City of Kivalina
Hazard Mitigation Plan

Prepared by
The City of Kivalina
Hazard Mitigation Planning Team

Updated December 2015

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U.S. Department of Homeland Security
Region X
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FEMA

November 20, 2015

Honorable Austin Swan, Sr.
Mayor, City of Kivalina
P.O. Box 50079
Kivalina, Alaska 99750

Dear Mayor Swan:

The U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) has approved the ***City of Kivalina Hazard Mitigation Plan*** as a local plan as outlined in 44 CFR Part 201. With approval of this plan, the City of Kivalina is now eligible to apply for the Robert T. Stafford Disaster Relief and Emergency Assistance Act's hazard mitigation project grants through November 19, 2020.

The plan's approval provides eligibility to apply for hazard mitigation projects through your state. All requests for funding will be evaluated individually according to the specific eligibility and other requirements of the particular program under which the application is submitted. For example, a specific mitigation activity or project identified in the plan may not meet the eligibility requirements for FEMA funding, and even eligible mitigation activities are not automatically approved for FEMA funding under any of the aforementioned programs. Approved mitigation plans may be eligible for points under the National Flood Insurance Program's Community Rating System (CRS). Additional information regarding the CRS can be found at www.fema.gov/national-flood-insurance-program-community-rating-system or through your local floodplain manager.

Over the next five years, we encourage your community to follow the plan's schedule for monitoring and updating the plan, and develop further mitigation actions. The plan must be reviewed, revised as appropriate, and resubmitted for approval within five years in order to continue project grant eligibility.

If you have questions regarding your plan's approval or FEMA's mitigation grant programs, please contact Scott Nelson, Emergency Management Specialist with Alaska Division of Homeland Security and Emergency Management, at (907) 428-7010, who coordinates and administers these efforts for local entities.

Sincerely,

Mark Carey, Director
Mitigation Division

cc: Ann Gravier, Alaska Division of Homeland Security and Emergency Management

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City of Kivalina
Hazard Mitigation Plan Update

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McQueen Elementary and High School Students
Gerald Picker, Principal

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Acronyms/Abbreviations

°F	Degrees Fahrenheit
ACCIMP	Alaska Climate Change Impact Mitigation Program
ACIA	Alaska Climate Impact Assessment
ACWF	Alaska Clean Water Fund
ADWF	Alaska Drinking Water Fund
AEA	Alaska Energy Authority
AECOM	AECOM, Consultant, or Contractor
AEEE	Alternative Energy and Energy Efficiency
AFG	Assistance to Firefighters Grant
AICC	Alaska Interagency Coordination Center
AK	Alaska
AKST	Alaska Standard Time
ANA	Administration for Native Americans
ARC	American Red Cross
ARW	Airport Runway
ASOS	Automated Surface Observing System
AVEC	Alaska Village Electric Cooperative
BIA	Bureau of Indian Affairs
CBO	Communications Building-Other
CCP	Citizen Corps Program
CDBG	Community Development Block Grant
CEHHWG	Climate, Ecosystems & Human Health Work Group
CFR	Code of Federal Regulations
CFP	Community Forestry Program
CGP	Comprehensive Grant Program
CIG	Conservation Innovation Grant
City	City of Kivalina
CO-OP	Cooperative
Corp	Corporation
CP	City of Kivalina's Draft Comprehensive Plan
CWSRF	Clean Water State Revolving Fund
DCCED	Department of Commerce, Community, and Economic Development
DCRA	Division of Community and Regional Affairs
DEC	Department of Environmental Conservation
Denali	Denali Commission
DHS	Department of Homeland Security
DHS&EM	Division of Homeland Security and Emergency Management
DHSS	Department of Health and Social Services
DGGS	Division of Geological and Geophysical Survey
DMA 2000	Disaster Mitigation Act of 2000
DMVA	Department of Military and Veterans Affairs
DNR	Department of Natural Resources

