Draft Matanuska-Susitna Borough Hazard Mitigation Plan Update

Farmland in the Borough, as seen from Lazy Mountain. Photo by Emily Russell/Alaska Public Media.

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February 2020

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Acronyms/Abbreviations

°F	Degrees Fahrenheit
% g	Percent of the Acceleration of Gravity
ACS	American Community Survey
AEC	Alaska Earthquake Center
AFG	Assistance to Firefighters Grant
AFS	Alaska Fire Service
AICC	Alaska Interagency Coordination Center
AKST	Alaska Standard Time
APA	American Planning Association
ARC	American Red Cross
AVO	Alaska Volcano Observatory
BLM	Bureau of Land Management
Borough	Matanuska-Susitna Borough
CC	Cryosphere
CDBG	Community Development Block Grant
CFP	Community Forestry Program
CHEMS	Community Health and Emergency Medical Services
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
DCCED	Department of Commerce, Community, and Economic Development
DCRA	Division of Community and Regional Affairs
DF&G	Department of Fish and Game
DGGS	Division of Geological and Geophysical Survey
DEC	Department of Environmental Conservation
DES	Department of Emergency Services
DHSS	Department of Health and Social Services
DHS&EM	Division of Homeland Security and Emergency Management
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

EMS	Emergency Medical Services
EQ	Earthquake
ER	Erosion
F	Fire
FEMA	Federal Emergency Management Agency
FIRMs	Flood Insurance Rate Maps
FL	Flood
FMA	Flood Mitigation Assistance
FP&S	Fire Prevention and Safety
FY	Fiscal Year
g	gravity as a measure of peak ground acceleration
GI	Geophysical Institute
HAZUS	Multi-Hazard Software
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HUD	Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
HWE	High Water Elevation
IA	Individual Assistance
IRS	Internal Revenue Service
Km	Kilometer
LEPC	Local Emergency Planning Committee
LiDAR	Light Detection and Ranging Software
M	Magnitude
Mb	Millibars
MAP	Mitigation Action Plan
MMI	Modified Mercalli Intensity
MP	Mile Post
mph	miles per hour
NOAA	National Oceanic and Atmospheric Administration
NFIP	National Flood Insurance Program
NWS	National Weather Service
PA	Public Assistance
PDM	Pre-Disaster Mitigation
PGA	peak ground acceleration

PIO	Public Information Officer
PSHAs	Probabilistic Seismic Hazard Analyses
PWs	Project Worksheets
RD	U.S. Division of Rural Development
REAA	Rural Education Attendance Area
RFC	Repetitive Flood Claim
RPSU	Rural Power System Upgrade
SAFER	Staffing for Adequate Fire and Emergency Response
SBA	U.S. Small Business Administration
SpUDs	Special Use Districts
Sq.	Square
Stafford Act	Robert T. Stafford Disaster Relief and Emergency Assistance Act
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, and Environmental
SW	Severe Weather
TF	Technical Feasibility
UAF	University of Alaska Fairbanks
UHMA	United Hazard Mitigation Assistance
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
U.S.	United States
USC	United States Code
USGS	United States Geological Survey
V	Volcanic Ash
VA	Veterans Assistance
VFA-RFAG	Volunteer Fire Assistance and Rural Fire Assistance Grant
VFD	Volunteer Fire Department
WUI	Wildland Urban Interface

1.0 Introduction

This section provides a brief introduction to hazard mitigation planning, associated grants, and a description of this 2019 Hazard Mitigation Plan (HMP) Update for the Matanuska-Susitna Borough (Borough).

1.1 Hazard Mitigation Planning

Hazard mitigation, as defined in Title 44 of the Code of Federal Regulations (CFR), Section §201, is "any sustained action taken to reduce or eliminate the long-term risk to people and property from natural hazards and their effects. Hazard mitigation is the only phase of emergency management specifically dedicated to breaking the cycle of damage reconstruction and repeated damage. As such, States and Local governments are encouraged to take advantage of funding provided by Hazard Mitigation Assistance (HMA) grant programs." (FEMA, 2015c). Hazard mitigation is any work done to minimize the impacts of any type of hazard event before it occurs and aims to reduce losses from future disasters. Hazard mitigation is a process in which hazards are identified and profiled, people and facilities at risk are analyzed, and mitigation actions are developed. Implementation of mitigation actions, which include long-term strategies such as planning, policy changes, programs, projects, and other activities, is the end result of this process.

1.2 Planning Requirements

1.2.1 Local Mitigation Plans

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 (U.S. 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). Section 322 directs State and Local entities to closely coordinate mitigation planning and implementation efforts. Additionally, it establishes the HMP requirement for the Federal Emergency Management Agency's (FEMA) HMA.

On October 2, 2015, FEMA published the Mitigation Planning Final Rule in the Federal Register, [Docket ID: FEMA-2015-0012], 44 CFR Part 201, effective November 2, 2015. Planning requirements for Local entities are described in detail in Section §201.6. Locally-adopted and FEMA-approved HMPs qualify jurisdictions for several HMA grant programs. This 2019 HMP Update for the Borough complies with Title 44 CFR Section §201.6 and applicable FEMA guidance documents as well as the 2018 State of Alaska HMP developed by the Department of Military and Veterans Affairs (DMVA) Division of Homeland Security and Emergency Management (DHS&EM).

Section 322 of the Stafford Act (42 USC 5165) as amended by P.L. 106-390 provides for State and Local governments to undertake a risk-based approach to reducing risks to natural hazards through mitigation planning. The National Flood Insurance Act of 1968 (42 USC 4001 et seq.) as amended, further reinforces the need and requirement for HMPs, linking Flood Mitigation Assistance (FMA) programs to State and Local HMPs. This change also requires participating National Flood Insurance Program (NFIP) communities' risk assessments and mitigation strategies to identify and address repetitively flood-damaged properties.

1.3 Grant Programs with Mitigation Plan Requirements

FEMA HMA grant programs provide funding to Local entities that have a FEMA-approved HMP. Two of the grants are authorized under the Stafford Act and DMA 2000, while the remaining three are authorized under the National Flood Insurance Act and the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act. As of June 19, 2008, the grant programs were segregated. The Hazard Mitigation Grant Program (HMGP) is a competitive, disaster-funded grant program whereas the other Unified Mitigation Assistance Programs (Pre-Disaster Mitigation [PDM] and FMA, although competitive) rely on specific pre-disaster grant funding sources, sharing several common elements.

> *"The DHS&EM FEMA HMA grant programs present a critical opportunity to protect individuals and property from natural hazards while simultaneously* ***reducing reliance on Federal disaster funds****. The HMA programs provide PDM grants annually to States, Local, and Tribal communities. The statutory origins of the programs differ, but all share the common goal of reducing the loss of life and property due to natural hazards.*
>
> *The PDM program is authorized by the Stafford Act and focuses on mitigation project and planning activities that address multiple natural hazards, although these activities may also address hazards caused by manmade events. The FMA program is authorized by the National Flood Insurance Act and focuses on reducing claims against the NFIP"* (FEMA, 2019h).

1.3.1 Hazard Mitigation Assistance (HMA) Unified Programs

The HMGP provides grants to Local entities to implement long-term hazard mitigation measures after a major disaster declaration. 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 Local entity with up to 20% of the total aggregate disaster damage costs to fund HMGP project or planning grants. The cost-share for this grant is 75% Federal/25% non-Federal.

The PDM grant program provides funds to Local entities 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 Fiscal Years (FY) 2016 and 2017, PDM program funding totaled approximately $90 million each year. The cost-share for this grant 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 properties. The primary source of funding for this program is the National Flood Insurance Fund. Grant funding is available for three types of grants, including Planning, Project, and Technical Assistance. Project grants, which use the majority of the program's total funding, are awarded to States and Local entities to apply mitigation measures to reduce flood losses to properties insured under the NFIP. In FY 2016, FMA funding totaled $199 million. In FY 2017, FMA funding totaled $160 million. The cost-share for this grant is 75% Federal/25% non-Federal.

The Borough participates in the NFIP.

1.4 HMP Description

The remainder of this HMP consists of the following sections and appendices:

Prerequisites

Section 2 addresses the prerequisites of plan adoption, which includes adoption by the Borough Assembly. The adoption resolution is included in Appendix C.

Community Description

Section 3 provides a general history and background of the Borough, including historical trends for population and the demographic and economic conditions that have shaped the area. A location figure of the area with its 26 Community Councils is included.

Planning Process

Section 4 describes the planning process and identifies the Project Team Members, the meetings held as part of the planning process, and the key stakeholders within the Borough. In addition, this section documents public outreach activities (Appendix B) and the review and incorporation of relevant plans, reports, and other appropriate information.

Hazard Analysis

Section 5 describes the process through which the Project Team identified, screened, and selected the hazards to be profiled in this 2019 HMP Update. The hazard analysis includes the characteristics, history, location, extent, impact, and recurrence probability statements of future events for each hazard. In addition, historical and hazard location figures are included.

Vulnerability Analysis

Section 6 identifies potentially vulnerable assets—people, residential and nonresidential buildings, critical facilities, and critical infrastructure—in the Borough. The resulting information identifies the full range of hazards that the Borough could face and potential social impacts, damages, and economic losses. Trends in land use and development are also discussed.

Mitigation Strategy

Section 7 defines the mitigation action plan (MAP) strategy which provides a blueprint for reducing the potential losses identified in the vulnerability analysis. The Project Team developed a list of mitigation goals and potential actions to address the hazard risks facing the Borough. Mitigation actions include preventive actions, property protection techniques, natural resource protection strategies, structural projects, emergency services, and public information

and awareness activities. Updates of mitigation actions implemented from the 2013 HMP are also provided.

Plan Maintenance

Section 8 describes the Project Team's formal plan maintenance process to ensure that the 2019 HMP Update remains an active and applicable document. The process includes monitoring, evaluating (Appendix F), and updating the HMP; implementation through existing planning mechanisms; and continued public involvement.

References

Section 9 lists the reference materials used to prepare this HMP Update.

Appendix A

Appendix A contains a glossary of terms that are used throughout this HMP Update.

Appendix B

Appendix B provides public outreach information, including public notices, newsletters, meeting sign-in sheets, public comments, community survey results, and presentations.

Appendix C

Appendix C provides the adoption resolution for the Borough.

Appendix D

Appendix D provides the FEMA crosswalk, which documents compliance of this HMP Update with FEMA criteria.

Appendix E

Appendix E contains the Benefit-Cost Analysis Fact Sheet used to prioritize mitigation actions.

Appendix F

Appendix F provides plan maintenance documents, such as an annual review sheet, the progress report form, and a community survey.

Appendix G

Appendix G provides values at risk for flooding by hydro unit.

Appendix H

Appendix H provides the historic wildfire incidents map.

Appendix I

Appendix I provides the Horseshoe Lake Road Community Assessment and Wildfire Protection Plan.

Appendix J

Appendix J provides the City of Houston Hazard Mitigation Plan.

Appendix K

Appendix K provides the City of Wasilla Hazard Mitigation Plan Update.

Appendix L

Appendix L provides the Native Village of Chickaloon Hazard Mitigation Plan.

2.0 Prerequisites

2.1 Adoption by Borough Assembly and Supporting Documentation

Requirements for the adoption of this 2019 HMP Update by the local governing body, as stipulated in the DMA 2000 and its implementing regulations, are described below.

DMA 2000 REQUIREMENTS: PREREQUISITES

Local Plan Adoption

Requirement §201.6(c)(5): The local hazard mitigation 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., Borough Assembly).

Element

- Has the local governing body adopted the updated plan?
- Is supporting documentation, such as a resolution, included?

Source: FEMA, 2015.

The Borough is the local jurisdiction represented in this 2019 HMP Update and meets the requirements of Section 322 of DMA 2000.

On March 16, 2020, the Borough Planning Commission held a public hearing on this HMP. The public was afforded an opportunity to provide comment and ask questions. The Planning Commission approved this HMP by Resolution __-__ (Appendix C). This action recommended this HMP Update to the Borough Assembly for adoption pending approval by the State of Alaska Hazard Mitigation Officer, FEMA, and a Public Hearing process. On March 17, 2020, this HMP was introduced at a regular meeting of the Borough Assembly. At the following regular meeting of the Assembly, there was a public hearing followed by adoption of the 2019 HMP Update by Ordinance __-__ on _____, 2020 with unanimous approval (Appendix C). The Borough Assembly adoption resolution and the FEMA letter of approval are also included in Appendix C.

2.2 Cities and Federally Recognized Entities within the Bourough

The City of Houston has a FEMA-approved and community-adopted HMP dated April 23, 2018. The City of Wasilla has a FEMA-approved and community-adopted HMP dated October 14, 2018. Representatives of the City of Palmer chose not to develop an HMP for the City or adopt the 2019 Borough HMP Update.

Two federally recognized tribes are located within the boundaries of the Borough. These tribes were given an opportunity to review the Borough HMP Update.

The Knik Tribe is a federally recognized tribe providing state and federal contracted social, educational, and economic development services to tribal members in the Upper Cook Inlet region of Alaska. Located in Southcentral Alaska, the tribe has the largest Alaska Native Village Service Area for a single tribal government covering over 25,000 square (sq.) miles. There are over 10,000 Alaska Native and Indian residents within the Tribal service area. Knik Tribal

Council has an old village site with historical significance, but no people live there. Knikatnu, Inc. is the Native corporation landowner of Knik Tribal Council's lands within the Borough.

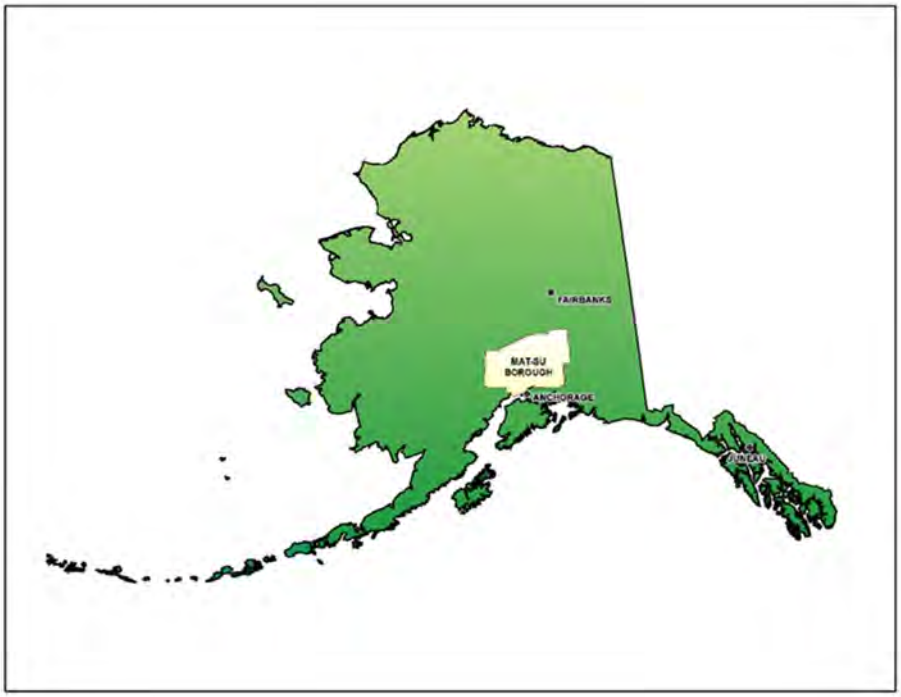
The Chickaloon Native Village is a federally recognized tribe providing services to an estimated 2,373 Alaska Natives and Native American Peoples living in their Alaska Native Village Service Area, as well as the non-native community members living in Glacier View, Chickaloon, Sutton, Palmer, and Butte.

Additionally, another federally recognized tribe located in Municipality of Anchorage has significant land holdings in the Borough. The Native Village of Eklutna serves approximately 400,000 members in the Municipality of Anchorage and the Borough and is located within the Municipality of Anchorage. The Eklutna Native Corporation (Eklutna, Inc.) has significant land holdings in the Municipality of Anchorage and the Borough, with approximately 67,000 additional acres due to be conveyed from the Bureau of Land Management (BLM) in the Borough.

3.0 Community Description

This section describes the location, government, geography, climate, history, demographics, economy, and transportation of the Borough.

3.1 Location



The Borough lies in the heart of Southcentral Alaska, encompassing over 25,000 sq. miles of rolling lowlands, mountains, lakes, rivers, and streams. The Borough includes portions of the Alaska Range to the northwest, portions of the Chugach Mountains to the southeast, and essentially the entire Talkeetna and Clearwater Ranges in its interior. The Municipality of Anchorage, Upper Cook Inlet, and Knik Arm delineate the Borough's southern border.

The Borough lies at approximately 61.6811 North Latitude and -149.0913 West Longitude (Department of Community, Commerce, and Economic Development [DCCED], Division of Community and Regional Affairs [DCRA], 2019). The Borough covers approximately 24,682 sq. miles of land and 578 sq. miles of water.

3.2 Government

The Borough is a second class borough incorporated in 1964 within the state of Alaska. The Borough has an elected Mayor and Assembly. The Borough Manager acts as chief administrator. The Borough has an appointed Planning Commission, Platting Board, Transportation Advisory Board, Historic Preservation Commission, as well as several advisory committees. The Borough's area-wide powers include: assessment and collection of taxes, education, planning and zoning, parks and recreation, ports, harbors and wharves, ambulance service, search and rescue, transportation systems, air pollution control, day care facilities, historic preservation, and transient accommodations taxation.

The Borough's non-area-wide powers include: fire suppression, regulation of fireworks, motor vehicles and operators, snow vehicles, solid waste, libraries, septic tank waste disposal,

economic development, limited health and social services, natural gas, electric, road improvement districts, animal control, and water pollution control.

3.3 Geography

The Borough is located in Southcentral Alaska and takes its name from the Athabascan Indian names for the two great rivers whose drainages form its broad central valley (the Matanuska and the Susitna Rivers). The Borough is bordered on the north by the Alaska Range and by the Chugach Range to the east. The Borough encompasses five geographically distinct regions: the Alaska Range, Talkeetna Mountains, Chugach Mountains, Susitna River Basin, and the Matanuska River Valley. Figure 1 is a graphic of the Borough's borders.

Alaska Range Region: The Alaska Range is an extremely remote, mountainous, and partially glaciated region which forms the northern and western geographic borders of the Borough. The range's main resource values include fish and wildlife, mining, and recreation. Denali National Park and Preserve is located in the northern portion of this region. Mt. McKinley or Denali, the tallest mountain in North America with an elevation of 20,320 feet, is located just north of the Borough boundary. On clear days, this peak can be viewed from many points within the Borough. This region is a remote, largely unsettled portion of the Borough.

Talkeetna Mountains Region: The Talkeetna Mountains region is the largest geographic region in the Borough. The region is generally defined as the Upper Susitna River Drainage Basin, but also includes the Central Talkeetna Mountains and the Clearwater Mountains. The region is characteristically rugged and remote, generally offering little potential for settlement except in limited areas. The George Parks Highway on the western border, the Glenn Highway on the southern border, and the Denali Highway in the northeast portion of the region offer relatively easy access for settlement in these limited areas. The Talkeetna Mountains region offers several recreational opportunities including hunting, fishing, snow-machining, skiing, backpacking, berry picking, white water rafting and kayaking, and canoeing. The community of Lake Louise is located near the eastern border of this region.

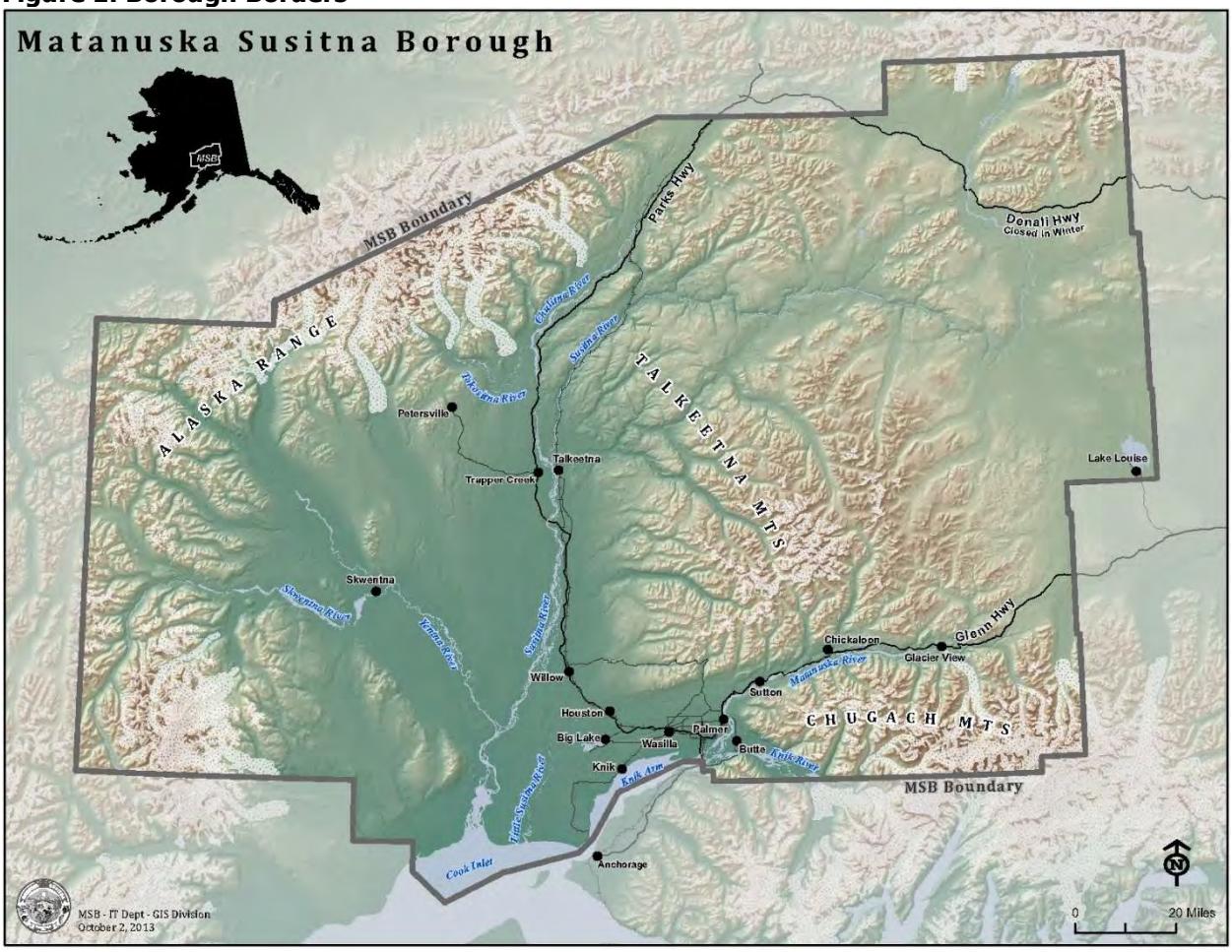
Chugach Mountains Region: The Chugach Mountains region is located in the southeast portion of the Borough. This region is almost entirely rugged mountains with more than 90% of its area above the tree line. Even though the Chugach Mountain Range is not the tallest range in the Borough, it does contain substantial glaciation due to its position as a major geographic barrier to weather systems originating in Prince William Sound and the Gulf of Alaska. The Matanuska, Knik, and Nelchina Glaciers are the area's largest glaciers and the points of origin for the region's largest rivers. The Knik Glacier is located just south of the Borough boundary. The Matanuska and Nelchina Glaciers are located within Borough boundaries. Although this region is unsettled, it supports considerable recreational use including backpacking, skiing, climbing, and hunting.

Susitna River Basin: The Susitna River Basin is the most diverse of the five geographic regions. The northern portion of the region is the drainage basin of the upper Chulitna River and includes the north Parks Highway and Denali State Park areas. The Parks Highway and Alaska Railroad divide the region and provide easy access to the land east of the Chulitna River. They also provide travelers with access to the high scenic values of the Alaska Range. The

recreational lowlands portion of the Susitna River Basin contains the majority of the Borough's surface resource wealth. Typically, the region consists of lowland muskeg interspersed with well-drained forests and numerous creeks and rivers. The region is accessible primarily by river boat, airplane, and dogsled. The Skwentna, Yenta, Kahiltna, and Susitna Rivers and their tributaries are all major anadromous fish waterways and provide migratory spawning and rearing habitat for five species of salmon. These rivers support one of the largest sport fisheries in the state. The area is also an important big game habitat and hunting area. The remote communities of Skwentna and Alexander Creek are located within this area. The remainder of the Susitna River Basin can be accessed by road and includes the communities west and north of the Cities of Houston and Wasilla. These areas also provide sport fishing opportunities including hunting, boating, hiking, skiing, and snow-machining.

Matanuska River Valley: The Matanuska River Valley encompasses the drainage basin of the Matanuska River, as delineated by the Talkeetna Mountains to the north, the Chugach Mountains to the south, following the Glenn Highway to the Borough's eastern border. The region includes the most heavily developed portion of the Borough normally referred to as the "core area". This is the area encompassing Palmer, Wasilla, and Houston, and the developed areas around and between these communities. Most of the services provided by the Borough are located within this "core area".

Figure 1. Borough Borders



3.4 Climate

The Borough falls within the transitional climate zone, characterized by a semi-arid atmosphere, long, cold winters, and mild summers, between the maritime zone to the south and the interior zone to the north. Interactions of weather fronts which blow in from the Gulf of Alaska and the mountainous topography create the varied weather conditions found throughout the Borough.

The normal annual temperature range in the Borough is -3 to 70 degrees Fahrenheit (°F). The mean monthly temperature in July/August is 58°F and in December/January is 13°F. Characteristically, the farther away from Cook Inlet and the higher the altitude, the colder the weather. Spring thaw (or "break-up") typically begins in late March or early April, depending on the location within the Borough and continues through May. Daylight hours range from a mean of 19 hours in June to five hours in December.

Precipitation in the Borough averages 15 inches annually at low elevations. In the mountains, it may exceed 80 inches. Precipitation throughout the Borough generally varies from 14 to 29 inches annually with approximately half the total precipitation falling as snow.

Local topography greatly influences both wind speed and direction. Two locally recurring winds, the Matanuska and the Knik, are notable. The Matanuska wind occurs during winter months and blows southwesterly down the Matanuska River Valley. The Knik wind occurs predominately during the summer months and blows westerly down the Knik River Valley. These winds often have velocities in excess of 60 miles per hour (mph) and occur from 16 to 25 days annually. Strong Chinook winds also occur along mountain range foothills during warm spells in the spring and winter.

3.5 History

The Athabascan Dena'ina (also known as Tanaina) Indians were settled in southcentral Alaska including the region now known as the Borough. In 1867, the U.S. purchased Alaska from Russia which had claimed it as its own during the 1700s. The Klondike Gold Rush brought thousands of prospectors and entrepreneurs to Alaska in the late 1800s and early 1900s. Gold was discovered in the Hatcher Pass area of the Borough in the early 1900s and it, along with coal mining and the construction of the Alaska Railroad, helped grow and sustain the local population. During the Depression, a U.S. government *New Deal* program brought a group of farmers to the Palmer area in an effort to establish an agricultural region in Southcentral Alaska. World War II brought the next population boom with millions of dollars spent on the Alaska-Canada Highway and the build-up of military bases and infrastructure in Alaska due to its close proximity to Japan. Construction of the regional road system and continued farming efforts spurred population growth in the Borough through the 1950s and 1960s. Alaska became the 49th State of the Union in 1959. The 1970s brought significant population growth and an economic boom to the entire state due to the construction of the 800-mile long Trans-Alaska pipeline. Today, the Borough is comprised of the lush farmlands of the Matanuska and Susitna Valleys, approximately 40 miles northeast of Anchorage. Low housing costs, the rural lifestyle, and a reasonable commute to Anchorage for employment and services has made the Borough one of the fastest growing areas of Alaska in recent years.

3.6 Demographics

The Borough is slightly larger in land area than the state of West Virginia. Most of the population is concentrated in the Borough's "core area", the approximately 100 sq. miles located between and around the cities of Palmer, Wasilla, and Houston, and several surrounding community council areas. Only about 1% of the Borough is populated, with the most densely-populated region located in the southcentral portion of the Borough (the "core area"). In 2019, 86% of Borough residents live in subdivisions and neighborhoods outside the City Limits of Wasilla and Palmer (ADN, 2019b). The remaining Borough population spreads out from this "core area" along two major corridors; the north-south Parks Highway and Alaska Railroad corridor and the east-west Glenn Highway corridor. A very small portion of the population is located along major river corridors.

The 2010 U.S. Census recorded 88,995 residents living in the Borough. The 2012 – 2016 American Community Survey (ACS) reported 98,679 residents living in the Borough, of which the median age was 34.8, indicating a relatively young population. The most recent 2018 DCCED certified population is 105,743 (DCRA, 2019). This population is expected to continue increasing as depicted in Figure 2.

About 84% of Borough residents recognize themselves as White, and 5% of Borough residents recognize themselves as Alaska Native. The percentage of males is 52%, and the percentage of females is 48%. The 2016 ACS indicated that there are 30,839 households with the average household having approximately four individuals.

There are three incorporated cities within the Borough: Houston, Palmer, and Wasilla. There are two Alaska Native entities within the Borough: The Chickaloon Village Traditional Council and the Knik Tribal Council. Additionally, Eklutna, Inc. owns significant land holdings within the Borough.

City of Houston: The City of Houston encompasses 25.3 sq. miles of land and 1.2 sq. miles of water and was incorporated as a third class city in 1966 and reclassified as a second class city in 1973. Houston is located at the northern edge of the population center of the "core area", 57 miles from Anchorage at North Latitude: 61.6312, West Longitude: -149.8007. Its 2018 DCCED certified population is 2,100. The City of Houston has a FEMA-approved and community-adopted HMP dated April 23, 2018.

City of Palmer: The City of Palmer is a Home Rule City encompassing 3.8 sq. miles of land and was formed in 1951. Palmer is located 42 miles northeast of Anchorage at North Latitude: 61.5934, West Longitude: -149.1093. Its 2018 DCCED certified population is 6,223.

City of Wasilla: The City of Wasilla encompasses approximately 11.7 sq. miles of land and 0.7 sq. mile of water and is bisected by the Parks Highway, 43 miles north of Anchorage at North Latitude: 61.5848, West Longitude: -179.4339. The City of Wasilla was incorporated in 1974 as a second class city and reclassified as a first class city in 1984. Its 2018 DCCED certified population is 8,801. The City of Wasilla has a FEMA-approved and community-adopted HMP dated October 14, 2018.

Chickaloon Native Village: The Chickaloon Native Village is an unincorporated community of 79.4 sq. miles of land and 0.8 sq. mile of water and is primarily along the Matanuska River east of the community of Sutton at North Latitude: 61.7765, West Longitude: -148.4933. Additional tribal lands are located in Sutton, the Butte area of Palmer, Wasilla, and outside of the Borough. Its 2018 DCCED certified population is 254 people.

The Knik Tribal Council is mostly a service provider and has an old village site that is uninhabited.

Additionally, there are several unincorporated communities within the Borough (Figure 3); most of these are represented by the following 26 Borough-recognized Community Councils:

- Big Lake
- Buffalo/Soapstone
- Butte
- Chase
- Chickaloon
- Fishhook
- Gateway
- Glacier View
- Greater Farm Loop
- Greater Palmer
- Knik-Fairview
- Lazy Mountain
- Louise, Susitna, Tyone
- Meadow Lakes
- North Lakes
- Petersville
- Point MacKenzie
- Skwentna
- South Knik River
- South Lakes
- Susitna
- Sutton
- Talkeetna
- Tanaina
- Trapper Creek
- Willow Area Community Organization

Figure 2. Borough's Historic Population

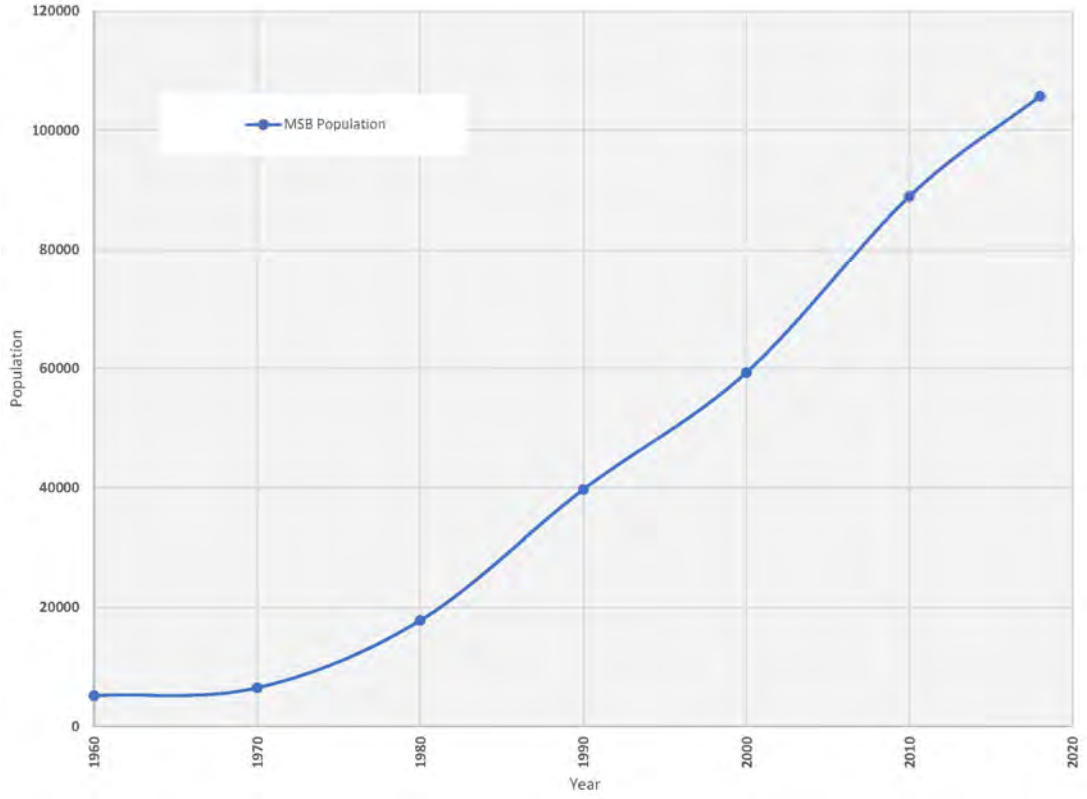
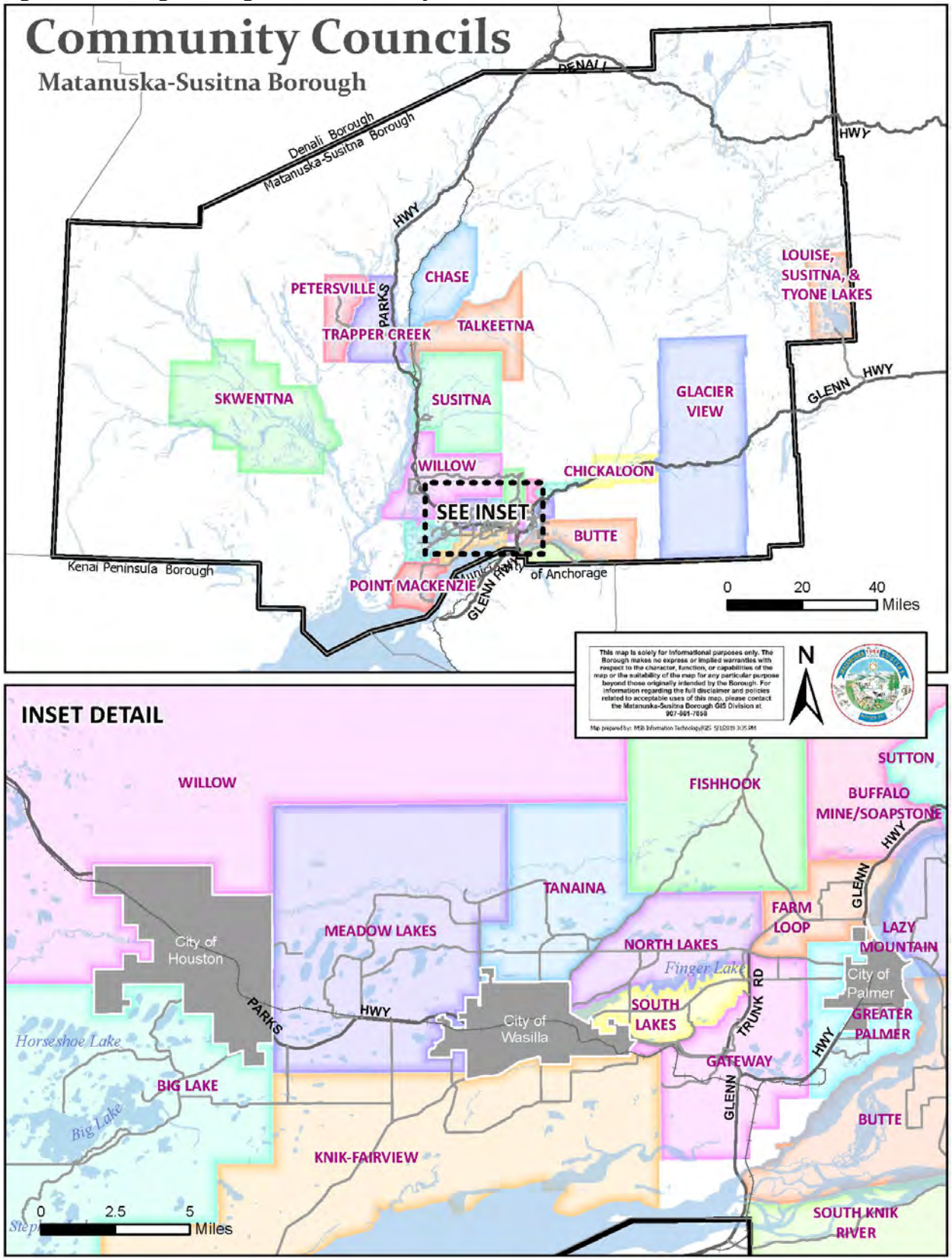


Figure 3. Borough-Recognized Community Councils



3.7 Economy

As of 2015, approximately 45% of all working Borough households have at least one family member who commutes to work outside the Borough, either in Anchorage, Eagle River, Joint-Base Elmendorf-Richardson, or to the oil pumping facilities on the North Slope of the Brooks Range. This means that on a typical workday, over 37,000 Borough residents are away from their homes at work, the overwhelming majority of them driving individual vehicles on the single road (Glenn Highway) leading south to Anchorage. Valley Transit uses two public buses and several 15 passenger vans to provide limited commuter transportation between the Borough and Anchorage.

The Borough's economy is primarily that of a bedroom community, with remnants of the Matanuska Valley's agricultural beginnings. There are a few family farms specializing in crops that do well in cold soils with a short yet intense growing season, as well as a small dairy industry. These farms are clustered around Palmer and the Point MacKenzie area. Tourism is the strongest local industry with prospects good for future sustained growth. Increasing population and tourist traffic have drawn large national retailers such as Wal-Mart, Lowes, and Home Depot to build in the "core area."

According to the 2016 ACS, the median household income in the Borough was $86,831. Approximately 9,350 individuals (9.67%) were reported to be living below the poverty level. The potential work force (those aged 16 years or older) in the Borough was estimated to be 74,564, of which 47,177 were actively employed (ACS, 2016).

3.8 Transportation

The Borough is traversed by two major federal highways, the Glenn Highway and the Parks Highway. The Glenn Highway traverses the eastern portion of the Borough and connects to the Richardson Highway at Glennallen. The Parks Highway traverses the Borough in a north/south direction parallel to the Susitna River. These two federal highways connect the Borough to the two major population centers of Alaska, Anchorage and Fairbanks, and are the major freight corridors linking the interior of Alaska with the coast. Virtually all out-of-state highway traffic travels through the Borough via one of the two interstate highways.

The Alaska Railroad traverses the Borough in a north/south direction, and, for most of its length, parallels the Parks Highway. It is a single-track line, with daily passenger service in summer reducing to weekly in winter. Flag stop service is available for areas north of Talkeetna, an area dotted with homesteads and vacation cabins not accessible by road. Development of a commuter rail system providing regular service to Anchorage has long been studied but not implemented due to high costs. Once the population reaches a critical point, commuter rail service may become financially feasible.

Palmer and Wasilla each have a Municipal Airport; however, there are no scheduled flights. Private aircraft owners and small flightseeing operations utilize both airports as well as the many small unpaved airstrips scattered throughout the Borough. The State Division of Forestry (DOF) bases its wildland firefighting air operations out of the Palmer Municipal Airport. The Borough contains more private airstrips per capita than any community of similar size in the U.S.

Construction on a 32-mile rail link between the Alaska Railroad main line in Houston and Port MacKenzie began in 2012. This rail link would provide Port MacKenzie customers/shippers with efficient rail transportation between the Port and Interior Alaska. As of September 2017, 75% of the project was complete.

Other transportation routes have been investigated. The Knik Arm Crossing Project was halted in 2016 due to a limited state budget. The project was developed to meet the current and projected transportation needs of the Municipality of Anchorage and the Borough with the goal of constructing a cost-affordable, vehicular toll bridge of about 2.7 miles across Knik Arm to join the Port of Anchorage area and Port MacKenzie area, as well as 19 miles of road to support the bridge's accessibility. The bridge would provide an efficient link between the operations and infrastructure of the two ports and offer an alternate north-south emergency response and disaster evacuation route. Work on this project is not expected to continue in the foreseeable future.

4.0 Planning Process

This section provides an overview of the planning process; identifies the Project Team members and key stakeholders; documents public outreach efforts; and summarizes the review and incorporation of existing plans, studies, and reports used to develop this HMP. Additional information regarding the Project Team and public outreach efforts is provided in Appendix B.

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

DMA 2000 Requirements: Planning Process

Local Planning Process

Requirement §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.

Element

- Does the plan provide a narrative description of the process followed to prepare the updated plan?
- Does the updated plan indicate who was involved in the planning process?
- Does the updated plan indicate how the public was involved?
- Does the updated plan discuss the opportunity for neighboring communities, agencies, businesses, academia, nonprofits, and other interested parties to be involved in the planning process?
- Does the planning process describe the review and incorporation, if appropriate, of existing plans, studies, reports, and technical information?
- 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, 2015.

4.1 Overview of Planning Process

The DMVA DHS&EM provided funding and project oversight to LeMay Engineering & Consulting, Inc. Ms. Jennifer LeMay, PE, PMP guided development of the Hazard Mitigation Project Team to assist the Borough with the HMP Update.

The planning process began on December 20, 2017, when the Local Emergency Planning Committee (LEPC) was informed that the HMP would be updated. Copies of the HMP were provided to members. Casey Cook, the Borough Emergency Manager, sent out a flyer soliciting comments on the 2013 HMP. Comments received were incorporated into the HMP. On January 22, 2019, an introductory meeting with DHS&EM and the Borough Department Heads was held to discuss what a hazard mitigation plan is, what information is required, and State of Alaska/FEMA grants that can be applied for and received by communities with Community-adopted, and State and FEMA-Approved HMPs. The Borough then posted the 2013 HMP on its website asking for public comments.

The following five-step process occurred from December 2017 through January 2020.

1. Organize resources: Members of the Project Team identified resources, including staff, agencies, and local community members, who could provide technical expertise and historical information needed in updating the 2013 FEMA-approved HMP.

2. Assess risks: The Project Team confirmed hazards specific to the Borough remained applicable and updated a risk assessment for the identified hazards, including the vulnerability analysis, prior to and during the development of the mitigation strategy.
3. Assess capabilities: The Project Team reviewed current administrative and technical, legal and regulatory, and fiscal capabilities to determine whether existing provisions and requirements adequately address relevant hazards.
4. Develop a mitigation strategy: After reviewing the risks posed by each hazard, the Project Team reviewed status updates from mitigation actions that were implemented from the 2013 HMP and updated a comprehensive range of potential mitigation goals and actions based on hazard events that had occurred since 2013. New mitigation actions were then integrated into the remaining mitigation actions to be completed and were then prioritized based on community concerns with flood/erosion identified as the top priority followed by fire and earthquake.
5. Monitor, evaluate, and update the HMP: The Planning Team developed a process to monitor the HMP to ensure it will be used as intended while fulfilling community needs. The Project Team then developed a process to evaluate the HMP on a yearly basis to compare how their decisions affect hazard impacts. They then outlined a method to share their successes with the Borough community members to encourage support for mitigation activities and to provide data for incorporating mitigation actions into existing planning mechanisms and providing data for the HMP's five-year update. Opportunities are described in the Continued Public Involvement Section of this HMP (Section 8).

4.2 Hazard Mitigation Project Team

Table 1 lists the Hazard Mitigation Project Team members and contact information.

Table 1. Hazard Mitigation Planning Team

NAME	TITLE	ORGANIZATION	PHONE
Taunnie Boothby, CFM	Borough Team Lead and Floodplain Manager	Borough	861.8526
Adam Bradway	Borough Planner	Borough	861.8608
Pam Graham	Borough Planner	Borough	861.8608
Casey Cook, Chair	Borough Emergency Manager, LEPC Advisory Board	Borough	861.8004
Casey Laughlin, Secretary	LEPC Advisory Board	LEPC	861.8005
Christian Hartley	Houston Fire Department		892.9130
Scott Bell	Menard Center Facility Supervisor		864.9105
Bea Adler	Resident		861.8005

NAME	TITLE	ORGANIZATION	PHONE
William Morrow	Red Cross		357.6060
Ray Hollenbeck	MARA – HAM Radio		373.6771
Kevin Munson	Mat-Su Health Services		352.3210
Rene' Dillow	Public Health		352.6631
Bryen Bartgis	South Central Foundation		631.7333
Kathy Watkins	Willow CERT		495.1040
Kenneth Hudson	MARA – HAM Radio		354.0206
Norman Straub	Resident		861.8005
Cathi Kramer	West Lakes Fire Department		354.8734
Kara Cahill	Mat-Su Regional		861.6575
Gene Belden	Wasilla Police		352.5421
Michael Chmielewski	Radio Free Palmer		982.7149
Dawn Hicks	Public Health		352.6600
Micah Weinstein	MTA Telecommunications		761.2121
Colleen Vague, Chair	Members	Borough Planning Commission	861.7851
Mary Anderson, Vice Chair			
Jason Ortiz			
Patricia Chesbro			
Chris Elder			
Stafford Glashan			
Sassan Mossanem			
Vern Halter, Mayor	Members	Borough Assembly	861.8683
Tim Hale			
Stephanie Nowers			
George McKee			
Ted Leonard			
Dan Mayfield			
Jesse Sumner			

NAME	TITLE	ORGANIZATION	PHONE
Tam Boeve			
Jennifer LeMay, PE, PMP	Mitigation Planner	LeMay Engineering & Consulting, Inc.	350.6061
Rick Dembroski	State of Alaska PDM Project Manager	DHS&EM	428.7015
Brent Nichols, CFM	State of Alaska Hazard Mitigation Officer	DHS&EM	428.7085

4.3 Public Involvement & Opportunity for Interested Parties to Participate

Table 2 lists the community's public involvement initiatives focused to encourage participation and public insight for the HMP effort.

Table 2. Public Involvement Mechanisms

Mechanism	Description
LEPC Meeting	On December 20, 2017, one of the agenda items at the LEPC meeting was the HMP Update. LEPC comments were incorporated into the HMP Update.
Notification of HMP Update and Request for Public Input	The Borough's website was updated with a hazard mitigation plan tab. The summary, scope, and benefits of the upcoming planning project was posted. The public was invited to comment on the 2013 HMP which was also posted on the website.
Public Survey	June 5 to 31, 2019: 721 people looked at the survey posted on the Borough's website, and 584 people answered at least one question. A brief summary is provided below this table, and the entire results are provided in Appendix B.
LEPC Meeting	On January 15, 2020, one of the agenda items at the LEPC meeting was the HMP Update. In particular, Tables 20 and 28 of the 2019 Draft HMP Update were discussed; comments were incorporated into the document after the meeting.
Public Notice, dated ____, 2020	Open House to discuss the Draft HMP Update. A public notice of the open house was prepared, and invitations were issued via the Borough's website, Facebook page, and using the local newspaper, The Frontiersman. An email was sent to the Chamber of Commerce to notify area businesses.
Public Notice, dated ___, 2020	Notice of the 30-day public comment period was provided to the public. The Draft HMP Update was also posted on the Borough's web page and Facebook page.
Public Notice, dated ____, 2020	Planning Commission meeting. The meeting was announced via public notice, radio, newspaper, website, Facebook, and a posted newsletter.
Public Notice, dated ____, 2020	Borough Assembly meeting. The meeting was announced via public notice, radio, newspaper, website, Facebook, and a posted newsletter.

The Project Team typically held internal monthly meetings twice a month as the Draft 2019 HMP Update was prepared.

In Spring 2019, the Borough posted the 2013 Plan on their website and offered the community the opportunity to participate in the updating process. Additionally, from June 5 to July 31, 2019, the Borough posted a public survey regarding hazard mitigation on its website. The survey was also shared multiple times on the Borough's Facebook page. The number of people that looked at the survey was 721, and the total number of people that answered one or more of the questions was 584. The public was advised of the survey via mailers sent to boards, Borough staff, and Community Councils. Survey results are briefly summarized below and are contained in their entirety in Appendix B.

