are an essential disaster management tool. Focused and coordinated planning enables effective damage abatement and ensures proper attention is assigned to reduce losses, damage, and materials management.	The Community has focused on higher priority actions and has not yet developed storm water ordinances.

Table 7-8 Unalaska's Mitigation Action Plan (MAP)

(Italicized Projects were brought forward from cross referenced – Identified Plans)

(See acronym and abbreviations list for complete titles)

Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
						TF: This action is feasible with limited fund expenditures.	
FL 6.2	Create detention storage basins, ponds, reservoirs etc. to allow water to temporarily accumulate to reduce pressure on culverts and low water crossings allowing water to ultimately return to its watercourse at a reduced flow rate.	Medium	City Public Works, Tribe Environmental Director	City, Tribe, ANA, Denali Commission, NRCS, USACE, USDA/EWP, USDA/ECP, DCRA/ ACCIMP	(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 facilities. TF: The community has the skills and resources to implement this action.	The community is working to improve storm water drainage. A drainage pond was installed, and more work is planned to reduce sediment entry into lakes.
GF 7.1	Complete a landslide location inventory; identify threatened critical facilities and other buildings and infrastructure.	Low	City Planning Department	City, Tribe, ANA, NRCS, Denali Commission, DCRA, USACE	Complete	B/C: Identifying ground failure locations is a minimal cost project which would decrease damage to facilities if they were sited appropriately. Project must be associated with an eligible relocation or construction project. TF: Technically feasible as the Community is currently aware of landslide locations but they have not created a formal locational inventory.	The mapping/GIS division of the City Planning Department has created an inventory and map of most known landslide and rockfall locations (see Appendix E).
GF 7.2	Update the Storm Water Management Plan to include regulations to control runoff, both for	Low	City Planning Department	City, Tribe, ANA, EPA, DEC/CWSRF	Will be deleted in next HMP update	B/C: Storm water management plans are an essential disaster management tool. Focused and coordinated planning enables	The Community does not meet the population requirements to

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Goal/ Action ID	Description	Priority (High, Medium, Low)	Responsible Department	Potential Funding Source(s)	Timeframe (1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (BC) / Technical Feasibility (T/F)	Update in 2018
	flood reduction and to minimize saturated soils on steep slopes that can cause landslides. (2020 Plan)					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. *This project is identified in the City's 2020 Plan.	warrant this action at this time. This action will be deleted in the next update.
TS 8.1	Increase available number of warning systems in high risk areas.	High	City Department of Public Safety, Tribe	City, Tribe, DHS/SHSP, EOP, DOF/AFG, FP&S, SAFER	Completed	B/C: Sustained emergency warning, response planning, and mitigation outreach programs enable communities to plan for, warn, and protect their hazard threatened populations. Each project type is cost dependent, but for the most part is cost effective and will help build and support community capacity enabling the public to prepare for, respond to, and recover from disasters. TF: This project is technically feasible using existing City staff.	The City maintains seven sirens and conducts weekly test on the warning system. Additionally, the primary cellular service provider for the region is working on improving its mobile emergency alerts.
TS 8.2	Develop a public education effort to reduce the public health	High	City LEPC, City Department of Public Safety,	City, Tribe	(1-3 Years)	B/C: Sustained mitigation outreach programs have minimal cost and will help build and	The LEPC promotes public education efforts through