Acronyms/Abbreviations

DOE	Department of Energy
DOF	Division of Forestry
DOI	Division of Insurance
DOL	Department of Labor
DOT/PF	Department of Transportation and Public Facilities
DSS	Division of Senior Services
EOC	Emergency Operations Center
EMPG	Emergency Management Performance Grant
EPA	Environmental Protection Agency
EPPS	Energy Production Plant-Small
EQ	Earthquake
EQIP	Environmental Quality Incentives Program
ER	Erosion
EWP	Emergency Watershed Protection Program
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FL	Flood
FMA	Flood Mitigation Assistance
FP&S	Fire Prevention And Safety
ft	Feet
FY	Fiscal Year
g	Gravity
GF	Ground Failure
GIS	Geospatial Information System
GPM	Gallons Per Minute
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HSGP	Homeland Security Grant Program
HP	Horse Power
HUD	Housing and Urban Development
IBHS	Institute for Business and Home Safety
IHBG	Indian Housing Block Grant
IHLGP	Indian Home Loan Guarantee Program
INAP	Indian and Native American Programs
IRS	Internal Revenue Service
Kts	Knots
M	Magnitude
MAP	Mitigation Action Plan
MMI	Modified Mercalli Intensity
mph	Miles Per Hour
NAHASDA	Native American Housing Assistance and Self Determination Act
NFIP	National Flood Insurance Program

Acronyms/Abbreviations

NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NRF	National Response Framework
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
PDM	Pre-Disaster Mitigation
PGA	Peak Ground Acceleration
PNP	Private Non-Profits
PWTS	Potable Water Treatment (Plant) System
RCASP	Remote Community Alert Systems
RD	Rural Development
RL	Repetitive Loss
RurALCAP	Rural Alaska Community Action Program Incorporated
RWST	Raw Water Storage Tank
SAFER	Staffing for Adequate Fire and Emergency Response
SBA	U.S. Small Business Administration
SHMP	Alaska State Hazard Mitigation Plan
SHSP	State Homeland Security Program
SOA	State of Alaska
Sq.	Square
Stafford Act	Robert T. Stafford Disaster Relief and Emergency Assistance Act
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, and Environmental
TWST	Treated Water Storage Tank
US or U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VFA-RFA	Volunteer Fire Assistance and Rural Fire Assistance Grant
VSW	Village Safe Water
WARN	Warning, Alert, and Response Network
WTP	Water Treatment Plant

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

1.1 OVERVIEW

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

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

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

This HMP complies with Title 44 CFR current as of January 1, 2014 and applicable guidance documents.

1.2 GRANT PROGRAMS WITH MITIGATION PLAN REQUIREMENTS

FEMA HMA grant programs provide funding to States, Tribes, and local entities that have a FEMA-approved State, Tribal, or Local Mitigation Plan. Two of the grants are authorized under the Stafford Act and DMA 2000, while the remaining three are authorized under the National Flood Insurance Act and the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act. Excerpts from FEMA's 2015 HMA Guidance, Part I is as follows:

> *"The U.S. Department of Homeland Security (DHS) FEMA HMA programs present a critical opportunity to reduce the risk to individuals and property from natural hazards, while simultaneously reducing reliance on Federal disaster funds. On March 30, 2011, the President signed Presidential Policy Directive 8 (PPD-8): National Preparedness, and the National Mitigation Framework was finalized in May 2013. The National Mitigation Framework comprises seven core capabilities, including:*
>
> - *Threats and Hazard Identification*
> - *Risk and Disaster Resilience Assessment*
> - *Planning*

- *Community Resilience*
- *Public Information and Warning*
- *Long-Term Vulnerability Reduction*
- *Operational Coordination*

HMA programs provide funding for eligible activities that are consistent with the National Mitigation Framework's Long-Term Vulnerability Reduction capability. HMA programs reduce community vulnerability to disasters and their effects, promote individual and community safety and resilience, and promote community vitality after an incident. Furthermore, HMA programs reduce response and recovery resource requirements in the wake of a disaster or incident, which results in a safer community that is less reliant on external financial assistance.