- The top three communities that responded were Meadow Lakes, Knik-Fairview, and the City of Wasilla.
- The majority of respondents ranked email/internet/social media as their preferred method of obtaining information from the Borough followed by television/radio and mail.
- 60% of respondents thought they were somewhat knowledgeable about natural hazards facing the Borough, and 24% of respondents felt they were well-informed.
- Hazard mitigation prevention measures such as planning, building codes, open space preservation, and floodplain regulations were determined to be extremely important (46%) and very important (35%), respectively, to influence the way land is developed and buildings are built.
- Property protection actions such as removing homes from the floodplain and elevating homes to stay above water levels during flooding were determined to be extremely important (30%) and very important (44%), respectively, to lessen the risk of property damage to homes.
- Public education and awareness such as outreach programs, public service announcements, and notices to residents and property owners were determined to be extremely important (57%) and very important (33%), respectively, to inform the public about natural hazards and the actions necessary to avoid potential injury or damage.
- Natural resource protection actions such as floodplain protection, habitat preservation, slope stabilizations, riparian buffers, and forest management in addition to minimizing losses were determined to be extremely important (38%) and very important (44), respectively, to preserve or restore the functions of natural systems.
- Critical facility protection such as placing generators in hospitals to ensure electrical power during a widespread power failure was determined to be extremely important (77%) and very important (19%), respectively.
- Emergency service actions such as warning systems, evacuation planning, emergency response training, and protection of critical emergency facilities or systems were determined to be extremely important (80%) and very important (17), respectively, to protect people and property during and immediately after a hazard event.
- Of the 496 responses received to the following open-ended question (What information do you expect to receive from the Borough during a natural disaster?), most of the survey responders expected to receive the following:
    - Who, What, When, Where and Why;
    - What the disaster is and where is it located – affected areas;
    - School status;
    - Is there an evacuation;
    - Location(s) of shelters;
    - Location(s) of clean water supplies;
    - Location(s) of medical care or triage locations;
    - Instructions for what should they do next;
    - Notification of road closures; and
    - Availability of services and utilities.

- Of the 496 responses received to open-ended questions, a number of responses indicated the Borough's response to the November 30, 2018 Earthquake was lacking and that the information needed was not shared by the Borough but instead by friends and neighbors via Facebook.
- Of the 120 responses received to the following open-ended question (Any other comments/suggestions?), the top comments included:
    - The Borough's communication with their citizens during the November 30, 2018 Earthquake was severely lacking;
    - The Borough needs to implement a Nixle Alert System;
    - The Borough needs to communicate more frequent updates to the public even if there is no news to report during a hazard event and recovery effort;
    - More public education is needed; and
    - The Borough needs to develop a plan to deal with the spruce bark beetles and the standing dead spruce.

On January 15, 2020, the LEPC met for their regularly scheduled meeting. One of the agenda items was the HMP Update. LEPC members reviewed the Draft HMP Update, and their comments were incorporated. Comments are included in Appendix B.

On March 18, 2020, the Borough and FEMA held an open house to discuss Risk Map data which resulted in new flood and earthquake hazard data and Borough-developed maps, the 2019 Draft HMP Update, and resilience of the community. Comments received during the Open House were incorporated into the Draft HMP Update. The Open House kicked off a 30-day public comment period. The Borough posted the Draft HMP Update on its website and asked the public to provide input and comment. Comments are included in Appendix B.

On April __, 2020, the Draft HMP Update was introduced at the regularly-scheduled Borough Planning Commission meeting. The importance of the MSB having an updated HMP was presented.

On April __, 2020, Jennifer LeMay gave a presentation summarizing the Draft HMP Update and proposed mitigation actions. A public hearing was conducted as an agenda item of the regularly-scheduled Borough Planning Commission meeting. Comments were incorporated into the Draft HMP Update. Comments are included in Appendix B.

On April ___, 2020, the Draft HMP Update was introduced at the regularly-scheduled Borough Assembly meeting. The importance of the MSB having an updated HMP was presented.

On May ___, 2020, Jennifer LeMay gave a presentation summarizing the Draft HMP Update and proposed mitigation actions. A public hearing was conducted as an agenda item of the regularly-scheduled Borough Assembly meeting. Comments were incorporated into the Draft HMP Update. The Draft HMP Update was then submitted to DHS&EM for review before being submitted to FEMA for review.

4.4 Incorporation of Existing Plans and Other Relevant Information

During the planning process, the Project Team reviewed and incorporated information from existing plans, studies, and reports into the 2019 HMP Update. The following were reviewed

and used as references for the jurisdiction information and hazard profiles in the risk assessment (see Section 6) of the HMP:

- *The Borough Community Wildfire Protection Plan*, updated in 2008. Alaska Department of Natural Resources (ANR) Department of Forestry (DOF).
- *The Mat-Su Borough Comprehensive Development Plan*, updated in 2005.
- *Mat-Su Borough Core Area Comprehensive Plan*, updated in 2007.
- The Matanuska-Susitna Borough *All-Hazards Mitigation Plan, Natural Hazards*, Final Update September 2013.
- *Risk Map Data Package*, FEMA Region X-Matanuska-Susitna Borough, Alaska, 2019 by FEMA, DCCED, and the State of Alaska Division of Geological and Geophysical Survey (DGGS).
- State of Alaska DCCED Community Profile, provided historical and demographic information, 2019.
- State of Alaska Hazard Mitigation Plan, updated by DHS&EM, 2018.

5.0 Hazard Profiles

This section identifies and profiles the hazards that could potentially affect the Borough.

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. Even though a particular hazard may not have occurred in recent history in the study area, all-natural hazards that may potentially affect the study area are considered; the hazards that are unlikely to occur or for which the risk of damage is accepted as being very low, are eliminated from consideration. Human and Technological, and Terrorism-related hazards are beyond the scope of this HMP.

Hazard profiling is accomplished by describing hazards in terms of their characteristics, history, location, extent, impact, and recurrence probability. Hazards are identified through the collection of historical and anecdotal information, review of existing plans and studies, and preparation of hazard maps of the study area. Hazard maps are used to determine the geographic extent of the hazards and define the approximate boundaries of the areas at risk.

5.2 Hazard Identification and Screening

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

DMA 2000 Requirements: Risk Assessment: Identifying Hazards

Identifying Hazards

Requirement §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.

Element

- Does the updated plan include a description of the types of all-natural hazards with the potential to affect the jurisdiction?
- Does the risk assessment identify the location (i.e., geographic area affected) of each natural hazard addressed in the updated plan?
- Does the risk assessment identify the extent (i.e., breadth, magnitude, or severity) and impact of each hazard addressed in the updated plan?
- Does the plan provide information on previous occurrences of each hazard addressed in the updated plan?
- Does the plan include recurrence probability statements of future events (i.e., chance of occurrence) for each hazard addressed in the updated plan?

Source: FEMA, 2015.

For the first step of the hazard analysis, the Hazard Mitigation Project Team reviewed possible hazards that could affect the Borough according to the 2018 Alaska HMP (DHS&EM, 2018a). 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 (see Table 3). The Hazard Mitigation Project Team

determined that the hazards that have the potential to impact the Borough include: changes in the cryosphere (new from 2019 and includes avalanche and drought hazards), earthquakes (high), flood/erosion (high), ground failure (removed from 2019 HMP Update), volcanoes (medium), severe weather (medium), and wildland/conflagration fires (high). The remaining hazards excluded through the screening process were considered to pose a lower threat to life and property in the Borough due to the low likelihood of occurrence or the low probability that life and property would be significantly affected.

Table 3. Identification and Screening of Hazards

Hazard Type	Should It Be Profiled?	Explanation
Changes in the Cryosphere	Yes	The Borough is experiencing an increase in fires and increased temperatures. Drought is also a concern. The Borough is also susceptible to changes in the cryosphere as its geographical area includes glaciers and mountains where snow avalanches occur. The slopes throughout the Hatcher Pass area and the slope of Pioneer Peak between Goose Creek and the Knik River Bridge are well-known avalanche areas in the Borough.
Earthquakes	Yes	Alaska is an earthquake-prone state. The Castle Mountain Fault was responsible for a mid-1980s quake felt locally. The fault crosses the Parks Highway and the Alaska Railroad tracks just before the bridge over the Little Susitna River. Scientists looked at predicting peak ground acceleration within a 15-mile radius of the Wasilla city center at a depth of 15 miles. Their conclusions were that 50% of the area is highly earthquake-prone and 40% of the area would be considered a deep subduction zone. There is a 10% deep thrust area 31 to 43 kilometers (km) directly below Wasilla with a profile much like the fault that triggered the 1964 Great Alaska Earthquake (Borough, 2013).
Floods/Erosion	Yes	The National Weather Service (NWS) operates a flood-forecasting network in the Borough. Predictions are often difficult for many of the smaller rivers because of the short time span between when the precipitation occurs and flooding starts. Significant flooding on the Little Susitna River and the Matanuska River have been caused by ice jams, snow melt, and unusual amounts of precipitation. In 2019, ice jam flooding on Willow Creek has been problematic.
Ground Failure	No	The terrain in the Borough is not one likely to produce ground failure. As the Borough develops more and spreads out, ground failure due to manmade development will be assessed. Historical anecdotes indicate roads were likely built on old wooden debris, and effects may be noticed in the future. On October 7, 2019, the Frontiersman, a local newspaper published an article about a major rockslide that traveled nearly 1,000 feet down the north face of Pioneer Peak. Palmer and Butte residents heard it before they saw it. Apparently, it crashed down rapidly; for many minutes afterward, residents heard the settling and pinging of various rocks finding their new spot on the mountainside. In the wake of the landslide, a new mountain mark was made on Pioneer Peak. Rocks were likely released as precipitation from the torrential rain on October 5, 2019 made its way into the rocks, and the expansion of the freezing water broke the section(s) off. Geologists call it mass wasting (Frontiersman, 2019). The Borough will evaluate if ground failure is appropriate to add as a hazard during the 2025 HMP Update.

Hazard Type	Should It Be Profiled?	Explanation
Tsunami & Seiche	No	This hazard does not exist for the Borough per the State of Alaska HMP (DHS&EM, 2018a).
Volcanoes	Yes	The Borough has been affected by volcanic ashfall from volcanoes on the Kenai Peninsula Borough in the past.
Severe Weather	Yes	High winds are the Borough's concern. Annual weather patterns, severe cold, and blizzards also are predominant threats. High winds can reach hurricane force and have the potential to seriously damage community infrastructures, especially above ground utility lines.
Wildland/Conflagration Fires	Yes	The Borough is located in a region where wildland fire is present at a high probability. The 1996 Millers Reach Fire originated in Houston and spread to the Big Lake area and was one of the worst wildland fires in state history. It involved 37 fire departments and over 100 different agencies and organizations. In addition, 1,800 fire-fighting and support personnel responded within the first 48 hours. It took almost two weeks for the fire to be contained and during this time, it burned 37,336 acres and destroyed 344 structures. The 2015 Sockeye Fire in the Willow area of the Borough was another major fire. It burned nearly 7,220 acres and destroyed 55 residences during eight days before it was contained. In 2019, the Borough was active with various fires—the Montana Creek, Malaspina, McKinley, and Deshka Landing. The Montana Creek fire consisted of 367 acres, and the Malaspina Fire consumed 85 acres. The most destructive of the fires, the 3,753-acre McKinley fire burned between Willow and the Talkeetna cutoff and destroyed 51 homes, three businesses, and 84 outbuildings in its rapid spread due to high winds, either knocking down power lines or causing trees to fall on power lines. The number of evacuees was estimated at 350 to 400. The Deshka Landing Fire burned 1,543-acres and moved into the Nancy Lake State Recreation Area. Road access on the Parks Highway and the Alaska Railroad adjacent to the fires was erratic.

5.3 Hazard Profile

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

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

- Hazard Characteristics;
    - Typical event characteristics;
    - Potential climate change impacts are primarily discussed in the Changes in the Cryosphere hazard profile but are also identified where deemed appropriate within selected hazard profiles;
- History (geologic as well as previous occurrences);
- Location;
- Extent (breadth, magnitude, and severity);

- Impact (general impacts associated with each hazard are described in the following profiles, and detailed impacts to the Borough's residents and critical facilities are further described in Section 6 as part of the overall vulnerability summary for each hazard); and
- Recurrence probability statement of future events.

The hazards profiled for the Borough are presented in the rest of Section 5.3. They are placed in alphabetical order which does not signify the importance level or risk.

5.3.1 Cryosphere

5.3.1.1 Hazard Characteristics

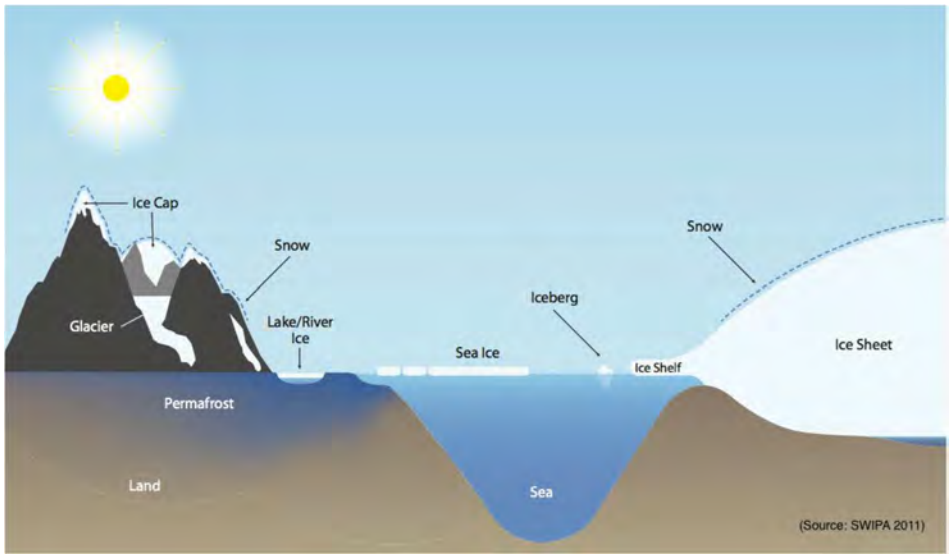
The "cryosphere" is defined as those portions of Earth's surface and subsurface where water is in solid form, including sea, lake, and river ice, snow cover, glaciers, ice caps and ice sheets, and frozen ground (e.g., permafrost) (Figure 4). The components of the cryosphere play an important role in climate. Snow and ice reflect heat from the sun, helping to regulate the Earth's temperature. They also hold Earth's important water resources, and therefore, regulate sea levels and water availability in the spring and summer. The cryosphere is one of the first places where scientists are able to identify global climate change.

Hazards of the cryosphere can be subdivided into four major groups:

- Glaciers;
- Permafrost and periglacial;
- Sea ice; and
- Snow avalanche.

Of these four major groups, all but sea ice applies to the Borough.

Figure 4. Cryosphere Components Diagram



Source: DHS&EM, 2018a

Glaciers are made of compressed snow, which has survived summer and transformed into ice. Over many years, layers of accumulated ice build into large, thickened ice masses. Due to the sheer mass of accumulated ice, glaciers flow like very slow rivers. Presently, glaciers occupy about 10% of the world's total land area, with most located in polar regions. Today's glaciers are much reduced from the last Ice Age, when ice covered nearly 32% of the land and 30% of the oceans. Most glaciers lie within mountain ranges that show evidence of a much greater extent during the ice ages of the past two-million years, and recent retreat in the past few centuries. Hazards related to glaciers include ice collapse (e.g., glacial calving and ice fall avalanche), glacial lake outburst flood, and glacial surge.

Permafrost and periglacial hazards are caused by the effects of changing perennially frozen soil, rock, or sediment (known as permafrost) and the landscape processes that result from extreme seasonal freezing and thawing (Figure 4). Permafrost is found in nearly 85% of Alaska and is thickest and most extensive in Arctic Alaska north of the Brooks Range. It is present virtually everywhere and extends as much as 2,000 feet below the surface of the Arctic Coastal Plain. Southward from the Brooks Range, permafrost becomes increasingly thinner and more discontinuous, broken by pockets of unfrozen ground until it becomes virtually absent in Southeast Alaska, with the exception of pockets of high-elevation alpine permafrost (DHS&EM, 2018a).

A snow avalanche is a mass of snow, ice, and debris that releases and slides or flows rapidly down a steep slope, either over a wide area or concentrated in an avalanche chute or track. Avalanches reach speeds of up to 200 mph and can exert forces great enough to destroy structures and uproot or snap large trees. A moving avalanche may be preceded by an "air blast," which is also capable of damaging buildings. Snow avalanches commonly occur in the high mountains of Alaska during the winter and spring as the result of heavy snow accumulations on steep slopes.

Alaska is particularly vulnerable to cryosphere hazards, as much of its social and economic activity is connected to the existence of snow, ice, and permafrost.

Glaciers

Ice Collapse hazards result from large ice chunks breaking off from a glacier, either through glacial calving or as an ice fall avalanche. These hazards are almost impossible to predict, and in contrast to most other hazards in the cryosphere environment, they can happen independently of weather (e.g., heavy precipitation and rapid warming). In Alaska, ice collapses have, on multiple occasions, been triggered by earthquakes. Depending on the volume of ice collapse, these hazards can have tremendously devastating effects and can cause additional hazards, such as flooding and snow avalanches.

Glacial Calving is the breaking away of a mass of ice from a near-vertical ice face along the terminus of a glacier, often into a large body of water. Glacier calving can be accompanied by a loud cracking or booming sound as the blocks of ice break loose and crash into the water. The entry of the ice into the water can cause large, sometimes hazardous, waves that can swamp boats and inundate nearby shores.

Ice Fall Avalanches are triggered by new or existing cracks (crevasses) in the glacier ice that allow chunks of a glacier to detach and fall down the slope as a mass of broken ice. The mass of these ice falls often triggers snow avalanches on the slope below as they hit the snowpack. Ice fall avalanches are unrelated to precipitation, temperature, or other typical snow avalanche factors.

Permafrost and Periglacial

In the periglacial environment, the effects of freezing and thawing drastically modify the ground surface. Types of modification include the displacement of soil materials, migration of groundwater, and the formation of unique landforms. Many periglacial regions are underlain by permafrost that strongly influences geomorphic processes acting in these parts of the world.

Permafrost, defined as ground with a temperature that remains at or below freezing (32°F) for two or more consecutive years, can include rock, soil, organic matter, unfrozen water, air, and ice. Regions with permafrost are typically categorized by percent of surface area underlain by permafrost (Figure 5): continuous (>90%), discontinuous (50-90%), sporadic (10-50%), and isolated (<10%) permafrost. The Borough has isolated, sporadic, and discontinuous permafrost. Figure 6 is a generalized permafrost hazard potential map of Alaska that was produced in 2018 as part of the State of Alaska HMP Update (DHS&EM, 2018a). The Borough is generally in a low or moderate permafrost hazard area.

Frost Cracking results from freezing soil contraction. This contraction can be forceful enough that the ground cracks in order to release tensile stress, similar to what happens when mud dries to form mud cracks. In extreme cases, polygons may form from thermal contraction in very cold environments and develop ice wedges within the cracks from meltwater and blowing snow accumulation. Frost cracking can be hazardous when it occurs in road surfaces, breaking pavement, and road bed structure.

Frost Heaving occurs when the soil surface is lifted with great strength from below by seasonal ice lens development in fine-grained soils. The temperature gradient from the freezing surface into the unfrozen ground drives liquid water to the freezing front, where it can freeze into solid ice lenses. Buildings and roads are affected by the lifting force of the growing ice lenses, but the most destructive conditions occur when there is differential frost heave. Differential frost heave occurs when ice lens formation is non-uniform, and only portions of the soil surface are pushed up—this can break building foundations and roads to pieces. A compounding effect of the seasonal ice lenses that cause frost heaving is that, upon thawing, the soil is left supersaturated, meaning that the liquid is carrying the weight of the soil. Pressure on the supersaturated soil, such as driving on a road across the thawed ice heave area, causes horizontal (lateral) movement of the soil and destruction of the overlying roadbed. This is the reason that roads can fail in spring, and why there are restrictions on axle weight.

Frost Jacking occurs when a solid object, such as a fence post or foundation block, is incrementally jacked out of the ground due to ice lens formation within the soil during repeated freeze-thaw cycles. Two mechanisms are believed to be responsible for frost jacking:

- Freezing soil grips the object and heaves upward due to expanding ice, thereby lifting the object out of the ground; and

- Water trickles underneath a solid object, and resultant ice growth during freezing pushes the object out of the ground. This process can cause foundations to break and buildings to collapse.

Snow Avalanche

Snow avalanche is a downhill mass movement of snow or fluidized snow. The damage caused by an avalanche varies based on the avalanche type, the consistency and composition of the avalanche flow, the flow's force and velocity, as well as the avalanche path. Their size, run-out distance, and impact pressure vary. Large avalanches have the potential to kill people and wildlife, destroy infrastructure, level forests, and bury entire communities. Significant avalanche cycles (multiple avalanches naturally releasing across an entire region) are generally caused by long periods of heavy snow, but avalanche cycles can also be triggered by rain-on-snow events, rapid warming in the spring, and earthquakes.

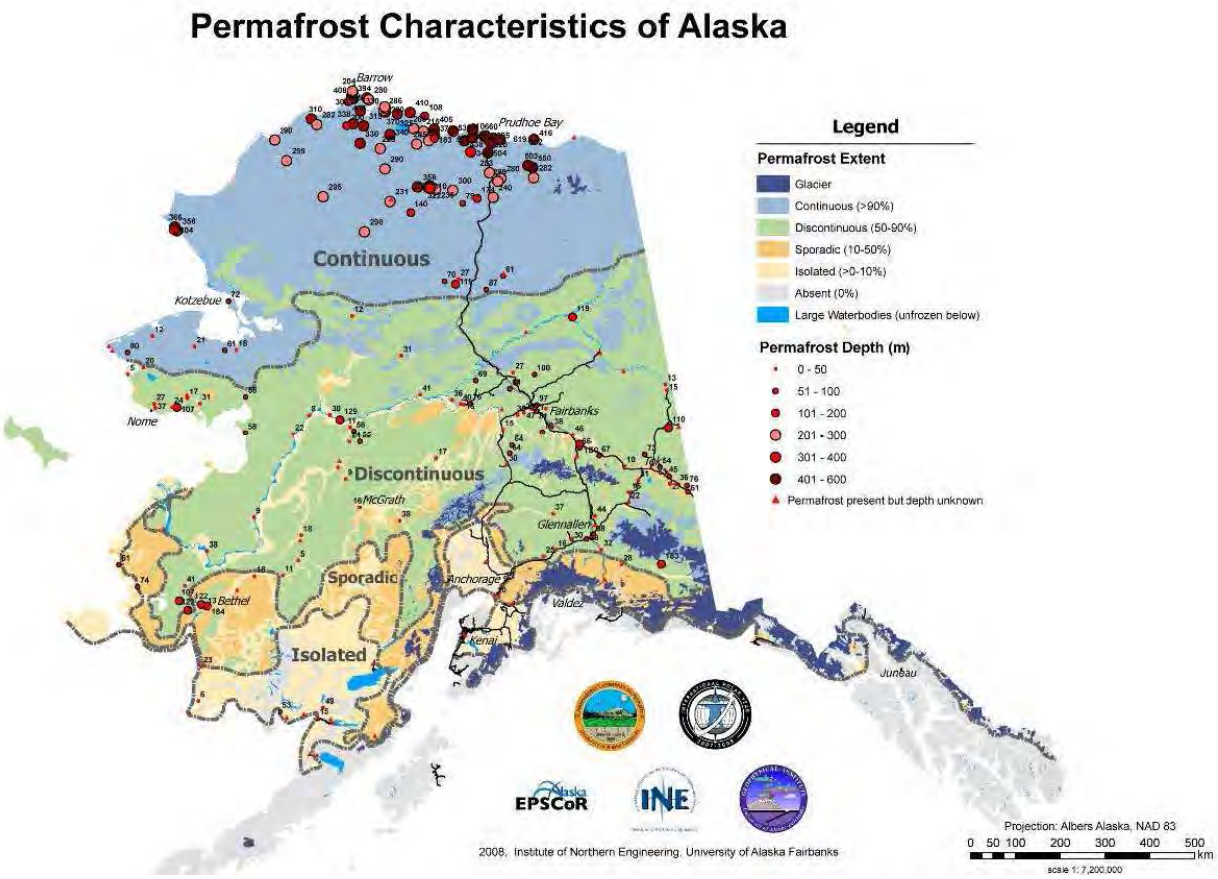
An avalanche releases when gravity-induced shear stress on or within the snowpack becomes larger than its shear strength. Triggers can be natural (e.g., rapid weight accumulation during or just after a snowstorm or rain event, warming temperatures, and seismic shaking) or artificial (e.g., human weight or avalanche-control artillery).

Terrain factors that influence avalanche release are slope angle, aspect, and curvature, as well as topography (terrain roughness). Avalanches are also controlled by vegetation cover and elevation, which are both factors in getting enough snow accumulation on the slope. Avalanches typically release on slopes greater than 25 degrees and less than 60 degrees; this is the slope range where the snow can accumulate enough to build a slab, but also where snow tends to remain in place without sluffing off due to gravity. It is important to remember that avalanche run-out (deposition) can occur on all slopes. Figure 7 is a generalized avalanche-potential map of Alaska that was produced in 1980 by compiling and cross-correlating topographic relief, snow-avalanche regions, climatic zones, snowpack characteristics, and known and suspected avalanche activity. The map includes regions that had little or no snow avalanche occurrence data and is therefore provisional until better data are available and new analysis methods and avalanche modeling can be applied.

New Alaska avalanche studies are currently being carried out by the DGGS and the University of Alaska Fairbanks (UAF). Figure 8 depicts potential snow avalanche release areas within a 6-mile buffer of roads in Alaska. The modeling uses digital topographic information as input and determines the potential release zones based on geostatistical parameters (e.g., elevation, slope, and curvature) and land cover (e.g., trees). This is a preliminary model result that does not include weather or snowpack parameters, but more advanced studies that will incorporate these elements are planned (DHS&EM, 2018a).

The slopes throughout the Hatcher Pass area and the slope of Pioneer Peak between Goose Creek and the Knik River Bridge are well-known avalanche areas in the Borough.

Figure 5. Permafrost Characteristics of Alaska



Alaska leads the nation in avalanche accidents per capita and experiences multiple fatalities each year due to this hazard. In addition to human risk, road closure due to avalanches is very costly. For example, a typical road closure with roughly 1,500 cubic feet of snow covering the road costs the Alaska Department of Transportation & Public Facilities (ADOT&PF) approximately $10,000 to remove. In the winter of 1999 to 2000, unusually high snowfall from the Central Gulf Coast Storm fueled avalanches in Cordova, Valdez, Anchorage, Whittier, Cooper Landing, Moose Pass, Summit, the Matanuska-Susitna Valley, and Eklutna. Damages in these communities exceeded 11 million dollars, resulting in the first presidentially-declared avalanche disaster in U.S. history. This storm is listed as 00-191 and is included in the Severe Weather Section 5.3.5.3.

Colorado and Alaska have the highest annual per capita death and injuries caused by avalanches. This is because some of the most-traveled roads pass through avalanche prone areas and because there is a high frequency of backcountry avalanches triggered by the many hikers, skiers, and snow machine users. There is growing exposure to this hazard as development continues to occur in avalanche-prone areas and participation in winter recreational activities increases.

Figure 6. Permafrost Hazard Areas Map

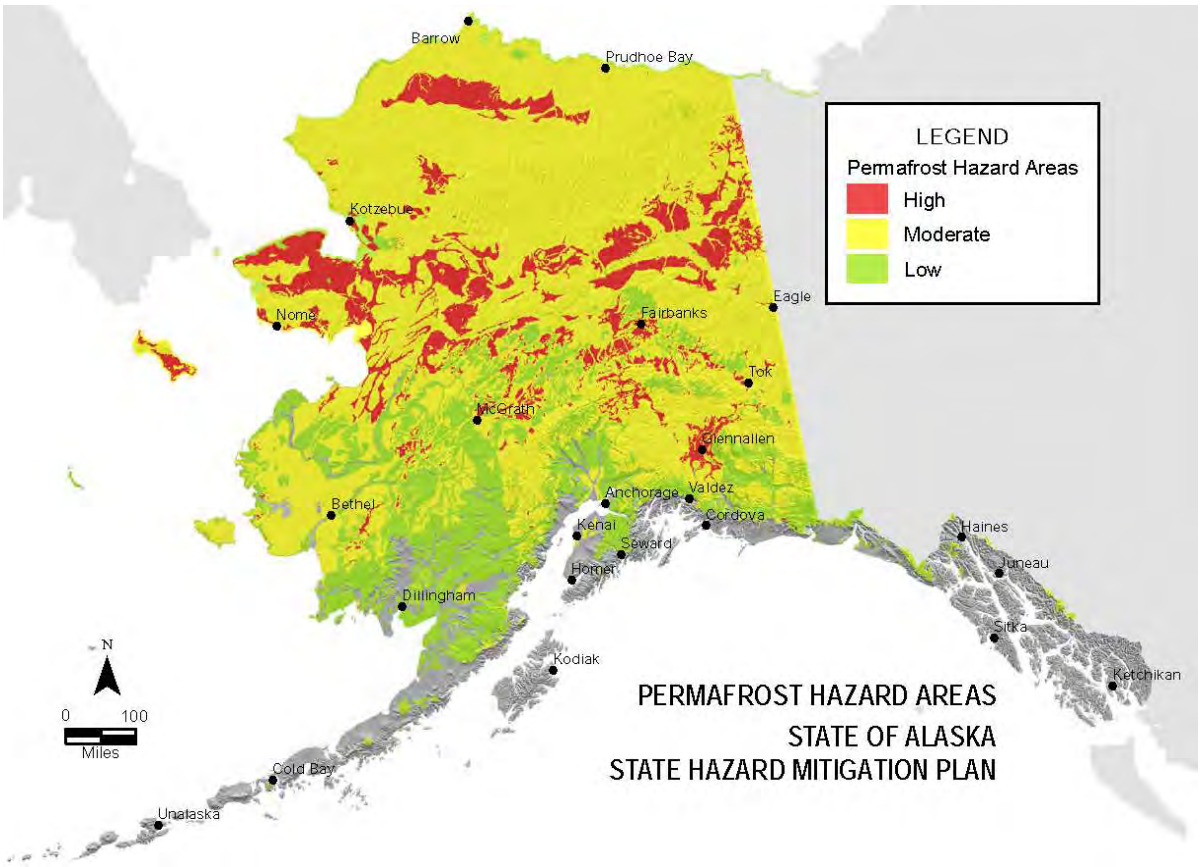


Figure 7. Map Depicting Alaska's Potential Snow-Avalanche Areas

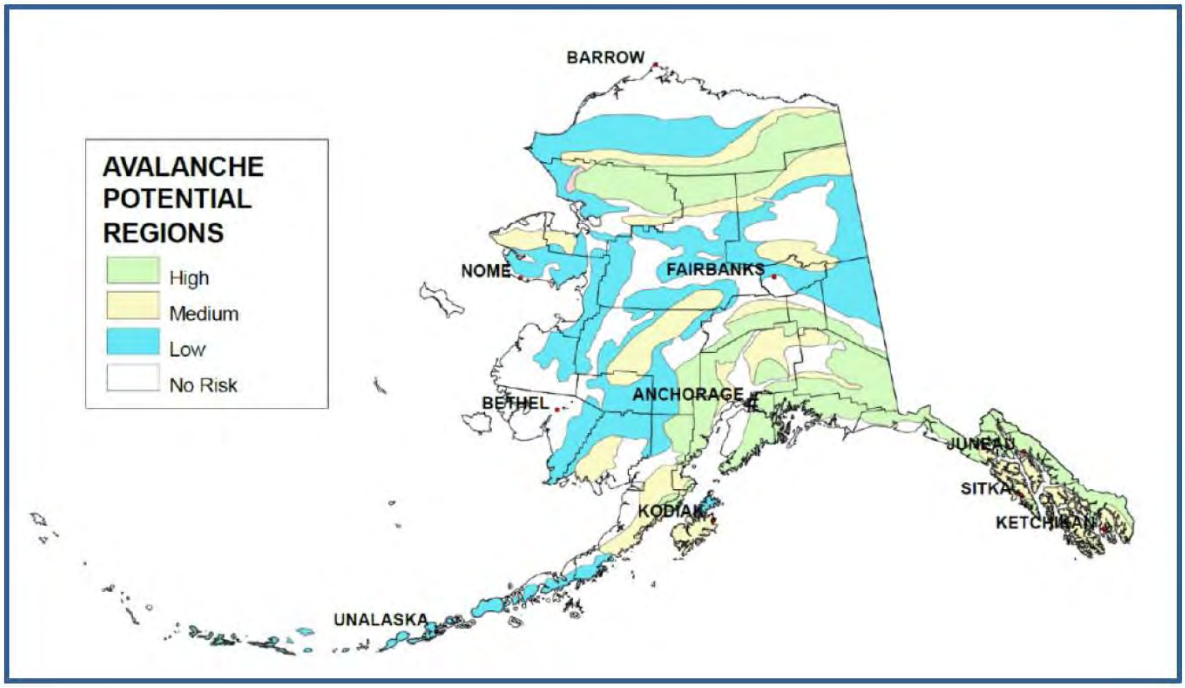
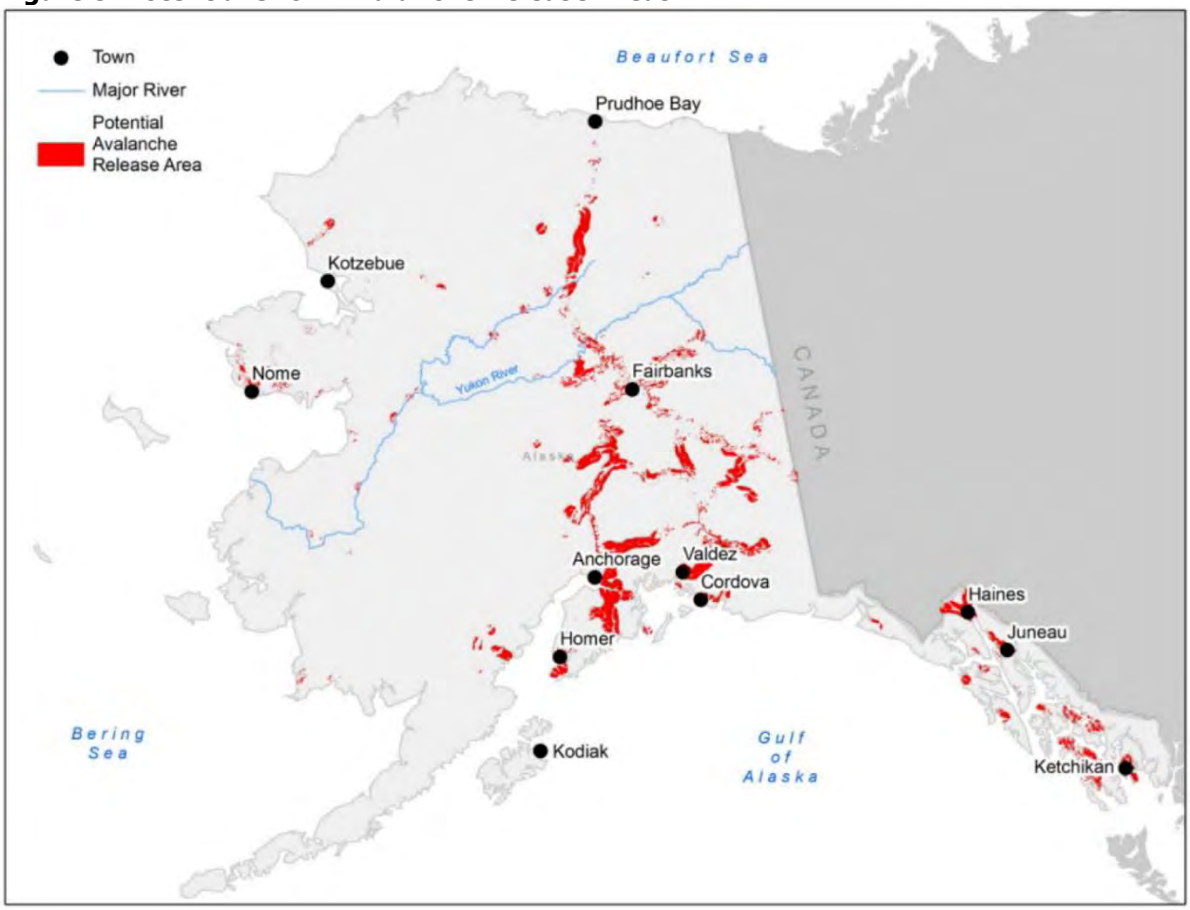


Figure 8. Potential Snow-Avalanche Release Areas



5.3.1.2 Climate Factors

Climate has a major effect on cryosphere hazards because these hazards are so closely linked to snow, ice, and permafrost. Changes in climate can modify natural processes and increase the magnitude and recurrence frequency of certain geologic hazards (e.g., avalanches, floods, erosion, slope instability, and permafrost thaw), which if not properly addressed, could have a damaging effect on Alaska's communities and infrastructure, as well as on the livelihoods and lifestyles of Alaskans.

During the last several decades, Alaska has warmed twice as fast as the rest of the U.S. Alaska's glaciers are in steep decline and are among the fastest-melting glaciers on Earth. New ice-dammed lakes are being formed in valleys formerly occupied by glaciers, and as climate change continues on its current trajectory, more ice-dammed lakes can be expected. Glacier retreat also causes debuttressing and valley-wall unloading, potentially increasing rockfall and landslide incidences.

Permafrost is at an increased risk of thawing as a result of climate change. The major climatic factor leading to warming and thawing permafrost is an increase in air temperatures. Another important factor is the potential increase in snow depth predicted by the majority of climate models. Snow insulates permafrost from low winter temperatures, which leads to an increase in ground temperatures and diminishes permafrost stability. When soils are warm, permafrost

becomes unstable and is sensitive to catastrophic collapse in conjunction with flooding and erosion. Even in non-ice-rich soils, process-driven models show more material is available for erosion and transport when the soil is thawed, which leads to increased exposure of underlying or adjacent frozen material to thermal and physical stressors (DHS&EM, 2018a).

Scientific data on the impacts of changing climate on the active layer (i.e., the surface layer above the permafrost that thaws each summer) is sparse, but on the decadal timescale (i.e., tens of years), the depth of the active layer looks to be increasing. This is potentially destructive to permafrost stability because the ground is not completely refreezing in winter.

Some studies suggest that warming climate may increase avalanche risk due to changes in snow accumulation and moisture content, as well as loss of snowpack stability because of changing air temperature. Increased rain-on-snow event frequency is leading to an increase in avalanche hazards all across Alaska.

The Borough has two main roads (Parks Highway and Glenn Highway) connecting to the rest of the state's road systems. Most Alaska communities have road choke points such as bridges and steep terrain that are susceptible to multiple natural hazard impacts from earthquakes, floods, and changes to the cryosphere events such as landslides, mudslides, and avalanches.

Although the Borough did not declare a disaster emergency declaration, the U.S. Drought Monitor showed moderate and abnormally dry conditions in the Borough. The U.S. Drought Monitor is produced through a partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the U.S. Department of Agriculture (USDA), and the National Oceanic and Atmospheric Administration (NOAA). Figure 9 illustrates drought conditions observed in Alaska. Drought conditions were experienced in the Borough in 2019.

Drought conditions increase wildfires. Drought conditions also have the potential to adversely affect subsistence resources such as salmon (loss of habitat, decreased survival rates, and decreased access to salmon spawning grounds). Furthermore, drought conditions have the potential for many unknowns related to subsistence resources when considering changes in the climate over time – berries, terrestrial animals, wild plants, etc. are all potentially affected by drought.

5.3.1.3 Cryosphere Hazard History

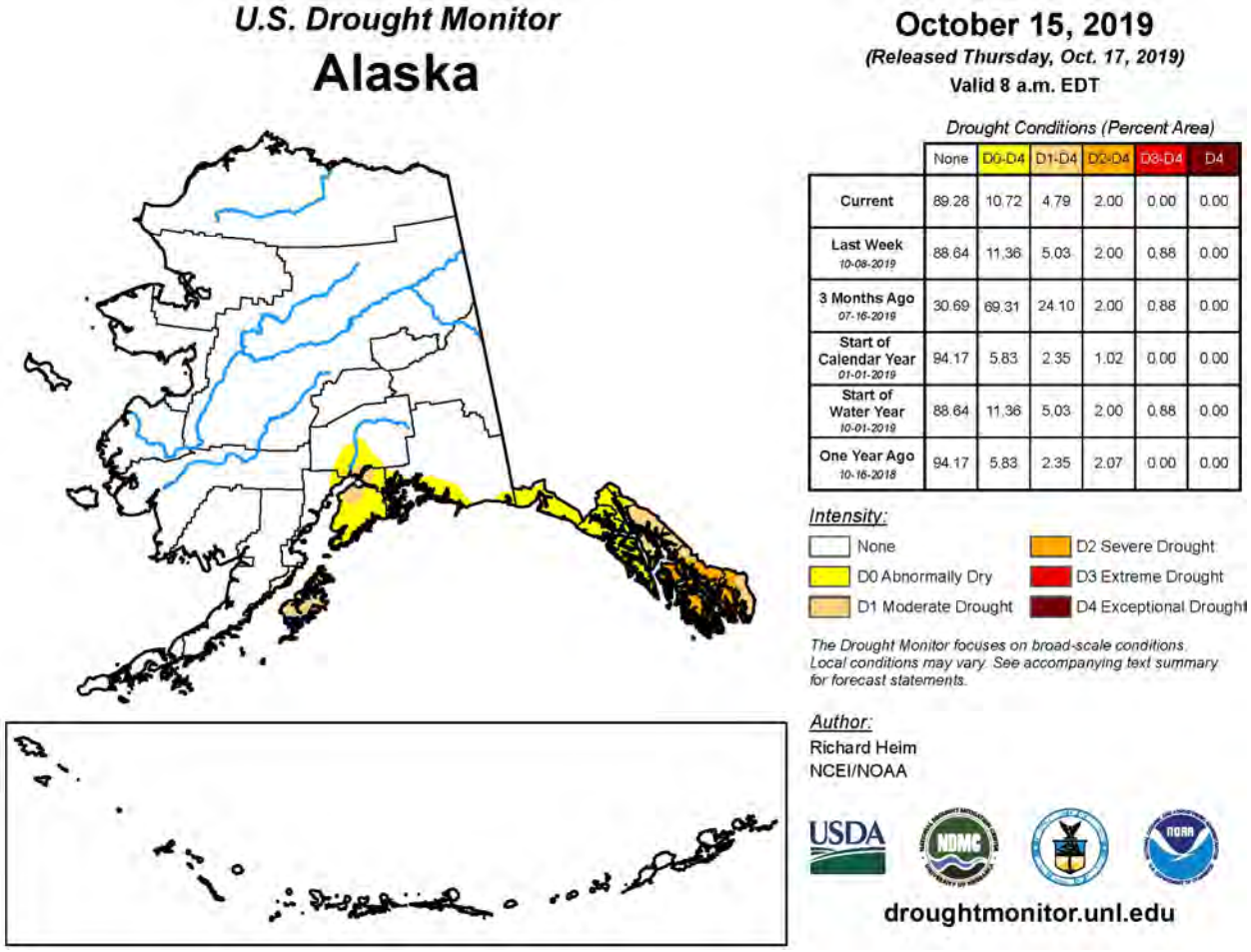
There is no written history of changes to the cryosphere for the Borough. Visual evidence includes:

- Frost heaves on the highways and roads;
- Powerlines tilting to the side; and
- Subsidence as the active layer melts.

A brief summary from *Alaska's Changing Environment: Documenting Alaska's physical and biological changes through observations* is provided below (Thoman and Walsh, 2019).

- Temperatures have been consistently warmer than at any time in the past century.

Figure 9. U.S. Drought Monitor of Conditions in Alaska



- The growing season has increased substantially in most areas, and the snow cover season has shortened.
- Precipitation overall has increased. In Southcentral, annual precipitation since the 1990s has increased 3.4%. Flooding and erosion have increased.
- Recent years have brought many temperature extremes to Alaska, including the warmest year (2016), the warmest month (July 2019), and in places like Anchorage, the warmest day (July 4, 2019).
- Warmer springs and earlier snow melt have lengthened the wildfire season. Wildfire seasons with more than one million acres burned have increased 50% since 1990, compared to the 1950 – 1989 period. The frequency of longer wildfire seasons has increased dramatically.
- A major outbreak of spruce bark beetles has been spreading through Southcentral Alaska during the past several years. The area affected by the outbreak increased from 33,000 acres in 2015 to 593,000 acres in 2018. While small populations of beetles are always present in spruce forests, sudden increases in their populations are favored by a dry summer, which reduces trees' capacity to produce sap, a defense against the beetle.

Longer and warmer summers also increase beetles' reproductive capacity, while milder winters increase over-winter survival rates.

Table 4 lists avalanche hazard events for the past 20 years.

Table 4. Borough Avalanche Events

DAY	EPISODE NARRATIVE
December 9, 2000	An avalanche fatality occurred between 1:30 pm and 2:00 pm. The put-in was an area north of Dunkle Mine, around Milepost 196 on the Parks Highway. The accident site was about 16 miles in from the road, just inside the park boundary. The victim went to help a stuck snowmachiner who had been "highmarking" on a hill which tapered into a ravine. The stuck snowmachiner got himself unstuck and rode downhill. The victim was just heading downslope when he was hit from behind (witnesses said he probably didn't even see the slide coming and thus, didn't accelerate to try to ride it out). The width of the slide was estimated between 1/4 and 1/2 mile wide. The victim was carried roughly 400 yards. A team of searchers found the sled and began probing upslope. Within about 15 minutes, they found the victim. He was buried face down, about four feet deep, roughly 20 feet upslope from his snowmachine.
February 3, 2001	Snowmachiners triggered an avalanche on a slope south of Eureka, near the east fork of the Matanuska River. The avalanche killed two members of the group and slightly injured a third man, who was carried downslope and trapped beneath his snowmachine until he was freed.
February 12, 2001	Three avalanches closed the road above the Motherlode Lodge in the Hatcher Pass area coupled with nearly three feet of new snow.
November 11, 2001	A small wind slab avalanche released under a 30-year old woman and her male friend. The slide carried the two about 100 yards down the slope. The man came to rest on top of the snow. The woman was buried, head-down, under three feet of snow. She perished.
April 20, 2002	A weekend storm reportedly dumped more than four feet of snow on the mountains around Hatcher Pass, setting up three avalanches that closed the road there. No injuries or property damage was reported; however, three people from the Hatcher Pass Lodge got stuck when they tried to leave Saturday. They were taken out by snowmachine.
February 9, 2003	Two snow-boarders were caught in an avalanche off Hatch Peak (in Hatcher Pass). One dug out, the other was buried for two hours before being finally dug out by rescuers who attempted, unsuccessfully, CPR. Heavy wet snow fell in the Pass during the prior week, with more than a foot since Thursday. High winds over the weekend shifted snow loads to lee slopes, including the northeast-facing run near the Pass. Both snow-boarders were at the base of the mountain when the avalanche let go.
February 28, 2006	An avalanche in Hatcher Pass above the Mother Lode Lodge killed a snow boarder.
November 2015	A person skiing on a solo trip disappeared and was assumed to be buried by an avalanche.
January 2, 2016	A person riding a snowmachine was caught in a terrain trap when an avalanche released above him. He was buried under six feet of snow and perished.
January 16, 2016	A snowboarder triggered an avalanche on Skyscraper Mountain in Hatcher Pass Recreation Area. He was buried under 7.5 feet of snow and perished.
November 22, 2017	An avalanche in Hatcher Pass took the life of a local ski coach. Strong winds and low snow caused the snowpack to be very unstable.
March 19, 2018	Hatcher Pass Avalanche Center reported an avalanche closed the road to the ski area at the top. Ten people were stranded at the ski area for 24 hours while DOT cleared the road. No one was injured.

5.3.1.4 Location, Extent, Impact, and Recurrence Probability

Location

The Matanuska, Knik, and Nelchina Glaciers are the area's largest glaciers and the points of origin for the region's largest rivers. The Knik Glacier is located just south of the Borough boundary. The Matanuska and Nelchina Glaciers are located within Borough boundaries. At 27 miles long by four miles wide, the Matanuska Glacier is the largest glacier accessible by car in the U.S. Its terminus feeds the Matanuska River. It lies near the Glenn Highway about 100 miles northeast of Anchorage and flows about one foot per day. Due to ablation of the lower glacier, as of 2007, the location of the glacier terminus has changed little over the previous three decades. Nelchina Glacier is located 15 miles south of Eureka. Nelchina Glacier heads on the north side of the Chugach Mountains, with Mounts Siegfried, Valhalla, and Fafnir on its western fork, and Audubon Mountain on its eastern fork. It trends north to its terminus at the head of the Nelchina River. Nelchina Glacier is 22 miles long and drains into Tazlina Lake.

Port MacKenzie, located across Knik Arm from Anchorage, is a deep-water port that mainly serves industrial customers. The Borough owns and operates the dock; and it has been in operation since 2001. In 2005, a new deep-draft dock was completed, allowing larger export ships to use the facility. Currently, the port is accessed via a 40-mile road from the highway in Wasilla. The 8,940-acre port is dedicated to commercial and industrial development. Sea ice is not an issue.

The slopes throughout the Hatcher Pass area and the slope of Pioneer Peak between Goose Creek and the Knik River Bridge are well-known avalanche areas in the Borough. There are no homes at Hatcher Pass. Homes along the Old Glenn Highway outside of Palmer have been relocated out of the danger zone.

Droughts and an increase of spruce bark beetle could increase fire risk Borough-wide.

Extent

Permafrost is found beneath nearly 85% of Alaska. Permafrost can harbor ice in many forms, ranging from massive ice bodies to ice lenses to disseminated interstitial ice crystals. Thawing causes landslides, ground subsidence, flooding, and erosion as well as lake disappearances or new lake development. Periglacial hazards result from the effects of repeated freezing and thawing and include frost cracking, frost heaving, and frost jacking, and can occur anywhere in the state.

The entire state of Alaska is at risk of effects of climate change. Historical climate data shows that the average annual temperature in Alaska has warmed about 4°F since the 1950s and 7°F in winter. The growing season has lengthened by about 14 days. Models predict continued warming, including an increase in temperature by 1.5 to 5°F by 2030 and 5 to 18°F by 2100.

Impact

Permafrost and periglacial impacts include a full range of damage from comparatively minor bending or buckling of manmade features due to heterogeneous movement, to complete destruction of infrastructure and buildings due to catastrophic ground failure and flooding.

Permafrost and periglacial processes have generated comparatively slow ongoing phenomena in the past, but warming climate is expected to increase the magnitude and frequency of damaging permafrost collapse. Frost cracking, frost heaving, and frost jacking are annually occurring events.

Snow avalanches are dangerous natural hazards that occur in mountainous areas. Approximately 30% of Alaska is subject to avalanche activity, and snow avalanche is the weather-related natural hazard that causes the most fatalities in the state. Driven by gravity, these hillslope mass movements of snow can release on slopes of 20–60°, but their run-out zones (where debris is deposited) can include slopes less than 20°, such as valley floors, and steep cliffs (slope > 60°). Large avalanches have the potential to kill people and wildlife, destroy infrastructure, level forests, and bury entire communities. In many areas of the state, avalanches lead to lengthy closures of important transportation routes. The economic impacts of such avalanches, from impeding traffic to removing avalanche debris blocking the transportation corridor, can be significant at both the local and state levels. Large avalanche cycles (multiple avalanches naturally releasing across a wide region) are generally caused by long periods of heavy snow, but avalanche cycles can also be triggered by rain-on-snow events, rapid warming in the spring, and earthquakes. Large avalanche cycles are more common in Alaska during pronounced climate events driven by changes in the Pacific Ocean, such as during La Nina/El Nino and the larger-scale Pacific Decadal Oscillation, that cause warmer air temperatures and heavier precipitation than normal. However, the effects on air temperature and precipitation during these climate abnormalities vary across the state, consequently, the resulting likelihood of avalanche activity depends on region.

Impacts associated with degrading permafrost include surface subsidence, infrastructure, structure, and/or road damage. Permafrost does not pose a sudden and catastrophic hazard, but improperly designed and constructed structures can settle as the ground subsides, resulting in loss of the structure or expensive repairs. Permafrost restricts use of the ground surface, and affects the location and design of roads, buildings, communities, and airfields. To avoid costly damage to these facilities, careful planning and design in the location and construction of facilities is warranted.

Permafrost impacts include a full range of damage from comparatively minor bending or buckling of manmade features due to heterogeneous movement, to complete destruction of infrastructure and buildings due to catastrophic ground failure. Permafrost has generated comparatively slow ongoing phenomena in the past, but warming climate is expected to increase the magnitude and frequency of damaging permafrost collapse. Indicators of a possible ground failure (involving melting permafrost) 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.

Recurrence Probability

Changes to the cryosphere are occurring and will continue to do so.

5.3.2 Earthquake

Alaska is one of the most seismically active regions in the world and is at risk of societal and economic losses due to damaging earthquakes. On average, Alaska has one "great" magnitude [(M) >8] earthquake every 13 years and one M 7-8 earthquake every year. Earthquakes have killed more than 130 people in Alaska during the past 60 years (DHS&EM, 2018a).

It is not possible to predict the time and location of the next big earthquake, but the active geology of Alaska guarantees that major damaging earthquakes will continue to occur and can affect almost anywhere in the state. Scientists have estimated where large earthquakes are most likely to occur, along with the probable levels of ground shaking to be expected. With this information, as well as information on soil properties and landslide potential, it is possible to estimate earthquake risks in any given area.

Alaska earthquake statistics include:

- Alaska is home to the second-largest earthquake ever recorded (1964 Great Alaska Earthquake, M 9.2);
- Alaska has 11% of the world's recorded earthquakes; and
- Three of the eight largest earthquakes in the world occurred in Alaska.

Since 1900, Alaska has had an average of:

- 45 M 5-6 earthquakes per year;
- 320 M 4-5 earthquakes per year; and
- 1,000 earthquakes located in Alaska each month.

Source: UAF Earthquake Center

5.3.2.1 Hazard Characteristics

An earthquake is a sudden motion or trembling caused by a release of stress accumulated within or along the edge of 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 rupture area. 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 more damaging than seismic waves because they cause larger motions and their frequency is close to harmonic frequencies for human structures and for sedimentary deposits.

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

- **Strong Ground Motion** is ground shaking. Strong ground motion intensity is directly correlated with earthquake magnitude (i.e., the larger the earthquake magnitude, the more intense and widespread the ground shaking will be). The strong ground motion severity is also dependent on the distance from the energy source.
- **Surface Rupturing** occurs when the subsurface patch of fault that slips in an earthquake intersects the earth's surface. This causes discrete, differential ground movement during intense earthquake shaking. The relative crustal block motion is dictated by the rupture's fault type, which can be horizontal, vertical, or a combination of both. Earthquakes larger than a M of 6.5 have sufficient energy to create surface ruptures, but whether or not this occurs is dependent on the earthquake's depth. The shallower a depth at which a significant earthquake occurs, the more likely it is to create a surface rupture. Permanent displacement along faults can be substantial. Surface ruptures, as a product of intense strong ground motion, can cause severe damage to existing structures.
- **Landslides/Debris Flows** occur as a result of horizontal seismic inertia forces induced in the slopes by 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 completely 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 M. 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 rupture (where the fault moved). While the area directly above the rupture usually experiences the most intense earthquake effects (e.g., shaking), the total area affected can cover hundreds of thousands of square miles, depending on the earthquake's M.

Larger earthquakes are less common than smaller earthquakes, such that the smallest earthquakes are extremely frequent, while the largest earthquakes are relatively infrequent.

Earthquakes are also classified by their felt effects (e.g., perceived shaking intensity). However, the effects of an earthquake are directly related to the distance from the earthquake rupture, among other parameters such as the type of crust where the earthquake occurs. In general, the closer one is to an earthquake's epicenter, the more severe the felt effects and damage will be. An earthquake's intensity is described by the Modified Mercalli Intensity (MMI) Scale. As shown in Table 5, the MMI Scale consists of 10 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).

Table 5. Perceived Shaking, Potential Damage, and Peak Ground Acceleration

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
MMI scale	I	II–III	IV	V	VI	VII	VIII	IX	X+

M is the measure of the earthquake's strength and 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.

Earthquakes in Southcentral Alaska are produced by a number of different tectonic features.

1. The strongest earthquakes in Southcentral Alaska are generated by the megathrust fault that marks the contact zone between the subducting Pacific and overriding North American plates. The 1964 M of 9.2 Great Alaska Earthquake, which is still the second largest earthquake ever recorded worldwide, began under Prince William Sound.
2. Intermediate depth seismicity (below 20 miles) occurs in the so-called Benioff Zone, where the subducting Pacific Plate descends towards the mantle beneath the North American Plate. This zone extends along Aleutian Arc, Alaska Peninsula, and Cook Inlet and terminates beneath the northern foothills of the Alaska Range. In southern and central Alaska, this seismicity abates at a depth of approximately 140 miles, reflecting the down-dip extension of the Pacific Plate. Historically, M 6+ earthquakes of this type have been recorded beneath Cook Inlet.
3. Crustal seismicity in this region can be attributed to three major sources: the faults and folds of the Cook Inlet basin, the Castle Mountain Fault (Figure 13), and the wide band of diffuse seismicity extending from northern Cook Inlet to the Denali Fault. Mapped geological structures in upper Cook Inlet are capable of generating strong earthquakes. The April 1933 M of 6.9 earthquake, which

caused considerable damage in Anchorage, appears to have occurred on such a structure. The Castle Mountain Fault, which passes 25 miles north of Anchorage, exhibits geological evidence of Holocene offsets and generated the M of 7.5 1984 Sutton earthquake. The diffuse zone of seismicity between Cook Inlet and the Denali Fault may mark a deformation zone between the Bering microplate to the west and the southern Alaska block to the east. This broad zone of seismicity includes a series of predominantly thrust faults, and a 1943 M of 7.0 earthquake may have originated in this band.

5.3.2.2 History

Since 1925, 39 earthquakes have been recorded with a M of 6.0 or greater within a 150-mile radius of the approximate center of the Borough (62.133610° N, 149.906096° W) (Table 6). Within the same area, there have been 179 earthquakes greater than a M of 5.0 and 1,119 greater than a M of 4.0. The largest two recorded earthquakes within 150 miles of the Borough within the last 20 years measured a M of 7.9 occurring on November 2, 2002, and M of 7.1 occurring on November 30, 2018. The November 30, 2018, earthquake caused significant damage to infrastructure and neighborhoods within the Borough (see Section 5.3.2.3 for preliminary impact numbers).

Table 6. Historical Earthquakes within a 150-Mile Radius of the Approximate Center of the Borough

Time	Latitude	Longitude	Depth	M	Place
November 30, 2018	61.3464	-149.9552	46.7	7.10	Point MacKenzie, Matanuska-Susitna Borough
September 25, 2014	61.9449	-151.8160	108.9	6.20	60 miles WNW of Willow
November 3, 2002	63.5141	-147.4529	4.2	7.90	Central Alaska
October 23, 2002	63.5144	-147.9116	4.2	6.60	Central Alaska
May 1, 1991	62.4760	-151.4130	114.2	6.30	Central Alaska
September 7, 1983	60.9760	-147.5000	45	6.40	Southern Alaska
July 12, 1983	61.0310	-147.2860	37	6.60	Southern Alaska
March 28, 1964	60.9080	-147.3390	25	9.20	1964 Prince William Sound Earthquake
October 21, 1962	61.3900	-149.2100	71	6.00	Southern Alaska
August 18, 1962	62.2600	-152.5400	46	6.13	Central Alaska
July 16, 1962	62.2700	-152.5800	50	6.00	Central Alaska
June 29, 1962	62.4000	-152.1700	23	6.00	Central Alaska
May 10, 1962	61.9600	-150.1100	82	6.00	Southern Alaska
August 28, 1959	63.4200	-148.8500	44	6.00	Central Alaska
October 3, 1954	60.6510	-150.3920	61.5	6.40	Kenai Peninsula
March 3, 1954	61.5400	-146.7800	56	6.25	Southern Alaska
June 25, 1951	61.1000	-150.1000	128	6.25	Southern Alaska
August 19, 1948	63.0000	-150.5000	100	6.25	Central Alaska
October 16, 1947	64.1310	-148.6130	26	7.20	Central Alaska
November 3, 1943	61.7760	-151.0510	15	7.60	Southern Alaska
July 30, 1941	60.9270	-151.0330	35	6.40	Kenai Peninsula
October 11, 1940	60.0000	-150.5000	UKN	6.00	Kenai Peninsula
September 4, 1935	63.7500	-152.5000	UKN	6.25	Central Alaska
August 2, 1934	61.5000	-147.5000	UKN	6.00	Southern Alaska
June 18, 1934	60.8550	-151.3160	15	6.00	Kenai Peninsula
June 2, 1934	61.2500	-147.0000	UKN	6.25	Southern Alaska
May 4, 1934	61.5350	-147.7810	25	6.90	Southern Alaska
June 19, 1933	61.2500	-150.5000	UKN	6.00	Southern Alaska
June 13, 1933	61.0000	-151.0000	UKN	6.25	Southern Alaska

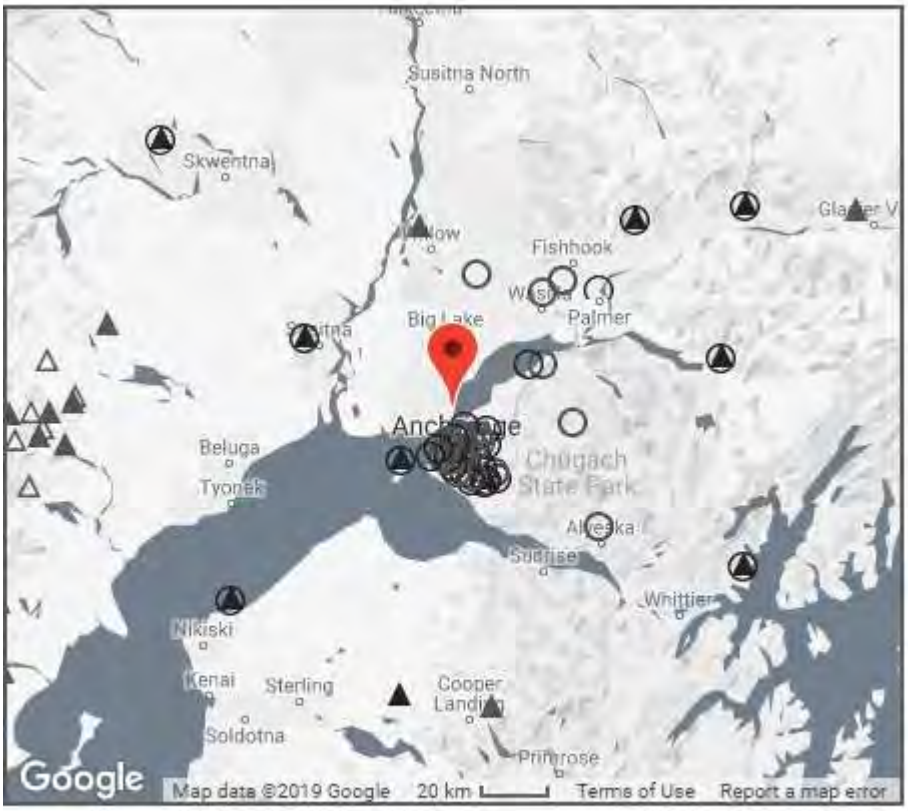
April 27, 1933	61.1310	-151.0040	15	6.90	Southern Alaska
January 4, 1933	60.9010	-148.3950	20	6.40	Kenai Peninsula
September 14, 1932	61.0000	-148.0000	50	6.25	Southern Alaska
June 8, 1932	62.5000	-153.3000	UKN	6.00	Central Alaska
March 25, 1932	62.5360	-152.9570	15	6.80	Central Alaska
March 25, 1932	62.5000	-153.0000	UKN	6.00	Central Alaska
July 3, 1929	62.5000	-149.0000	UKN	6.25	Central Alaska
January 21, 1929	64.0000	-148.0000	UKN	6.25	Central Alaska
June 21, 1928	60.5590	-147.0390	15	6.80	Southern Alaska
February 23, 1925	61.1090	-147.7550	25	6.60	Southern Alaska

Additionally, the 2002 Denali Fault earthquake provided disaster assistance to the Borough per the DHS&EM Disaster Cost Index (DHS&EM, 2018b).

03-203 Denali Fault Earthquake (AK-DR-1440) Declared November 6, 2002 by Governor Knowles, then FEMA Declared November 8, 2002 - A major earthquake with a preliminary magnitude of 7.9 occurred on the Denali Fault in Interior Alaska on November 3, 2002, with strong aftershocks. The earthquake caused severe & widespread damage and loss of property, and threat to life & property in the Fairbanks North Star Borough, the Denali Borough, the **Matanuska-Susitna Borough**, and numerous communities within the Delta Greely, Alaska Gateway, Copper River, and Yukon-Koyukuk Regional Education Attendance Areas including the cities of Tetlin, Mentasta Lake, Northway, Dot Lake, Chistochina and Tanacross, and the unincorporated communities of Slana and Tok. The areas experienced severe damage to numerous personal residences requiring evacuations and sheltering of residences; extensive damage to primary highways including the Richardson Highway, the Tok Cutoff, **the Parks Highway**, and road links to communities including the road to Mentasta and Northway. Damage to supports for the Trans-Alaska Pipeline necessitated the shutdown of the pipeline. Additionally, fuel spills from residential storage tanks, significant damage to water, septic, sewer and electrical systems also occurred. Not all of the areas listed in the State disaster were included in the Federal Individual Assistance Program. Assistance to those areas was through the State Individual Assistance Program. Additionally, not all of the areas listed in the State declaration were eligible for all categories of assistance under the Federal Public Assistance Program. Those areas were only eligible for Debris Removal & Emergency Protective Measures under the Federal Public Assistance Program but were eligible for all Permanent Work categories under the State Public Assistance Program. FEMA also authorized 404 Mitigation funding. DOT submitted an appeal letter after funding was denied by FEMA for permanent repair of the runways at Northway and Gulkana Airports. On August 10, 2004, FEMA granted the second appeal, which awarded DOT an extra $13.5 million to conduct the repairs. Individual Assistance totaled $67K for 12 applicants. Public Assistance totaled $24.8 million for 17 applicants with 53 project worksheets (PWs).

The President declared a disaster (DR-4413) for the November 30, 2018 Earthquake with a M of 7.1 with its epicenter at Point MacKenzie, Alaska within the Borough, but a description has not yet been added to the DSH&EM Disaster Cost Index (DHS&EM, 2018b). This earthquake was located 10 miles north of Anchorage, at a depth of 29 miles and occurred at 8:29 am. It was followed by numerous significant aftershocks. See Figure 10 for the epicenter location and Figure 11 for pictures of some damages.

Figure 10. November 30, 2018 Earthquake Epicenter at Point MacKenzie



November 30, 2018 08:29:29 AKST
61.3234°N 149.9234°W Depth 27.4 miles

Wide-spread damage occurred to structures and roadways throughout the Borough as well as the Anchorage Municipality. Houston Middle School in the Borough was destroyed, and FEMA is determining whether it will be a demolition/rebuild project. A brief summary of observed strengths from the Quick-Look After-Action Report on January 29, 2019 included:

- Matcom was able to maintain call receiving and dispatch services throughout the incident even though suffering physical damage to the dispatch center.
- The Department of Emergency Services was able to answer all requests for service although some calls had to be reprioritized and stacked.
- Fire Service Areas and Emergency Medical Services (EMS) were able to manage the requests for emergency services including two structure fires, 31 EMS calls, and 111 calls for fire department assistance, which included 49 reported gas leaks.
- The Borough School District competently protected the students in their care and conducted a rapid assessment of damages.
- The MatSu Regional Medical Center was able to maintain their services and overcame structural and operational challenges in providing care to 117 persons injured by the earthquake.

Figure 11. Vine Road, Houston Middle School, and Alaska Railroad

5.3.2.3 Location, Extent, Impact, and Recurrence Probability

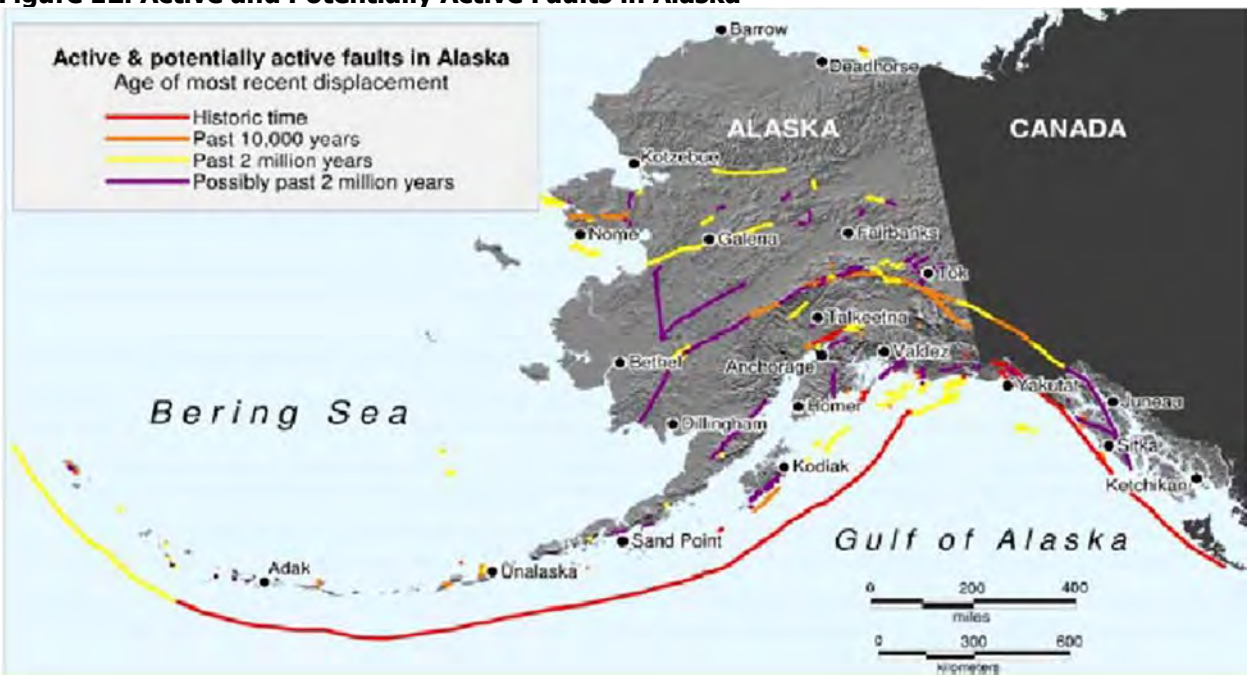
Location

The Uniform Building Code rates the entire state of Alaska in Earthquake Zone 4, the highest hazard level. Figure 12 shows the locations of active and potentially active faults in Alaska. Approximately 75% of Alaska's detected earthquakes occur in the Alaska Peninsula, Aleutian, Cook Inlet, and Anchorage areas. About 15% occur in Southeast Alaska, and the remaining 10% occur in the Interior. The greatest earthquake in North American history occurred in the Alaska-Aleutian Seismic zone. That earthquake was a M of 9.2, lasting between four and five minutes and was felt over a 7,000,000 sq. mile area. This earthquake was 75 miles southeast of Palmer and 85 miles southeast of Wasilla which are the primary population centers of the

Borough. It caused a significant amount of ground deformation as well as triggering landslides and tsunamis resulting in major damage throughout the region. The megathrust zone where the North Pacific Plate plunges beneath the North American Plate still has the potential to generate earthquakes up to a M of 9. Within 25 miles of Anchorage, there are at least three suspected active faults with the potential to create earthquakes with M's of 7.5. One of them, the Castle Mountain Fault, produced an earthquake with an M of 7.5 near Sutton in 1984 and may have generated a M of 6.9 in an earthquake that shook Anchorage in 1933. This area is of concern, as a great deal of development has and continues to occur along the fault.

The Borough's "core area" is in the Cook Inlet basin. The Cook Inlet basin is a northeast-trending fore arc basin located between the Chugach and Kenai Mountains to the south and the Alaska Range and the Aleutian volcanic arc to the north and west. Major fault zones are close to the margin of the basin: the Castle Mountain fault to the north, the Bruin Bay fault to the northwest, and the Border Ranges fault along the south. Folds in the basin are complex, discontinuous structures that have variable shape and convergence and are commonly anchored by blind thrust faults. These are thrust faults that do not rupture all the way up to the surface so there is no evidence of it on the ground. They are "buried" under the uppermost layers of rock in the crust. Figures 13 and 14 show the major faults in the Borough's "core area".

Figure 12. Active and Potentially Active Faults in Alaska



Extent

Although major earthquakes occur relatively infrequently, the Borough remains vulnerable to significant damages from an earthquake.

"Alaska has changed significantly since the damaging 1964 earthquake, and the population has more than doubled. Many new buildings are designed to withstand intense shaking; some older

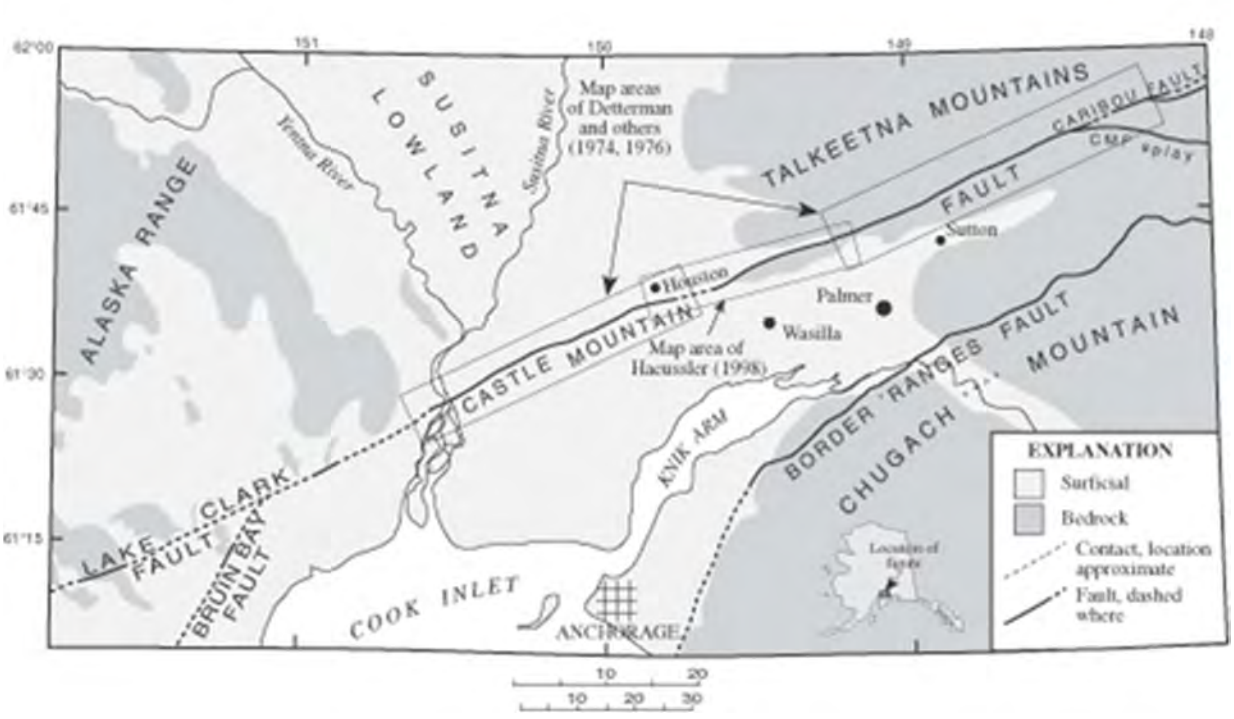
buildings have been reinforced, and development has been discouraged in some particularly hazardous areas.

Despite these precautions, and because practices to reduce vulnerability to earthquakes are not applied consistently in regions of high risk, future earthquakes may still cause life-threatening damage to buildings, cause items within buildings to be dangerously tossed about, and disrupt basic utilities and critical facilities.

FEMA estimates that with the present infrastructure and policies, Alaska will have the second highest average annualized earthquake-loss ratio (ratio of average annual losses to infrastructure) in the country. Reducing those losses requires public commitment to earthquake-conscious siting, design, and construction. The Seismic Hazards Safety Commission is committed to addressing these issues. Earthquake-risk mitigation measures developed by similar boards in other states have prevented hundreds of millions of dollars in losses and significant reductions in casualties when compared to other seismically active areas of the world that do not implement effective mitigation measures. The San Francisco (1989), Northridge (1994), and Nisqually (2001) earthquakes caused comparatively low losses as a result of mitigation measures implemented in those areas. Many of these measures were recommended by the states' seismic safety commissions."

Source: HAZUS 99 Estimated Annualized Earthquake Losses for the U.S., FEMA Report 66. September 2000. Via DHS&EM, 2018a.

Figure 13. Location of Major Faults in the Houston-Wasilla-Palmer Area



Source: U.S. Geological Survey website

Impact

The State of Alaska Individual Assistance program is designed to provide grant funding to individuals and families for damages to their real property and personal property, as well as medical expenses that are a direct result of the disaster event. In addition, the Individual Assistance program can provide temporary housing to individuals and families that cannot return to their homes. Preliminary cost impacts from the November 30, 2018 Earthquake (DR-4413) are:

- Individual Assistance Applications Approved: 4,338;
- Total Individuals & Households Program Dollars Approved: $26,554,587.86; and
- Total Public Assistance Grants Dollars Obligated: $9,383,316.49.

The State of Alaska Public Assistance program is designed to help communities, government organizations, and certain non-profits make repairs to utilities, public buildings, roads, bridges, and other critical infrastructure damaged by the declared event. The Borough lists categories for public assistance in Table 7.

Table 7. Public Assistance for the Borough (170-006F3-00)

Subrecipient	Count of Project #	Estimated Cost
Applicant Signed Project	1	$350,654.00
Obligated	8	$1,291,075.69
Pending CRC Project Development	9	$41,704,813.00
Pending EEI Completion	8	$1,532,421.56
Pending FEMA Insurance / 406 HMP Mitigation Completion	1	$99,917.00
Pending QA Review	1	$90,181.00
Grand Total	**29**	**$45,069,062.25**

Preliminary cost impacts for individual homes within the Borough are included in Table 8.

Table 8. Earthquake Data

Borough 2018 November Cook Inlet Earthquake	
Total Applicants from Borough Before FED DEC:	2794
Total Applicants from Borough Reconsideration:	75
Total of Warrants issued by State to Borough Applicants:	26
Total $ amount awarded to Borough Applicants:	**$323,090.75**

Preliminary cost impacts reported from FEMA are included in Table 9. Not all damaged buildings were reported to the Borough, State, or FEMA, and the unidentified damages are not accounted for.

Table 9. FEMA Individual Assistance Grants to Communities Within the Borough

Borough/ City	Registrations	Total HA	Total ONA	Total IHP	# Max Grant	# Owners	# Renters	# Undesignated	Major Damage (Renter)	Moderate Damage (Renter)
BIG LAKE	191	$671,956.83	$10,507.74	$682,464.57	6	183	4	4	0	0
CHICKALOON	2	$10,343.45	$1,278.34	$11,621.79	0	2	0	0	0	0
HOUSTON	89	$235,307.18	$8,827.87	$244,135.05	1	82	6	1	0	1
LAKES	6	$3,498.73	$133.02	$3,631.75	0	5	1	0	0	0
MEADOW LAKE	3	$464.65	$0.00	$464.65	0	3	0	0	0	0
PALMER	576	$1,297,504.11	$20,613.62	$1,318,117.73	11	553	23	0	1	5
SKWENTNA	1	$6,467.53	$0.00	$6,467.53	0	1	0	0	0	0
SUTTON	22	$111,451.78	$2,984.78	$114,436.56	1	20	1	1	0	0
TALKEETNA	21	$14,175.08	$266.04	$14,441.12	0	21	0	0	0	0
TRAPPER CREEK	8	$4,433.26	$229.95	$4,663.21	0	7	1	0	0	0
WASILLA	1,650	$2,968,879.00	$81,065.67	$3,049,944.67	18	1,578	63	9	0	8
WILLOW	102	$361,880.34	$5,591.09	$367,471.43	2	100	1	1	1	0
Matanuska-Susitna	**2,671**	**$ 5,686,361**	**$ 131,498**	**$ 5,817,860**	**39**	**2,555**	**100**	**16**	**2**	**14**

Shake maps use recorded and predicted ground motions to show where and how intensely the ground shook during an earthquake—most crucially, they help identify areas of likely damage within minutes of a significant earthquake. Shake maps are color-coded to show how strongly the ground shook in different places. Each color corresponds to a number on the Modified MMI (link or sidebar), which was created to describe an earthquake's severity in a given place. Figures 15-19 are shake maps from five different scenarios. Figure 15 is a fabrication of the 1964 Great Alaska Earthquake using existing infrastructure in the Borough. Figure 16 is the actual shake map generated from the November 30, 2018 Earthquake. Figure 17 is a fabricated scenario meant to show potential hazard from an earthquake with a magnitude of 7.5 with its epicenter near the Castle Mountain Fault (Figure 14). Figures 18 and 19 are fabricated scenarios meant to show potential hazards from an aftershock with a magnitude of 6.8 if the epicenter was centered in Wasilla or Houston, respectively.

Recurrence Probability

While it is not possible to predict an earthquake, the U.S. Geological Survey (USGS) has developed earthquake probability maps that use the most recent earthquake rate and probability models. These models are derived from earthquake rate, location, and M data as well as from mapping of active faults, from the USGS National Seismic Hazard Mapping Project.

The measure of peak ground acceleration is relative to the acceleration due to gravity (1 g). At 1 g vertical acceleration, objects will be lofted off the ground as it moves down, and then experience twice their own weight when the ground moves up. One g of horizontal acceleration will make flat ground feel as though it is sloped at 45 degrees – steep enough that most things would fall. Figure 20 indicates that the USGS earthquake probability model places the probability of an earthquake in the Borough with a likelihood of experiencing severe shaking (0.30g to 1.80g peak ground acceleration) at a 2% probability in 50 years. A 2% probability in 50 years is the rare, large earthquake, and statistically, it happens on average every 2,500 years.

Figure 14. Fault Lines in Palmer, Wasilla, & Houston

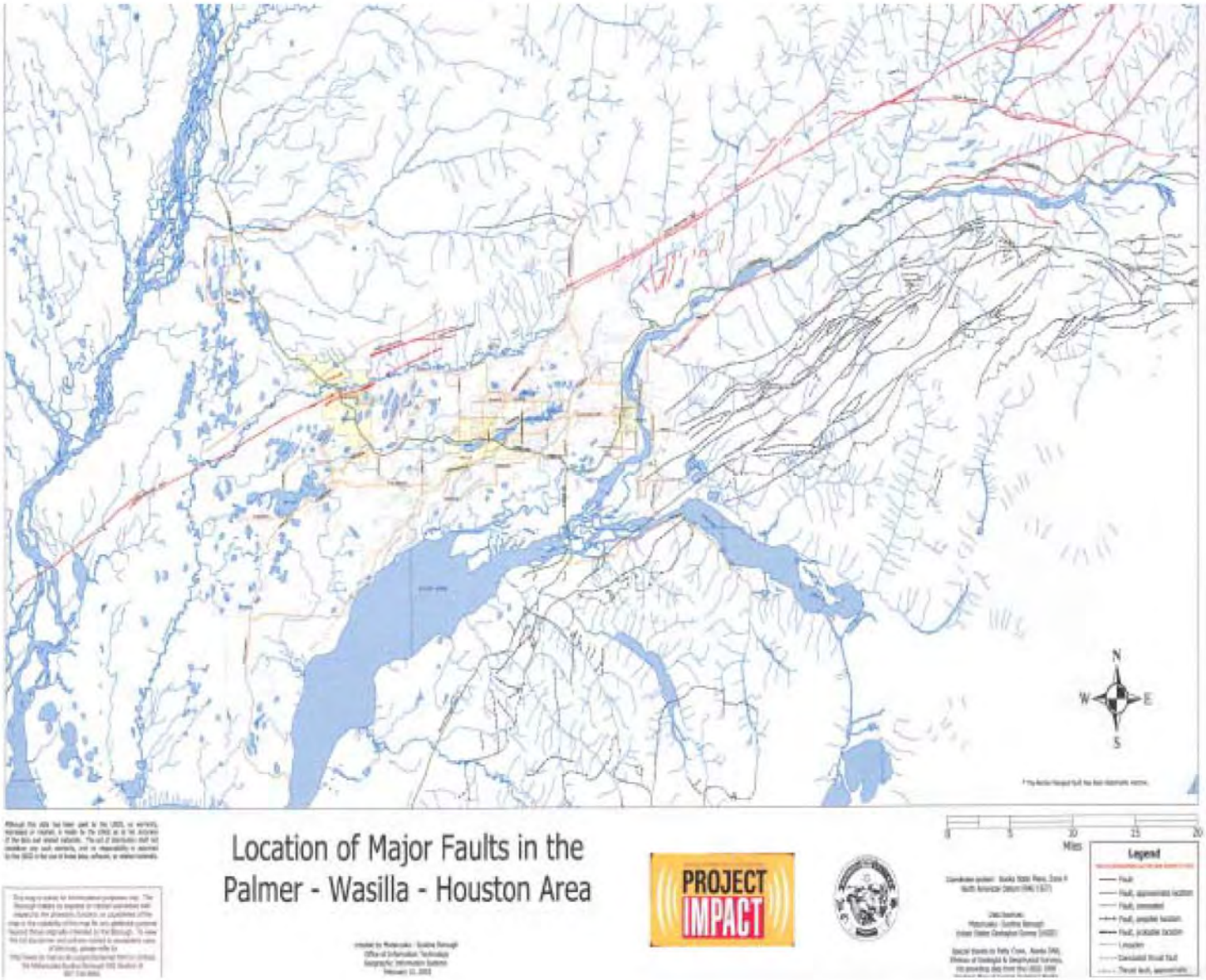


Figure 15. 2019 Shakemap, M9.2 Alaska Mainshock Scenario

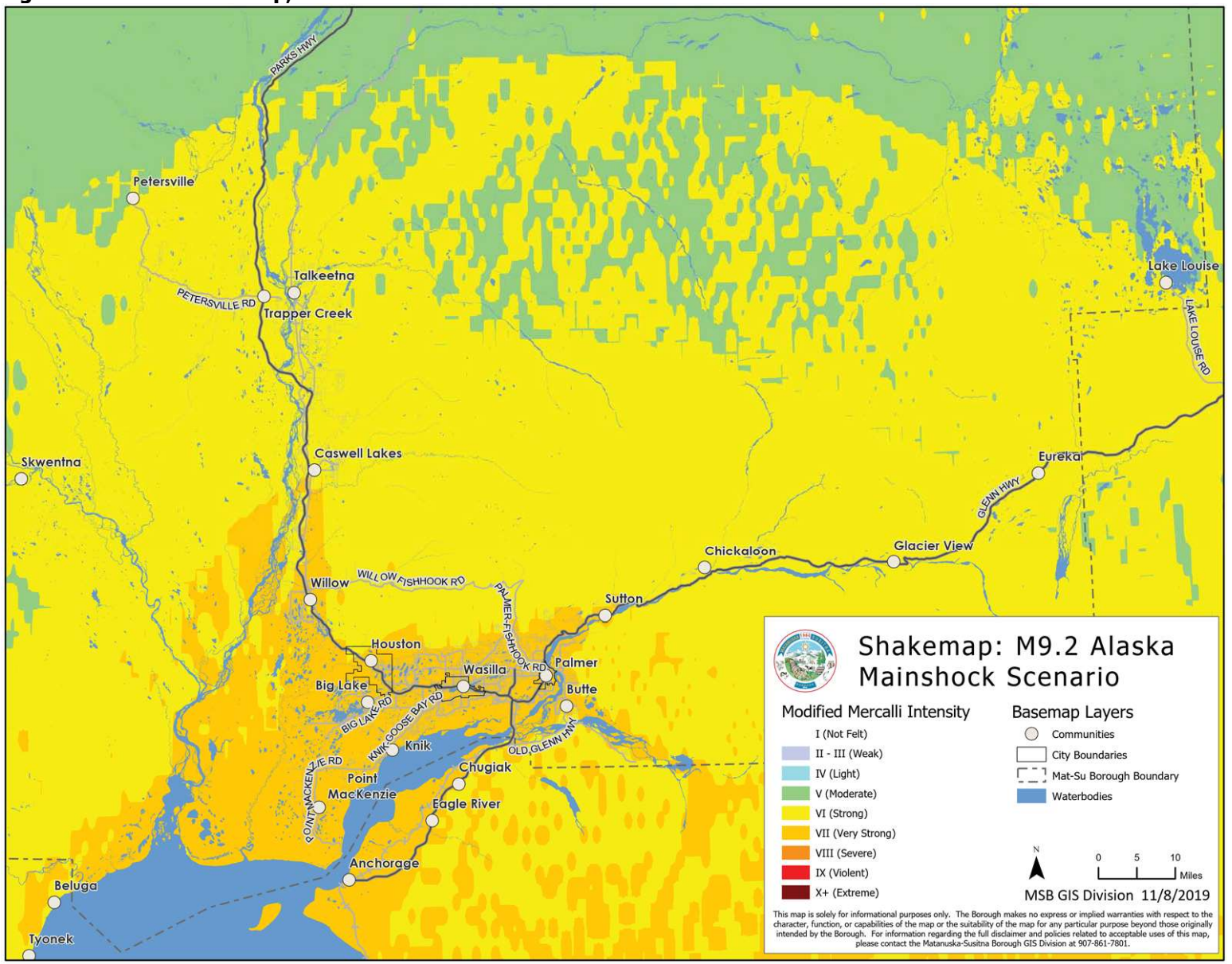


Figure 16. 2019 Shakemap, M7.1 November 30, 2018 Anchorage Earthquake

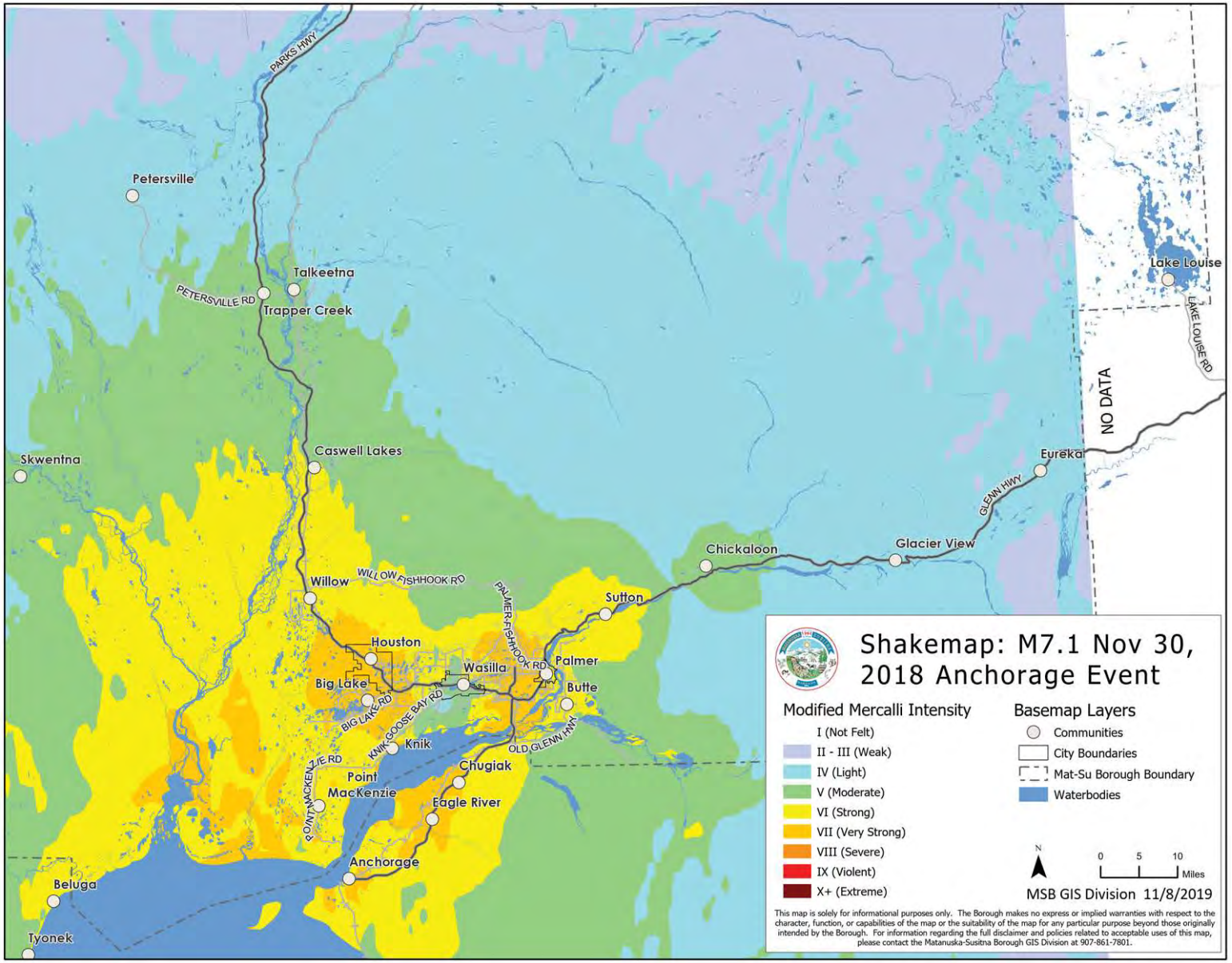


Figure 17. 2019 Shakemap, M7.5 Castle Mountain Fault Scenario

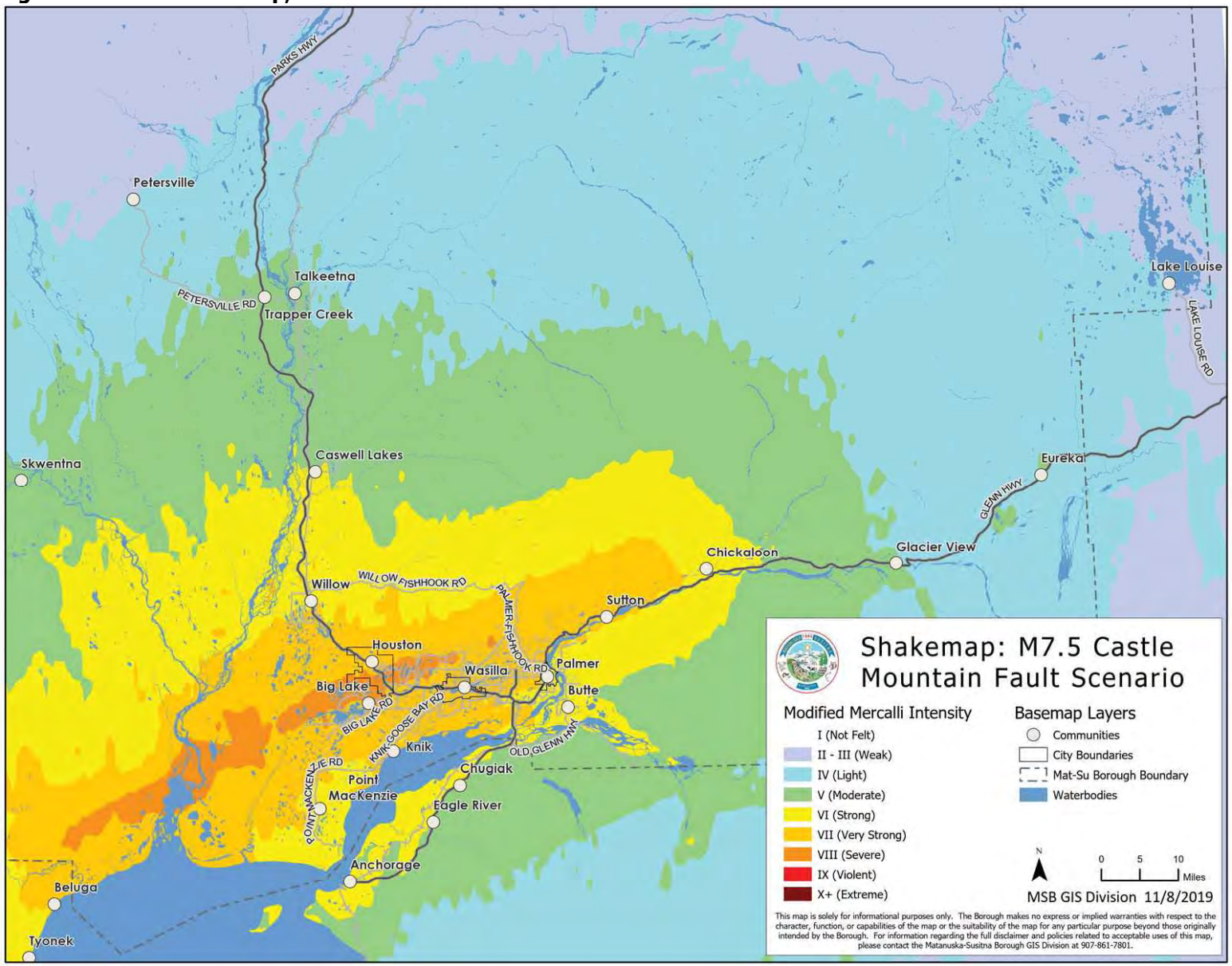


Figure 18. 2019 Shakemap, M6.8 Wasilla Aftershock Scenario

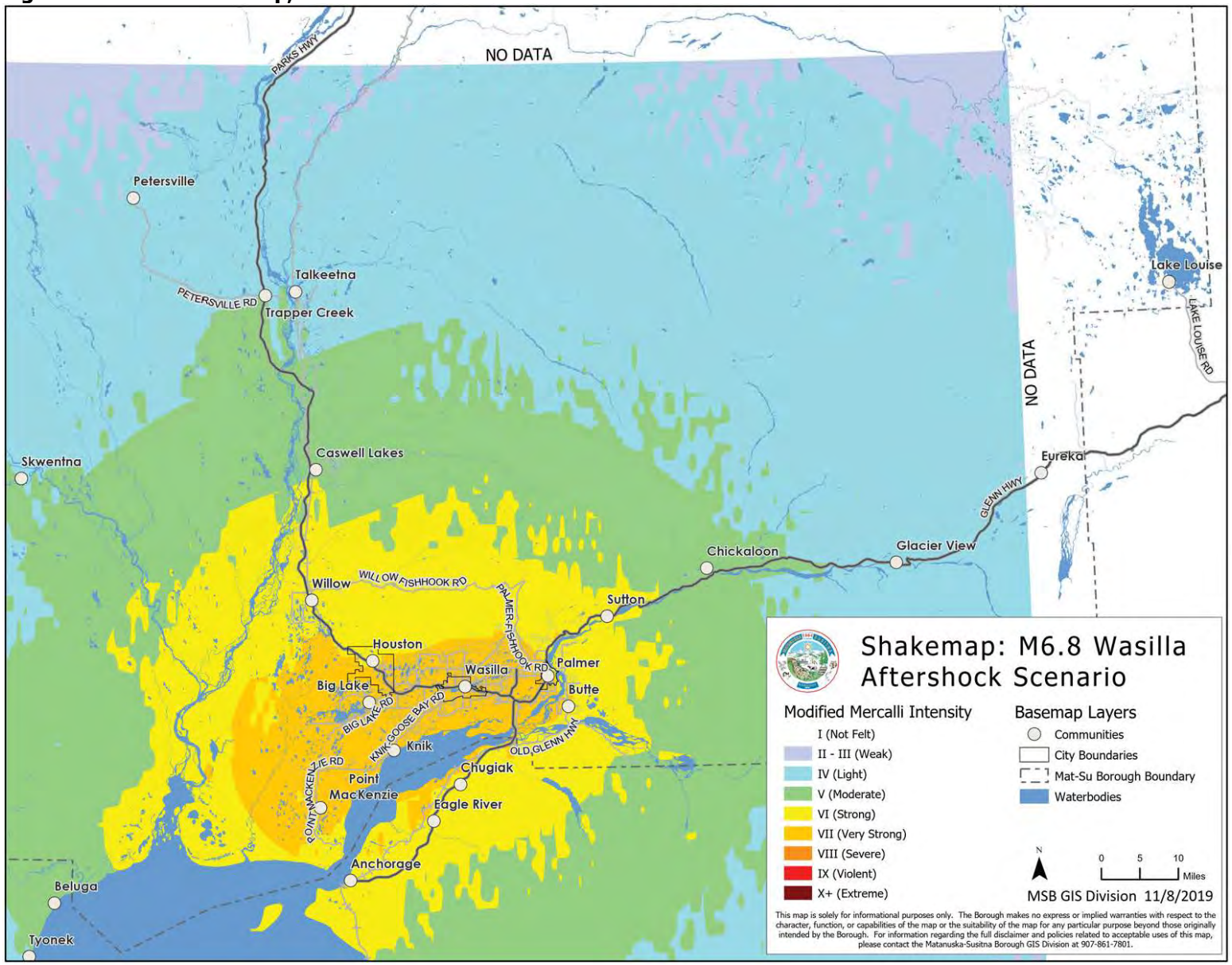


Figure 19. 2019 Shakemap, M6.8 Houston Aftershock Scenario

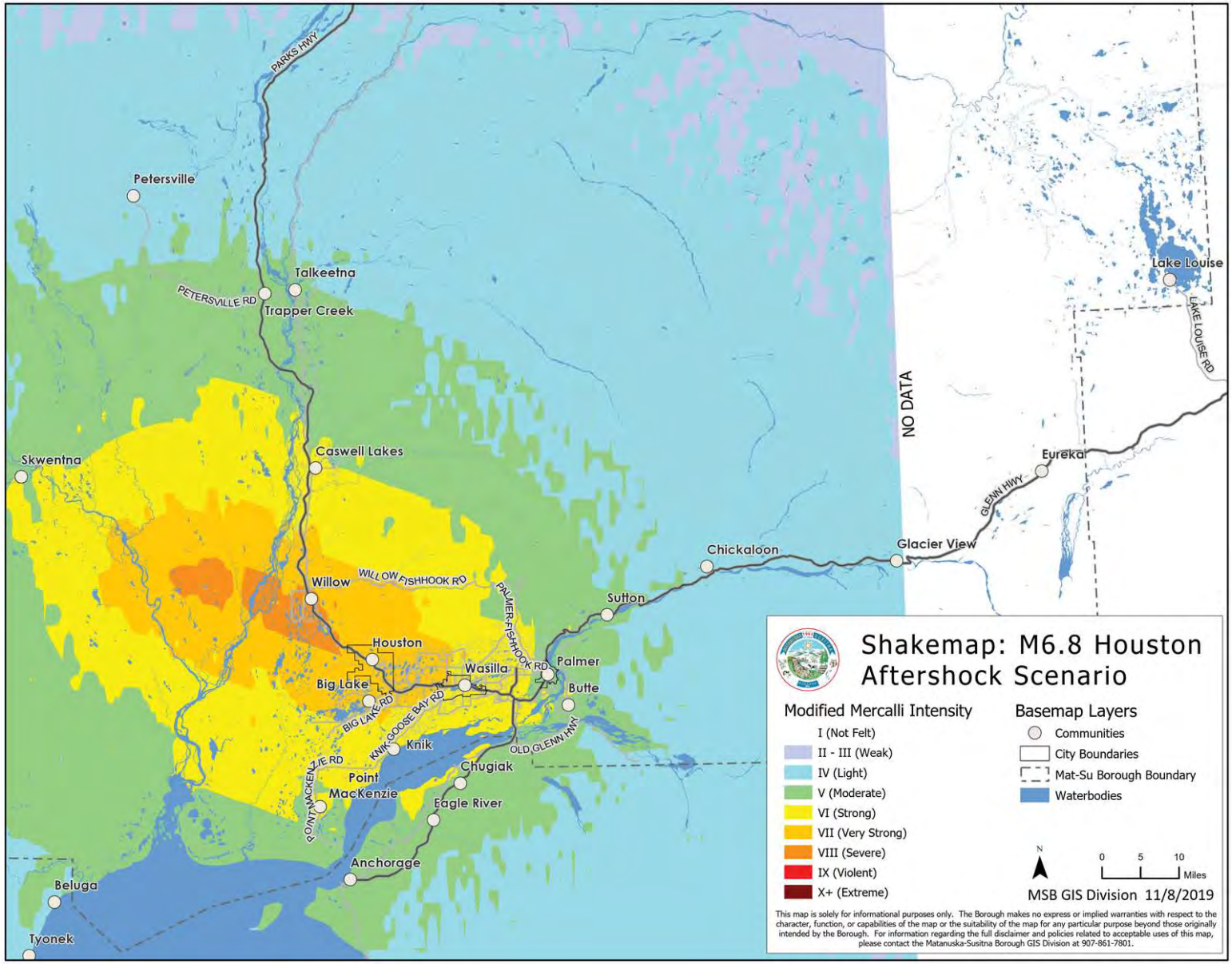
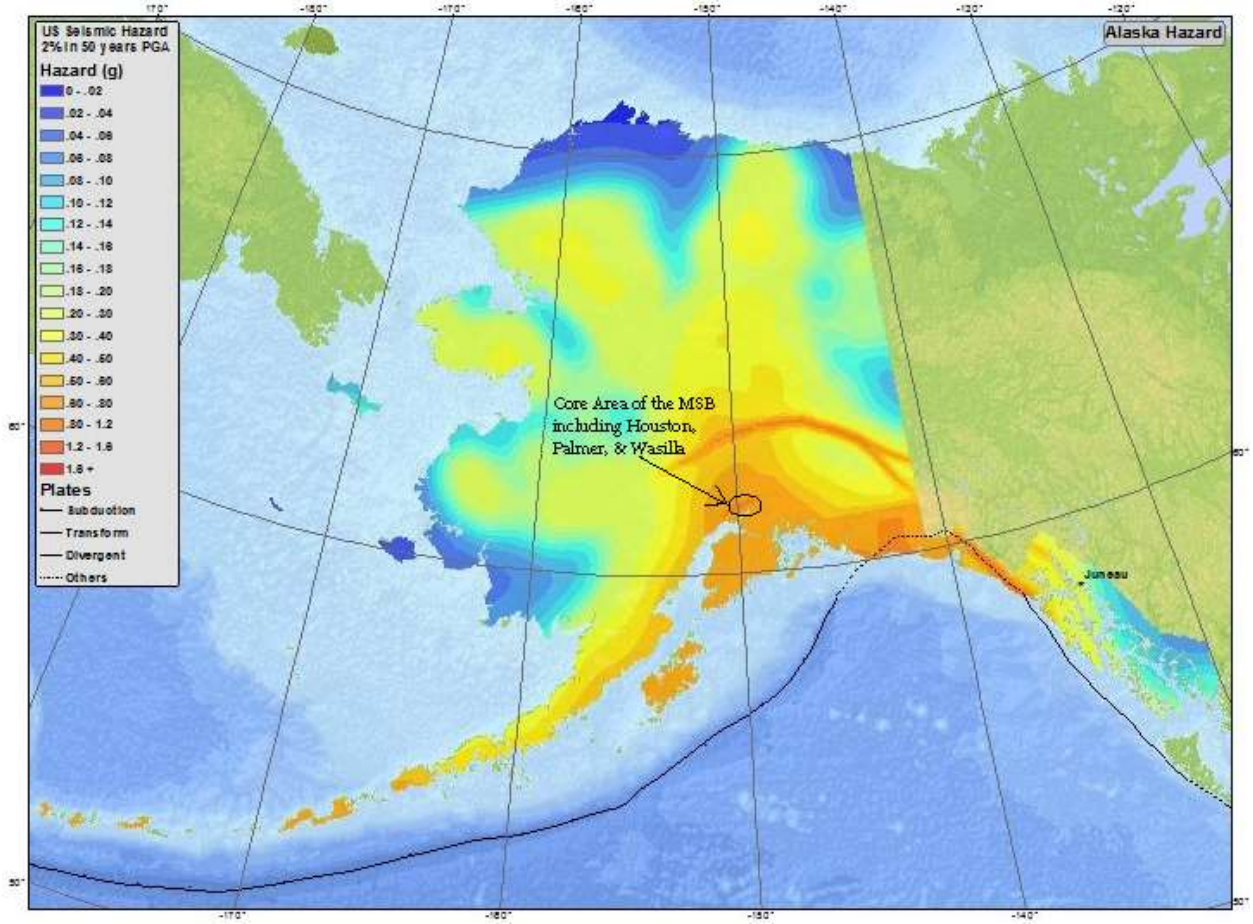


Figure 20. State of Alaska Earthquake Probability



5.3.3 Flood and Erosion

5.3.3.1 Hazard Characteristics

Floods

Floods in the Borough can occur as a result of a combination of factors, including heavy snow pack, temperature, sunshine, and precipitation. The sequence of events affects the flooding potential. Spring floods on streams may occur as a result of an above-normal snowfall during the winter followed by an unusually cold spring and a rapid snowmelt. Summer and fall floods usually result from intense precipitation. In addition, an ice jam could occur during winter or spring breakup, causing overbank flooding. Ice jams have caused the highest flooding on Willow Creek, but no frequency has been applied to this type of flood. The principal flood problems are natural obstructions such as trees and vegetation along the banks, manmade obstructions such as bridges and boat docks, ice jams, the accumulation of brush and debris along and within the streambed which can be carried downstream by high water and block bridge openings or other constrictions, and inadequately-sized culverts.

Flooding is Alaska's most common disaster, often costing in excess of one million dollars annually, causing major disruptions to society and occasionally, loss of life (DHS&EM, 2018a).

Many floods are predictable based on rainfall patterns. The Borough experiences the following types of flooding:

Rainfall-runoff flooding is the most common type of flooding in Alaska, typically occurring in late summer through early fall. Rainfall intensity, duration, distribution, as well as pre-existing soil moisture conditions and geomorphic characteristics of the watershed all contribute to the flood's magnitude. These floods result from high rainfall amounts and accompanying high surface runoff rates.

Snowmelt flooding typically occurs from April through June, but is most common in the spring when rapidly warming temperatures quickly melt snow. Snowpack depth, spring weather patterns, and geomorphic characteristics of the watershed influence the magnitude of flooding. Rainfall and high temperatures can exacerbate snowmelt floods.

Ice jam floods occur after an ice jam develops, causing water to rise upstream behind the jam. When the jam releases, the stored water causes downstream flooding. Damage from ice jam floods is usually worse than from rainfall runoff or snowmelt floods because the ice jam floods are usually higher, the water levels change more rapidly, and the ice causes physical damage. Ice jams usually develop where the channel slope decreases, gets shallower, or where constrictions occur such as at bridges, bends in the river, headwaters, and reservoirs. During spring breakup, ice jams commonly dam water along big rivers. This flooding is exacerbated by snowmelt. Significant flooding on the Susitna River and the 2019 Willow Creek flooding was caused by ice jams and snow melt.

Aufeis, also called glaciation or icing, accumulates during winter along stream and river valleys in arctic and subarctic environments. It forms by the upwelling of river water behind ice dams, or by ground-water discharge. The latter mechanism prevails in high-gradient alpine streams as they freeze solid. Ground-water discharge is blocked by ice, disturbing the steady-state condition and causing a small incremental rise in the local water table until discharge occurs along the bank and over the top of the previously formed ice. Successive ice layers can lead to aufeis accumulations that are several meters thick. Aufeis typically melts out during summer and will often form in the same place year after year.

Ground-water flooding occurs when water accumulates and saturates the soil. The water table rises and floods low-lying areas, including homes, septic tanks, and other facilities.

Flash floods are characterized by a rapid rise in water. They are often caused by heavy rain on small stream basins, ice jam formation, or by dam failure. They are usually swift moving and debris filled, causing them to be very powerful and destructive.

Fluctuating lake level floods occur when lake inflow is excessive, flooding areas around the lake. Generally, lakes buffer downstream flooding due to the storage capacity of the lake.

Glacial outburst flooding is called a jökulhlaup. They are the result of a sudden release of water from a glacier or glacially dammed lake resulting in rivers rapidly rising downstream. This can happen on many Alaskan rivers, including the Susitna River. Sometimes, glacial outburst flooding is predictable, but not always.

To develop flood predictions, the NWS and DHS&EM operate a flood-forecasting network in the most populated parts of Alaska including the Borough. Predictions are also difficult for many of the smaller rivers because of the short time span between when the precipitation occurs and the flooding starts.

Erosion

Erosion is the action of surface processes (such as water) that remove soil, rock, or dissolved material from one location and transport it to another location. Erosion can be gradual or occur quite quickly as the result of a flash flood, storm, or other event. Most of the geomorphic change to a river system is due to peak flow events that can dramatically increase the erosion rate. Erosion is a problem in developed areas where disappearing land threatens development and infrastructure (DHS&EM, 2018a). Erosion rarely causes death or injury. However, erosion causes the destruction of property, development, and infrastructure.

Erosion is a process that involves the gradual wearing away, transportation, and movement of land. However, not all erosion is gradual. It can occur quite quickly as the result of a flash flood, coastal storm, or other event. Most of the geomorphic change that occurs in a river system is in response to a peak flow event. It is a natural process but its effects can be exacerbated by human activity. Erosion is a problem in developed areas. The disappearing land threatens development and infrastructure. There are two main types of erosion that affect human activity in the Borough:

- Riverine erosion; and
- Wind erosion.

Riverine erosion results from the force of flowing water into 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 breaches, erosion and deposition of materials are a constant issue. In more stable meandering channels, episodes of erosion may occur occasionally. Examples of riverine erosion that threaten both public and private property are found in the Borough. Riverine erosion on the meandering Matanuska River, near Palmer has threatened the stability of several houses and some infrastructure. This braided river system has cut a wide channel that has altered course several times since the first mapped channels in 1906. A dramatic shift occurred in the 1950s. Efforts to control the river, from sacrificial boulder dikes to deepening the center channel by excavating the gravel, have met with limited and short-lived success. In 1992 and 1994, several homes went over the banks of the river due to active erosion.

Riverine erosion risk is predominantly along the Matanuska River in the communities of Butte, Chickaloon, Palmer, and Sutton. While flooding along the river corridor is somewhat rare, high water events have resulted in significant negative effects from erosion. The braided glacial river moves back and forth across a wide braided plain, exposing each river bank to occasional prolonged periods of erosion. The river shifted in channel migration direction in the early 1990s, when the main channel migrated to the left bank of the river, resulting in major loss of homes and land.

Development along the Matanuska River has occurred without much knowledge of or consideration to river channel migration. As a result, homes have been destroyed, agricultural land lost, infrastructure damaged, and tax base lost as the river has shifted back and forth across its plain. There are no existing regulations for development based on riverine erosion, and such development in threatened areas is continuing. These types of development are regulated by requiring setbacks of 75 feet from the new structure to the ordinary high-water mark of a waterbody.

Wind erosion is when wind is responsible for the removal, movement, and redepositing of land. It occurs when soils are exposed to high-velocity wind. The wind will pick up the soil and carry it away. Wind erosion can cause a loss of topsoil, which can hinder agricultural production. Loess, deposits of silt laid down by wind action, can reduce visibility, causing automobile accidents, hinder machinery, and have a negative effect on air and water quality, creating animal and human health concerns. Wind erosion also causes damage to public utilities and infrastructure.

Wind erosion is a significant problem for the Matanuska Valley with gusts of up to 100 mph. Dust from the Matanuska and Knik river drainage systems can cause dust storms that greatly exceed national health-based standards. Sources of particulate come from river drainages, volcanoes (ashfall), wildfires (ash), burned-over areas (wildfires), gravel pits, agriculture plowing, road sanding, wood stoves, open burning, unpaved roads, and bare soil/erosion. April thru June and August are the months most prevalent to dust storms.

5.3.3.2 Climate Factors

Climate and weather are the two primary drivers of flooding and erosion in Alaska. Weather (i.e., the day-to-day state of the atmosphere) affects these hazards in the short-term with individual episodes of rainfall, wind, and temperature that initiate or intensify individual episodes of flooding or erosion. Climate is affecting the long-term incident rate and severity of these hazards, especially in Alaska, which is particularly vulnerable due to its high northern latitude and the unique importance of snow, ice, and permafrost.

5.3.3.3 Flood and Erosion History

The Borough has a history of flood and erosion events described in the DHS&EM Disaster Cost Index (DHS&EM, 2018b). These events are listed below. The numbers are references to the way the State tracked various disaster events over the years.

7. Willow Creek, December 20, 1979: Abnormal weather conditions, caused by a combination of extreme debris jams, abnormal temperature variations and glaciation caused flooding of Willow Creek in the **Matanuska-Susitna Borough**, rendering roads in the area impassable and threatening homes.

56. Southcentral Alaska Flood (Major Disaster), October 12, 1986, FEMA declared (DR-0782) on October 27, 1986: Record rainfall in Southcentral Alaska caused widespread flooding in Seward, **Matanuska-Susitna Borough**, and Cordova. The President declared a Major disaster implementing all public and individual assistance programs, including Small Business Association (SBA) disaster loans and disaster unemployment insurance benefits. Flooding was particularly severe in the Seward area of the Kenai Peninsula and in tributaries to the Susitna

River from Talkeetna downstream. Flood damage was estimated at $20 million, and the region was declared a Federal disaster area."

97. Mat-Su Borough, August 4, 1989: The Governor declared a disaster to mitigate a flood threat caused by high water in the Matanuska River and placed the Old Glenn Highway and private residences along the river at risk. Funding was applied towards construction of an earthen/gravel dike.

144. Mat-Su Borough, July 18, 1991: Severe bank erosion near the Circle View Subdivision area along the Matanuska River destroyed one home and threatened several others, causing the **Mat-Su Borough** to support either construction of emergency bank protection measures or relocation of homes. The Governor's Declaration authorized a loan of up to $500,000 dollars to the **Mat-Su Borough**. The following year, the legislature converted this loan to a grant.

172. Matanuska River Erosion: On July 1, 1994, **Matanuska-Susitna Borough** sustained serious damage and threats to life and property resulting from erosion of the Matanuska River, in the vicinity of Circle View Estates. As a result of this disaster, authority was granted under Alaska Statutes, Section 26.23.020 to loan $500,000.00 from the Disaster Relief Fund to the **Matanuska-Susitna Borough**.

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

The 77-foot span of Hunter Creek Bridge on Knik River Road slumped into Hunter Creek, leaving 36 people and their animals stranded on the far end of the dead-end road, about 10 miles southeast of Palmer. The National Guarded helped evacuate 27 people to the other side of the Knik River using helicopters. The creek, usually narrow enough to throw rocks over, carved a 150-foot wide swath down the hillside on its way to the Knik River just downstream. "You could hear boulders crashing into the pillars and see the trees piling against them." The area was one of several places throughout Southcentral Alaska hampered by heavy rain the a few days. More than 2.5 inches of rain fell in Palmer and much more fell in the mountains nearby. Several other areas flooded, including the Susitna Valley settlement of Skwentna where some residents took refuge in the post office and roadhouse. In addition, the Old Glenn Highway was closed after the Knik River sent more than three feet of water cascading over it just past the Old Knik River Bridge (ADN, 1995).

07-220 2006 August Southcentral Flooding (AK-07-220) declared August 29,2006 by Governor Murkowski, then FEMA declared (DR-1663) on October 16, 2006: Beginning on August 18, 2006 and continuing through August 24, 2006, a strong weather system caused severe flooding, resulting in severe damage and threats to life and property, in the Southcentral part of the State including the **Matanuska-Susitna Borough**, the City of Cordova and the Copper River Highway area in the Chugach REAA, the Richardson Highway area in the Copper River REAA and Delta/Greely REAA, the Denali Highway area, and **the Alaska Railroad and Parks Highway areas in the Matanuska-Susitna Borough** and the Denali Borough. The Little Susitna River flooded its banks north of the communities of Wasilla and Meadow Lakes. Concurrently, the Talkeetna River overflowed its banks in the downtown and surrounding areas of Talkeetna. Willow Creek in the community of Willow also overflowed. Governor Murkowski signed a state disaster declaration bringing recovery resources to the several homeowners who were severely impacted and enabling washed-out roads and bridges to be rebuilt. Damage cost estimates were near $21 million in Public Assistance primarily for damage to roads, bridges, and rail lines. Individual Assistance estimates were near $2 million.

12-240, 2012 September Storm declared by Governor Parnell on October 17, 2012, then FEMA declared November 27, 2012 (DR-4094): Beginning on September 4, 2012, and continuing, a strong weather system produced high winds and heavy rains, resulting in severe and widespread wind damage and flooding throughout much of Southcentral and Interior Alaska. The series of storms created a threat to life and property in the **Matanuska-Susitna Borough,** Kenai Peninsula Borough, Alaska Gateway REAA, and the Chugach area. The magnitude of the storm resulted in wind damages and flooding which necessitated debris clearance, emergency protective measures, damage to public facilities including roads, bridges, railroad, electrical distribution and water systems; and damage to private residences to include losses of personal property. A large number of roads and bridges were affected; damage to the Alaska Railroad was severe enough to shut down the rail service for several days. Approximately 823 properties suffered damage from flooding and erosion, almost 60 homes were either severely damaged or destroyed, traffic on 60 roads was disrupted, and 40 of those roads were closed. Mostof the damage occurred along the Little Susitna River and Willow Creek. As a result of the raging rivers, the Talkeetna dike/revetment was damaged, part of the Shirley Towne Bridge was washed away and the approach to Yoder Bridge was washed out. Super saturated ground and elevated water tables caused additional flooding of homes and septic systems, damaging property and road beds outside of typical “flood prone” areas. State estimates of damage to individual property approached $3.5 million, public infrastructure exceeded $19 million statewide, and the military base in Anchorage sustained an addition $3.5 million in flood damages. There was one fatality associated with the flooding.

16-258, 2016 Mat-Su River Erosion declared by Governor Walker on August 22, 2016: During the week of August 14 through 20, 2016, there was imminent threat of flooding in the **Matanuska-Susitna Borough** along the Old Glenn Highway from Mile 12 through Mile 15. Flooding in this area had the potential to cause substantial damage to the highway, infrastructure, and local homes. The ADOT&PF was immediately called to accomplish necessary emergency protective measures to prevent damaging flooding from public and private infrastructure.

FEMA-4391-DR, 2018 Damage to the Alaska Railroad declared by Governor Bill Walker on June 28, 2018, then President Trump declared on September 5, 2018: Ice jams formed along the Susitna River during spring breakup, which resulted in flooding along the river northeast of Talkeetna during the period from May 11-13, 2018. Workers with the Alaska Railroad Corporation discovered a five-mile section of track flooded and covered with chunks of ice after an ice jam caused an eight- to ten-foot vertical water level rise between Talkeetna and Curry, on the Susitna River. Significant sections of track were damaged and moved horizontally by as much as 25 feet. At the same time, significant areas of erosion/damage to the railroad bed itself also occurred which had to be rebuilt. Rail service was disrupted for several days. The total Public Assistance cost estimate was $2,011,378.

Events that occurred, but weren't declared disasters are listed in Table 10.

Table 10. Historical Flood Events that were Identified by NWS that were not FEMA or Governor Declared Disasters

DAY	EPISODE NARRATIVE
July 22, 1981	A torrential rainstorm resulted in widespread flooding, stream over flow and damage to bridges and culverts in Southcentral Alaska. This condition made travel hazardous throughout the region and in some cases, roads were impassable to all traffic, including emergency vehicles. The Governor's Proclamation of a Disaster Emergency enabled the Department of Emergency Services (DES) to provide the affected communities with immediate recovery assistance, resulting in the restoration of the area's transportation system. No direct assistance was provided to individuals and families.
January 28, 1989	To mitigate the threat of flooding to homes and the Glenn Highway from the Matanuska River, funds were applied toward construction of an earthen/gravel dike.
April 14, 1990	The Major Disaster Declaration by the President in response to statewide flooding in the Spring of 1989 authorized the commitment of federal funds to projects designed to mitigate flood damage in future years. Since the federal funding required a State matching share, the Governor declared a disaster to provide these funds and authorize their expenditure.
May 8, 2002	A "flash flood" caused by breaking ice dams, developed Tuesday morning along a small portion of the Matanuska River. In the Richie subdivision, Mile 64 Glenn Highway, one resident reported that his family lost thousands of dollars in personal property stored outside under fabric shelters. Other residents said that this breakup has been the most dramatic since at least 1980.
May 15, 2002	Ice jammed up on the Talkeetna River just upstream from the Susitna River confluence. This caused localized flooding which washed out some sections of the ballast and shoved the track out of alignment. According to Alaska Railroad personnel, "This was the railroad's most significant damage due to flooding in more than a decade." Rail traffic was suspended between Anchorage and Fairbanks during the flood event for nearly two days. Two passenger trains were canceled, including the first run of the season for the "Denali Star".

August 13, 2002	Newspaper reports indicated a flash flood along portions of McRoberts Creek. Reference was made to "...apparently a landslide coming down the shallow gorge that channels the creek..." and also to "...heavy rains...". Apparently, a dozen homes were indirectly impacted. Little verification data was available to assess the situation.
May 3, 2009	An ice jam created flooding along the Susitna River in Talkeetna. Flooding destroyed part of the Alaska Railroad tracks in the area by large chunks of ice. Flooding was caused by snow melt and river ice jams due to rapid spring warming combined with excessive snow pack and river ice thickness.
July – August 2012	The main channel of the Matanuska River moved within its braided plain. This natural event combined with a record high snowfall, resulted in severe erosion from Sutton to Palmer. Properties along the Glenn Highway at approximately Milepost 65 lost acres of ground, a septic system, personal property and structures, and even a historic home to the fast-moving river. In addition, two properties around Milepost 15 of the Old Glenn Highway suffered extreme erosion, loss of outbuildings and ultimately had to be abandoned by the property owners.
July 10-12, 2018	A deep, anomalously strong upper level trough and associated surface low dug southward across Western Alaska. As a result, nearly the entire atmosphere across Southern Alaska shifted to southwesterly flow, which brought copious amounts of Pacific moisture into Southern Alaska. This rainfall combined with already high-water levels due to snowmelt from anomalously warm temperatures earlier in the month. The Yentna and Skwentna Rivers, already high due to snowmelt, were expected to reach near bank full during the second week of July as the weather pattern turned wetter. On July 10th, a local lodge near the confluence of the Yentna River and Lake Creek reported flooding in cabins and outbuildings resulting in 18 inches of water getting inside. A Flood Advisory was issued as a result of this report. Later that same day, an update from Lake Creek was received saying that the river had risen to 2-3 feet above the bank and that most of the property, including numerous waterfront lodges, were flooded.
August 14-15, 2018	An upper level low digging southward across Southwest Alaska, brought moist flow off the Gulf into Southcentral on southeasterly winds. This brought higher than normal rainfall to the northern and western Susitna Valley. The river gauge on the Yentna River at Lake Creek went into minor flood stage for a brief period on August 14th. McDougall's Lodge Cabins were evacuated due to flooding water.
December 21, 2019	An ice jam caused Willow Creek to flood, prompting at least 12 households in Willow to evacuate. Six homes were damaged by floodwaters (one homeowner stood in knee-deep water). Deneki Bridge was impassable to vehicle traffic until the situation stabilized, trapping people on the wrong side of the water. Fishhook Road and areas west of the bridge were also impacted. On December 23, 2019, the Borough Mayor and Borough Manager declared a Local Disaster Emergency and requested that the Governor declare a Disaster Emergency and provide State Assistance to the Borough in its response and recovery from this event.

Source: NWS, 2019

5.3.3.4 Location, Extent, Impact, and Recurrence Probability

Location

Looking at a map of the Borough, it is immediately evident that due to the large number of rivers, streams and lakes, the predominant hazard is flooding. As throughout the rest of Alaska, there are so many lakes and streams that not all of them are formally named.

Increasing the accuracy of flood mapping is an important first step in flood mitigation. The Borough Code Title 17: Zoning, Chapter 17.29 sets forth general standards for flood hazard reduction. Code Compliance Officers are charged with enforcing the code. Flood Insurance Rate Maps (FIRMS) were newly revised on September 27, 2019.

Certain areas have been identified as particularly susceptible to flooding. These are shown on FIRM panels published in 2019. The Planning Department is now using Light Detection and Ranging Software (LiDAR) as a valuable tool for managing the Special Flood Hazard Areas. The flood insurance study and the DFIRMs are on file at the Permit Center. Additionally, the Borough Planning and Land Use Department has gone to great lengths to identify, record, map, and obtain flood plain development permit applications for all flood plain development that has occurred since 1985.

Figures 21, 22, and 23 show the impacts of the land that is eroding adjacent to the Matanuska River. Erosion is primarily affecting two areas in the Borough. Figure 21 shows an overview of both areas. Figure 22 shows the Sutton area where HMGP projects occurred in 2018. Figure 23 shows the Butte area where HMGP projects are occurring. The Borough received a FEMA grant to acquire up to 15 properties that were impacted by erosion of the Matanuska River. This grant was available to homeowners that voluntarily participated, and a total of seven homeowners participated. Two homes in the Sutton area were acquired and demolished in 2018, and the land has been deeded to remain as open space in perpetuity. Five homes in the Butte area have been acquired and will be demolished by Summer 2020 with the land deeded to remain as open space in perpetuity. One additional homeowner in the Butte area may decide to participate in January 2020.

Another area of flooding concern is an alluvial fan, outside of the Borough's mapped "Special Flood Hazard Area". The area is Hunter Creek and is located at Mile 9.6 on the Knik River Road. The 77-foot span of the Hunter Creek Bridge slumped into the creek in September 1995 (refer to DR-1072 on October 13, 1995 in Section 5.3.3.3 for information). The Cedars Subdivision platting was finalized in 2014, and single-family residential development is ongoing in this area. Figures 24 and 25 illustrate the alluvial fan.

Alluvial fan flooding is characterized by a sudden torrent of water capable of carrying rocks, mud, and debris that debouches from valleys and canyons and spreads over the fan surface. Fan flood flows are characterized by surging, erosion, scour, channel avulsion, mud and debris flows, and sheet flows on the lower portions of the fan surface.

Figure 21. 2018 Hazard Mitigation Grant Program - Butte & Sutton Acquisition Areas

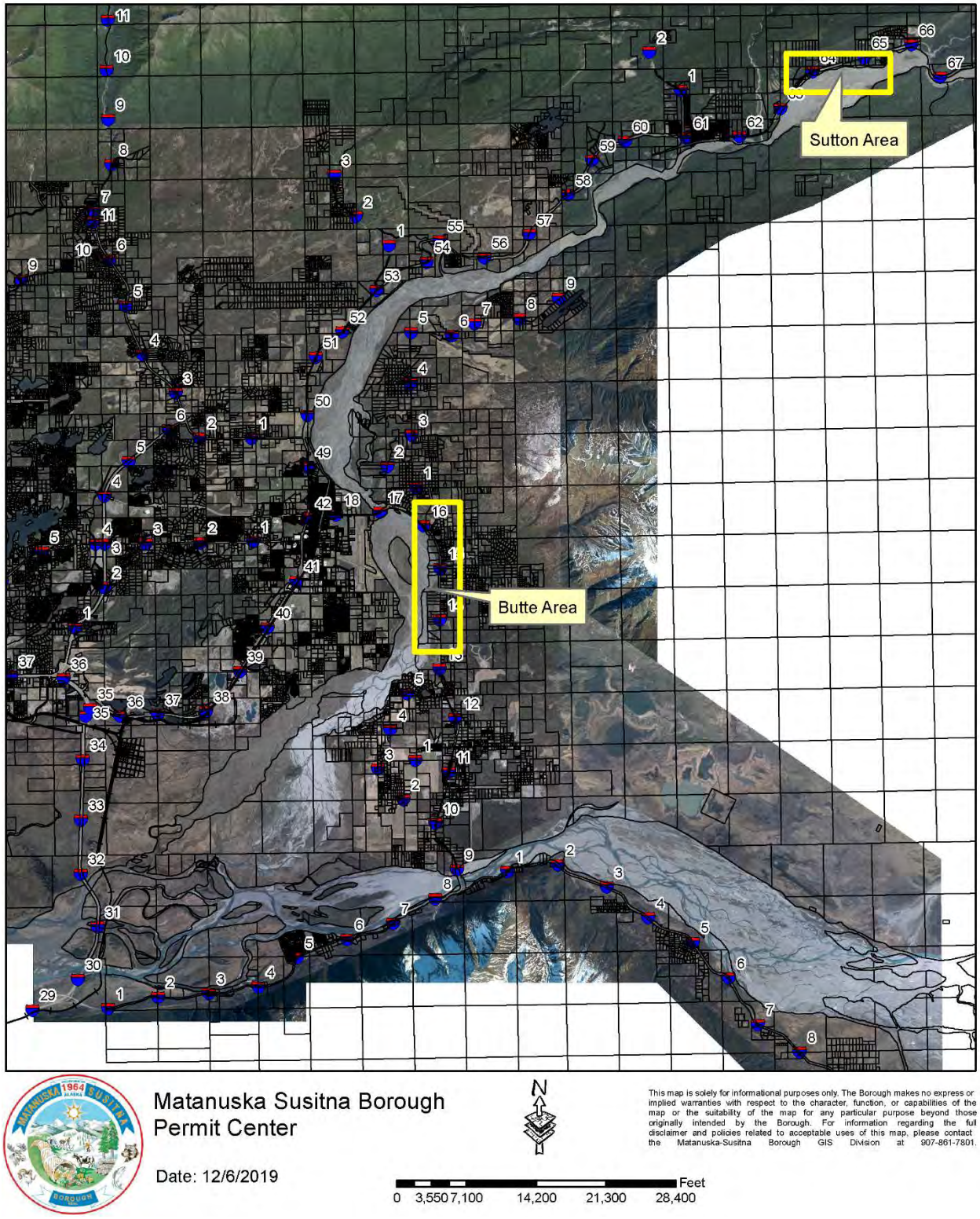


Figure 22. 2018 Hazard Mitigation Grant Program - Sutton Acquisitions

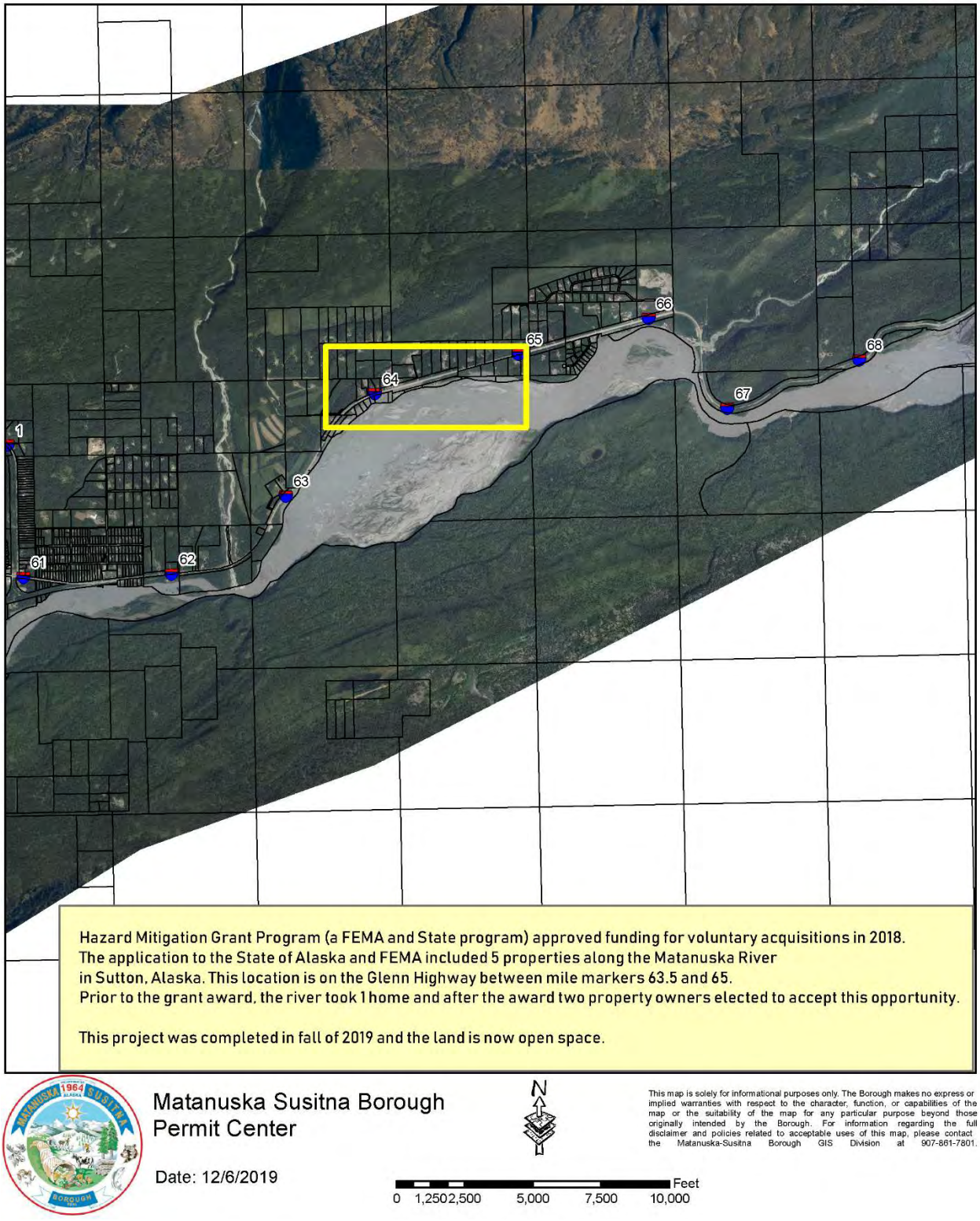


Figure 23. 2018 Hazard Mitigation Grant Program - Butte Acquisitions

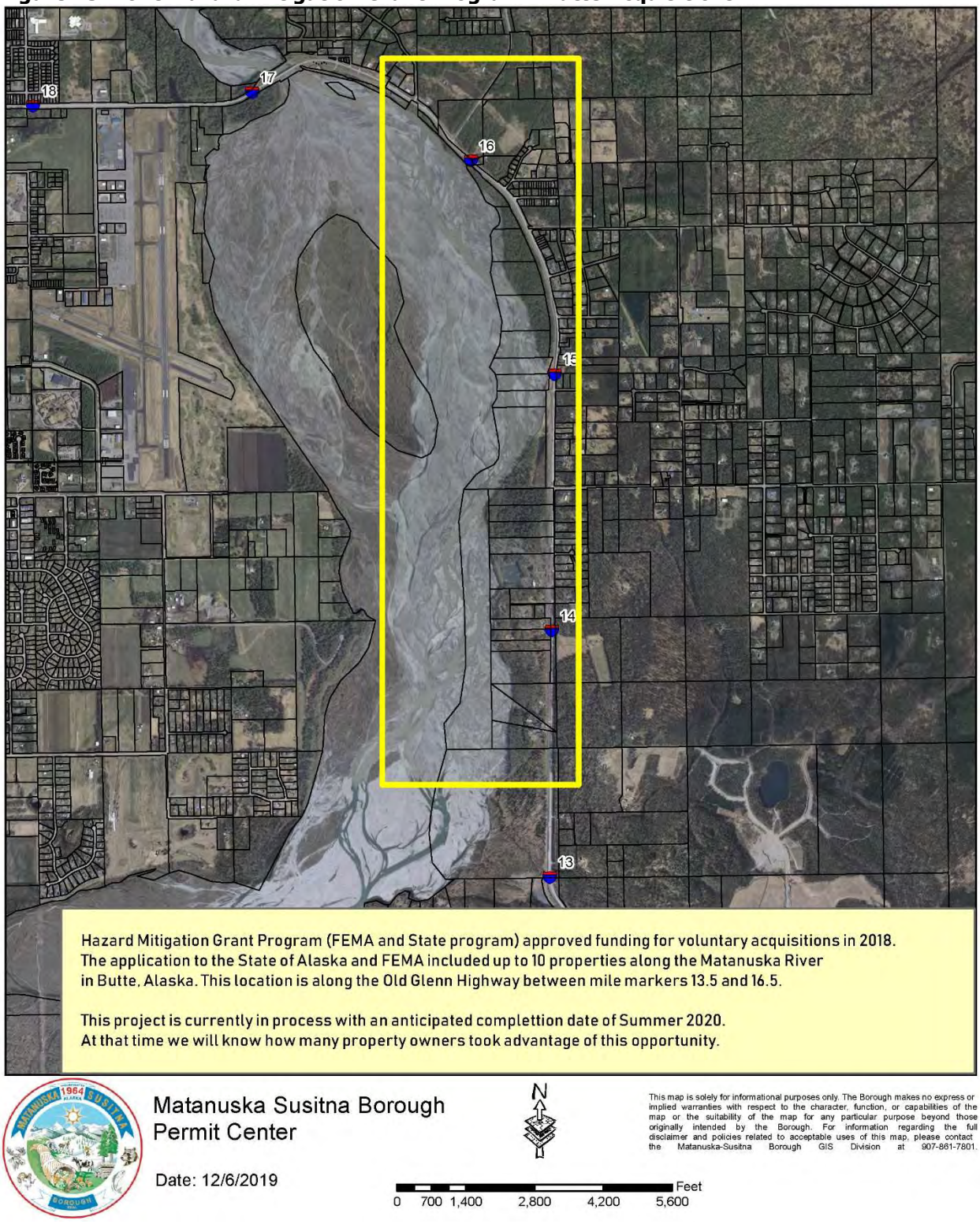


Figure 24. The Cedars Subdivision - Hunter Creek approximately Mile 9.5 Knik River Road

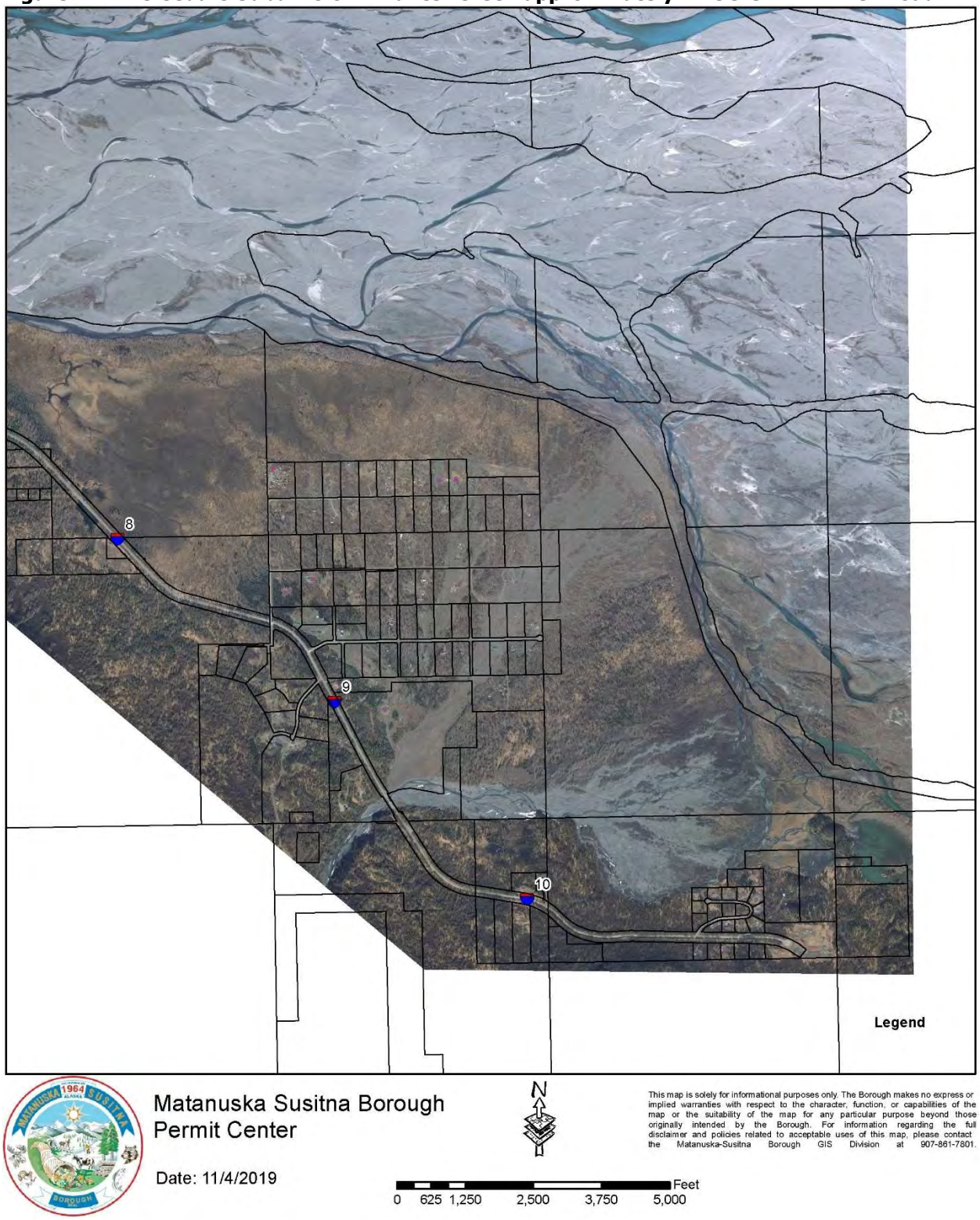
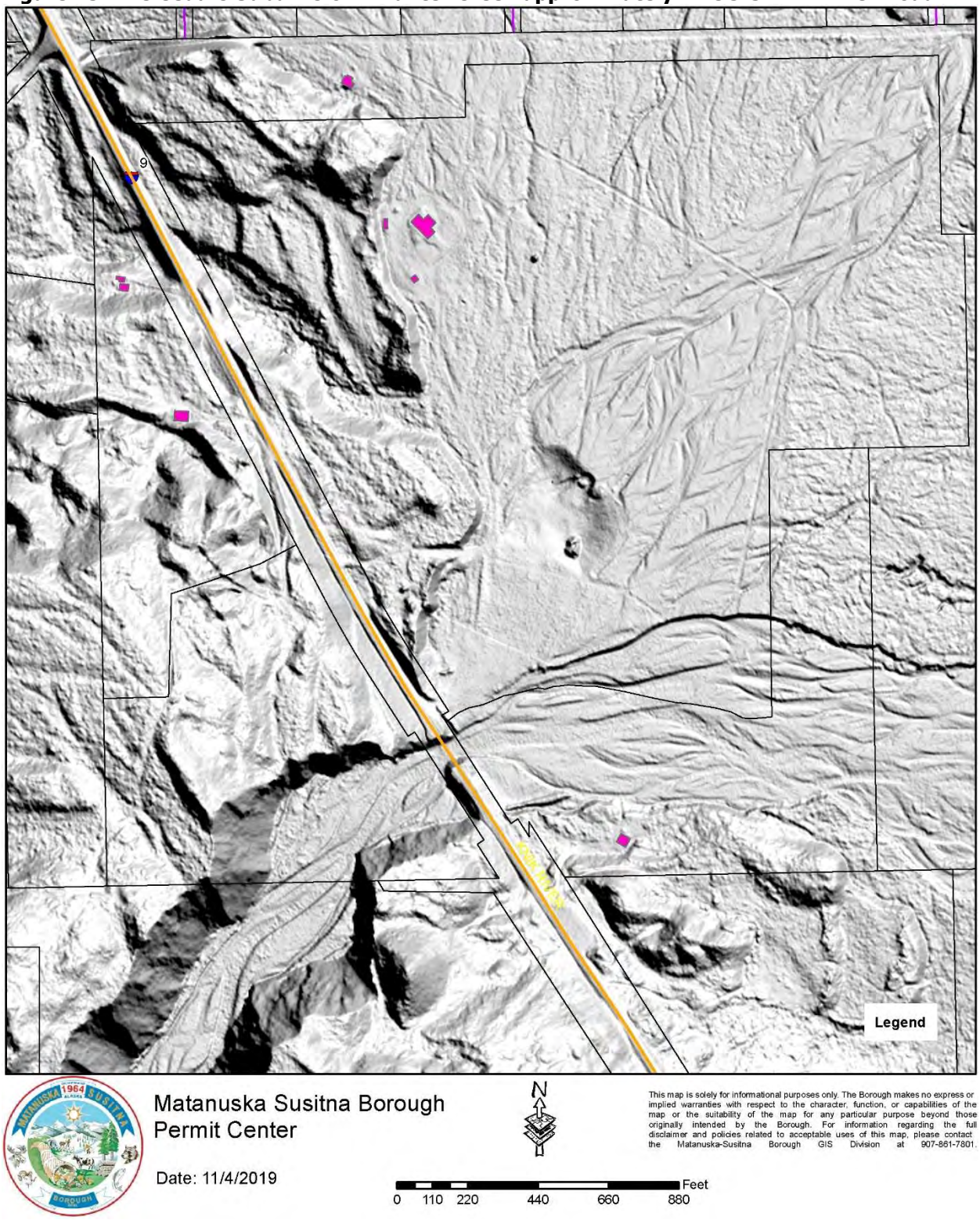


Figure 25. The Cedars Subdivision - Hunter Creek approximately Mile 9.5 Knik River Road



The Alaska Department of Fish and Game (ADF&G) Fish Passage Assessment Program was created in 2000 and charged with assessing state-owned road crossings for impacts to fish passage. Since that time ADF&G has also assessed crossings on Borough, municipality, private, and federal roads and on the Alaska Railroad. Salmon and other fish move throughout the watershed year-round, and unobstructed access to habitat is critical to helping maintain a healthy fish population. Properly designed bridges and culverts have little or no adverse effect on fish, aquatic organisms, and other riverine animals, but when culverts are too small, too steep, or incorrectly placed relative to the natural stream, they impede both up- and downstream fish movement. This program has been continued, and more information on the projects within the Borough can be accessed at: https://www.adfg.alaska.gov/index.cfm?adfg=fishpassage.main.

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 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 existence of attenuating features in the watershed, including natural features such as lakes and human-built features such as dams.
- Flow velocity.
- Availability of sediment for transport, and the bed and embankment watercourse erodibility.
- Location of potentially-impacted structures related to the base flood elevation as indicated with their certified high-water mark.

A variety of natural and human-induced factors influence the erosion process. River orientation and proximity to up and downstream river bends can influence erosion rates. Embankment composition also influences erosion rates, as sand and silt erode easily, whereas boulders or large rocks are more erosion-resistant. Other factors that may influence erosion include:

- Geomorphology;
- Amount of encroachment in the high hazard zone;
- Proximity to erosion-inducing structures;
- Nature of the topography;
- Density of development;
- Structure types along the embankment; and
- Embankment elevation.

Impact

Flood depth grids were completed for the Borough in 2019. Flood depth grids illustrate the flood depth, in feet above the ground surface, to demonstrate the variability of flood depths in flood- prone areas. Figures 26, 27, 28, and 29 include depth grids for multiple flood scenarios for Willow Creek which recently flooded on December 21, 2019: 10% (10-year), 4% (25-year), 2% (50-year), 1% percent (100-year) annual chance. This information is useful for visualizing flood impacts outside of the regulatory purview and for examining the vulnerability of structures in terms of severity and frequency.

The Matanuska River has eroded peoples' homes away. Recent mitigation projects have allowed homeowners to voluntarily sell their homes and relocate (see Figures 21-23).

Recurrence Probability

Future populations of the Borough can expect to see flooding and erosion at the same or increased rates as current populations have experienced.

5.3.3.5 NFIP

Requirements for communities that participate in the NFIP, as stipulated in DMA 2000 and its implementing regulations, are described below.

DMA 2000 Requirements: Risk Assessment – NFIP

Profiling Hazards

Requirement §201.6(c)(2)(ii): The risk assessment shall address NFIP insured structures that have been repetitively damaged by floods.

Element

- Are there repetitively damaged properties in the jurisdiction?

Source: FEMA, 2015.

The function of the NFIP is to provide flood insurance at a reasonable cost to homes and businesses located in floodplains. In trade, the communities within the Borough regulate new development and substantial improvement to existing structures in the floodplain or require developers to build safely above flood heights to reduce future damage to new construction. The program is based upon mapping areas of flood risk and requiring local implementation to reduce flood damage primarily through requiring the elevation of structures above the base (100-year) flood elevations.

The Borough participates in the NFIP; the NFIP area includes the incorporated areas of the cities of Houston, Palmer, Wasilla, and Talkeetna. Table 11 defines FIRM zone definitions, and Table 12 contains current NFIP statistics for the Borough. Table 13 contains Borough and State Floodplain Coordinators that implement the NFIP. Tables 14 and 15 identify the number of structures and land use of properties that are within flood zones in the Borough.

Figure 26. 10-Year or 10% Flood Depth Grid Willow Creek

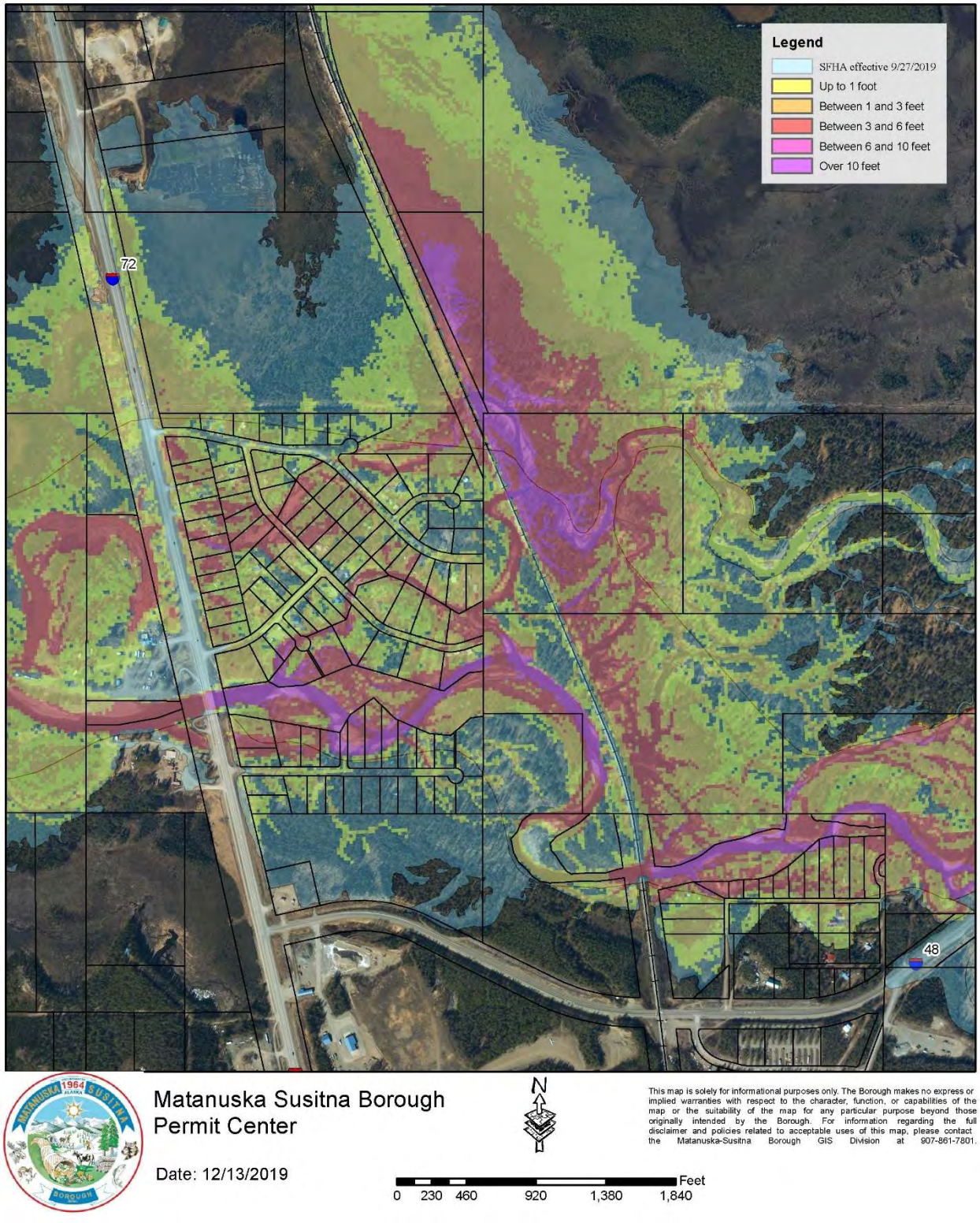


Figure 27. 25-Year or 4% Flood Depth Grid Willow Creek

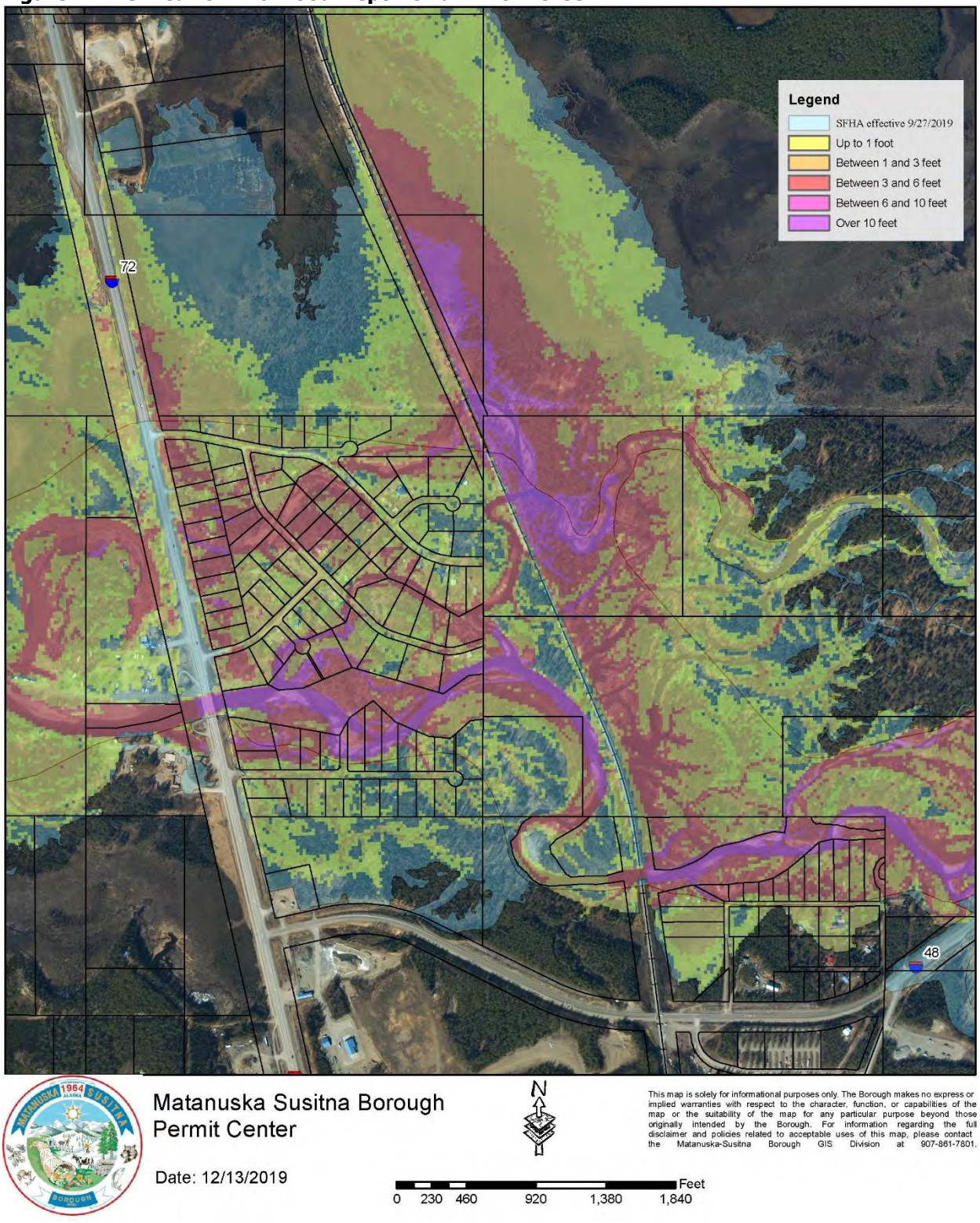


Figure 28. 50-Year or 2% Flood Depth Grid Willow Creek

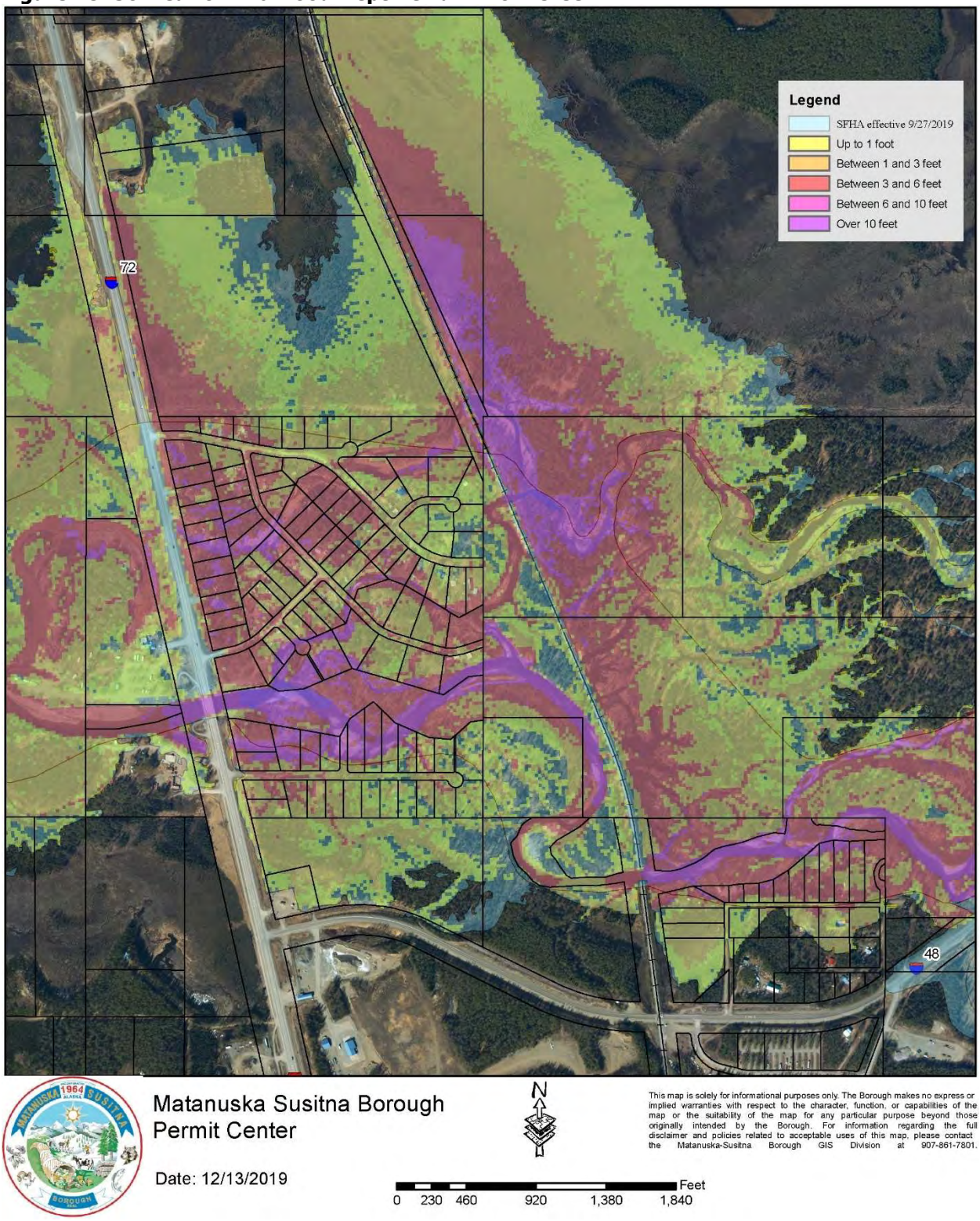


Figure 29. 100-Year or 1% Flood Depth Grid Willow Creek

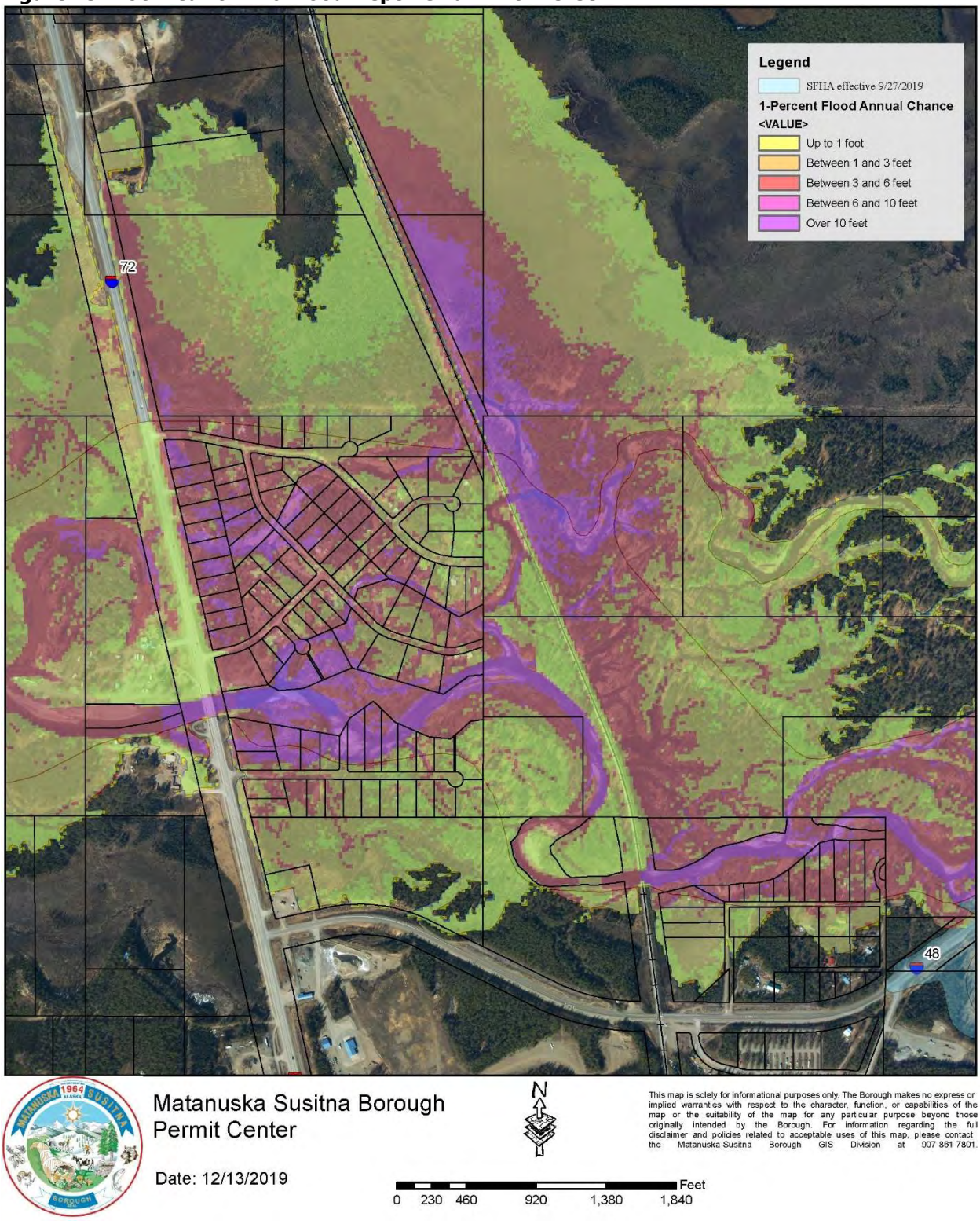


Table 11. FIRM Zone Definitions

Firm Zone	Explanation
A	Areas of 100-year flood; base flood elevations and flood hazard not determined.
AO	Areas of 100-year shallow flooding where depths are between one and three feet, average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one and three feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one foot or where the contributing drainage area is less than one-square mile; or areas protected by levees from the base flood.
C	Areas of minimal flooding.
D	Areas of undetermined, but possible, flood hazards.

Flood insurance purchase may be required in A, AO, AH, and A-numbered zones as a condition of loan or grant assistance. An Elevation Certificate is required as part of the development permit. The Elevation Certificate is a form published by FEMA, required to be maintained by communities participating in the NFIP. According to the NFIP, local governments maintain records of elevations for all new construction or substantial improvements in floodplains and must keep certificates on file.

Elevation Certificates are used to:

1. Record the elevation of the lowest floor of all newly-constructed buildings, or substantial improvement, located in the floodplain.
2. Determine the proper flood insurance rate for floodplain structures.
3. Local governments must ensure that elevation certificates are completed correctly for structures built in floodplains. Certificates must include:
   - The location of the structure (tax parcel number, legal description, and latitude and longitude) and use of the building.
   - The FIRM panel number and date, community name, and source of base flood elevation date.
   - Information on the building's elevation.
   - Signature of a licensed surveyor or engineer.

Table 12. Current NFIP Statistics for Borough

Emergency Program Date Identified	**Regular Program Entry Date**	**Map Revision Date**	**NFIP Community Number**	**CRS Rating Number**	**Borough Total # of Current Policies (9/30/19)**
2/28/1978	5/01/1985	9/27/2019	020021	-	225
Borough Total Premiums	**Borough Total Dollars of Paid Losses**	**AK State Average Value of Losses**	**AK State # of Current Policies**	**AK State Total Premiums**	**AK Total Loss Dollars Paid**
$222,010	$1,248,284	$15,227	2,352	$2.2 million	$9.7 million
Borough Average Premium	**AK State Average Premium**	**Borough Repetitive Loss Claims**	**Borough Dates of Rep. Losses**	**Borough Total Rep. Loss**	**Borough Average Building Rep. Loss**
$987	$906	6	2006 & 2012	$45,296	$7,480
Borough Minus Rated Policies	**Borough Total Insurance in Force**	**Borough Total Claims Since 1978**	**AK State Total Claims Since 1978**	**Borough Average Value of Losses**	**Borough Total Dollars of Paid Losses**
18	$55,983,700	78	640	$16,004	$1,248,284

Table 13. State and Local Floodplain Coordinators

Borough Floodplain Coordinator	Matanuska-Susitna Borough Contact: Taunnie Boothby Planning Department 350 E Dahlia Ave Palmer, AK 99645 Phone: (907) 861-8526 E-Mail: taunnie.boothby@matsugov.us
State of AK Floodplain Coordinator	Floodplain Management Programs Coordinator Division of Community and Regional Affairs Department of Commerce, Community & Economic Development Contact Person: Jimmy C. Smith 550 West 7th Avenue, Suite 1640 Anchorage, AK 99501 Phone: (907) 269-4132 E-Mail: jimmy.smith@alaska.gov Website: https://www.commerce.alaska.gov/web/dcra/PlanningLandManagement/FloodplainManagement.aspx

Table 14. Borough Structures within the Flood Zones

Flood Zones	Acres	Land Appraisal	Building Appraisal	Number of Structures
only 1% chance/year	174,778	$180,789,300	$324,628,308	1,893
both 1% & 0.2% chance/year	26,614	$47,431,200	$69,170,600	672
only 0.2% chance/year	2,777	$11,125,000	$21,420,148	210
TOTALS	**204,169**	**$239,345,500**	**$415,219,056**	**2,775**

Table 15. Borough Flood Zones by Land Use

Flood Zones	Undeveloped	Residential	Commercial	Agricultural	Mixed Use	Other	Total
only 1% chance/year	55.81%	40.58%	1.66%	0.05%	1.17%	0.73%	100%
both 1% & 0.2% chance/year	49.04%	48.02%	0.45%	0.23%	1.81%	0.45%	100%
only 0.2% chance/year	45.45%	45.06%	1.98%	0.00%	4.35%	3.16%	100%

5.3.4 Volcanoes and Ashfalls

5.3.4.1 Hazard Characteristics

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 Aleutians. An average of one to two eruptions per year occurs in Alaska. 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.

Volcanic Ash

Volcanic ash, also called tephra, is fine fragments of solidified lava and rock crystals ejected into the air by a volcanic explosion. The fragments range in size, with the larger falling nearer the source. Ash is a problem near the source because of its high temperatures (may cause fires), burial (the weight can cause structural collapses; for example, it was 100 miles from Novarupta to Kodiak where structures collapsed), and impact of falling fragments. Further away, the primary hazard to humans is damage to machinery (including airplanes in flight), decreased visibility, and inhaling the fine ash (long-term inhalation can lead to lung cancer). Lightning in large ash clouds can also pose a hazard. In Alaska, this is a major problem as many of the major flight routes are near historically active volcanoes. Ash accumulation may also interfere with the distribution of electricity due to shorting of transformers and other electrical components (ash is an excellent conductor of electricity).

The largest volcanic eruption of the 20th century occurred at Novarupta Volcano in June 1912. The eruption started by generating an ash cloud that grew to thousands of miles wide during the three-day event. Within four hours of the eruption, ash started falling on Kodiak, darkening the city. It became hard to breathe because of the ash and sulfur dioxide gas. The water became undrinkable and unable to support aquatic life. Roofs collapsed under the weight of the ash. Some buildings were destroyed by ash avalanches while others burned after being struck by lightning from the ash cloud. Similar conditions could be found all over the area. Some villages ended up being abandoned, including Katmai and Savonoski Villages. The ash and acid rain also negatively affected animal and plant life. Large animals were blinded, and many starved because their food was eliminated.

The single greatest volcanic hazard in the Borough is airborne ash, fine fragments of rock blown high into the atmosphere during explosive volcanic eruptions.

5.3.4.2 History

The Alaska Volcano Observatory (AVO), which is a cooperative program of the USGS, Alaska DNR DGGS, and the UAF Geophysical Institute (GI), monitors the seismic activity at 23 of Alaska's 41 active volcanoes in real time. In addition, satellite images of all Alaskan and Russian volcanoes are analyzed daily for evidence of ash plumes and elevated surface temperatures. Russian volcanoes are also a concern to Alaska as prevailing winds could carry large ash plumes from Kamchatka into Alaskan air space. AVO also researches the individual history of Alaska's active volcanoes and produces hazard assessment maps for each center. The Alaska Tsunami Warning Center, located in Palmer, also monitors volcanic and earthquake activity throughout the Pacific region.

The Borough has experienced volcanic ash in 1989, 1990, and 1992 from Mt. Redoubt and Mt. Spurr. These eruptions disrupted transportation and industry, particularly jet aircraft (Figure 30).

5.3.4.3 Location, Extent, Impact, and Recurrence Probability

Location

Figure 13 illustrates the spread of ash fall which is dependent on wind direction.

Extent

For any given eruption, the depth of ash deposited at any given location depends on the total volume of ash ejected, the wind direction, and the distance between the volcano and a given location.

Extreme ashfall events, similar to the 1912 event, would have similar extreme consequences including building damage up to and including collapses, disruption of travel (air, sea, land), disruption of water, electric power and communications, and health and environmental impacts. Smaller ashfall events would result in little or no building damage, but would still have significant impacts, including:

- Respiratory problems for at-risk populations such as young children, people with respiratory problems and the elderly;
- Disruption of air, marine, and land traffic;
- Clean-up and ash removal from roofs, gutters, sidewalks, roads, vehicles, mechanical systems and ductwork, engines, and mechanical equipment;
- Clogging of filters and possible severe damage to vehicle engines, furnaces, heat pumps, air conditioners, commercial and public buildings combined heating, ventilation, and air conditioning (HVAC) systems and other engines and mechanical equipment;
- Disruption of public water supplies drawn from surface waters, including degradation of water quality (high turbidity) and increased maintenance requirements at water treatment plants;
- Disruption/clogging of storm water drainage systems;
- Disruption of electric power from ash-induced short circuits in distribution lines, transmission lines, and substations; and
- Disruption of communications.

A major factor in determining ashfall is wind direction. Additionally, if there is a large ashfall, wind could blow and redistribute ashfall several times which would be a prolonged hazard.

Impact

The eruption of Mount Redoubt in 1989 caused widespread distribution of ash over the central and southern peninsula and resulted in power outages and disruption of traffic. Volcanic ash nearly caused the greatest loss of life of any disaster event in Alaska. During the 1989 eruption of Mount Redoubt, a commercial airliner, with 245 passengers and crew aboard, flew into an ash cloud resulting in a loss of power to all four engines.

Another impact of major ashfall is a breakdown of soil cover, accelerating erosion. This impact was seen on the flanks of Okmok in the eastern Aleutian Islands following the 2008 eruption. Former grasslands were cut with networks of deep, rapidly eroding gullies.

The Borough has experienced a few tenths of an inch of ashfall on residents' vehicles and homes. Planes are grounded. Operation of motorized equipment including vehicles is discouraged due to potential for damage. The Borough has a shelter in place policy.

Recurrence Probability

Ash fall from volcanic eruptions is a threat to health and to equipment that may draw in fine, abrasive particles. The Borough's Department of Emergency Services receives weekly monitoring reports from the AVO and alerts whenever an eruption is imminent or observed. Ash fall from prior eruptions is persistent and is carried along with glacial silt, primarily along the Matanuska River near Palmer. During times of high winds these fine particles may pose a significant health threat. Public notification and education are the primary mitigation strategies for minimizing damage due to volcanic eruptions.

The recurrence probability for the future residents of the Borough would remain the same as for current residents.

Figure 30. Areas Affected by Ash Falls

5.3.5 Severe Weather

5.3.5.1 Hazard Characteristics

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

High Winds

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 cyclonic force. In Alaska, high winds (winds in excess of 60 mph) occur frequently over coastal areas along the Gulf of Alaska. They can also combine with loose snow to produce ground blizzards.

Localized downdrafts, downbursts, and microbursts, are also common wind hazards. Downbursts and microbursts are often generated by thunderstorms. Downbursts are areas of rapidly falling rain-cooled air. Upon reaching the ground, downbursts spread out in all directions in excess of 125 mph. Microbursts are smaller scale, more concentrated downbursts reaching speeds up to 150 mph. Both types of wind, commonly lasting five to seven minutes, are hazardous to aviation. These winds reach hurricane force and have the potential to seriously damage community infrastructure (especially above ground utility lines) while disrupting vital marine transportation.

High winds occur in the Borough when there are winter low-pressure systems in the North Pacific Ocean and the Gulf of Alaska. They can reach hurricane force and have the potential to seriously damage community infrastructure, especially above ground utility lines. High winds can also be a localized problem where a pressure differential occurs across a mountain range (a katabatic wind), such as those found in Anchorage's Hillside area and in the Matanuska River Valley near Palmer.

Winter Storms

Winter storms include a variety of phenomena described above and may include several components such as wind, snow, and ice storms. Ice storms include freezing rain, sleet, and hail and can be the most devastating of winter weather phenomena; often causing automobile accidents, power outages, and personal injury. Freezing rain coats every surface it falls on with an icy glaze. Freezing rain most commonly starts in a narrow band on the cold side of a warm front, where surface temperatures are at or just below freezing temperatures. Ice crystals high in the atmosphere grow by collecting water vapor molecules, 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.

Thunderstorms

Thunderstorm hazards include lightning, heavy rain, snow, up drafts, down drafts, severe aircraft turbulence and icing, damaging hail, high winds, and flash flooding. A thunderstorm is considered severe if winds reach 60 mph or generate surface hail at least one inch in diameter. Thunderstorms affect relatively small areas; the average thunderstorm is about 15 miles in diameter and lasts less than 30 minutes in any given location.

Lightning exists in all thunderstorms. It is formed from built-up charged ions within the thundercloud. Lightning is hazardous to humans and frequently starts wildfires in Alaska's interior northern boreal forests. The BLM lightning activity sensors positioned across the interior locate an average of 26,000 cloud-to-ground lightning strikes per year. Very active

thunderstorm days may feature 8,000 to 12,000 lightning strikes, mainly occurring during the late afternoon hours from the end of June to the beginning of July.

Lightning-caused injuries and deaths are unusual in Alaska. However, in 1986, one person was killed and three others injured near Tok, when they took shelter under a tree that was struck by lightning.

Alaska has a relatively low frequency of thunderstorm occurrence. In a typical year, Alaska has fewer than 20 days with thunderstorms, and they do not occur uniformly over the State. They are virtually unknown in the Borough.

Hail

Thunderstorms produce hail in ball or irregular shapes greater than 0.75 inch in diameter. The size and severity of the storm determine the size of the hailstones. Alaskan hail is small (pea-sized) and fairly rare. Lightning and hail may become bigger and more frequent with changes in the cryosphere. In August 1992, a sudden hailstorm deposited a blanket of 0.5 diameter hailstones to a depth of one inch in an area north of Wasilla.

Heavy and Drifting Snow

Heavy snow generally means an accumulation of more than 12 to 24 inches of snow inside of 24 hours. Sometimes, roadways will close, disrupting supply flow and emergency response service access. Excessive accumulation will collapse roofs, knock down trees and power lines, damage parked light aircraft, and capsize small boats. Heavy snow increases flooding risks. Heavy snow is associated with vehicle accidents, overexertion, and hypothermia. Drifting is the uneven distribution of snowfall and snow depth caused by strong surface winds. Drifting snow may occur during or after a snowfall.

Record heavy snow occurred in Anchorage on March 17, 2002, when two to three feet of snow fell in less than 24 hours over portions of the city. Ted Stevens International Airport recorded a storm total of 28.7 inches, and an observer near Lake Hood measured over 33 inches. Anchorage was essentially shut down during the storm, which fortunately occurred on a Sunday morning when a minimal number of businesses were open. Both military bases, universities, and many businesses remained closed the following day, and Anchorage schools remained closed for two days. It took four days for snow plows to reach all areas of the city. It doesn't take several feet of snow to cause considerable risk to residents of the Anchorage area. On March 20, 2001, more than 100 vehicle accidents occurred in the Anchorage-Eagle River area when 8 to 12 inches of snow fell.
Snowfall in the Borough is typically lighter than that received in Anchorage, however, because the Borough abuts the northern border of the Municipality of Anchorage, its residents are directly impacted by these events. Commuters are especially impacted.

Heavy Rain/Freezing Rain/Ice Storm

Freezing rain and ice storms describe occasions when excessive ice accumulations are expected during a heavy rain event. They are a particularly hazardous winter weather phenomena and often cause numerous automobile accidents, power outages, and personal injury. Ice storms form from freezing rain and pass through a thin layer of cold air just above the ground and cool

to below freezing. The drops remain in a liquid state until they impact a surface and freeze on contact. Ice accumulations can damage trees, utility poles, and communication towers which disrupts transportation, power, and communications.

Cold

The definition of extreme cold varies according to the normal climate of a region. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme". In Alaska, extreme cold usually involves temperatures - 40 °F with additional wind chills. Excessive cold may accompany winter storms or can occur without storm activity during clear skies with high barometric pressure. Extreme cold accompanied by wind exacerbates exposure injuries such as frostbite and hypothermia.

Extreme cold interferes with infrastructure across Alaska for days or sometimes weeks at a time. Liquid fuels may congeal or freeze, denying motorized transportation, heat, and electricity generation. In desperation, some people choose to burn propane stoves indoors, increasing their risk to carbon monoxide poisoning.

5.3.5.2 Climate Change Influences

Increases in carbon dioxide, methane, and other gases in the atmosphere are generally warming and changing the climate worldwide by trapping heat that would have escaped back into space. Trees and other plants cannot absorb as much carbon dioxide through photosynthesis as is produced by burning fossil fuels. Therefore, carbon dioxide builds up and changes precipitation patterns, increases storms, wildfires, and flooding frequency and intensity; and substantially changes flora, fauna, fish, and wildlife habitats.

In contemporary usage, climate change commonly refers to the change in global or regional climate patterns that spans from the mid- to late 20th century to the present. Evidence collected by scientists and engineers from around the world tells an unambiguous story: the planet is warming. Climate change at locations in high northern latitudes, such as Alaska, is causing rapid and severe environmental change.

Alaska's temperature rise rate has been twice the average of the rest of the U.S. in recent decades. During the period from 1949 to 2014, the Statewide average annual air temperature increased by 3°F, and the average winter temperature increased by 6°F (ACRC, 2018). This included considerable annual and regional variability, and was accompanied by a greater number of extremely warm days and fewer extremely cold days (CCSP, 2008). The Statewide average annual precipitation during this same period has increased by about 10%, with recent decades showing amounts largely above normal, but with substantial annual and regional variability (Shulski and Wendler, 2007, ACRC, 2018).

Global climate is projected to continue changing over this century, and changes to Alaska's climate are expected to be unprecedented (Chapin et al, 2014). Average annual temperatures in Alaska are projected to rise by an additional 2°F to 4°F by 2050, and by 6°F to 12°F by the end of the century depending on emission levels (Stewart et al, 2013). Projections of annual precipitation show an increase across Alaska as part of the broad pattern of increases projected for high northern latitudes.

Snow cover extent and depth have been decreasing in most places in Alaska for nearly three decades. Warmer winter temperatures change the precipitation frequency of snow and rain, and are producing more frequent rain-on-snow events.

5.3.5.3 History

The Borough has a history of severe weather events described in the DHS&EM Disaster Cost Index (DHS&EM, 2018b). These events are listed below.

4. **Matanuska-Susitna Borough, February 9, 1979:** As a result of a winter storm generating high winds and drifting snow, many roads in the **Matanuska-Susitna Borough** were rendered impassable to all traffic, including emergency vehicles. ADOT&PF was tasked by DHS&EM and public assistance was provided to clear the roads; the Alaska National Guard conducted rescue operations to provide to isolated and stranded individuals. Subsequent to the Governor's request, the SBA made disaster loans available to some 44 residents and 24 businesses which suffered damage as a result of the storm. The State did not make any direct grants to individuals or families.

108. Moose Feeding Project: Record snowfall depths prevented moose from gaining access to their usual feeding grounds forcing them to starve and attempt to use the Alaska Railroad tracks to access food. This caused numerous collisions with vehicles and disrupted train traffic.

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.

00-191 Central Gulf Coast Storm declared February 4, 2000 by Governor Murkowski 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 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. On March 17, 2000, the Governor again expanded the disaster area and declared that a condition of disaster existed 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.

03-204 Southcentral Windstorm (AK-DR-1461) Declared March 28, 2003 by Governor Murkowski, then FEMA declared April 26, 2003: A major windstorm with sustained and severe winds that exceeded 100 mph occurred between March 6 and March 14, 2003. The windstorm

affected the **Matanuska-Susitna Borough**, the Municipality of Anchorage, and the Kenai Peninsula Borough. Severe damage occurred to numerous personal residences and local businesses; extensive damage occurred to public facilities (i.e. schools, libraries, community centers, airports, buildings, and utilities). Although damages were widespread, Anchorage facilities received the most damages. Federal Disaster Assistance for Debris Removal, Emergency Protective Measures and all Permanent Work categories were approved under the Public Assistance Program. FEMA also authorized 404 Mitigation funding and individual assistance under the Individual and Household Program. Individual Assistance totaled $48K. Public Assistance totaled $2.5 million for 24 applicants with 87 PW's. Hazard Mitigation totaled $532K. The total for this disaster was $3.47 million.

12-240, 2012 September Storm declared by Governor Parnell on October 17, 2012, then FEMA declared November 27, 2012 (DR-4094): Beginning on September 4, 2012, and continuing, a strong weather system produced high winds and heavy rains, resulting in severe and widespread wind damage and flooding throughout much of Southcentral and Interior Alaska. The series of storms created a threat to life and property in the **Matanuska-Susitna Borough**, Kenai Peninsula Borough, Alaska Gateway Regional REAA, and the Chugach area. The magnitude of the storm resulted in wind damages and flooding which necessitated debris clearance, emergency protective measures, damage to public facilities including roads, bridges, railroad, electrical distribution and water systems, and damage to private residences to include losses of personal property.

The Borough has experienced severe weather events from 2000 through 2019 according to NOAA. Table 16 contains notable events that were not declared disasters.

Table 16. Severe Weather Events

DATE	EVENT TYPE	EPISODE NARRATIVE
April 4, 1980	High Wind	The Governor proclaimed a Disaster Emergency subsequent to a hurricane force windstorm which caused damage to over 5,000 residences and businesses in the Anchorage area and parts of the Borough. Though most of the residents were insured against their losses, the State provided a number of Individual and Family Grants and temporary housing, as well as public assistance to the Municipality. In addition, the SBA made disaster loans available to affected individuals.
Winter 1990	Heavy Snow	Because of record snowfalls in Southcentral Alaska, the Legislature appropriated a special grant to local governments affected in order to supplement normal snow and ice removal budgets. The Legislature directed that funds be managed by the Division of Emergency Services.
December 13, 2000	High Wind	Brisk northeast wind gusts above 60 mph began at the Wasilla Fire Station. Modified arctic air flowing out of the Copper River Basin...associated with strong high pressure in the Northwest Territories of Canada...was the cause of the winds. Peak gusts reached 70 mph.
February 1, 2001	Winter Storm	A weakening low moved into western Prince William Sound. Gusty east winds preceded the low. Strong pressure rises accompanied the weakening low. Significant precipitation was reported on the west and southwest side of the low. In the Matanuska Valley, Palmer recorded 5 - 6 inches of snow, Hatcher Pass Lodge 7 inches, and 3 inches of new snow fell at the Talkeetna airport. At a site 20 miles south of Cantwell,

		one foot of new snow was reported. Between midnight and 4 pm Thursday, the Anchorage Police Department (APD) reported 98 vehicle crashes. In addition to the vehicle crashes, the APD reported 68 vehicles went off the road.
February 11, 2001	Heavy Snow	A strong low moved into the northern Bering Sea Saturday as its front swept into the south central region of the State. Initial marine over running of the arctic air resulted in heavy snow in the Susitna Valley. Strong down slope winds resulted in a delay in the onset of the heavy snow over the Anchorage and Palmer areas until Sunday evening. Spotter reports of snowfall were 12 inches in Palmer and 8 to 16 inches in the Susitna Valley.
March 18, 2001	High Wind	In the Susitna Valley, reports received from East Fork Maintenance Camp of DOT mentioned 6 inches of new snow. Typically, in cases like this, sporadic reports do not reflect highest amounts...which, in this case, likely exceeded the 8 inch/12 hours or less threshold for a heavy snow warning. Locally strong winds were reported near the Matanuska River. These winds were caused by moderate to strong high pressure in the eastern Alaskan interior and moderate low pressure in the Gulf of Alaska. Northeast wind gusts reached 71 mph.
March 22-24, 2001	High Wind	Another Matanuska wind event was set up by moderate, cold high pressure in the Copper River Basin and complex low pressure in the Gulf of Alaska. Modified arctic air spilled through the Matanuska Glacier/River toward Cook Inlet. Gusts reached 66 mph Friday and 69 mph Saturday. Although the last wind gust of 60+ mph at the Wasilla Fire Station was reported at 2 am Friday, winds at the site again gusted to 59 mph Saturday. With these Matanuska wind cases, it is known that higher winds blow further up-river (where there are no gauges to measure speeds).
April 2-4, 2001	High Wind	In advance of a moderate front, strong, damaging southeast winds hit the Anchorage Municipality Zone Monday. Winds reached 60 + mph along the Upper Hillside by 8 pm Monday. Peak winds reported in the Anchorage area: 90+ mph at Glenn Alps, 88 mph at Rabbit Creek, 73 mph at both Muldoon and Alpenglow. Snow began falling in the Susitna Valley early Monday evening. Trapper Creek reported 16 inches of snow by Tuesday morning. 9 inches of new snow was reported near the Parks Highway at Colorado Lake (3 miles from Igloo) since 7 pm Tuesday, with 30 inches of snow since Sunday (4/1/01).
May 2-4, 2001	Heavy Snow	A late season snowstorm developed along and just north of the arctic front, dumping between 12 and 18 inches across portions of the northern Susitna Valley, the Portage and Whittier area and over Turnagain Pass late Wednesday through Friday morning. Snowfall amounts along higher elevations in the Anchorage and Palmer area totaled between 8 and 12 inches.
November 17, 2001	Ice Storm	A moderate ridge, building northwestward from Canadian British Columbia into Prince William Sound, accompanied by moderate pressure rises (2.5 - 4.5 mbs/hour) and a northwestward moving arctic front in the area, produced locally very gusty easterly winds around Turnagain Arm, along higher elevations of the mountains east of Anchorage and along much of the Matanuska River. Anchorage Daily news reported a headline of "Ice storm glazes the Glenn (highway)". Sub headline read "Freezing rain halts traffic, coats highway, local roads in slick sheaths." In the article, "Eagle River got the worst of it (freezing rain). Starting about 5 p.m. the northbound Glenn Highway backed up after motorists lost traction on the Eagle River hill. Scores of cars, with

		estimates ranging from 30 to 75, also got stuck on Eagle River Loop road, further jamming the Glenn at the Hiland Road exit. Police struggled to get sanding trucks in place. Tow trucks got stuck. The National Weather service issued a freezing rain warning at 5:30 pm after a meteorologist reported a quarter-inch of ice coating her car in Birchwood. Most of Anchorage got a thin coating of freezing rain, as did Palmer. Alaska State Troopers reported a few minor accidents in Palmer and Wasilla." There was a north gust of 97 mph at Williwaw.
March 9-10, 2002	Heavy Snow	Strong, northeasterly "Matanuska" winds were reported around Palmer. Gusts peaked at 85 mph at midnight Saturday.
March 18-19, 2002	Heavy Snow	A moderate frontal system, moving into South Central Alaska, caused locally strong southeast wind around the Anchorage Municipality and areas of heavy snow in the Susitna Valley. Wind gusts of 97 mph were reported at a remote upper elevation location known as Site Summit (near Alpenglow Ski area). Other reports of 69 mph gusts were received at Glen Alps, along the Upper Anchorage Hillside, late Thursday morning. In the Susitna Valley, 1 - 1.5 feet of new snow fell in roughly a 24 hour or less interval around Talkeetna, Chulitna, and Swan Lake.
April 20, 2002	Heavy snow	Southerly winds aloft, associated with two low pressure systems in the eastern Bering Sea and Alaska, produced areas of heavy snow in the Susitna Valley. Reports around Petersville Road indicated close to 30" of snow 'hammered' the area. Lesser amounts were reported around Talkeetna and Skwentna...however snow at lower elevations rapidly melted as it fell.
February 23, 24, 2003	Heavy Snow	An occluded front, associated with a strong low near the Aleutians, moved up into South-central Alaska early Monday, continuing north into the Susitna Valley. The front produced areas of heavy snow in the Susitna Valley, mostly in northern sections. At the Kenny Creek Lodge, at Mile 17.5 on the Petersville Road, a spotter report indicated 2 feet of snow fell in less than a 24-hour period. Heavy snow was also reported at Chulitna, Hayes River, Big River Lakes, and near Skwentna.
March 12-14, 2003	High Wind	A "Bora" type windstorm hit much of the Matanuska Valley, Anchorage and portions of the Kenai Peninsula.Very cold air funneled down the Matanuska Valley, driven by a large high centered over the Chukotsk Peninsula. A combination of strong convergence aloft, a tight surface pressure gradient, and terrain forcing brought hurricane-force winds to the ground over a large portion of greater Anchorage. Damage reports were numerous and included small planes, roofs torn off buildings, car ports caving in and siding blown off. Power outages of 9 hours or more were reported. Communications were also impacted. Lots of broken signs, traffic lights rendered inoperable, partial roof collapses, lost roofing shingles and garbage cans scattered all over west Anchorage and the Palmer area.When the 109 mph gust hit the Ted Steven's International Anchorage airport at 10:42 pm, the tower was abandoned and the airport closed to incoming traffic. Just prior to that, an Alaska Airlines flight received clearance to land with winds "three five zero at eight zero knots (92 mph)". Flights right behind it decided to go to Fairbanks and Juneau! In all, around 15 flights were diverted to Fairbanks, which became a parking lot for 747s Thursday. Hurricane force winds with gusts up to 100 mph wreaked havoc in the Borough. High winds were sustained for several days with temperatures of 0°F, making for a windchill factor of -53°F.
July 16-17, 2003	Winter Storm	An unusual winter storm affected areas of the northern Susitna Valley to McKinley National Park. A rare cold front passage occurred across

		interior Alaska dipping as far south as the Talkeetna area. Warm moist air flowed into this front from the Cook Inlet region causing a convergence zone. Expected 24-hour QPF was around 3 inches for the northern Susitna Valley for this event. The cold air did push south off the Alaska range and caused the snow to occur down to an elevation of approximately 1500 feet. Water equivalent amounts ranged from 2.64 inches in 24 hours at Trapper Creek to 5.7 inches at Cantwell. Minor flooding occurred north of Talkeetna. Whole trees were floating down the Jack River, near Cantwell, and local residents reported not having ever seen that in all the years they lived there.
July 22-29, 2003	Storm	Another strong storm moved into northwest Alaska bringing heavy rain into the interior and south central regions of the state. Rainfall amounts were reported at 7.45 inches over a day and a half period at the base of Ruth Glacier. Talkeetna reported 1.78 inches and Hatcher Pass reported 2.34 inches in a 24-hour period. This event occurred 11 days after a previous major flood event that occurred over the same region July 16-17. High freezing levels and extremely moist soil conditions contributed to the excessive runoff that lead to the rapid rise of many of the small streams in the Susitna Valley. Four inches of water was reported along the Parks Highway at Honolulu Creek. Some erosion is occurring at the approaches to the bridge across Honolulu Creek. Susitna Landing had water in the parking lot and campground. Railroad tracks sustained washout damage near Curry, about 20 miles north of Talkeetna.
November 8-9, 2003	Heavy Snow	A front pushed through the south central region of the state resulting in heavy snowfall along the Chugach mountains and along the maritime polar boundary inland of the coast. Snowfall in the northern Susitna Valley fell at a rate of over an inch an hour, resulting in 18 inches of snow over an 11-hour period. Total snowfall reached 25 inches in the northern Susitna Valley.
November 23-24, 2003	Heavy Snow	A strong low in the northern Bering Sea had a trailing front that extended across the eastern Bering Sea and pushed into southwest Alaska Sunday November 23rd. Cold air already in place over the south central Region coupled with the inflow of moisture associated with this front and the formation of a low along the front resulted in localized areas of heavy snowfall in the Matanuska Valley. The Alaska and West coast Tsunami Warning center reported a storm total of 20 inches over a 16-hour period.
January 6-7, 2004	High Wind, Drifting Snow	Strong high pressure over interior Alaska combined with a rapidly deepening low in the Gulf of Alaska resulted in strong northerly wind across the south central region and northern gulf coast of Alaska. The north wind reached 86 mph in the Palmer and Wasilla area as a result of the channeling down the Matanuska Valley. Drifting snow and sand resulted in the derailment of the Alaska Railroad train at the junction of the Parks Highway resulting in closing the Parks Highway for several hours.
March 19, 2004	High Wind	Strong high pressure in the Bering Sea along with a developing low in the Gulf of Alaska increased the pressure gradient over much of the area during the period creating high winds over the North Gulf Coast. Wasilla reached a peak wind of 72 mph with estimated wind gusts to 75 mph across the Matanuska Valley.
September 29-30, 2004	Heavy Snow	A low moved from the southwest Gulf of Alaska into the Susitna Valley. This resulted in a strong push of moisture into the Susitna Valley over the colder air in the northern Susitna Valley. The Orographic lift typical of the "bench" near Chulitna resulted in heavy snow beginning late

		Wednesday night that continued until the snow changed over to rain Thursday afternoon. The cooperative observer reported that 12 inches of snow fell from 10 p.m. Wednesday night through Thursday morning.
October 1, 2004	Heavy Rain	A strong Bering Sea storm pushed extremely moist air into south central Alaska. Heavy rain and snow occurred over the previous weekend resulting in saturated soil throughout the region. Rainfall of moderate to heavy rates was reported by observation sites in the Susitna Valley south to the Anchorage bowl. Amounts of 2 to 3 inches were observed across this region with higher estimated amounts along the Chugach and Talkeetna Mountains. This resulted in the small streams in the Anchorage Bowl and in the central Susitna Valley, which were already elevated from the weekend storm, to rise above bank full stage and cause minor flooding.
November 26-28, 2004	Heavy Snow	This storm was associated with a pronounced southerly fetch which brought warm moist air into the Southcentral Region. Rain fell throughout much of Southcentral except in the northern zones where orographically enhanced snowfall rates left several feet of wet snow over the Northern Susitna Valley. Some residents reported snowfall rates of upwards of 3 to 4 inches per hour on the 27th and 28th.
December 22-24, 2004	Heavy Snow	The peak wind was 102 mph gust at Glen Alps trail head at 4 am Wednesday morning, December 22nd. The strong southeast flow pushed deep moist air into the Susitna Valley resulting in heavy snow north of Talkeetna. Spotter reports were of at least 13 inches of snow overnight at Gate Creek Lodge near Trapper Creek.
January 3-4, 2005	Heavy Snow	A storm system south of the Gulf of Alaska merged with a front moving eastward off the central Bering Sea. The southerly flow and abundant moisture supply brought up to 35 inches of snow in 24 hrs to areas north of Talkeetna. The influx of warm air also produced mixed precipitation in southern portions of the zone with freezing rain and rain reported.
January 17-18, 2005	High Wind	Strong high pressure and deep cold air over the eastern interior of Alaska along with a large low-pressure system in the Gulf of Alaska resulted in strong outflow wind through the channeled terrain of the Chugach Mountains. The wind peaked at 93 mph in the Wasilla area at the Cottonwood Creek Public Safety building. A tractor Trailer was blow on to its side on the north bound off-ramp of the Parks Highway on to Trunk Road.
March 20-21, 2005	High Wind	Strong high pressure over interior Alaska coupled with an intensifying low in the Gulf of Alaska resulted in strong gap outflow wind through the Chugach Mountains. The wind peaked at 81 mph at the Wasilla airport. The strong wind blew the McDonalds sign down and also knocked trees down in the Palmer-Wasilla area causing localized damage.
June 14, 2005	Hail	Hail potential of 3/4 inch or more with this thunderstorm. This thunderstorm occurred over a relatively uninhabited region. A report was received from the Alaska Railroad that "ping-pong ball" size hail was observed near Curry.
June 15, 2005	Hail	A strong thunderstorm moved off the Alaska Range and merged with a weaker thunderstorm that moved off the Talkeetna Mountains 10 miles east of Talkeetna. A spotter reported golf ball size hail and trees blown down along with flooding basements of a couple of local businesses, but this did not result in any property damage.
February 10, 2006	Ice Rain	Very light freezing rain and moderate rainfall in the Palmer and Wasilla areas created treacherous driving conditions along the Glenn Highway.

		Numerous cars went off the road and one accident required medical attention.
August 18-24, 2006	Extreme Rain	Widespread heavy rain fell over much of central and south central Alaska beginning August 17th and continuing through August 23rd. Heavier rains Friday caused rises on both gauged and un gauged rivers throughout this area. 24-hour rainfall amounts of up to 6 inches were reported through the Susitna River valley by Saturday morning along with widespread reports of flooding and road wash outs. This event resulted in the tentative flood of record for the river gauge on the Little Susitna River at the Parks highway with a preliminary crest near 14 ft. Moderate rain fell earlier in the week beginning on the 12th and 13th in the Susitna Valley. Total rainfall measured at the Ruth Glacier RAWS was 16.42 inches for this event and the Hatcher Pass RAWS measured 14.86 inches of rain.
October 9-10, 2008	Heavy Snow	An intense north Pacific storm produced high wind across south central Alaska along with heavy snow along the Alaska Range. Snowfall totals were as high as 2.5 feet in the Susitna Valley at Skwentna and 2 feet and Puntilla and Hayes River lodges. Calls from observers at Skwentna, Puntilla, and Hayes reported 2 to 2.5 feet of snow fell overnight.
January 10-11, 2010	High Wind	A strong low in the Gulf of Alaska combined with deep cold arctic air over the interior of Alaska produced strong gap wind through the Chugach Mountains. High wind in the Palmer-Wasilla area caused significant damage.
March 8-9, 2010	Winter Storm	An intense storm moved into the Gulf of Alaska March 8th resulting in heavy snow and blizzard conditions from Southwest Alaska to Prince William Sound and inland into the Copper River Basin. Spotters reported over 17 inches of snow along Fishhook Road from this storm.
August 5-6, 2010	Freezing Rain	High freezing levels combined with moderate rain in the Susitna Valley resulted in the Yentna River rising above flood stage August 5th. Rainfall in the Susitna Valley were 1 to 1.5 inches prior to the rising water.
September 24, 2010	High Wind	A strong low moved into the Gulf of Alaska. This storm, coupled with high pressure over interior Alaska produced strong north winds across the region and through the channeled terrain of south central Alaska. Over 10,000 people lost electric power in the south central region as a result of the high wind. The strongest wind observed was a 78 mph gust in the Palmer/Wasilla area. This strong wind event occurred early in the fall while trees still had leaves on them. This resulted in an uncharacteristically high number of trees being blown down, some of which fell across power-lines causing the unusually high number of power outages. Based upon insurance company information, it is estimated that $500,000 of damage occurred from this storm in the Matanuska Valley to the Anchorage area.
December 15, 2010	High Wind	A strong storm in the Gulf of Alaska combined with deep cold arctic air and high pressure over interior Alaska resulted in strong north gap winds across south central Alaska. Along with the strong wind, low temperatures resulted in low wind chills across much of the south central and southeast mainland regions of Alaska. The peak measured wind was 87 mph in the Wasilla area. Gusts very likely reached around 100 mph during this event based upon the damage and power outages associated with this event in the Palmer and Wasilla area. Wasilla Airport observed a peak gust of 87 mph.

November 16-17, 2011	High Wind	Strong north wind blew down the Matanuska Valley causing some damage in the Palmer area. A sign at a local gas station blew over due to the high wind. Several trees were blown down across the road.
November 29, 2012	High Wind	A strong Gulf of Alaska low coupled with deep cold arctic air and high pressure of the Alaska mainland produced the typical strong cold advection outflow gap winds along the coast. Winds peaked at 97 mph in Valdez. Strong wind in Palmer blew the roof off one house and blew over a stop light. Along with the strong wind, humidity was extremely low and the lack of snow cover resulted in extreme wild fire danger. A vehicle crash and fire spread to the grass and neighboring homes and forest. A downed power line started a fire.
December 20, 2012	High Wind	Strong deep cold air over interior Alaska coupled with low pressure in the Gulf of Alaska produced the typical strong gap winds through the mountain passes and channeled terrain of the Chugach Mountains. The wind peaked at 97 mph during this event.
March 12, 2013	High Wind	A large area of high pressure centered near the Arctic Coast combined with a low in the Gulf of Alaska produced a strong pressure gradient over Southern Alaska. This strong pressure gradient produced warning level winds in the Matanuska Valley and in various places along the north coast of the Gulf of Alaska. Strong winds coming out of the Matanuska River valley reached the intersection of the Glenn and Parks highways near Palmer. The Glenn Highway milepost 35 weather information sensor reported peak wind gusts of 78 and 84 mph the afternoon of March 12. The wind blew down trees and knocked down a traffic sign 6 miles SW of Palmer.
November 22, 2013	Winter Storm	A strong North Pacific storm moved into the Gulf of Alaska November 21st pushing copious moisture and warm air aloft over the southern mainland of Alaska. This storm produced snow and blowing snow across the Chugach Mountains, freezing rain over the Kenai Peninsula to the southern Susitna Valley, and areas of snow and freezing rain across southwest Alaska. The freezing rain resulted in school closures from Anchorage to the Palmer and Wasilla area. Several school buses slid off the road and one bus flipped on its side in the Wasilla area due to the icy roads. Blizzard conditions in Thompson Pass to MP 82 resulted in the Alaska DOT closing the road during this event. Wasilla school district transportation department reported significant ice accumulation. Several buses slid off the road and one flipped on its side.
February 5-6, 2015	High Wind	On February 5 and 6, an Arctic high-pressure ridge extended from the Alaska Interior into the Canadian Yukon at around 1,040 millibars. This ridge, combined with a low-pressure system around 966 millibars located in the Eastern Gulf of Alaska created a strong pressure gradient over Prince William Sound and the northern extent of Cook Inlet. Gap winds developed and damaged vessels in harbor and buildings in the region. At station PAAQ, Palmer, wind gusts passed 60 mph. Winds continued to gust above warning criteria for the next two hours. The peak gust of 75 miles-per-hour occurred at 10 p.m. February 6. DOT station GTFA2 measured a peak gust of 71 mph. An unoccupied single engine plane was damaged at the Palmer airport.
March 6-7, 2015	Heavy Snow	The Susitna Valley's largest snow event of the season occurred in early March as a storm from the Bering Sea moved east across mainland Alaska. The associated cold front, and southerly flow ahead of the front, provided the necessary moisture and lift to bring nearly one and a half feet of snow to the most populated areas of the northern Susitna. Elsewhere in Southcentral precipitation was rather mixed. Southeast

		downslope winds warmed surface temperatures into the low forties. in Anchorage, where rain fell. Higher elevations of Homer received up to two inches of wet snow. Peak snowfall in the northern Susitna Valley occurred between midnight and 6:00 am on March 7, 2015. The DOT near Trapper Creek reported 12 inches of snowfall by 4:00am from the Talkeetna Spur road to mile 163 of the Parks Highway. The highest snowfall amount was reported by a spotter in Chulitna with 16 inches of snow by the afternoon of March 7th. Early on the morning of March 7, a power outage occurred impacting approximately 2500 members in greater Willow, Talkeetna, Petersville, and Trapper Creek area. The outage was blamed on heavy snow.
April 16, 2015	Lightning Strike	A lightning strike near Houston knocked out power for more than 28,000 people. The lightning strike at 5:42 p.m. affected the Intertie between Anchorage and Fairbanks, knocking out power from Willow to as far as North Pole and Salcha. According to Golden Valley Electric Association, the strike knocked out 11 substations.
August 18, 2015	Hail	Severe thunderstorms developed over the Matanuska and Susitna Valleys before moving over Cook Inlet and dying out. One storm over populated areas produced large hail. Another thunderstorm appeared severe on radar but was not in a populated area and did not produce any local storm reports. Largest hail reports were estimated from social media to be around 1.0 inch. An NWS employee reported 1.0-inch drifts of pea-sized hail.
September 27-30, 2015	Heavy Rain	A strong low-pressure system moved across the state from the northwest, bringing heavy precipitation to the Southcentral area. The precipitation started as rain, then switched to snow as cold temperatures moved in behind the front. Heavy rain overnight caused minor flooding of the streams and rivers in the central Susitna valley. A cooperative observer at Amber Lake recorded 1.55 inches of rainfall in 24 hours on Sept 27th. Willow Creek reached one foot above minor flood stage and Montana Creek reached 1.5 feet above minor flood stage. Ten homes were impacted by the water, with water surrounding them but not flooding the homes. One road was washed out.
October 24-26, 2017	Heavy Snow	A negatively-tilted trough over the Kenai Peninsula shifted to the northeast and allowed precipitation to overspread Southcentral Alaska. An antecedent cold air mass allowed for snowfall over inland locations while coastal locations remained in a rain/snow mix. The greatest snow accumulations were observed over the Susitna Valley. Multiple reports of 9 to 12 of snowfall fell near and east of Skwentna. The base of Mount Susitna reported 7 inches of snow while Talkeetna reported 8.5 inches of snow. Storm Total Reports: 11 inches at Bentalit Lodge, 12 to 18 inches at the Cantwell DOT and 12.5 inches at the Chulitna DOT.

Source: NWS, 2019

5.3.5.4 Location, Extent, Impact, and Recurrence Probability

Location

In the Borough, there is potential for weather disasters. High winds can topple trees, damage roofs and windows, and result in power outages. Heavy snow can cause power outages or collapse roofs of buildings. Storms can make commuter travel to Anchorage difficult. Extreme weather is most prevalent during the winter with any combination of cold temperatures, strong winds, storm surge, and heavy snow.

Extent

The entire Borough is affected. Wind gusts have peaked at 100 mph.

Severe weather is a normal part of living in Alaska. However, sometimes the confluence of elements produces extreme conditions. Being prepared is the key to survival. Alternate forms of home heat and lighting, stored food, appropriate clothing, and advance planning are critical.

The most common forms of damage to structures as a result of severe wind includes loss of roofing materials, damage to doors and hinges, broken water lines due to freezing, fallen trees, structural failure of out-buildings, fallen or damaged exterior lights, flag poles, and antennae. Overhanging signs on businesses and satellite dishes become airborne projectiles under certain conditions.

Heavy snow brings another set of damages. Structural deflection or collapse of structures is common. Deflection causes cracks or breakage of interior walls and finishes. Falling ice from roof eaves can knock out electric meters, damage vehicles, break windows, and threaten injury to passersby. Sliding snow can cause damages described above plus cause damage to roof mounted vents and other equipment. Wind packed snow and ice can block windows and emergency exits.

Impact

Heavy snowfall can also damage infrastructure and critical facilities. Heavy snowfalls make transportation difficult, especially by road, and result in more money spent on snow plow services. High numbers of injuries and fatalities are not expected with a heavy snow event. Heavy snow can have a greater impact on people who need access to medical services, emergency services, pedestrians, and people who rely on public transportation. The cost of fuel to heat homes during times of heavy snow can be a financial burden on populations with low or fixed incomes.

Borough residents most vulnerable to the hazard of severe weather are the homeless who lack adequate shelter and those on fixed incomes who may not be able to adequately heat their homes.

Extreme weather also interferes with community infrastructure and its proper functions. It can cause fuel to congeal in storage tanks and supply lines, stopping electric power generation, which in turn causes heaters and furnaces to stop. 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 not intended for indoor use during extreme weather events.

Recurrence Probability

Alaska will continue to experience diverse and seasonal weather events. Severe weather will occur annually in the Borough. Severe wind and rain are becoming more likely with climate change, while extreme snow and cold are becoming less likely. While the trend is toward warming, periods of extreme cold persist. January 2020 is an example of that. Climate change is causing extremes of both heat and cold, resulting in unpredictability in how current and future residents prepare.

5.3.6 Wildfire and Conflagration Fire

During the five-year period spanning 2013 through 2018, over 82 fire-related fatalities were recorded in Alaska. Since 2013, the State has declared over 3,077 fire-related emergencies or disasters. Firefighter and public safety are the primary concern of each local and fire response agency. In Alaska, thousands of acres burn every year in 300 to 800 fires, primarily between the months of March and October. According to the Alaska Interagency Coordination Center (AICC), Alaska lost 7,815,368 acres from 2013 to 2017. This figure consisted of the 2,408 wildland fires that started throughout that same time period. This is an average of 3,246 acres per wildland fire (DHS&EM, 2018a).

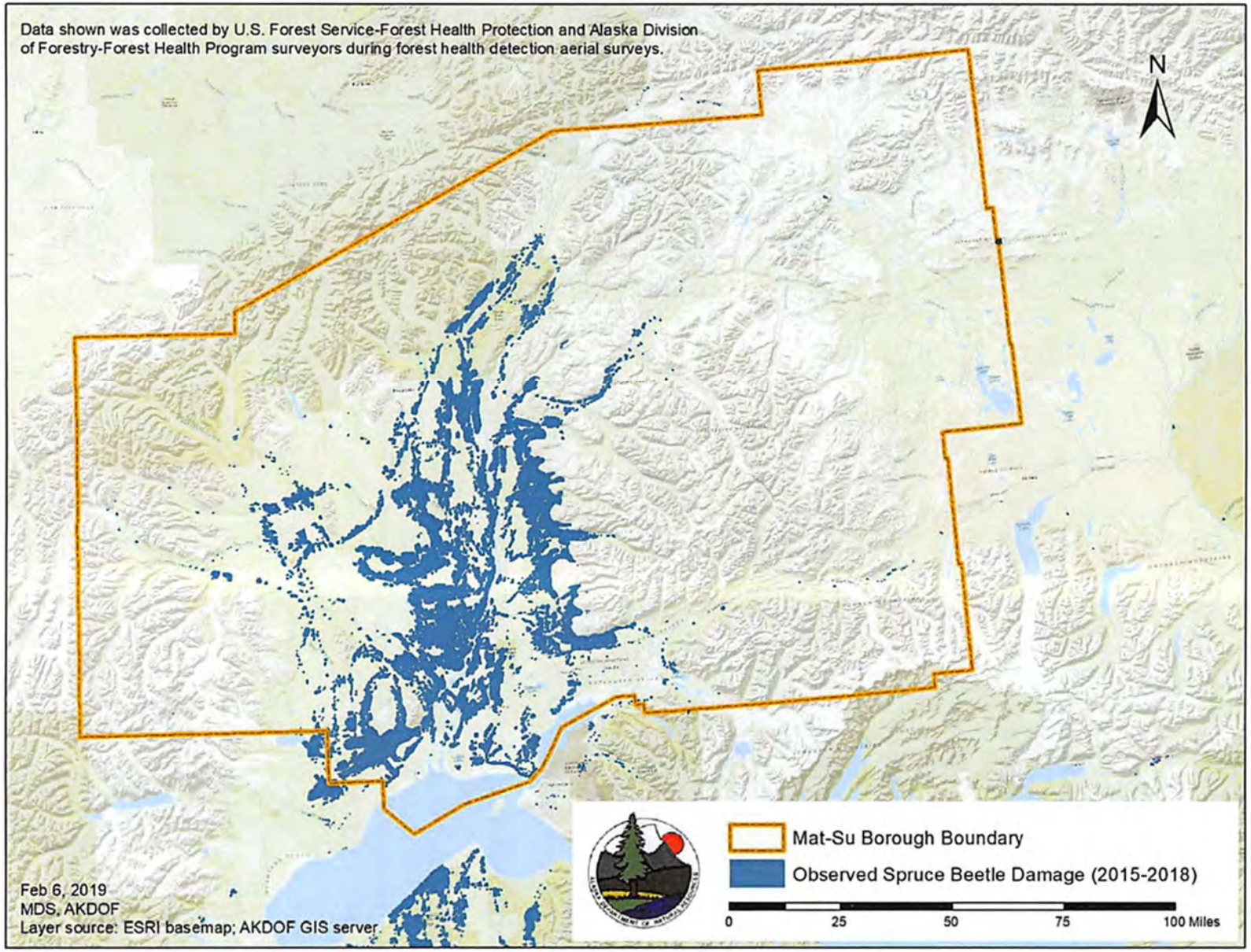
For the purposes of profiling the hazard, fires are characterized by their primary fuel sources into two categories:

- Wildland fire, which consumes natural vegetation.
- Community fire conflagration, which propagates among structures and infrastructure.

For the purpose of this HMP, fires in the Borough tend to be wildland fires that consume structures.

The Borough has experienced a regional spruce bark-beetle outbreak. Fire risk has increased in recent years due to spruce bark beetle infestations which have affected both white and black spruce forest stands. These infestations have impacted an estimated 309,746 acres (nearly 500 sq. miles) of spruce forest in the Borough. Dead and dying spruce trees present a wildfire hazard when standing because they can support intense, rapidly moving crown fires. These insect-killed trees also present a hazard after they have fallen because they can support very intense surface fires. Wildfire in either fuel type is very difficult for firefighters to control by direct attack. As of 2004, an estimated four million acres of spruce in Southcentral Alaska have been affected. While spruce bark beetle outbreaks are natural events, the magnitude of spruce mortality during historic episodes was typically much less (20% to 30%) than the current infestation in which mortality rates exceeded 90% (DOF, 2008). Figure 31 illustrates observed spruce bark beetle damage from 2015 to 2018.

Figure 31. Spruce Bark Beetle Areas



5.3.6.1 Management in Alaska

In Alaska, fire management is the responsibility of three agencies: DOF, BLM (through the Alaska Fire Service (AFS), and U.S. Forest Service (USFS). See Figure 32. Each agency provides firefighting coverage for a portion of the State regardless of land ownership. These agencies have cooperated to develop a state-wide interagency wildland fire management plan. In the Borough, the DOF has the responsibility to manage fire response.

In 2008, the Borough adopted a Community Wildfire Protection Plan (CWPP) for its entire acreage. The majority of wildland fires that occur in the Borough are human-caused, and most of these fires are located within the wildland urban interface (WUI). These fires have the potential to threaten life and property because of their proximity to habitation. The Alaska Interagency Fire Management Plan has mapped all areas in the Borough into one of four fire protection designations or levels: Critical, Full, Modified, or Limited. The CWPP only designates a small portion of the burnable land in the Borough as either Modified or Limited, and very few fires are ignited in these regions.

Nearly every community in the Borough contains an area designated for critical or full protection from wildfire. Wildfire risk includes damage to structures, property, and loss of life in every community in the Borough.

Alaska's statutory wildfire season normally begins on April 1 and ends on August 31. Extension of the fire season under state law means that small and large scale burn permits will be required for open debris burning or the use of burn barrels through September 30. With several wildfires burning in Southcentral Alaska and high fire danger persisting due to continued warm, dry conditions, the DNR Commissioner announced that Alaska's statutory wildfire season in 2019 would be extended from August 31 to September 30. This was the first time the fire season was extended since 2006 legislation shifted the five-month season to start and finish one month earlier. The one-month extension was necessary to ensure public safety. While acreage burned in the 2019 fire season falls well below the record season of 2004, when approximately 6.6 million acres burned, it marked the fifteenth time in 80 years of records that Alaska has seen more than 2 million acres burn in a single season. As of August 30, 2019, 682 fires had burned more than 2.5 million acres this season.

5.3.6.2 Hazard Characteristics

A wildland fire is a type of wildfire that spreads through consumption of vegetation. It often begins unnoticed, spreads quickly, and is usually signaled by dense smoke that may be visible for miles around. Wildland fires can be caused by human activities (such as arson or unattended campfires) or by natural events such as lightning. Wildland fires often occur in forests or other areas with ample vegetation. In addition to wildland fires, wildfires can be classified as tundra fires, urban fires, interface or intermix fires, and prescribed burns.

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

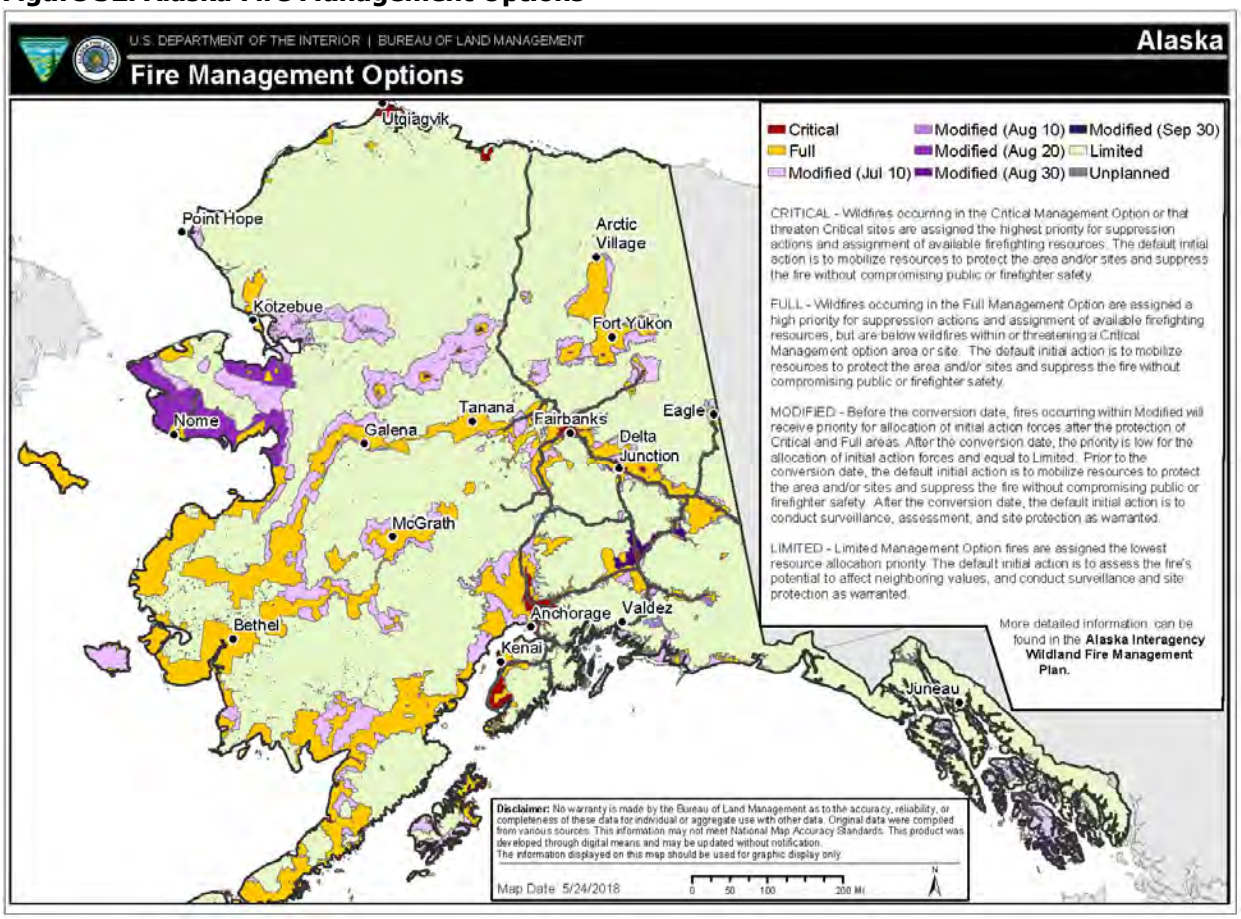
- **Topography:** As slope increases, the rate of wildland fire spread increases. South-facing slopes are also subject to more solar radiation, making them drier, and thereby,

intensifying wildland fire behavior. However, ridgetops may mark the end of wildland fire spread since fire spreads more slowly or may even be unable to spread downhill.

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

The frequency and severity of wildland fires is also dependent on other hazards, such as lightning, drought, and infestations (such as the damage caused by spruce-bark beetle

Figure 32. Alaska Fire Management Options



infestations or spruce needle aphids). The risk of wildfire has increased significantly over the past two decades, due in large part to the spruce-bark beetle infestation. If not promptly controlled, wildland fires may grow into an emergency or disaster. Even small fires can threaten lives and resources and destroy improved properties; they can also impact transportation corridors and/or infrastructure. In addition to affecting people, wildland fires may severely affect livestock and pets. Such events may require emergency water, food, evacuation, and shelter.

The indirect effects of wildland fires can be catastrophic. In addition to stripping the land of vegetation and destroying forest resources, large, intense fires can harm the soil, waterways, and the land itself. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and enhance rivers and stream siltation, thereby increasing flood potential, harming aquatic life, and degrading water quality. Lands stripped of vegetation are also subject to increased debris flow hazards.

Conflagration fires are very difficult to control. Complicating factors are wind, temperature, slope, proximity of structures, and community firefighting capability, as well as building construction and contents. Additional factors facing response efforts are hazardous substance releases, structure collapse, water service interruptions, unorganized evacuations, and loss of emergency shelters. Historical national conflagration examples include the Chicago City Fire of 1871 and the San Francisco City Fire following the 1906 earthquake. In 2018, the deadliest and most destructive wildfire in California encompassed 20,000 acres, killed 85 people, and almost completely incinerated the town of Paradise. The fire was sparked by transmission lines owned by Pacific Gas & Electric. Dry vegetation and high winds caused extreme rates of spread.

Many wildland firefighters are neither equipped nor trained for conflagration fires. When wildland firefighters encounter structure, vehicle, dump or other non-vegetative fires during the performance of their wildland fire suppression duties, firefighting efforts are often limited to wildland areas.

Fire services are operated by the Borough and City of Palmer. Structural fire suppression within defined service areas is the responsibility of the Borough and Palmer Fire Departments.

5.3.6.3 Climate Factors

According to the Global Climate Change Impacts in the U.S., published in 2009 by the U.S. Global Change Research Program, "Under changing climate conditions, the average area burned per year in Alaska is projected to double by the middle of this century. By the end of this century, area burned by fire is projected to triple under a moderate greenhouse gas emissions scenario and to quadruple under a higher emissions scenario" (DHS&EM, 2018a).

Since 1990, Alaska has experienced nearly twice the number of wildfires per decade compared to the period from 1950 to 1980. For example, the sparsely-populated arctic region experienced only three wildfires over 1,000 acres from 1950 to 1970. Since 2000, there have been over 33 large wildfires in this same region.

Wind blows down dead trees that have been affected by spruce-bark beetles. As air temperatures warm, spruce-bark beetles spread; typically, this occurs when temperatures are over 60 °F.

5.3.6.4 History

The Borough has a history of fire events described in the DHS&EM Disaster Cost Index (DHS&EM, 2018b). These events are listed below.

1996 Prator Lake Fire: "In 1996, one week before the devastating Millers Reach Wildfire, No. 2, Houston found itself fighting a wildfire in Houston on the south side of Prator Lake. Most area firefighters were fighting other wildfires throughout the Borough. Firefighting was performed with a skeleton crew from Houston as well as the Fire Department's Explorer post consisting of local teenagers. The fire was extinguished and kept around 12 acres in size. This fire was combined with the Millers Reach Wildfire No. 2 in the State and Federal disaster declarations." (Houston, 2018).

96-181 Millers Reach Fire declared June 4, 1996 by Governor Knowles, then FEMA-declared (DR-1119) on June 8, 1996: A fire which began on June 2, 1996, near Houston, Alaska on Millers Reach Road spread rapidly, destroying 344 structures and burning 37,366 acres in the Houston-Big Lake area. Command and control of this fire was initially controlled from the Houston High School with a Type I Incident Management Team. Later, a Unified Command structure was established at the Creekside Plaza Mall in Wasilla which consisted of Local, State and Federal representatives. On June 4th, 1996, Governor Knowles declared a State Disaster Declaration, and President Clinton signed the Federal Disaster Declaration (AK-1119-DR) on June 8th, 1996. This provided the State with Federal Disaster relief funding for the incident. This fire involved 37 fire departments and over 100 different agencies and organizations. In addition, 18,000 fire-fighting and support personnel responded within the first 48 hours. It took almost two weeks for the fire to be contained, and during this time, it burned 37,336 acres and destroyed 344 structures. The fire was contained on June 10th and declared under control on June 15th. Individual Assistance totaled $1.87 million for 425 applicants. Public Assistance totaled $5.1 million for 7 applicants with 50 DSR's. Hazard Mitigation totaled $1.75 million. The total for this disaster was $9.35 million.

Investigations suggested that either a firework tied end to end or an escaped campfire may have started the fire. Per DNR, no definitive cause of the fire was determined.

Mitigation measures valued at $1.3 million were instituted as a result of the Millers Reach Fire. Among the most successful, and models for future measures are:

- Creation of defensible space around critical facilities in the City of Houston;
- Defensible space demonstrations in and around the Big Lake community;
- Development of dependable year-round water supply for the South Houston area;
- Fire breaks which can be used as evacuation routes;
- widened access to the Prator Lake fire tanker fill site;
- Installation of metal siding and roofing on several community center buildings;
- An advertising campaign including television; and
- Video and printed brochures informing the public about fire hazards.

AK-15-249, 2015 Sockeye Wildfire declared by Governor Walker on June 15, 2015: Beginning on June 14, 2015 and continuing, a large urban interface wildfire exacerbated by record high

temperatures caused widespread damage to the community of Willow and surrounding areas of the Borough. The response to the wildfire was hampered by conditions leading to red flag warnings for record warm temperatures, strong winds, low humidity, and dry thunderstorms that affected the entire central portion of the state, including the Borough. The wildfire damaged or destroyed at least 50 private homes and/or secondary structures and damaged several more, and resulted in 175 residents seeking refuge in temporary shelters. Open debris burning was the cause of the fire. The following conditions existed as a result of this disaster: a robust emergency response and management operation requiring substantial additional labor, equipment, and support costs to combat the fire; activation of the emergency operations center; damage or destruction of at least 50 homes and other structures; evacuation and sheltering of 175 residents and hundreds of pets/work animals; severe damage to personal and real property; disruption of power, natural gas, communications, and other utility infrastructure.

On August 23, 2019, the Governor issued a Disaster Declaration for the Matanuska-Susitna Borough to provide aid to those who have been affected by the McKinley and Deshka Landing wildfires: As of December 31, 2019, the State DHS&EM's Disaster Cost Index has not been updated with information pertaining to these fires.

The Montana Creek and Malaspina Fires occurred in July 2019; fire information for both fires are summarized on Figures 33 and 34.

The McKinley Fire started near Milepost 91 of the Parks Highway on August 17, 2019. This human-caused fire consumed 3,288 acres and was 95% contained on September 26 (see Figure 35). The fire began 18 miles north of Willow, and fuels were timber (grass and understory) and two feet of brush. Fifty-two primary residences, three commercial structures, and 84 outbuildings were destroyed in the fire by the evening of August 18 and morning of August 19th. The Alaska Department of Public Safety, State Fire Marshal, and Alaska State Troopers, and the Community Organizations Active in Disasters worked with the Alaska DOF and the Borough to assist the communities in dealing with effects of the fire. A story map of the fire can be viewed at: https://nifc.maps.arcgis.com/apps/MapSeries/index.html?appid=efa18adc74714e089dd91fd3a9bb70bf. There is a link on the first page of the story map with the McKinley Fire drone footage showing burn intensities, blowdown, and damage. There is also an 11-minute video of the fire that can be viewed at: https://www.youtube.com/watch?v=5j1LRvPGO7Y&feature=youtu.be. Pictures of the fire can be viewed at: https://akfireinfo.com/2019/09/24/mckinley-fire-final-slideshow-management-back-to-palmer-forestry-thursday-26-2019/.

Figure 33. Public Information Map for Montana Creek and Malaspina Fires

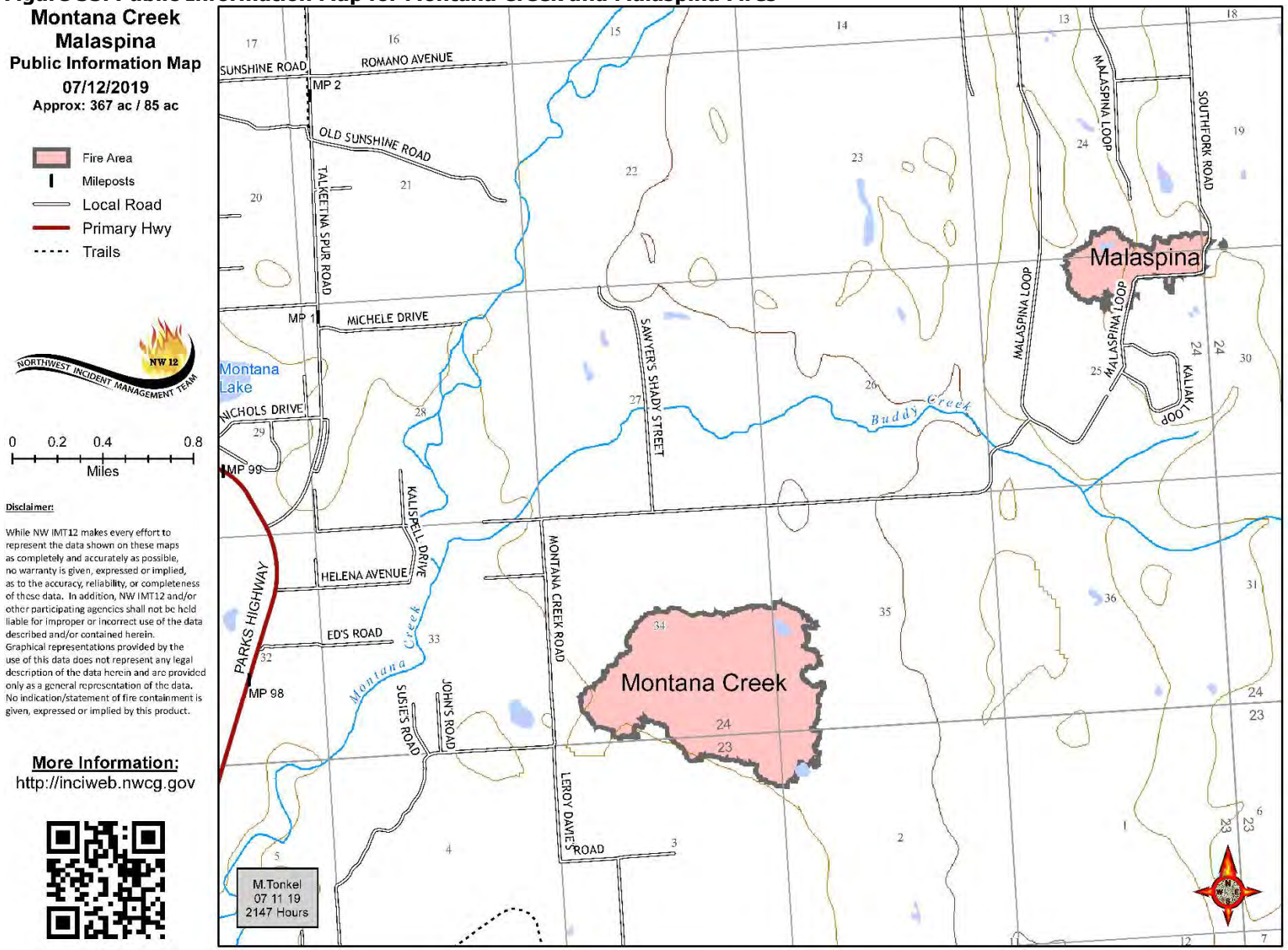


Figure 34. Summary for Montana Creek and Malaspina Fires

MONTANA CREEK AND MALASPINA FIRES SUMMARY

INFORMATION STATS:

⇒ The Montana Creek-Malaspina Fire Facebook posts with videos were viewed on twice as many screens on average compared to posts without video during NVA IMT 12's time here.

⇒ The average number of screens which viewed posts on the page during the fire was 6,988 views. The post announcing the Level 3-"Go" evacuations was viewed on 55,549 screens.

FINANCE:

⇒ Financial operations were in compliance with direction from agency representatives.
⇒ Costs were updated daily and kept current.
⇒ Local resources such as hotels, restaurants, equipment, crews, overhead, fuel and supplies injected $533,005.00 into the local economy.
⇒ As of July 15, 2019 the total cost of Montana Creek and Malaspina Fire is $2.9M.

BAKER RIVER HOTSHOTS

July 4 at 8:27 PM

"A couple shots from the Montana Creek Fire on this 4th of July. Crew working hard to contain the fire with limited resources available. Sadie's mod hauling hose into the line... Al, Jack, and Nick using Alaska style spruce swatters to knock down the fire in the muskeg.... a CL-215 water scooping plane trying to slow the fire on the south flank."

BAKER RIVER HOTSHOTS

July 9 at 10:24 AM

"Crew nearing the end of our tour in Alaska. A couple pics of our most recent initial attack fire near Talkeetna, the Malaspina Fire."

MONTANA CREEK FIRE STARTED

July 3, 2019
Final Fire Acreage:
367 Acres

MALASPINA FIRE STARTED

July 7, 2019
Final Fire Acreage:
85 Acres

PEAK OPERATIONAL RESOURCE COUNT (ON JULY 12TH)

⇒ 2 Type 2IA Crews
⇒ 4 Type 2 Crews
⇒ 4 Engines
⇒ 4 Water Tenders
⇒ 1 Dozer
⇒ 15 Line Overhead

MONTANA CREEK AIR SUMMARY

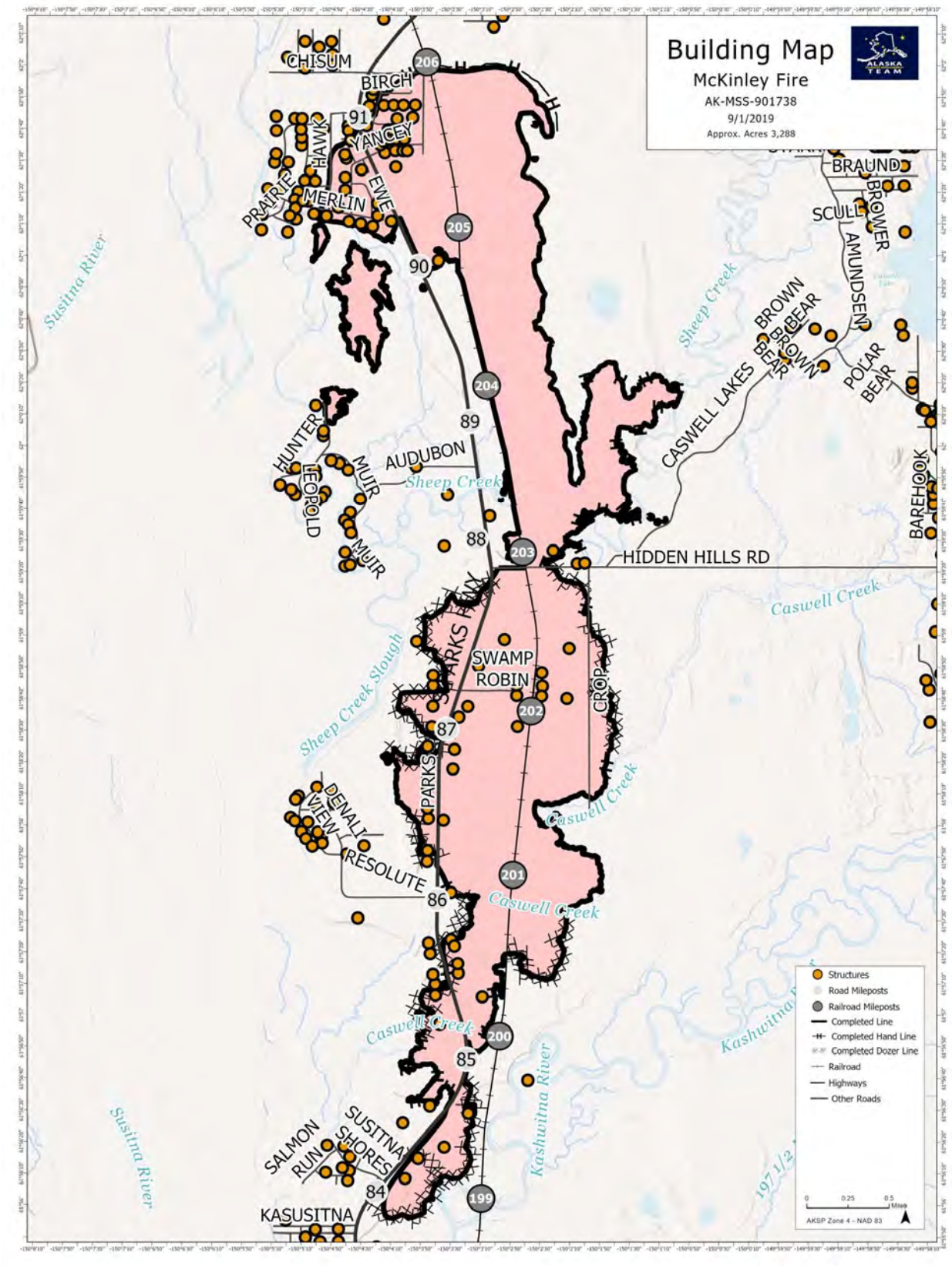
⇒ 174,596 gallons of water dropped
⇒ 46,307 gallons of retardant dropped
⇒ 67.5 flight hours
⇒ 33.5 rotor wing
⇒ 34.0 fixed wing
⇒ UAS FLIR

MALASPINA AIR SUMMARY

⇒ 58,408 gallons of water dropped
⇒ 23,528 gallons of retardant dropped
⇒ 35.3 flight hours
⇒ 11.6 rotor wing
⇒ 23.7 fixed wing
⇒ UAS FLIR

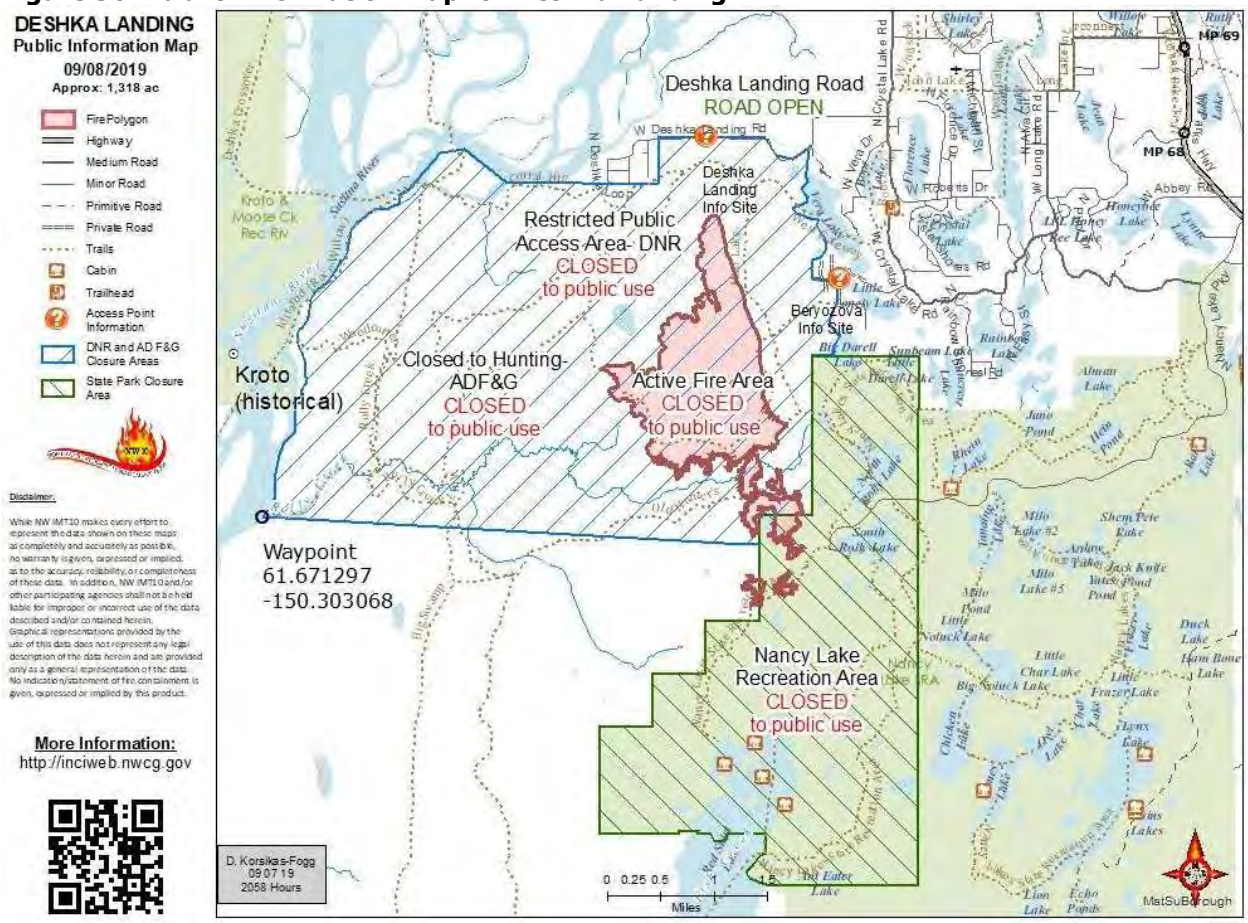
Photos retrieved from Baker River Hotshots Facebook page on 7/17/2019. Information Stats and Financials provided by Northwest Incident Management Team 12 working for Department of Natural Resources- Division of Forestry.

Figure 35. Building Map for McKinley Fire



The 1,318-acre Deshka Landing Fire, which started August 17, 2019, five miles south of Willow, Alaska remained at 95% containment as of September 9, 2019 when management of the fire was turned over to the Alaska DNR, DOF's Borough Forestry Office. The Deshka Landing Fire was a human-caused fire which spread rapidly to the south with a strong wind event. Initial attack involved smoke jumpers aided by two Alaska hand crews, the Tanana Chiefs and the Gannett Glacier Crew. Fuels involved were timber, brush, and short grass as well as beetle killed spruce and mixed hardwoods.

Figure 36. Public Information Map for Deshka Landing



5.3.6.5 Location, Extent, Impact, and Recurrence Probability

Location

Nearly every community in the Borough contains an area designated for critical or full protection from wildfire. Wildfire risk includes damage to structures, property, and loss of life in every community. Figure 37 shows the State's wildfire hazard areas.

Extent

Generally, fire vulnerability dramatically increases in the late summer and early fall as vegetation dries out, decreasing plant moisture content, and increasing the ratio of dead fuel to living fuel. However, various other factors, including humidity, wind speed and direction, fuel

load and type, and topography can contribute to the intensity and spread of wildland fires. The common causes of wildland fires in Alaska include lightning strikes and human negligence.

Climate and fire data confirm that fire season length and fire severity have increased with the recent ambient temperature increases. Another outcome of the warmer climate trend is the arrival of earlier than normal "snow-free" dates. This translates to an earlier spring fire season. The fire season for the Borough typically occurs from April to September, with the greatest fire activity occurring between May and June, when live fuel moisture is dry from the winter freeze, and high-pressure weather systems bring higher temperatures and lower humidity conditions (DOF, 2008).

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

The fuels in the Borough are mostly in transition from thick, green forests to decaying dead spruce. Spruce forests, whether live or dead, are both flammable and provide radiant heat and ember spot fires that advance fire through air convection.

Impact

As of November 23, 2019, wildfires had burned more than 2.68 million acres this wildfire season in Alaska. The cost of fighting this summer's Alaska wildfires has topped $300 million, and state and local officials say the final tally may not be known for years (ADN, 2019a). This total does not include the cost to Alaskans who saw their land torched and their homes burned. Through November 21, Alaska DOF recorded $224.9 million in firefighting expenses for 2019. The U.S. Department of Interior reported $72 million. The U.S.F.S.—an agency of the USDA—reported $7 million in expenses through November 18.

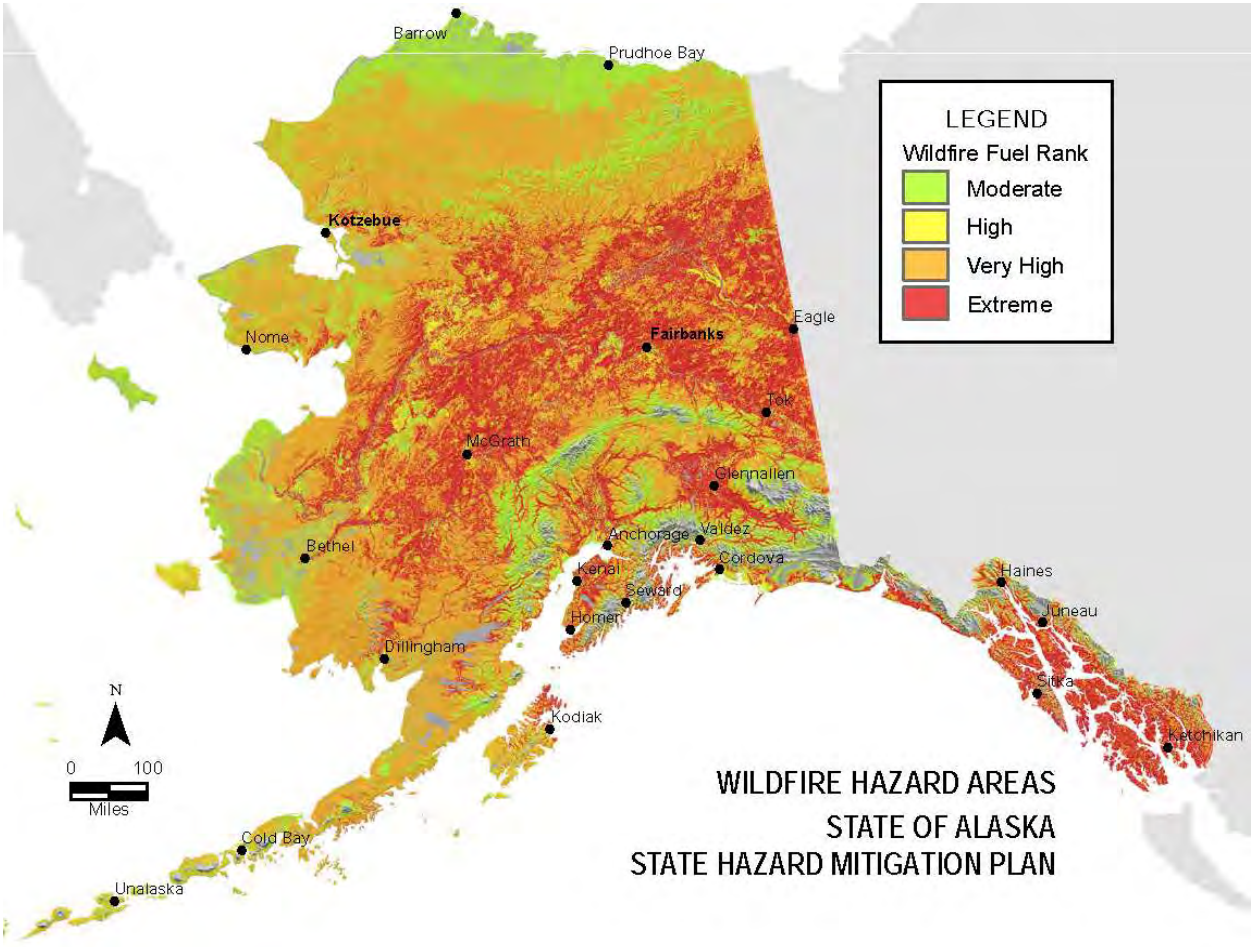
Impacts of a wildland fire that interfaces with the population center could grow into an emergency or disaster if not properly controlled. A small fire can threaten lives, homes, resources and destroy property. In addition to impacting people, wildland fires may severely impact livestock and pets. Such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

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

Recurrence Probability

Increased community development, fire fuel accumulation, and weather pattern uncertainties indicate that seasonal wildfires will continue into the future. Future residents will experience similar experiences at an increased rate than current residents due to changes in the cryosphere and an increase in spruce bark beetle.

Figure 37. Borough's Wildland Fire Risk



6.0 Vulnerability Analysis

This section provides an overview of the vulnerability analysis.

6.1 Overview of a Vulnerability Analysis

A vulnerability analysis predicts the exposure extent that may result from a given hazard event and its impact intensity within the Borough. This qualitative analysis provides data to identify and prioritize potential mitigation measures by allowing the community to focus attention on areas with the greatest risk. A vulnerability or risk analysis is divided into the following five focus areas:

1. Asset Inventory;
2. Infrastructure Risk, Vulnerability, and Losses from Identified Hazards;
3. Development Changes and Trends;
4. Data Limitations; and
5. Future Development Considerations.

DMA 2000 requirements for developing risk and vulnerability assessment initiatives are described below.

DMA 2000 Requirements: Risk Assessment, Assessing Vulnerability, Overview

Assessing Vulnerability: Overview

§201.6(c)(2)(ii): The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described. This description shall include an overall summary of each hazard and its impact on the community. 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 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): 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.

Element

- Does the updated plan include a description of the jurisdiction's vulnerability to each hazard?
- Does the updated plan include an overall summary description of the jurisdiction's vulnerability to each hazard?
- Does the updated plan describe vulnerability in terms of the types and numbers of existing buildings, infrastructure, and critical facilities located in the identified hazard areas?
- Does the updated plan describe vulnerability in terms of the types and numbers of future buildings, infrastructure, and critical facilities located in the identified hazard areas?
- Does the updated plan estimate potential dollar losses to vulnerable structures?
- Does the updated plan describe the methodology used to prepare the estimate?

Source: FEMA, 2015.

DMA 2000 Requirements: Risk Assessment, Assessing Vulnerability, Addressing Repetitive Loss

Properties Assessing Vulnerability: Addressing Repetitive Loss Properties

Requirement §201.6(c)(2)(ii): [The risk assessment] **must** also address NFIP Insured structures that have been repetitively damaged by floods.

Element

- Does the updated plan describe vulnerability in terms of the types and numbers of repetitive loss properties in the identified hazard areas?
- Does the updated plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements as appropriate?

Source: FEMA, 2015.

6.2 Current Asset Exposure Analysis

6.2.1 Critical Asset Infrastructure

Assets that may be affected by hazard events include population (for community-wide hazards), residential buildings, and critical facilities and infrastructure. Assets are grouped into two structure types: critical infrastructure and residential properties. The assets and associated values throughout the Borough are identified and discussed in detail in the following subsections.

DMA 2000 Recommendations: Risk Assessment, Assessing Vulnerability, Identifying Structures

Assessing Vulnerability: Identifying Structures

Requirement §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 area.

Element

- Does the updated plan describe vulnerability in terms of the types and numbers of existing buildings, infrastructure, and critical facilities located in the identified hazard areas?
- Does the updated plan describe vulnerability in terms of the types and numbers of future buildings, infrastructure, and critical facilities located in the identified hazard areas?

Source: FEMA, 2015.

6.2.1.1 Critical Infrastructure

Critical infrastructure is defined as a facility that provides essential products and services to the general public, such as preserving quality of life while fulfilling important public safety, emergency response, and disaster recovery functions. Critical facilities and infrastructure for the Borough are profiled in this HMP and include the following (see also Table 17):

- Government: Borough administrative offices, departments, or agencies;
- Emergency Response: including fire personnel services; and fire-fighting equipment;
- Health Care: medical clinics, congregate living, health, residential and continuing care, and retirement facilities; and
- Community Gathering Places.

Table 17. Alaska's Critical Infrastructure

• Hospitals, Clinics, & Assisted Living Facilities	• Satellite Facilities	• Power Generation Facilities	• Oil & Gas Pipeline Structures & Facilities	• Schools
• Fire Stations	• Radio Transmission Facilities	• Potable Water Treatment Facilities	• Service Maintenance Facilities	• Community Washeterias
• Police Stations	• Highways and Roads	• Reservoirs & Water Supply Lines	• Community Halls & Civic Centers	• National Guard Facilities
• Emergency Operations Centers	• Critical Bridges	• Waste Water Treatment Facilities	• Community Stores	• Landfills & Incinerators
• Any Designated Emergency Shelter	• Airports	• Fuel Storage Facilities	• Community Freezer Facilities	• Community Cemeteries
• Telecommunications Structures & Facilities		• Harbors / Docks / Ports		

DMA 2000 Recommendations: Estimating Potential Losses

Assessing Vulnerability: Estimating Potential Losses

Requirement §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.

Element

- Does the updated plan estimate potential dollar losses to vulnerable structures?
- Does the updated plan describe the methodology used to prepare the estimate?

Source: FEMA, 2015.

6.2.1.2 Infrastructure Risk, Vulnerability, and Losses from Identified Hazards

Tables 18 and 19 provide a summary of critical facilities in the Borough and critical facilities located in the floodplain, respectively.

Table 18. Critical Facilities

Number of Critical Facilities	Property Acres	Land Appraisal	Building Appraisal	Total Land & Building Appraisal
188	9,615	$50,845,900	$1,217,196,766	$1,268,042,666

Table 19. Critical Facilities in Flood Zones

Flood Zone	Type	Name	Land Appraisal	Building Appraisal	Total Land & Building Appraisal
1% chance/yr	Utility	Talkeetna Lift Station at G & Gliska	N/A	N/A	N/A
1% chance/yr	Utility	Talkeetna Pump House Building	N/A	N/A	N/A
1% chance/yr	Utility	Talkeetna Water Treatment Plant	N/A	N/A	N/A
1% chance/yr	Train Depot	Talkeetna Winter Train Depot	N/A	N/A	N/A
0.2% chance/yr	Public Safety	Jones PSB 11-1	$117,100	$950,000	$1,067,100

0.2% chance/yr	Public Safety	NPS Talkeetna Ranger Station	$104,100	$999,600	$1,103,700
0.2% chance/yr	Airport	Talkeetna Airport	N/A	N/A	N/A
0.2% chance/yr	Utility	Talkeetna Lift Station at Airport 3rd & D	N/A	N/A	N/A
0.2% chance/yr	Utility	Talkeetna Lift Station at Latitude 62 Restaurant	N/A	N/A	N/A
0.2% chance/yr	Utility	Talkeetna Sewer & Water Lagoons	$100,000	$9,300,000	$9,400,000
0.2% chance/yr	Train Depot	Talkeetna Summer Train Depot	N/A	N/A	N/A

See Figure 38 for a critical facilities map. Table 20 summarizes the results of the vulnerability analysis. Table 21 shows landownership within the Borough. Tables 22 and 23 identify property values based on community area within the Borough and their vulnerabilities to hazard events. Table 24 breaks out the number of residential structures within the Borough by structure type.

Figure 38. Critical Facilities Map

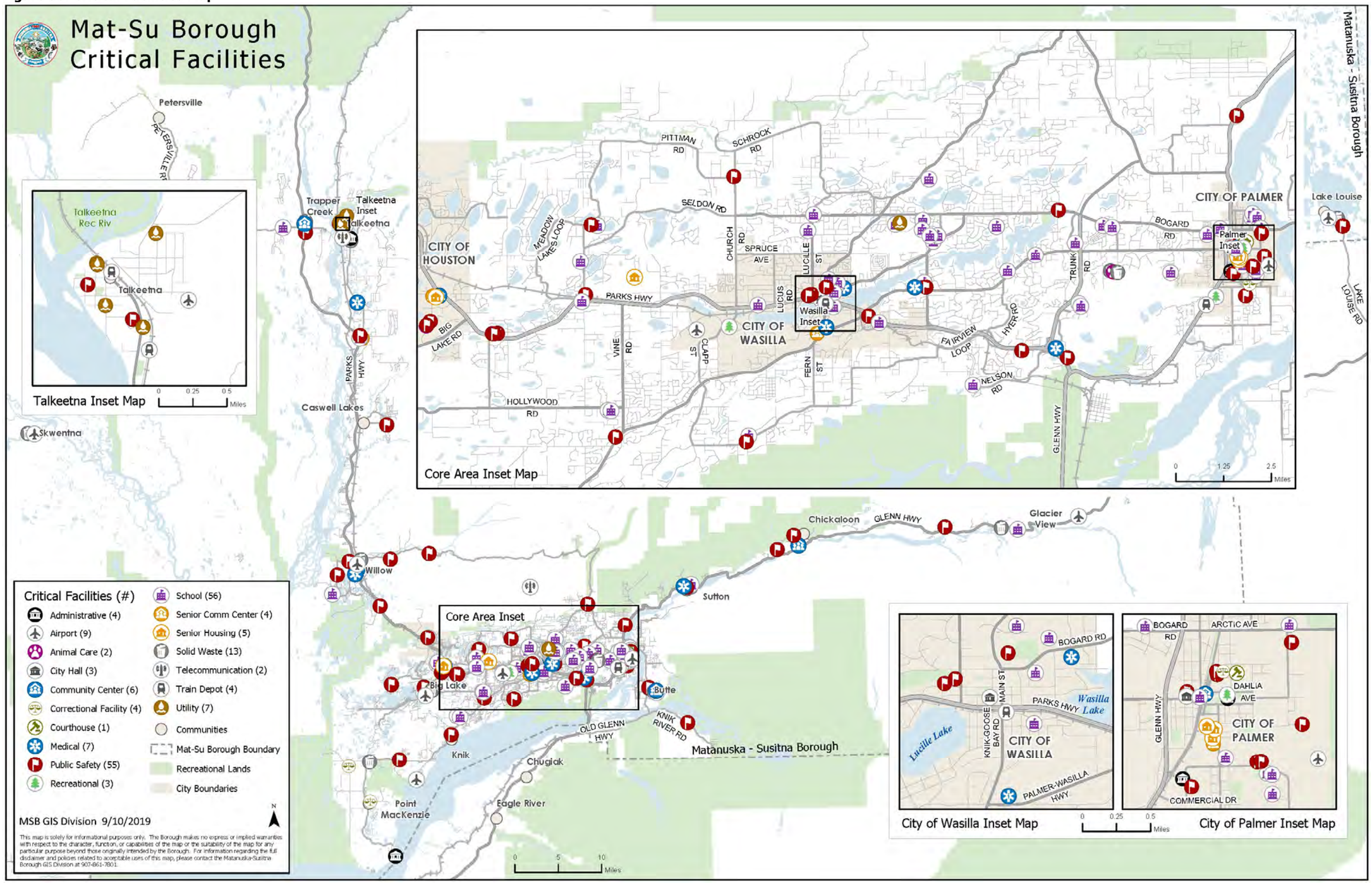


Table 20. Hazard Vulnerability Analysis

	Earthquake	Severe Weather	Wildland & Conflagration Fires	Volcanic Ash Fall	Flood/ Erosion	Changes to the Cryosphere
History	High	Moderate	High	Low	High	Low
Vulnerability	High	Moderate	High	Moderate	High	High
Probability	Moderate	Moderate	Moderate	Low	Low throughout most of Borough with a few high hazard areas	Low throughout most of Borough with a few high hazard areas
Location	Structures within the 100 sq. mile "core area" have the most intense Modified MMI levels on the shake maps. In 2019, 86% of Borough residents live in subdivisions and neighborhoods outside the City Limits of Wasilla and Palmer.	Entire Borough	Entire Borough	Mostly within the "core area" near the southern boundary	Flooding is in valleys. Erosion for wind is valleys. Erosion for water if river, creek, and stream banks.	The slopes throughout the Hatcher Pass area and the slope of Pioneer Peak between Goose Creek and the Knik River Bridge are well-known avalanche areas in the Borough. There are no homes at Hatcher Pass. Homes along the Old Glenn Highway outside of Palmer have been relocated out of the danger zone. Droughts and an increase of spruce bark beetle could increase fire risk Borough-wide.
At-Risk Pop.	In general, the entire Borough is at risk depending on the community's location	In general, the entire Borough is at risk regardless of location.	Some areas within the Borough have	Wind direction is an important factor on which areas of the	Special flood hazard areas show areas	This is very difficult to quantify.
At-Risk Buildings						

At-Risk Building Value	to the known fault lines. Refer to the shake maps that show differing results across the Borough (Figures 14-19).	The January 2020 cold snap of below zero temperatures is non-discriminating.	higher propensities to fire based on spruce bark beetle infestation (Figure 31). Fire could occur in other areas, but the blue highlighted areas have the most fuel.	Borough would be affected. At this moment based on current volcano eruptions, the "core area" is most at risk, but this could change depending on the wind direction and location of the erupting volcano.	vulnerable to flooding.	

Risk Assessment						
Consequence to People	Injuries or death from structural collapse; fires; secondary diseases due to poor sanitation	Injuries or death from structural collapse, prolonged exposure to low temperatures. Injury caused by flying debris; hardship due to disruption of vital services, transportation, utilities	Injuries or death due to fire, heat, smoke and structure collapse	Illness & death from respiratory distress; injuries & death caused by accidents due to lower visibility	Respiratory distress due to flying dust, reduced visibility may cause injury & death; sudden water erosion.	Injury & death, hardship due to disruption of essential services, loss of shelter
Consequence to Property	Structural damage to buildings, fuel supplies, communications, utilities, emergency facilities	Damage to roofs, utility lines, disruption of fuel and essential supplies, disruption of communications	Structural damage to buildings, loss of critical facilities, loss of power lines	Structural damage due to weight of ash, damage to electronic equipment & machinery	Wind erosion removes top soil; Water erosion under cuts foundations, footings and stream banks	Downed utility lines, damage to structures, vehicles & equipment

Consequence to Environment	Alteration of landforms, water degradation due to fuel spills; fire, landslides	Possible damage to flora & fauna	Pollution of streams and lakes, loss of vegetative cover; injury & death of fauna	Damage to plants caused by lower solar penetration, or suffocating layer of ash	Pollution of streams and lakes	Damage to flora & fauna; degradation of water quality

6.2.1.3 Land Use and Development Trends

Requirements for land use and development trends, as stipulated in DMA 2000 and its implementing regulations, are described below.

DMA 2000 Recommendations: Risk Assessment, Assessing Vulnerability, Analyzing Development Trends

Assessing Vulnerability: Analyzing Development Trends

Requirement §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.

Element

- Does the updated plan describe land uses and development trends?

Source: FEMA, 2015.

Lands within the Borough are subject to subdivision and zoning ordinances contained in Borough Code Section 17. There is one Aviation Overlay District and 14 Residential Overlay Districts that have elected to form residential land use districts that restrict development. Prime farmland is located around Palmer, Point MacKenzie, and the Fish Creek Area. There are three Single Family Residential Land Use Districts, nine Special Zoning Districts (SpUDs) (three have subdistrict SpUDs in the Borough, each with its own Comprehensive Plan). See Figures 39-41.

The Borough is expected to continue to expand as the fastest growing area in Alaska, increasing 58% by 2045, according to state labor practices (ADN, 2019b). The state's population grew by 0.4% on average each year from 2010 to 2018, with the majority of growth in the Anchorage/Borough regions. The Borough's growth rate was the fastest at an average of 2.1% annually during the past eight years — more than five times the statewide average (ADOL, 2019). Housing units continue to be constructed. Table 24 lists the number of structures identified by the Borough Assessor's Office from 2013-2019 by structure type.

Table 21. Borough Land Ownership

Owner	Acre	Percent of Total Area
State Government & Other	15,170,726	94%
Borough Government	215,040	1%
Private	413,722	3%
Alaska Native	324,265	2%
Total	16,123,753	100%

Table 22. Property Value by Borough Community Area in 2019

City & CC Names	Parcel Count	Acres	Land Appraisal	Building Appraisal	Total Land & Building Appraisal	Number of Structures
Big Lake	5,999	82,632	$225,249,200	$392,717,909	$617,967,109	3,641
Buffalo Mine/Soapstone	674	17,242	$27,828,000	$55,875,550	$83,703,550	587
Butte	2,252	169,258	$68,376,700	$241,853,202	$310,229,902	1,737
Chase	1,538	227,730	$11,330,100	$3,858,234	$15,188,334	241
Chickaloon	922	94,817	$22,055,600	$19,672,996	$41,728,596	408
Farm Loop	1,174	6,164	$74,478,500	$220,113,196	$294,591,696	1,107
Fishhook	2,381	41,837	$123,092,400	$371,622,168	$494,714,568	2,209
Gateway	2,562	16,228	$212,579,100	$716,621,625	$929,200,725	2,229
Glacier View	2,115	917,215	$26,462,200	$37,845,950	$64,308,150	463
Greater Palmer	1,903	6,104	$109,328,900	$400,480,840	$509,809,740	1,855
Houston	2,094	16,158	$49,880,900	$153,654,828	$203,535,728	1,158
Knik-Fairview	9,177	54,645	$375,716,700	$1,441,439,778	$1,817,156,478	7,612
Lazy Mountain	984	25,819	$41,842,000	$108,193,600	$150,035,600	809
Louise, Susitna, & Tyone Lakes	1,117	183,377	$23,822,800	$10,871,850	$34,694,650	503
Meadow Lakes	5,936	40,857	$229,288,100	$671,165,692	$900,453,792	4,718
North Lakes	3,992	10,286	$228,067,500	$804,770,956	$1,032,838,456	3,895
Palmer	2,555	4,110	$153,468,100	$640,842,071	$794,310,171	2,189
Petersville	906	133,967	$7,081,100	$6,826,383	$13,907,483	261
Point Mackenzie	1,655	103,986	$65,612,900	$281,979,850	$347,592,750	439
Skwentna	4,484	710,048	$25,398,000	$16,925,750	$42,323,750	864
South Knik River	890	58,803	$14,362,700	$38,397,300	$52,760,000	474
South Lakes	2,127	4,638	$169,167,300	$539,773,725	$708,941,025	2,172
Susitna	5,870	389,173	$111,469,600	$141,700,450	$253,170,050	2,090
Sutton	1,127	22,471	$25,518,100	$73,997,800	$99,515,900	632
Talkeetna	2,727	269,694	$66,924,600	$116,947,688	$183,872,288	1,333
Tanaina	3,337	14,810	$152,924,700	$593,824,300	$746,749,000	3,359
Trapper Creek	2,247	181,684	$40,915,300	$32,968,408	$73,883,708	790
Wasilla	4,080	9,081	$356,405,900	$1,114,760,089	$1,471,165,989	3,565
Willow	6,133	299,608	$197,411,000	$242,290,900	$439,701,900	3,094
None	25,189	12,011,306	$162,010,800	$102,792,983	$264,803,783	1,715
Borough TOTALS	**108,147**	**16,123,747**	**$3,398,068,800**	**$9,594,786,071**	**$12,992,854,871**	**56,149**

Table 23. Property Value by General Ownership within the Borough in 2019

General Ownership	Parcel Count	Acres	Land Appraisal	Building Appraisal	Total Land & Building Appraisal	Number of Structures
Borough	1,905	215,042	$160,431,100	$1,019,634,500	$1,180,282,547	236
City	218	2,173	$27,127,300	$74,531,100	$101,660,791	114
Cooperative	84	265	$5,418,700	$20,572,000	$25,991,049	20
Federal	80	4,420	$7,750,000	$9,902,400	$17,656,900	14
Mental Health	230	39,123	$31,122,500	$292,700	$31,454,553	5
Native Corporation	1,128	324,265	$124,714,700	$63,700	$125,103,793	8
Private	72,560	413,722	$2,891,110,900	$8,408,656,676	$11,300,253,858	55,516
Public University	141	24,767	$34,298,800	$15,030,132	$49,353,840	8
State	2,068	161,522	$115,981,300	$46,102,863	$162,247,753	228
Other	29,732	14,938,454	$113,500	$0	$15,081,686	0
TOTALS	108,146	16,123,753	$3,398,068,800	$9,594,786,071	$13,009,086,770	56,149

Table 24. Number of Structures within the Borough by Type, 2013-2019

Year	Single Family	Residential with Garage	Mobile Home	Duplex	Triplex	Four-Plex	Detached Four-Plex	Group Quarters	Residential Under Construction	Commercial/Other
2013	40,834	5,876	1,438	745	505	401	170	9	198	4,004
2014	41,004	5,899	1,444	749	522	458	170	9	199	4,071
2015	41,463	5,947	1,458	771	543	596	170	9	207	4,135
2016	41,880	5,988	1,461	806	568	794	171	9	214	4,184
2017	42,063	6,016	1,473	815	573	830	174	9	216	4,283
2018	42,409	6,057	1,481	816	578	850	174	9	225	4,348
2019	42,574	6,086	1,484	834	579	863	178	9	233	4,388

Figure 39. Borough SpUDs

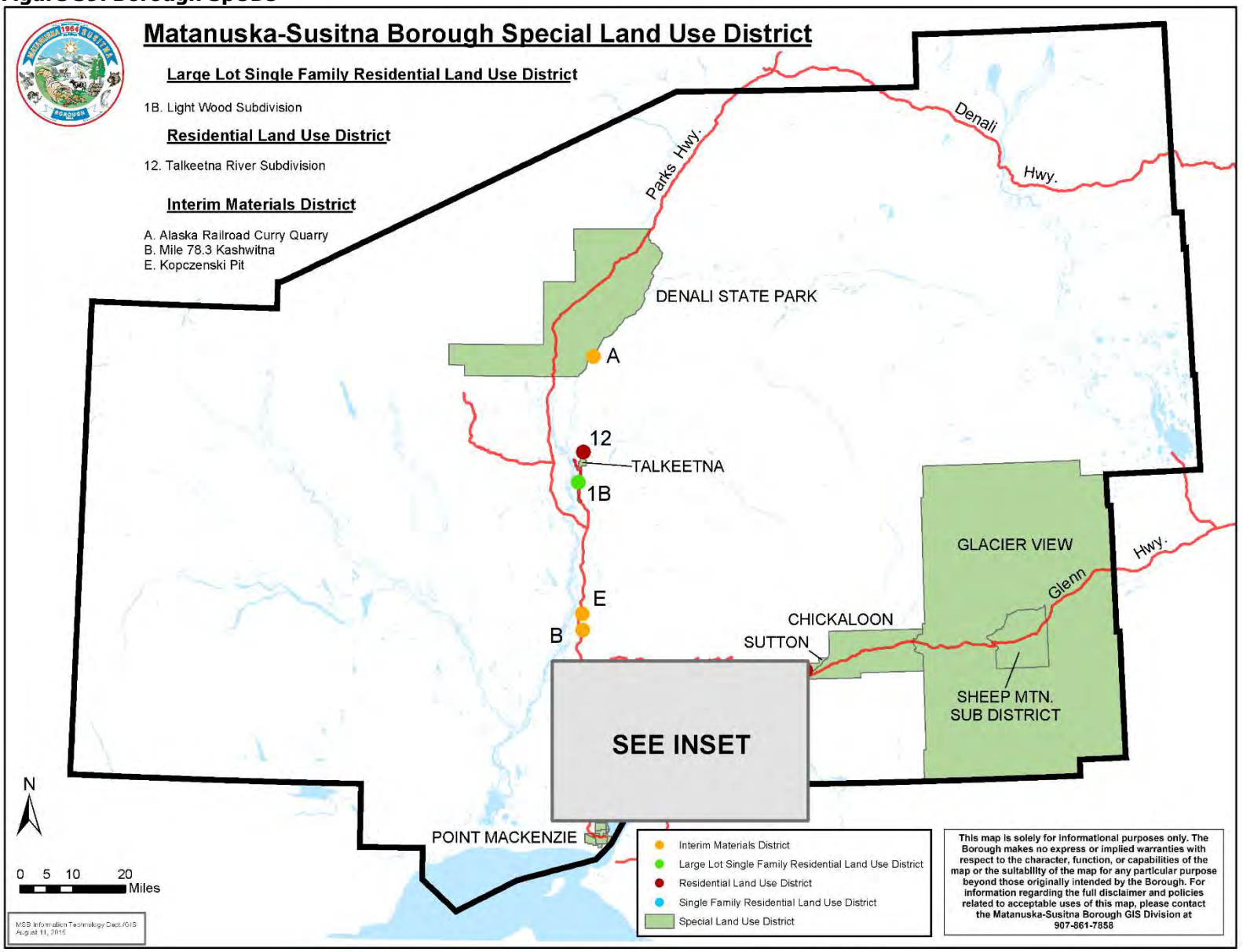


Figure 40. Inset for Figure 39

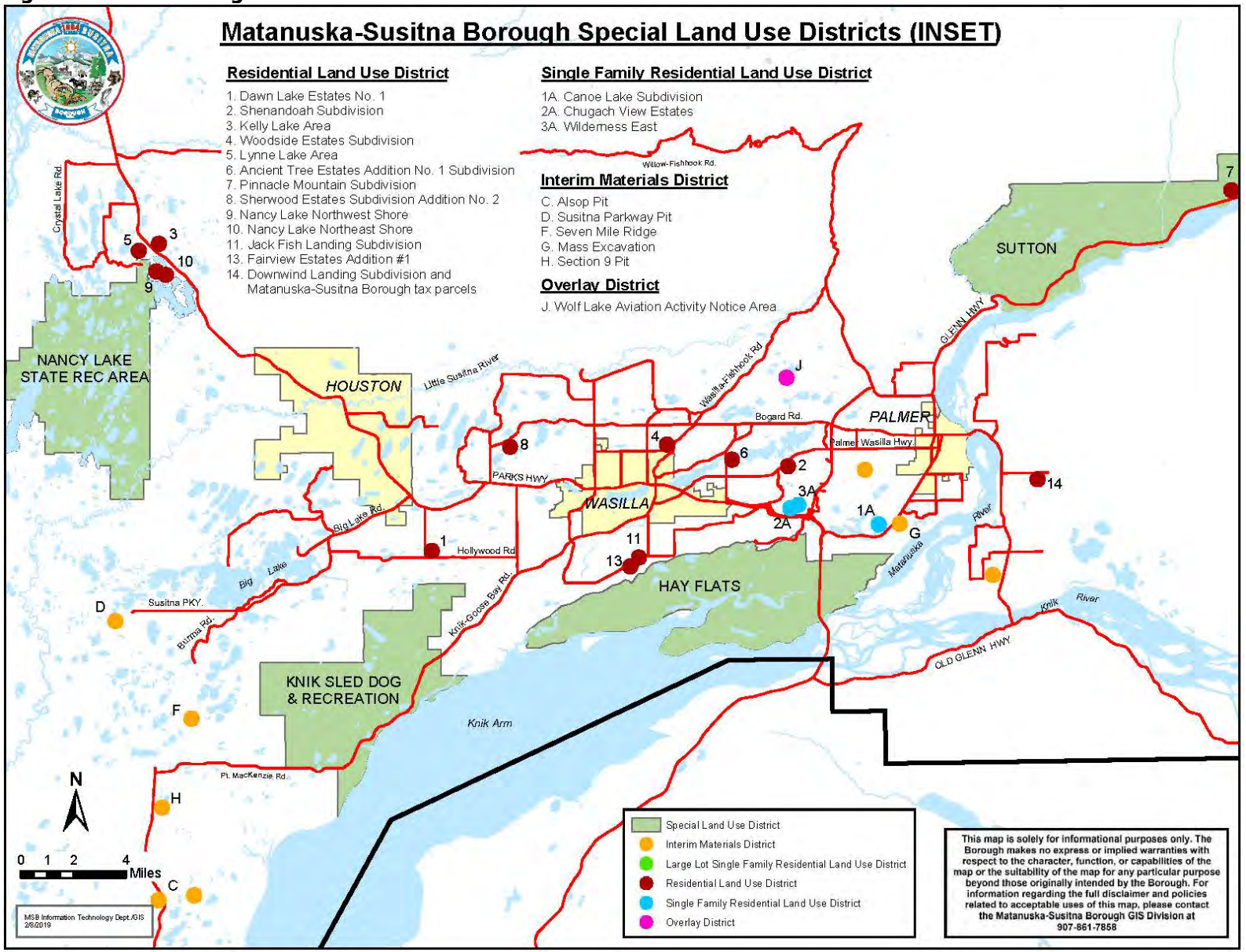
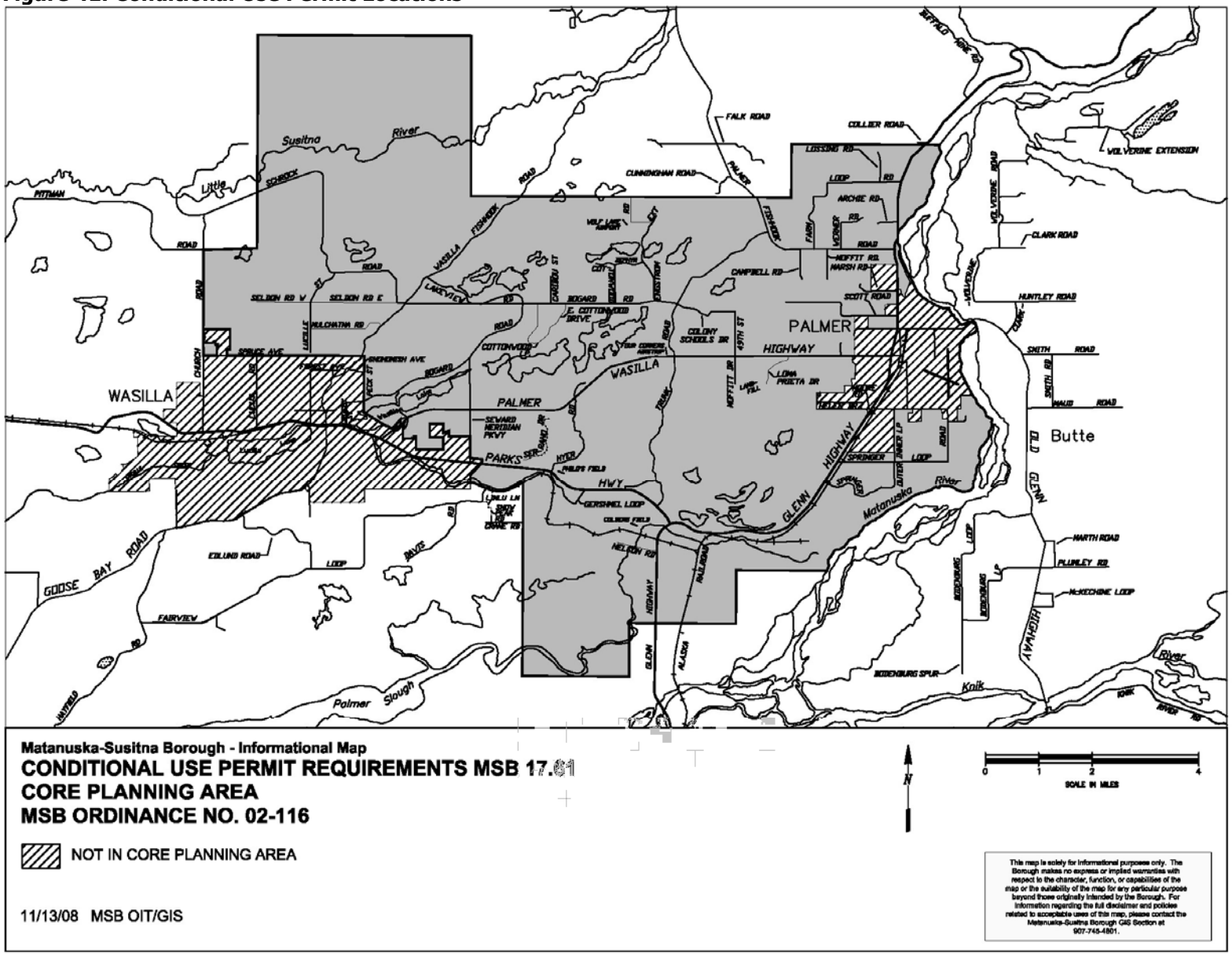


Figure 41. Conditional Use Permit Locations



6.2.1.4 Data Limitations

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

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

7.0 Mitigation Strategy

A mitigation strategy provides the blueprint for implementing desired activities that will enable the Borough to continue to save lives and preserve infrastructure by systematically reducing hazard impacts, damages, and community disruptions. This section outlines the process for preparing a mitigation strategy including:

1. Develop Mitigation Goals to mitigate the hazards and risks identified (see Sections 5 and 6).
2. Identify Mitigation Actions to meet the Mitigation Goals.
3. Evaluate Mitigation Actions.
    a. Describe and analyze Local mitigation policies, programs, and funding sources.
    b. Evaluate Federal and State hazard management policies, programs, capabilities, and funding sources.
4. Implement the Mitigation Action Plan (MAP).

The goal of all mitigation is the reduction of risk. Accordingly, the primary purpose of this HMP Update is to identify strategies for increasing the level of protection from vulnerability to natural hazards experienced by residents and visitors within the Borough. All other goals and objectives are in support of this purpose.

It is challenging to address a comprehensive HMP for the entire Borough considering that it encompasses a land mass larger than the state of West Virginia but lacking some of the infrastructure normally expected in a jurisdiction of that size. A “do-it-yourself” frontier attitude, typical of most Alaskan communities prevails. Residents tend to consider the Borough to be made up of small rural communities without much need for government intervention. This is beginning to change. Increasing pressures caused by growing population, especially the increased number of commuters who, rather than seeing much of the Borough as rural, have turned the southern, more densely populated areas into a suburban bedroom community. This has shaped their expectations regarding services and amenities.

Portions of the Borough have experienced the negative repercussions of not having a mitigation strategy. Repetitive losses, such as the continual erosion of the banks of the Matanuska River require long range planning. The challenge of securing funding for these projects is as constant as the river. In 1970, the first Borough-wide Comprehensive Plan was developed and adopted by the Assembly. Alaska statute requires that a local community’s comprehensive plan address, at a minimum, three issues: land use, transportation, and public facilities. The 2005 update to the Comprehensive Plan addressed those issues and added six others, including natural and man-made hazards. Comprehensive plans have been developed for distinct regions of the Borough with regard to land use development, infrastructure, and the economy. SpUDs have been established to identify and meet specific, local needs. The Borough’s planners and land use managers are working closely with each community, maintaining an open dialogue to identify shared goals.

Hazard mitigation considerations are integrated into future planning activities in accordance with the goals and policies set forth in Policy PM-1 as set forth in the Planning Method section

of the Borough's Comprehensive Plan which states: "Continue the use of four general planning categories to address the various planning needs of residents and communities; the general planning categories being: state and federal, Borough-wide and regional, community, and specialty or functional plans." Long- and short-range strategies were identified in the 2013 HMP to reflect the 2005 Comprehensive Plan's goal to address the issue of mitigation from Borough-wide and specialty/functional perspectives and updated in this 2019 HMP Update.

Planners, public works managers, and emergency coordinators from each of the Borough's jurisdictions collaborated in all aspects of this HMP. Corresponding Borough personnel assisted in development of plans for each jurisdiction as well. Because hazards do not stop at the city limits, these entities will continue to work collaboratively to implement common plans to mitigate common hazards. Funding will be applied accordingly to support mitigation projects that benefit all Borough residents.

Because the following goals, objectives, and actions were formulated by a multi-jurisdictional team, they are meant to apply to all jurisdictions within the Borough unless otherwise designated. They also apply to all hazards identified. Objectives are identified as short range: achievable within three to five years; long range: requiring from five to ten years to accomplish; and ongoing.

Currently, selection of Capital Improvement Projects relies on a nomination process. Borough departments, Community Councils, and other entities are afforded the opportunity to nominate projects utilizing a standard format. The projects are reviewed annually by the planning department and prioritized by the Borough Assembly. Funding is predicated on a project's position on the annual capital improvement priority list.

7.1 Developing Mitigation Goals

Requirements of hazard mitigation goals, as stipulated in DMA 2000 and its implementing regulations, are described below.

DMA 2000 Requirements: Mitigation Strategy –Hazard Mitigation Goals

Local Hazard Mitigation Goals

Requirement §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

- Does the plan include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards?

Source: FEMA, 2015.

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, goals were developed to reduce or avoid long-term vulnerabilities to identified hazards (Table 25).

Table 25. Mitigation Goals

No.	Goal Description
Multi-Hazards (MH)	
MH 1	Ensure residents of and visitors to the Borough are aware of their vulnerability to natural hazards and know how to mitigate the effects and prepare for emergency response.
MH 2	Strengthen partnerships between the Borough, other jurisdictions, and agencies serving Borough residents.
MH 3	Utilize Borough governmental powers to integrate hazard mitigation into all development planning.
MH 4	Reduce vulnerability to repetitive power outages.
Natural Hazards	
FL 1	Eliminate vulnerability to flooding (FL) within the Borough.
FL 2	Decrease the financial losses caused by floods.
FL 3	Improve habitat preservation and stream enhancement.
ER 1	Reduce property damage caused by wind or water erosion (ER).
SW 1	Mitigate vulnerability to severe weather (SW) within the Borough.
SW 2	Strengthen the ability of public facilities to withstand SW.
WF 1	Reduce the fire (F) danger in the WUI.
WF 2	Improve the fire suppression capability of Borough firefighters.
WF 3	Use the Borough Assembly's legislative power to institutionalize fire mitigation measures in Borough code.
EQ 1	Increase public awareness of how to survive an earthquake (EQ).
EQ 2	Promote adoption of building codes to require earthquake-resistant construction practices and materials.
CC 1	Eliminate the loss of life and assets due to avalanche.
V 1	Reduce health problems caused by volcanic ash (V).
V 2	Reduce property damage caused by volcanic ash.

7.2 Identifying Mitigation Actions

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

DMA 2000 Requirements: Mitigation Strategy - Identification and Analysis of Mitigation Actions

Identification and Analysis of Mitigation Actions

Requirement §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

- Does the updated plan identify and analyze a comprehensive range of specific mitigation actions and projects for each hazard?
- Do the identified actions and projects address reducing the effects of hazards on new buildings and infrastructure?
- Do the identified actions and projects address reducing the effects of hazards on existing buildings and infrastructure?

Source: FEMA, 2015.

After mitigation goals and actions were developed, the Project 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 an HMP. Mitigation actions are usually

grouped into three broad categories: property protection, public education and awareness, and structural projects. The Project Team placed particular emphasis on projects and programs that reduce the effects of hazards on both new and existing buildings and infrastructure. These potential projects are listed in Table 26.

Table 26. Mitigation Goals and Potential Actions
(Bold ID items were selected for implementation by the Planning Team)

Goals		Actions	
No.	**Description**	**ID**	**Description**
MH 1	Ensure residents of and visitors to the Borough are aware of their vulnerability to natural and man-made hazards and know how to mitigate the effects and prepare for emergency response.	1.1. Provide educational materials directly to the public. Implementation of these projects is achievable within the short term and is ongoing.	Develop portable, durable, and professional quality displays for use at fairs and special events.
			Partner with community service agencies to identify and learn how to best reach populations with special needs.
			Target the business community through the Think AHEAD program in partnership with the Small Business Development Council and the Red Cross. **2020 Update:** This program has ended.
			Use the Citizen Corps programs, CERT and Neighborhood Watch, as a means of disseminating information and training.
			Continue to use the Alaska State Fair as a major educational opportunity.
			Re-design the exhibits in the Project Impact trailer and ask a pro-active group to bring it to fairs and schools, expanding the hazard education outreach program. **2020 Update:** This program has ended.
			Distribute materials at special events such as Iditarod Days, Fourth of July, Emergency Preparedness Exp annually in September, Colony Days, Founders' Days, Earth Day, Willow Winter Carnival, and Health Fairs.
			Commemorate Arbor Day, the anniversary of the Good Friday Quake, or Millers Reach Fire with appropriate public education messages in local media.
			Place literature in venues visited by tourists and residents.
			Review all development applications for flood zone designations.
			Disseminate flood preparedness information through fire stations, public libraries, and other Borough offices.
			Attend community meetings to discuss hazards, mitigation, and recovery.
		1.2. Utilize the internet as a tool for reaching target audiences (short term and on-going actions).	Strengthen the presence of disaster mitigation and emergency preparedness information on the Borough website.
			Maintain sampling of residents' opinions on mitigation issues utilizing an interactive version of the mitigation survey.
			Update Borough information on social media outlets such as Facebook and Twitter to keep public advised on pending storms and current disaster events.
			Provide emergency information to include issues of seasonal urgency such as flood watch, weather, fire danger, etc.

Goals		Actions	
No.	**Description**	**ID**	**Description**
			Provide links to other organizations and educational resources such as LEPC, Red Cross, NOAA (weather), AVO (volcano), earthquake, etc.
MH 2	Strengthen partnerships between the Borough, other jurisdictions, and agencies serving Borough residents.	2.1. Work with the School District, private schools, and home school networks to introduce mitigation education into school curricula (long range).	Identify needs for improvement of subject matter and delivery (short range).
			Assist with development and provision of resources and materials (short range).
			Encourage local community resident participation through Community Councils (short range).
		2.2. Work with the Red Cross and the Salvation Army to evaluate emergency shelters to ensure they are appropriately secured and supplied (short range and ongoing).	Ensure emergency shelters have emergency power.
			Add functional needs shelters, and pet-friendly shelters.
			Educate the public about shelters and evacuation protocols.
		2.3. Establish lines of communication with incorporated cities.	Work with cities to help ensure responsible development within flood-prone areas.
		2.4. Work with USACE to design, construct, and inspect flood protection infrastructure.	Develop mitigation actions.
		2.5. Work with FEMA to ensure accurate and complete mapping of flood prone areas.	RiskMap Study and updated FIRMS.
MH 3	Utilize Borough governmental powers to integrate hazard mitigation into all development planning.	3.1. Keep the All-Hazards HMP updated.	Make mitigation planning a regular part of Planning Commission, Historic Preservation Commission, and Community Council activities.
			Incorporate mitigation measures into comprehensive development plans.
			Work with the Borough's GIS department to improve hazard mapping.
			Continue to involve Community Councils to solicit input for future mitigation projects, and anticipate future needs.
			Maintain a list of mitigation projects to enable taking advantage of funding opportunities on short notice.
MH 4	Reduce vulnerability to repetitive power outages.	4.1. Explore the feasibility of alternate power systems.	Implement a system of distributed power systems to provide individual incentives through the process of "net metering."
			Encourage localized power generation through alternative means such as wind turbines.
FL 1	Eliminate vulnerability to floods within the Borough.	1.1. Increase accuracy of flood zone maps (long range).	Apply for FEMA support to update FIRMs.
			Determine new base flood elevation in "approximate A" zones.
			Re-map areas where erosion has changed floodplain characteristics.
			Track damage reports in unmapped areas during high water events.

Goals		Actions	
No.	**Description**	**ID**	**Description**
			Identify and map areas outside of FIRMs that are subject to flooding.
		1.2. Maintain flood watch protocols for rivers and streams (ongoing).	Request that the State of Alaska include the Matanuska and Susitna Rivers. **2020 Update:** There is now a Flood Watch Program. The State DHS&EM has a River Watch Program.
			Coordinate the chain of flood information including local observers, DOT, Public Works, and the media.
			Develop signs for installation at strategic river and creek road crossings whenever conditions threaten flooding.
			Monitor snowpack for advance awareness of possible flood conditions.
		1.3. Reduce the vulnerability of structures within flood zones (short to long range).	Survey existing structures at risk to identify ownership and feasibility of mitigation measures.
			Regulate all construction in known flood hazard areas.
			Ensure critical facilities are built above the 500-year (0.2% annual chance of flooding) floodplain.
			Encourage all structures to be elevated 2 feet above the Base Flood Elevation (BFE).
			Seek 100% compliance with Borough 17.29 Flood Damage Prevention.
		1.4. Identify mitigation measures to prevent flooding (short range).	Survey culverts and perform needed upgrades and replacements.
			Clear debris from culverts and narrow stream passages.
			Increase level of storm drain management.
			Maintain revetments and dikes.
FL 2	Decrease the financial losses caused by floods.	2.1. Participate in federal and state programs designed to aid communities such as the NFIP and CRS which adjusts insurance rates based on mitigation measures undertaken by the community (short range).	Encourage owners of homes and businesses at risk to purchase flood insurance.
			Coordinate flood mitigation measures in compliance with DCEED's standards for participation in CRS.
FL 3	Improve habitat preservation and stream enhancement.	3.1. Support bank stabilization and debris clearance (short range).	Encourage maintenance of a vegetative buffer adjacent to streams or rivers to help absorb flood waters and prevent erosion.
			Participate in state or federal programs which support this objective.
			Install adequately sized culverts.

Goals		Actions	
No.	**Description**	**ID**	**Description**
ER 1	Reduce property damage caused by wind or water erosion.	1.1 Limit construction in areas vulnerable to riverine erosion (long range).	Adopt in Borough code restrictions on new building construction in areas vulnerable to erosion.
		1.2. Educate the public about actions they can take to reduce erosion on private property.	Provide information about public and government structural and nonstructural erosion control options.
		1.3 Establish state-appointed advisory boards for the Matanuska and Susitna Rivers similar to the advisory board for the Kenai River Special Management Area (long-term).	Charge the advisory boards with determining how to reduce erosion and flooding property damage.
SW 1	Mitigate vulnerability to severe weather within the Borough.	1.1. Adopt standards for residential construction for snow load and wind resistance for new construction on a regionally-appropriate basis throughout the Borough (long-range).	Enlist participation of building professionals and Borough resources to formulate standards appropriate to local conditions.
			Create a regional hazard map to show builders the varying wind, snow load, temperature, flood threats, and erosion hazards.
			Conduct an education campaign to develop a constituency in favor of adopting building codes for new construction.
			Empower a means for enforcing compliance with the codes.
		1.2. Encourage opportunities for builders and home remodelers to learn to build to snow load and wind resistant standards (short range).	Utilize methodologies identified in the all-hazards education portion of this plan to disseminate information to target audiences.
			Provide classes in partnership with existing builders' groups.
		1.3. Educate the public about how to survive severe winter weather (short range).	Support the initiatives described in the all-hazards education component of this plan.
SW 2	Strengthen the ability of public facilities to withstand severe water.	2.1. Initiate mitigation measures against wind damage (short and long range).	Conduct an engineering review of existing structures built with public funds including storage sheds, pavilions, and greenhouses.
			Design new structures to higher wind speed standards for securing roofing materials and accessories beyond IBC prescribed minimums. Consider alternatives to use of loose-laid roof membrane.
			Install wind deflection structures like tree screens or earth berms.
			Install stronger than code minimum light standards and flag poles in high wind areas.
			Convert hydronic heat media from water to glycol.
			Install auxiliary generators to power heating plants without loss of primary electric service.
			Install reinforced continuous hinges on all exterior doors. Add strapping or anchor systems to structures where needed.

Goals		Actions	
No.	**Description**	**ID**	**Description**
		2.2. Initiate mitigation measures against snow and ice damage (short and long range).	Provide structural capacity in excess of UBC minimums over large clear-span areas such as school gyms with low-slope roofs.
			Provide structural roofs over meters and equipment exposed to falling ice and snow at exterior doors.
			In high snowfall areas of the Borough, design structures to mitigate damage of roof-mounted equipment. Similarly, decisions to hold snow on a roof or to allow it to shed must consider vulnerability of the area beneath the eaves.
WF 1	Reduce the wildfire danger in the WUI.	1.1. Support the Spruce Bark Beetle Wildland Fire Mitigation Program (short range).	Identify areas of fuel loading in the wildland/urban interface.
			Clear the hazard trees in proximity to homes and right of way to provide line of defense in partnership with the State DOF and private sector businesses and land owners. Establish a means for homeowners to dispose of cleared brush in cooperation with the Borough landfill and transfer sites.
		1.2. Qualify the Matanuska-Susitna Borough as a FireWise community (short range).	Bring the concept of defensible space to every subdivision in the Borough.
			Assist homeowners in clearing fire hazards from around their homes.
			Create demonstrations of FireWise landscaping at public buildings.
			Ensure FireWise communities are no larger than the number of homes that can collaboratively clear fire hazards from the areas around their homes.
		1.3. Sensitize children to wildland fire issues (short range).	Develop a partnership with the School District.
			Reinforce concepts of FireWise through summer library programs and non-traditional learning opportunities.
WF 2	Improve the fire suppression capability of Borough firefighters.	2.1. Ensure sufficient resources are available (ongoing).	Continue Borough Assembly appropriations to support necessary fire suppression capabilities throughout the Borough, including areas beyond the borders of current fire service districts.
			Support engineering study of dry hydrant system.
			Identify and improve alternate road access for fire suppression equipment.
			Require that subdivisions have more than one entry road.
WF 3	Use the Borough Assembly's legislative power to institutionalize fire mitigation measures in Borough code.	3.1. Encourage development of a Borough building code (long range).	Adopt fire safety building standards for materials and construction.
		3.2. Eliminate the sale and use of fireworks in the Borough (short and long range).	Enforce Borough code banning fireworks.
			Increase signage and advertising to alert the public to the illegality and danger of fireworks.

Goals		Actions	
No.	**Description**	**ID**	**Description**
		3.3. Reduce fuel wood on Borough lands with salvage sales of beetle infested/killed spruce.	New in 2019.
EQ 1	Increase public awareness of how to survive an EQ.	1.1. Implement education strategies (short range).	Distribute brochures to public venues, tourist centers, and health care facilities.
			Engage the school district as a partner to educate children.
EQ 2	Promote adoption of building codes to require earthquake-resistant construction practices and materials.	2.1. Work with government and private sector to draft realistic and enforceable building codes which address the ability of a structure to withstand a serious quake (short and long range).	Garner public support through public demonstrations of survivability and economic benefits of safe building practices.
			Promote dissemination of seismic retrofit information to owners of homes and commercial properties.
		2.2. Strengthen all public structures in the Borough against earthquake damage (short and long range).	Conduct a survey of all structures owned and utilized by Borough government to determine seismic survivability and retrofit as necessary.
			Pay special attention to seismic safety of coal bed methane distribution infrastructures.
CC 1	Eliminate the loss of life and assets due to avalanche.	1.1. Support an aggressive avalanche education program (ongoing).	Utilize the local media to alert residents and visitors of danger and provide instruction for personal protection.
		1.2. Prohibit future development in known avalanche zones (short and long range).	Include this prohibition in Borough code.
V 1	Reduce health problems caused by volcanic ash.	1.1. Deliver public information about the dangers of volcanic ash fall and ways to remain safe (short range).	Distribute brochures to public venues, tourist centers, and health care facilities.
			Engage the school district as a partner to educate children about ash fall.
			Continue support of Air Quality Alert phone number (352-DUST).
			Utilize the local media to alert residents and visitors of danger and provide instruction for personal and property protection.
V 2	Reduce property damage caused by volcanic ash.	1.2. Deliver public information about the dangers of volcanic ash fall to structures and electrical and mechanical equipment (short range).	Utilize local media and brochures to alert residents and tourists alike to enable protective measures to mitigate damage to vehicles, computers and other equipment.
			Provide ash clean-up and disposal instructions.

The Project Team reviewed the simplified social, technical, administrative, political, legal, economic, and environmental (STAPLEE) evaluation criteria (Table 27) and the Benefit-Cost Analysis Fact Sheet (Appendix E) 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 the Borough chooses to implement.

Table 27. 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, Tribal, 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, Tribal, State, and Federal laws

On January 15, 2020, the Project 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. Prioritizing the mitigation actions in the MAP Matrix was completed on January 15, 2020 to provide the Borough with an approach to implementing the MAP. Table 28 defines the mitigation action priorities.

7.3 Evaluating and Prioritizing Mitigation Actions

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

Requirement: §201.7(c)(3)(iii): [The mitigation strategy section shall include] an action plan describing how the actions identified in Section (c)(3)(ii) will be prioritized, implemented, and administered by the Local Government. 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

- Does the updated mitigation strategy include how the actions are prioritized?
- Does the updated mitigation strategy address how the actions will be implemented and administered?
- Does the updated prioritization process include an emphasis on the use of a cost-benefit review to maximize benefits?

Source: FEMA, 2015.

7.4 Implementing a Mitigation Action Plan

Requirements for Local Government policies in mitigation strategies, as stipulated in DMA 2000 and its implementing regulations, are described below.

DMA 2000 Requirements: Mitigation Strategy

Implementation of Mitigation Actions

Requirement: §201.6(c)(3)(iii): [The mitigation strategy section shall include]: an action plan describing how the actions 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.

For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of their plan.

Element

- Does the plan contain a mitigation action plan?

Source: FEMA, 2015.

Table 28. Borough Mitigation Action Plan

Action ID	Description	Priority	Responsible Department	Potential Funding	Timeframe	Benefit-Costs / Technical Feasibility	2019 Update
MH 1	Utilize the internet and social media as a tool for reaching target audiences to communicate hazard specific information throughout the cycle of an event.	High	Borough PIO and DES	Borough	Ongoing; the Borough has increased its use of the internet and social media as a means to gain and communicate information before, during, and after a disaster.	Provides current information to all with internet access. The public must be kept up to date on issues. A firm policy for the PIO needs to be in place so that it cannot be discretionary as to the who, how, when, etc.	The Borough conducted a public survey online in June/July 2019. 721 residents responded, and the Borough is incorporating their feedback into its emergency procedures.
MH 2	Work with the Red Cross and the Salvation Army to evaluate emergency shelters to ensure they are appropriately secured, supplied, and identified.	High	Borough DES Emergency Manager	Borough DES and Red Cross	Ongoing	Provides secure sheltering and feeding for disaster survivors and responder families.	Emergency shelters have been identified. The Red Cross and Salvation Army continue to monitor supply levels.
WF 1	Identify areas of fuel loading in the wildland/urban interface.	High	DOF	Borough Planning, Emergency Services, participating Borough communities, DOF	2020-2021	Identification of hazard areas facilitates design and prioritization of mitigation actions.	Ongoing as new information becomes available. Figure 31 identifies observed spruce bark beetle damage in the Borough from 2015 to 2018.
WF 2	Clear the hazard trees in proximity to homes in partnership with State DOF and private sector businesses and land owners.	High	DOF	DHS Preparedness Technical Assistance Program, HMGP, PDM Grants, Western WUI grant, Spruce Bark Beetle Mitigation Grant, ARRA Grant	2020-2025	National statistics state that there is a $10 benefit for every $1 spent on wildfire mitigation.	Obtaining funding is a priority for Emergency Services.
WF 3	Encourage subdivisions and neighborhoods to qualify as nationally recognized FireWise Communities.	High	Borough DES Manager	HMGP, FEMA, Western WUI Grant, Homeowners	2020-2025	Residents in a FireWise Community commit to maintaining FireWise standards. It is the most	Horseshoe Lake became a FireWise community with a plan. Other communities

Action ID	Description	Priority	Responsible Department	Potential Funding	Timeframe	Benefit-Costs / Technical Feasibility	2019 Update
				Associations, Community Councils		sustainable form of wildfire mitigation?	are encouraged to evaluate their needs.
WF 4	Ensure sufficient firefighting resources are available.	High	Borough Fire Chief	Borough Emergency Services, CIP; Rasmussen, FMA, PDM, HMGP, USACE, NRCS, FEMA, AFG	Ongoing	Sufficient fire suppression resources enable the saving of lives and property. Firefighting capability is a factor in a community's ISO rating.	The Borough regularly evaluates, maintains, and improves firefighting resources, including hiring and training new personnel. The Borough spent roughly 17% of its budget on emergency services in 2019.
WF 5	Develop and maintain Community Wildfire Protection Plans for Community Council areas in the Borough.	Medium	Borough Emergency Services, Planning, Community Councils, Homeowners' Associations	Borough, Western WUI	Ongoing	Community Wildfire planning identifies and prioritizes areas of risk and engages landowners in actively protecting their property.	When will 2008 WCCP be done? Have any other plans been done for communities?
EQ 1	Seismic Hazard Risk Mapping.	Medium	USGS, ADGGS, Borough DES and Planning	FEMA, DGGS	Done.	Hazard mapping will help reduce risk to public infrastructure and housing developments.	FEMA data was provided to the Borough in 2019. Shake maps have been prepared.
EQ 2	Increase public awareness of how to survive an earthquake.	High	Borough School District, Emergency Services, DHS&EM	Borough, DHS&EM, SHSGP	Ongoing	A comprehensive earthquake safety program, delivered as appropriate to all ages and audiences will save lives.	The Borough has a preparedness page on its website with information on preparing for a natural disaster. Borough schools have periodic earthquake drills and discus earthquake safety. Additionally, the Borough participates in the Alaska Shield earthquake exercises, which promote earthquake preparedness throughout the state.
EQ 3	Promote adoption of building codes to require earthquake-resistant construction practices and materials.	High	Borough Planning and Land Use	Borough	Ongoing	Seismic standard construction will increase survivability of occupants.	The Borough Fire Marshal enforces code compliance with International Building Codes, which includes standards for construction

Action ID	Description	Priority	Responsible Department	Potential Funding	Timeframe	Benefit-Costs / Technical Feasibility	2019 Update
							materials based on seismic loads.
F 1	Increase accuracy of flood zone maps (long range).	High	Borough Department of Planning and Land Use	FEMA	5 years	Increases ability to accurately manage zones of high flood hazard	The FIRM maps were updated in 2019.
F 2	Maintain flood watch protocols and use of hydrological gauges on rivers and streams.	High	State, Borough Public Works, Planning, Emergency Services	State, Borough, USGS	Ongoing. The Borough has been increasing its funding of local stream gages for the last 5 years.	Provides early warning resulting in reduced losses and quicker response.	The USGS maintains hydrological gauges on rivers and streams throughout the Borough, including the Matanuska, Susitna, Little Susitna, Talkeetna, and Knik rivers and Montana and Willow creeks.
F 3	Reduce vulnerability of structures within flood zones via demonstration projects of dredging, dike or levy systems, stream bank management.	Medium	Borough Planning & Land Use, Public Works	Borough, DHS&EM, FEMA, NRCS	Ongoing	Reduces amount of vulnerable structures within Borough.	
FL/ER 1	Establish state appointed advisory boards for the Matanuska and Susitna Rivers similar to the advisory board for the Kenai River Special Management Area.	High	Borough DES, Administration, Community Development, Planning and Land Use, Public Works	State of Alaska	5 years	Advisory board will help implement mitigation projects as well as river use guidelines in a special management area.	Was an advisory board created?
FL 2	Wasilla Creek Bridge on Nelson Project (one-mile west/one-mile south of the Glenn Interchange)	High					New in 2019
FL 3	Lucille Street Culvert Project at Locharren (Wasilla)	High					New in 2019
FL 4	Sushana Drive over Little Susitna River (approximately 5 miles north of Wasilla)						New in 2019
FL 5	Big Lake Jolly Creek Drainage Improvements Project						New in 2019
FL 6	Have the Cities of Wasilla, Houston, and Palmer update their Memorandums of Understanding with the Borough for the Borough						New in 2019

Action ID	Description	Priority	Responsible Department	Potential Funding	Timeframe	Benefit-Costs / Technical Feasibility	2019 Update
	Floodplain Administrator to obtain permits to construct in floodplain areas.						
FL 7	Capital projects still needs funds to complete the work from the 2012 flood						
FL 8	Use flood depth grids for discussion before development .						
SW 1	Adopt standards for residential construction for snow load and wind resistance for new construction on a regionally appropriate basis throughout the Borough (long-range).	Medium	Borough Planning and Land Use and DES	Borough, DHS&EM	5 years	Increase structure and citizen survival rates during severe weather events utilizing new Risk Map technologies.	Were standards added?
CC 1	Support an aggressive avalanche education program.	High	Borough, State Parks and Recreation	Borough, State Parks and Recreation	1 to 3 years	Education about the risk of avalanches, avalanche safety, and conservative backcountry decision making has consistently proven to be effective at reducing the number of fatalities from avalanches.	Through Assembly resolution 2016-18, the Borough backed the Alaska Avalanche Information Center's efforts to install educational signs around trailheads near high-avalanche-risk areas.
V 1	Deliver public information about the dangers of volcanic ash fall and ways to remain safe.	Medium	Borough School District, Emergency Services, DHS&EM	Borough, DHS&EM, AVO	1-5 years	Ensuring the public has knowledge of the risk and necessary preparation for a volcanic ashfall event will help residents protect themselves and reduce the necessary response after such an event.	Information about volcanic ash fall danger is undertaken by interagency cooperation between the NWS, DHS&EM, FAA, and the AVO through local communication networks and media outlets. The Borough may assist in reaching those who are not reachable by normal media and provide educational materials on preparation.
	Conduct a study to map the Cedars Subdivision as a potential future flood area. Depending on the size of the watershed, and length of stream – we could look at doing a study there.						

Action ID	Description	Priority	Responsible Department	Potential Funding	Timeframe	Benefit-Costs / Technical Feasibility	2019 Update
	We'll also be sending out the Notice of Funding for the CTP program for next year soon – if the Borough would want to pursue a study on your own. Let's get some details together and see what we can come up with (specific area, miles to be studied/mapped, watershed area, approximate A zone vs detailed A zone, floodway needs, LiDAR coverage, etc).						
	Educate Cedars Subdivision residents regarding the history of Hunter Creek flooding and potential hazard area concerns that they may face if river moves.						
	Add language to the platting code to identify natural hazards before subdivisions are platted.						
	Add language in the subdivision construction manual to identify natural hazards.						

8.0 Plan Maintenance

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

The following three process steps are addressed in detail here:

1. Monitoring, evaluating, and updating the HMP;
2. Implementation through existing planning mechanisms; and
3. Continued public involvement.

8.1 Monitoring, Evaluating, and Updating the HMP

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

DMA 2000 Requirements: Plan Maintenance Process - Monitoring, Evaluating, and Updating the Plan

Monitoring, Evaluating and Updating the Plan

Requirement §201.6(c)(4)(i, ii, and iii): [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; b] a process by which local government incorporates the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate; and c] discussion on how the community will continue public participation in the plan maintenance process.

Element

- Does the updated plan describe the method and schedule of monitoring the plan, including the responsible department?
- Does the updated plan describe a system for monitoring implementation of mitigation measures and project closeouts?
- Does the updated plan describe the method and schedule for updating the plan within the five-year cycle?

Source: FEMA, 2015.

This HMP Update was prepared as a collaborative effort among the Project Team and LeMay Engineering & Consulting, Inc. To maintain momentum, the Borough will use the Project Team Lead (Borough Flood Management Coordinator) to monitor, evaluate, and update the HMP. Each authority identified in Table 28 will be responsible for implementing the MAP. The Borough Planner will serve as the primary point of contact and will coordinate local efforts to monitor, evaluate, and revise the HMP.

Each member of the Project Team will conduct an annual review during the anniversary week of the HMP's official FEMA approval date to monitor the progress in implementing the HMP, particularly the MAP. As shown in Appendix F, the Annual Review Worksheet will provide the basis for possible changes in the HMP MAP by refocusing on new or more threatening hazards, adjusting to changes to or increases in resource allocations, and engaging additional support for the HMP implementation. The Borough Flood Management Coordinator 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 Project Team Meeting. Each review, as shown on the Annual Review Worksheet, will include an evaluation of the following:

- Participation of authorities and others in the HMP implementation;
- Notable changes in the risk of natural hazards;
- Impacts of land development activities and related programs on hazard mitigation;
- Progress made with the MAP (identify problems and suggest improvements as necessary and provide progress reports on implemented mitigation actions); and
- The adequacy of local resources for implementation of the HMP.

A system of reviewing the progress on achieving the mitigation goals and implementing the MAP activities and projects will also be accomplished during the annual review process. During each annual review, each authority administering a mitigation project will submit a Progress Report to the Project Team. As shown in Appendix F, the report will include the current status of the mitigation project, including any changes made to the project, the identification of implementation problems and appropriate strategies to overcome them, and whether or not the project has helped achieve the appropriate goals identified in the HMP.

In addition to the annual review, the Project Team will update the HMP every five years. To ensure that this update occurs, in the fourth year following adoption of the HMP, the Project Team will undertake the following activities:

- Request grant assistance from DHS&EM and FEMA to update the HMP (this can take up to one year to obtain and one year to update the HMP);
- Thoroughly analyze and update the risk of natural hazards;
- Provide a new annual review (as noted above), plus a review of the three previous annual reviews;
- Provide a detailed review and revision of the mitigation strategy;
- Prepare an updated MAP for the Borough;
- Prepare an updated Draft HMP;
- Submit an updated Draft HMP to DHS&EM and FEMA for approval;
- Submit the DSH&EM- and FEMA-approved plan for adoption by the Borough Assembly; and
- Return the adoption resolution to FEMA to receive formal approval.

8.2 Implementation Through Existing Planning Mechanisms

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

DMA 2000 Requirements: Plan Maintenance Process - Incorporation into Existing Planning Mechanisms

Incorporation into Existing Planning Mechanisms

Requirements §201.6(c)(4)(ii): [The plan shall include a] process by which the Local Government integrates the HMP into other ongoing Borough planning efforts as well as other planning mechanisms such as comprehensive or capital improvement plans when appropriate.

Element

- Does the updated plan identify other planning mechanisms available for incorporating the mitigation requirements of the mitigation plan?
- Does the updated plan include a process by which the Borough government will incorporate the mitigation strategy and other information contained in the plan (e.g., risk assessment) into other planning mechanisms, when appropriate?

Source: FEMA, 2015.

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

- Conduct a review of the community-specific regulatory tools to assess the integration of the mitigation strategy. These regulatory tools are identified in the capability assessment section (see Tables 29-31).
- Work with pertinent community departments to increase awareness of the HMP and provide assistance in integrating the mitigation strategy (including the MAP) into relevant planning mechanisms. Implementation of these requirements may require updating or amending specific planning mechanisms.
- The Borough Planning Department will be responsible for providing a copy of this HMP to contractors focused on developing new or updating existing Local Plans and ensuring that this HMP is incorporated into plans as applicable.

The Borough will involve the public to continually reshape and update this HMP. A paper copy of this HMP will be available at the Borough Office. This HMP will also be stored on the State DCCED/DCRA's plans website for public reference. Planners are encouraged to integrate components of this HMP into their own plans.

The following tables outline the resources available to the Borough for mitigation related funding and training. The tables delineate the Borough's regulatory tools, technical specialists, and financial resource available for project management.

Table 29. Regulatory Tools

Regulatory Tools (ordinances, codes, plans)	Existing?	Comments (Year of most recent update; problems administering it, etc.)
Comprehensive Plan	Yes	Matanuska-Susitna Borough Comprehensive Plan Update adopted by the Assembly, 2005, provides goals and actions for Hazard Mitigation and Land Use.
Land Use Plan	Yes	Included in the Matanuska-Susitna Borough Comprehensive Plan Update, 2005.
Economic Plan	Yes	Economic Development Strategic Plan 2010- 2015. Comprehensive Economic Development Plan 2013.
Emergency Utility Plan	No	
Emergency Response Plan, 2008	Yes	Updated 2010, limited resources and staff committed to administration
Wildland Fire Protection Plan	Yes	Updated 2008
Building codes	No	
Fire Insurance Rating	Yes	Fire insurance ratings based on level of service provided in individual fire service areas
Zoning ordinances	Yes	Updated annually, no land use requirements related to natural hazards
Subdivision ordinances or regulations	Yes	Does not address seismic hazard
Special purpose ordinances	No	
Transportation Plan	Yes	Matanuska-Susitna Borough Long Range Transportation Plan, Updated 2007 addresses land and transportation management.

Local Resources

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

Table 30. 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	Departments of Public Works and Planning and Land Use
Engineer or professional trained in construction practices related to buildings	Yes	Department of Public Works
Planner or engineer with an understanding of natural and/or human-caused hazards	Yes	Department of Planning and Land Use
Floodplain Manager	Yes	Department of Planning and Land Use
Surveyors	Yes	Capital Projects Department
Staff with education or expertise to assess the jurisdiction's vulnerability to hazards	Yes	Multiple Departments
Personnel skilled in Geospatial Information System (GIS) and/or Hazards Us-Multi Hazard (Hazus-MH) software	Yes	Department of Information Technology
Scientists familiar with the hazards of the jurisdiction	Yes	Department of Planning and Land Use

Emergency Manager	Yes	Emergency Services Department
Grant Writers	Yes	Departments of Planning and Land Use, Emergency Services
Public Information Officer	Yes	Administration

The following table includes additional information on existing Borough authority, policies, and programs.

Table 31. Financial Resources

Funding Resources	Y/N	Has the source been used in the past? Could it be used in the future?
Capital Improvement Project Funding	Yes	The CIP could be used to list capital improvements to protect public structures such as bridges and roads from future flooding and erosion events.
Authority to levy taxes for special purposes	Yes	The Borough has created special service areas along the Matanuska River to raise tax revenues for erosion mitigation projects.
Fees for water, sewer, gas, or electric services	Yes	The Borough collects service fees.
Impact fees for new development	Yes	The Borough is eligible to collect impact fees for new development.
Storm water utility fee	Yes	The Borough would be eligible to collect storm water utility fees.
Incur debt through general obligation bonds and or special tax bonds	Yes	The Borough has sold voter approved general obligation bonds for roads and schools.
Community Development Block Grant	Yes	The Borough has received a CDBG to construct a warm storage building for Lake Louise Emergency Response Equipment.
Other federal funding programs	Yes	The Borough has received grants for FireWise Program Implementation.
State funding programs	Yes	The Borough received pre-disaster mitigation grant to draft the first mitigation plan and updates. The Borough is eligible for flood mitigation assistance and is a NFIP participant.

8.3 Continued Public Involvement

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

DMA 2000 Requirements: Plan Maintenance Process - Continued Public Involvement

Continued Public Involvement

Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the Government will continue public participation in the plan maintenance process.

Element

- Does the updated plan explain how continued public participation will be obtained?

Source: FEMA, 2015.

The Borough is dedicated to involving the public directly in the continual reshaping and updating of the HMP. A paper copy of the HMP and any proposed changes will be available at the Borough Planning and Land Use Office. An address and phone number of the Borough Floodplain Manager to whom people can direct their comments or concerns will also be available at the Borough Office.

The Borough give handouts containing safety and emergency prevention information as well as Fire Wise pamphlets to the public. Community surveys will be provided intermittently on the Borough's Facebook and website to remind the community about the potential hazards that could affect Borough residents as well as to provide an opportunity for the community to comment on their concerns. See Appendix F for a sample public opinion survey. Any public comments received regarding the HMP will be collected by the Borough Floodplain Manager, included in the annual report, and considered during future HMP updates.

The Project Team will continue to raise community awareness about the HMP and the hazards that affect the Borough.

Federal Resources

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

- FEMA, through its Emergency Management Institute, offers training in many aspects of emergency management, including hazard mitigation. FEMA has also developed a large number of documents that address implementing hazard mitigation at the local level. Key resource documents are available from the FEMA Publication Warehouse (1-800-480-2520) and are briefly described here:
    - How-to Guides. FEMA has developed a series of how-to guides to assist States, communities, and Tribes in enhancing their hazard mitigation planning capabilities. The first four guides describe the four major phases of hazard mitigation planning. The last five how-to guides address special topics that arise in hazard mitigation planning such as conducting cost-benefit analysis and preparing multi-jurisdictional plans. The use of worksheets, checklists, and tables make these guides a practical source of guidance to address all stages of the hazard mitigation planning process. They also include special tips on meeting DMA 2000 requirements.
    - Post-Disaster Hazard Mitigation Planning Guidance for State and Local Governments. FEMA DAP-12, September 1990. This handbook explains the basic concepts of hazard mitigation and shows State, Tribal, and Local governments how they can develop and achieve mitigation goals within the context of FEMA's post-disaster hazard mitigation planning requirements. The handbook focuses on approaches to mitigation, with an emphasis on multi-objective planning.
    - Mitigation Resources for Success compact disc (CD). FEMA 372, September 2001. This CD contains a wealth of information about mitigation and is useful for State, Tribal, and Local government planners and other stakeholders in the mitigation process. It provides mitigation case studies, success stories, information about

Federal mitigation programs, suggestions for mitigation measures to homes and businesses, appropriate relevant mitigation publications, and contact information.

  - A Guide to Federal Aid in Disasters. FEMA 262, April 1995. When disasters exceed the capabilities of State, Tribal, and Local governments, the President's disaster assistance programs (administered by FEMA) is the primary source of Federal assistance. This handbook discusses the procedures and process for obtaining this assistance, and provides a brief overview of each program.
  - The Emergency Management Guide for Business and Industry. FEMA 141, October 1993. This guide provides a step-by-step approach to emergency management planning, response, and recovery. It also details a planning process that businesses can follow to better prepare for a wide range of hazards and emergency events. This effort can enhance a business's ability to recover from financial losses, loss of market share, damages to equipment, and product or business interruptions. This guide could be of great assistance to a community's industries and businesses located in hazard prone areas.
  - The FEMA Hazard Mitigation Assistance Guidance and Addendum, February 5, 2015. The guidance introduces the five HMA grant programs, funding opportunities, award information, eligibility, application and submission information, application review process, administering the grant, contracts, additional program guidance, additional project guidance, and contains information and resource appendices (FEMA, 2015).

- Department of Agriculture (USDA). Assistance provided includes: Emergency Conservation Program, Non-Insured Assistance, Emergency Watershed Protection, Rural Housing Service, Rural Utilities Service, and Rural Business and Cooperative Service.
- Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy, Weatherization Assistance Program. This program minimizes the adverse effects of high energy costs on low-income, elderly, and handicapped citizens through client education activities and weatherization services such as an all-around safety check of major energy systems, including heating system modifications and insulation checks.
- Department of Health and Human Services, Administration of Children & Families, Administration for Native Americans (ANA). The ANA awards funds through grants to American Indians, Native Americans, Native Alaskans, Native Hawaiians, and Pacific Islanders. These grants are awarded to individual organizations that successfully apply for discretionary funds. ANA publishes in the Federal Register an announcement of funds available, the primary areas of focus, review criteria, and the method of application.
- Department of Housing and Urban Development (HUD), Office of Homes and Communities, Section 108 Loan Guarantee Programs. This program provides loan guarantees as security for Federal loans for acquisition, rehabilitation, relocation, clearance, site preparation, special economic development activities, and construction of certain public facilities and housing.
- Department of Housing and Urban Development, Community Development Block Grants (HUD/CDBG). Provides grant assistance and technical assistance to aid

communities in planning activities that address issues detrimental to the health and safety of local residents, such as housing rehabilitation, public services, community facilities, and infrastructure improvements that would primarily benefit low-and moderate-income persons.

- Department of Labor (DOL), Employment and Training Administration, Disaster Unemployment Assistance. Provides weekly unemployment subsistence grants for those who become unemployed because of a major disaster or emergency. Applicants must have exhausted all benefits for which they would normally be eligible.
- Federal Financial Institutions. Member banks of Federal Deposit Insurance Corporation, Financial Reporting Standards or Federal Home Loan Bank Board may be permitted to waive early withdrawal penalties for Certificates of Deposit and Individual Retirement Accounts.
- Internal Revenue Service (IRS), Tax Relief. Provides extensions to current year's tax return, allows deductions for disaster losses, and allows amendment of previous tax returns to reflect loss back to three years.
- U.S. Small Business Administration (SBA). May provide low-interest disaster loans to individuals and businesses that have suffered a loss due to a disaster. Requests for SBA loan assistance should be submitted to DHS&EM.
- USACE Alaska District's Civil Works Branch studies potential water resource projects in Alaska. These studies analyze and solve water resource issues of concern to the local communities. These issues may involve navigational improvements, flood control or ecosystem restoration. The agency also tracks flood hazard data for over 300 Alaskan communities on floodplains or the sea coast. These data help local communities assess the risk of floods to their communities and prepare for potential future floods. The USACE is a member and co-chair of the Alaska Climate Change Sub-Cabinet.

State Resources

- DHS&EM is responsible for improving hazard mitigation technical assistance for Tribal and Local governments for the State of Alaska. Providing hazard mitigation training, current hazard information, and communication facilitation with other agencies will enhance local hazard mitigation efforts. DHS&EM administers FEMA mitigation grants to mitigate future disaster damages such as those that may affect infrastructure including the elevation, relocation, or acquisition of hazard-prone properties. DHS&EM also provides mitigation funding resources for mitigation planning.
- Division of Senior Services (DSS): Provides special outreach services for seniors, including food, shelter, and clothing.
- Division of Insurance (DOI): Provides assistance in obtaining copies of policies and provides information regarding filing claims.
- Department of Military and Veterans Affairs (DMVA): Provides damage appraisals and settlements for VA-insured homes, and assists with filing of survivor benefits.
- The Community Health and Emergency Medical Services (CHEMS) is a section within the Division of Public Health within the Department of Health and Social Services (DHSS).

DHSS is charged with promoting and protecting the public health and one of CHEMS' responsibilities is developing, implementing, and maintaining a statewide comprehensive emergency medical services system. The department's statutory mandate (Alaska Statute 18.08.010) requires it to:

- Coordinate public and private agencies engaged in the planning and delivery of emergency medical services, including trauma care, to plan an emergency medical services system;
- Assist public and private agencies to deliver emergency medical services, including trauma care, through the award of grants in aid;
- Conduct, encourage, and approve programs of education and training designed to upgrade the knowledge and skills of health personnel involved in emergency medical services, including trauma care; and
- Establish and maintain a process under which hospitals and clinics can represent themselves to be trauma centers because they voluntarily meet criteria adopted by the department which are based on an applicable national evaluation system.

- DCRA within the DCCED. DCRA administers the HUD/CDBG, FMA Program, and the Climate Change Sub-Cabinet's Interagency Working Group's program funds and administers various flood and erosion mitigation projects, including the elevation, relocation, or acquisition of flood-prone homes and businesses throughout the State. This department also administers programs for State "distressed" and "targeted" communities.
- Division of Environmental Conservation (DEC). The DEC's primary roles and responsibilities concerning hazards mitigation are ensuring safe food and safe water, and pollution prevention and pollution response. DEC ensures water treatment plants, landfills, and bulk fuel storage tank farms are safely constructed and operated in communities. Agency and facility response plans include hazards identification and pollution prevention and response strategies.
- Department of Transportation and Public Facilities (DOT/PF) personnel provide technical assistance to the various emergency management programs, to include mitigation. This assistance is addressed in the DHS&EM-DOT/PF Memorandum of Agreement and includes, but, is not limited to: environmental reviews, archaeological surveys, and historic preservation reviews.

  In addition, DOT/PF and DHS&EM coordinate buy-out projects to ensure that there are no potential right-of-way conflicts with future use of land for bridge and highway projects, and collaborate on earthquake mitigation.

  Additionally, DOT/PF provides safe, efficient, economical, and effective operation of the State's highways, harbors, and airports. DOT/PF uses it's Planning, Design and Engineering, Maintenance and Operations, and Intelligent Transportation Systems resources to identify the hazard, plan and initiate mitigation activities to meet the transportation needs of Alaskans and make Alaska a better place to live and work. DOT/PF budgets for the temporary replacement bridges and materials necessary to make the multi-modal transportation system operational following a natural disaster.

- The Department of Natural Resources (DNR) administers various projects designed to reduce stream bank erosion, reduce localized flooding, improve drainage, and improve discharge water quality through the stormwater grant program funds. Within DNR, the Division of Geological and Geophysical Survey (DGGS) is responsible for the use and development of Alaska's mineral, land, and water resources, and collaboration on earthquake mitigation.
    - DNR's DGGS collects and distributes information about the State's geologic resources and hazards. Their geologists and support staff are leaders in researching Alaska's geology and implementing technological tools to most efficiently collect, interpret, publish, archive, and disseminate that information to the public
    - The DNR's Division of Forestry (DOF) participates in a statewide wildfire control program in cooperation with the forest industry, rural fire departments, and other agencies. Prescribed burning may increase the risks of fire hazards; however, prescribed burning reduces the availability of fire fuels, and therefore, the potential for future, more serious fires.
    - DOF also manages various wildland fire programs, activities, and grant programs such as the FireWise Program, the Community Forestry Program (CFP) and the Volunteer Fire Assistance and Rural Fire Assistance Grant (VFA-RFAG) programs.

Other Funding Sources and Resources

The following provide focused access to valuable planning resources for communities interested in sustainable development activities.

- FEMA, http://www.fema.gov - includes links to information, resources, and grants that communities can use in planning and implementation of sustainable measures.
- American Planning Association (APA), http://www.planning.org - a non-profit professional association that serves as a resource for planners, elected officials, and citizens concerned with planning and growth initiatives.
- Institute for Business and Home Safety (IBHS), http://ibhs.org - an initiative of the insurance industry to reduce deaths, injuries, property damage, economic losses, and human suffering caused by natural disasters.
- American Red Cross (ARC). Provides for the critical needs of individuals such as food, clothing, shelter, and supplemental medical needs. Provides recovery needs such as furniture, home repair, home purchasing, essential tools, and some bill payment may be provided.
- Crisis Counseling Program. Provides grants to State and Borough Mental Health Departments, which in turn provide training for screening, diagnosing, and counseling techniques. Also provides funds for counseling, outreach, and consultation for those affected by disaster.

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APPENDIX A. Definitions

Aufeis: When new ice continues to form on top of older ice. Ice-forming situations occur wherever there are continuous sources of water and freezing temperatures.

Alluvial Fan: Area of deposition where steep mountain drainages empty into valley floors. Flooding in these areas often includes characteristics that differ from those in riverine or coastal areas.

Alluvial Fan Flooding: Flooding that occurs on the surface of an alluvial fan (or similar landform) that originates at the apex of the fan and is characterized by high velocity flows; active processes of erosion, sediment transport, and deposition; and unpredictable flow paths.

Anabatic Wind: Any wind blowing up an incline; the opposite to katabatic wind.

Avalanche: Mass of snow and ice falling suddenly down a mountain slope and often taking with it earth, rocks and rubble of every description.

Base Flood Elevation: The computed elevation to which floodwater is anticipated to rise during the base flood. Base Flood Elevations are shown on FIRMs and on flood profiles. The Base Flood Elevation is the regulatory requirement for the elevation or floodproofing of structures. The relationship between the Base Flood Elevation and a structure's elevation determines the flood insurance premium.

Borough: The basic unit of local government in Alaska, analogous to counties in other states.

Caldera: A caldera is a large, usually circular depression at the summit of a volcano formed when magma is withdrawn or erupted from a shallow underground magma reservoir.

Chinook: A warm down-slope wind.

Community Rating System: An NFIP program that provides incentives for NIFP Communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of policyholders in these communities are reduced.

Community: Any state, area, or political subdivision thereof, or any tribe or tribal entity that has the authority to adopt and enforce statutes for areas within its jurisdiction.

Community Council: A nonprofit, voluntary, self-governing association of residents of an area. It is recognized by assembly resolution but is not an arm of the Borough. There are 26 Community Councils in the Borough.

Critical Facility: Facilities critical to the health and welfare of the population and that are especially important during and after a hazard event. Critical facilities include, but are not limited to, shelters, hospitals, and fire stations.

Dam: A structure built across a waterway to impound water.

Development: Any manmade change to improved or unimproved real estate including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations, or storage of equipment or materials.

Earthquake: A sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of the earth’s tectonic plates.

Earthquake Swarm: A collection of earthquakes that are frequent in time. There is no identifiable main shock.

Economic Disaster: When the annual income to workers in the designated area dropped below the average annual income for the base period for workers in the designated area and the drop in income is of such magnitude that the average family income of all residents of the designated area as determined by the department is below the poverty guidelines issued by the federal Department of Health and Human Services, adjusted by the department to reflect subsistence economic patterns and appropriate cost-of-living differentials; the availability of alternate employment shall be considered in determining whether an economic disaster has occurred under this paragraph.

Elevation: The raising of a structure to place it above flood waters, generally above the base flood elevation, on an extended support structure.

Emergency Operations Plan: A document that: describes how people and property will be protected in disaster and disaster threat situations; details who is responsible for carrying out specific actions; identifies the personnel, equipment, facilities, supplies, and other resources available for use in the disaster; and outlines how all actions will be coordinated.

Erosion: The wearing away of the land surface by running water, wind, ice, or other geological agents.

Federal Disaster Declaration: See Presidential Disaster Declaration.

Federal Emergency Management Agency (FEMA): A federal agency created in 1979 to provide a single point of accountability for all federal activities related to hazard mitigation, preparedness, response, and recovery.

Flash Flood: A flood event occurring with little or no warning where water levels rise at an extremely fast rate.

Flood: A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.

Floodplain: A "floodplain" is the lowland adjacent to a river, lake, or ocean. Floodplains are designated by the frequency of the flood that is large enough to cover them. For example, the 10-year floodplain will be covered by the 10-year flood; the 100-year floodplain by the 100-year flood.

"Flood Frequencies:" Frequencies are determined by plotting a graph of the size of all known floods for an area and determining how often floods of a particular size occur. The frequency is the chance of a flood occurring during a given timeframe. It is the percentage of the probability of flooding each year. For example, the 100-year flood has a 1% chance and the 10-year flood has a 10% chance of occurring in any given year.

Fumarole: Fumaroles are vents from which volcanic gas escapes into the atmosphere. Fumaroles may occur along tiny cracks or long fissures, in chaotic clusters or fields, and on the surfaces of lava flows and thick deposits of pyroclastic flows. They may persist for decades or centuries if they are above a persistent heat source or disappear within weeks to months if they occur atop a fresh volcanic deposit that quickly cools.

Geographic Information System: A computer software application that relates physical features of the earth to a database that can be used for mapping and analysis.

Governing Body: The legislative body of a jurisdiction such as a municipal or Borough assembly or a city council.

Hazard: A source of potential danger or adverse condition. Any situation that has the potential for causing personal injury or death, or damage to property and the environment.

Hazard Mitigation: Any action taken to reduce or eliminate the long-term risk to human life and property from natural hazards (44 CFR Subpart M 206.401).

Hazard Mitigation Grant Program: The program authorized under §322 of the Disaster Mitigation Act 2000, which may provide funding for mitigation measures identified through the evaluation of natural hazards.

Hazard and Vulnerability Analysis: The identification and evaluation of all the hazards that potentially threaten a jurisdiction and analyzing them in the context of the jurisdiction to determine the degree of threat that is posed by each.

Hydro Unit: Short for Hydrologic Unit. A drainage area delineated to nest in a multi-level, hierarchical drainage system. Its boundaries are defined by hydrographic and topographic criteria that delineate an area of land upstream from a specific point on a river, stream, or similar surface water. A hydrologic unit can accept surface water directly from upstream drainage areas, and indirectly from associated surface areas such as remnant, non-contributing, and diversions to form a drainage area with single or multiple outlet points.

Infrastructure: The public services of a community that have a direct impact to the quality of life. Infrastructure refers to communication technology such as phone lines or Internet access, vital services such as public water supply and sewer treatment facilities, and includes an area's transportation system, regional dams or bridges, etc.

Interferometry: A method employing the interference of electromagnetic radiation to make highly precise measurements of the angle between the two rays of light.

Inundation: The maximum horizontal distance inland reached by a tsunami.

Jökulhlaup: A sudden flood-like release of water from a glacier (glacier outburst flooding).

Jurisdiction: The authority to apply the law; the territory under a given authority or control.

Katabatic wind: Any wind blowing down an incline; the opposite to anabatic wind.

Lahar: Lahar is an Indonesian word for a rapidly flowing mixture of rock debris and water that originates on the slopes of a volcano. Lahars are also referred to as volcanic mudflows or debris flows. They form in a variety of ways, chiefly by the rapid melting of snow and ice by pyroclastic flows, intense rainfall on loose volcanic rock deposits, breakout of a lake dammed by volcanic deposits, and as a consequence of debris avalanches.

Landslide: Downward movement of a slope and materials under the force of gravity.

Lava dome: Lava domes are rounded, steep-sided mounds built by very viscous magma. Such magmas are typically too viscous (resistant to flow) to move far from the vent before cooling and crystallizing. Domes may consist of one or more individual lava flows.

LiDAR: Light Detection and Ranging technology which uses pulsed light from lasers or other sources to accurately measure distances. It is used to create maps and 3-D imagery.

Local Government: Any Borough, municipality, city, township, public authority, school district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency, or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity, for which an application for assistance is made by a State or political subdivision of a state.

Magma: Molten rock originating from the Earth's interior.

Municipality: A political subdivision incorporated under the laws of the state that is a home rule or general law city, a home rule or general law borough, or a unified municipality.

Natural Disaster: Any natural catastrophe, including any hurricane, tornado, storm, high water, wind, driven water, tsunami, earthquake, volcanic eruption, landslide, snowstorm, fire, or drought. (44 CFR Subpart M206.401)

Orthophoto: An aerial photo that has been corrected to eliminate the effects of camera tilt and relief displacement. The ground geometry is recreated as it would appear from directly above each and every point.

Overlay Zone: Overlay zones (overlay districts) create a framework for conservation or development of special geographical areas. In a special resource overlay district, overlay provisions typically impose greater restrictions on the development of land, but only regarding those parcels whose development, as permitted under the zoning, may threaten the viability of the natural resource. In a development area overlay district, the provisions may impose restrictions as well, but also may provide zoning incentives and waivers to encourage certain types and styles of development. Overlay zone provisions are often complemented by the adoption of other innovative zoning techniques, such as floating zones, special permits, incentive zoning, cluster development and special site plan or subdivision regulations, to name a few.

Period: A length of time. For waves, it is the length of time between two successive peaks or troughs, which may vary due to interference of waves. Tsunami periods generally range from 5 to 60 minutes.

Planning: The act or process of making or carrying out plans; the establishment of goals, policies and procedures for a social or economic unit.

Preparedness: The steps taken to decide what to do if essential services break down, developing a plan for contingencies, and practicing the plan. Preparedness ensures that people are ready for a disaster and will respond to it effectively.

Presidential Disaster Declaration: The formal action by the President of the United States to make a state eligible for major disaster or emergency assistance under the Robert T. Stafford Relief and Emergency Assistance Act, Public Law 93- 288, as amended.

Pyroclastic: Pertaining to fragmented rock material formed by a volcanic explosion or ejection from a volcanic vent.

Pyroclastic Flow: Lateral flow of a turbulent mixture of hot gases and unsorted pyroclastic material (volcanic fragments, ash, etc.) that can move at high speeds.

Recovery: The long-term activities beyond the initial crisis period and emergency response phase of disaster operations that focus on returning all systems in the community to a normal status or to reconstitute these systems to a new, less vulnerable condition.

Response: Those activities and programs designed to address the immediate and short-term effects of the onset of an emergency or disaster.

Retrofit: The strengthening of existing structures to mitigate disaster risks.

Rift Zone: A rift zone is an elongate system of crustal fractures associated with an area that has undergone extension (the ground has spread apart).

Risk: The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a particular threshold due to a specific type of hazard event. It can also be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Riverine: Relating to, formed by, or resembling rivers (including tributaries), streams, creeks, brooks, etc.

Riverine Flooding: Flooding related to or caused by a river, stream, or tributary overflowing its banks due to excessive rainfall, snowmelt or ice.

Run-up: The maximum vertical height of a tsunami in relation to sea level.

Seiche: An oscillating wave (also referred to as a seismic sea wave) in a partially or fully enclosed body of water. May be initiated by long period seismic waves, wind and water waves, or a tsunami.

Stafford Act: 1) The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended. 2) The Stafford Act provides an orderly and continuing means of assistance by the Federal Government to State, local and tribal governments in carrying out their responsibilities to alleviate the suffering and damage which result from disaster.

State Disaster Declaration: A disaster emergency shall be declared by executive order or proclamation of the Governor upon finding that a disaster has occurred or that the occurrence or the threat of a disaster is imminent. The state of disaster emergency shall continue until the governor finds that the threat or danger has passed or that the disaster has been dealt with to the extent that emergency conditions no longer exist and terminates the state of disaster emergency by executive order or proclamation. Along with other provisions, this declaration allows the governor to utilize all available resources of the State as reasonably necessary, direct and compel the evacuation of all or part of the population from any stricken or threatened area if necessary, prescribe routes, modes of transportation and destinations in connection with evacuation and control ingress and egress to and from disaster area. It is required before a Presidential Disaster Declaration can be requested.

State Hazard Mitigation Officer (SHMO): The SHMO is the representative of state government who is the primary point of contact with FEMA, other state and Federal

agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.

Storm Surge: Rise in the water surface above normal water level on open coast due to the action of wind stress and atmospheric pressure on the water surface.

Tectonic Plate: Torsionally rigid, thin segments of the earth's lithosphere that may be assumed to move horizontally and adjoin other plates. It is the friction between plate boundaries that causes seismic activity.

Tephra: Tephra is a general term for fragments of volcanic rock and lava regardless of size that are blasted into the air by explosions or carried upward by hot gases in eruption columns or lava fountains. Tephra includes large dense blocks and bombs, and small light rock debris.

Topography: The contour of the land surface. The technique of graphically representing the exact physical features of a place or region on a map.

Tribal Government: A Federally recognized governing body of an Indian or Alaska Native Tribe, band, nation, pueblo, village or community that the Secretary of the Interior acknowledges to exist as an Indian tribe under the Federally Recognized Tribe List Act of 1994, 25 U.S.C. 479a. This does not include Alaska Native corporations, the ownership of which is vested in private individuals.

Tsunami: A sea wave produced by submarine earth movement or volcanic eruption with a sudden rise or fall of a section of the earth's crust under or near the ocean. A seismic disturbance or land slide can displace the water column, creating a rise or fall in the level of the ocean above. This rise or fall in sea level is the initial formation of a tsunami wave.

Volcano Vent: Vents are openings in the Earth's crust from which molten rock and volcanic gases escape onto the ground or into the atmosphere. Vents may consist of a single circular-shaped structure, a large elongated fissure and fracture, or a tiny ground crack.

Vulnerability: Describes how exposed or susceptible to damage an asset it. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. The vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power – if an electrical substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Other, indirect effects can be much more widespread and damaging than direct ones.

Wildfire: An uncontrolled fire that spreads though vegetative fuels, exposing and possibly consuming structures.

Worst Case Scenario: The term "worst case scenario" is somewhat self-explanatory. It includes the potential for a "cascade effect", which was assumed in analyzing the risk from each hazard. The term "cascade effect" is used to describe the triggering of several hazard occurrences from an initial event. An earthquake for instance, might also trigger avalanches, collapsed buildings, transportation and utility disruptions, and hazardous material releases, each of which might trigger additional events, all part of the same incident.

Zoning Ordinance: An ordinance under the state or local government's police powers that divides an area into districts and, within each district, regulates the use of land and buildings, height, and bulk of buildings or other structures, and the density of population.