Hazard mitigation is defined as any sustained action taken to reduce or eliminate long-term risk to people and property from natural hazards and their effects. This definition distinguishes actions that have a long-term impact from those that are more closely associated with immediate preparedness, response, and recovery activities. Hazard mitigation is the only phase of emergency management specifically dedicated to breaking the cycle of damage, reconstruction, and repeated damage. Accordingly, States, territories, federally-recognized tribes, and local communities are encouraged to take advantage of funding that HMA programs provide in both the pre- and post-disaster timelines.

In addition to hazard mitigation, FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) Program provides communities with education, risk communication, and outreach to better protect its citizens. The Risk MAP project lifecycle places a strong emphasis on community engagement and partnerships to ensure a whole community approach that reduces flood risk and builds more resilient communities. Risk MAP risk assessment information strengthens a local community's ability to make better and more informed decisions. Risk MAP allows communities to better invest and determine priorities for projects funded under HMA. These investments support mitigation efforts under HMA that protect life and property and build more resilient communities.

The whole community includes children, individuals with disabilities, and others with access and functional needs; those from religious, racial, and ethnically diverse backgrounds; and people with limited English proficiency. Their contributions must be integrated into mitigation/resilience efforts, and their needs must be incorporated as the whole community plans and executes its core capabilities.

WHOLE COMMUNITY

A. HMA Commitment to Resilience and Climate Change Adaptation

FEMA is committed to promoting resilience as expressed in PPD-8: National Preparedness; the President's State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience; the Administrator's 2011 FEMA Climate Change Adaptation Policy Statement (Administrator Policy 2011-OPPA-01); and the 2014–2018 FEMA Strategic Plan. Resilience refers to the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies. The concept of resilience is closely related to the concept of hazard mitigation, which reduces or eliminates potential losses by breaking the cycle of damage, reconstruction, and repeated damage. Mitigation capabilities include, but are not limited to, community-wide risk

reduction projects, efforts to improve the resilience of critical infrastructure and key resource lifelines, risk reduction for specific vulnerabilities from natural hazards and climate change, and initiatives to reduce future risks after a disaster has occurred.

FEMA is supporting efforts to streamline the HMA programs so that these programs can better respond to the needs of communities nationwide that are addressing the impacts of climate change. FEMA, through its HMA programs:

- *Develops and encourages adoption of resilience standards in the siting and design of buildings and infrastructure*
- *Modernizes and elevates the importance of hazard mitigation*

FEMA has issued several policies that facilitate the mitigation of adverse effects from climate change on the built environment, structures and infrastructure. Consistent with the 2014–2018

FEMA Strategic Plan, steps are being taken by communities through engagement of individuals, households, local leaders, representatives of local organizations, and private sector employers and through existing community networks to protect themselves and the environment by updating building codes, encouraging the conservation of natural and beneficial functions of the floodplain, investing in more resilient infrastructure, and engaging in mitigation planning. FEMA plays an important role in supporting community-based resilience efforts, establishing policies, and providing guidance to promote mitigation options that protect critical infrastructure and public resources.

FEMA encourages better integration of Sections 404 and 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended (Stafford Act), Title 42 of the United States Code (U.S.C.) 5121 et seq., to promote more resilience during the recovery and mitigation process. FEMA regulations that implement Sections 404 and 406 of the Stafford Act allow funding to incorporate mitigation measures during recovery activities. Program guidance and practice limits Section 406 mitigation to the damaged elements of a structure. This limitation to Section 406 mitigation may not allow for a comprehensive mitigation solution for the damaged facility; however, Section 404 funds may be used to mitigate the undamaged portions of a facility.

Recognizing that the risk of disaster is increasing as a result of multiple factors, including the growth of population in and near high-risk areas, aging infrastructure, and climate change, FEMA promotes climate change adaptation by:

- *Incorporating sea level rise in the calculation of Benefit-Cost Analysis (BCA)*
- *Publishing a new HMA Job Aid on pre-calculated benefits for hurricane wind retrofit measures, see HMA Job Aid (Cost Effectiveness Determination for Residential Hurricane Wind Retrofit Measures Funded by FEMA)*
- *Encouraging floodplain and wetland conservation associated with the acquisition of properties in green open space and riparian areas*
- *Reducing wildfire risks*
- *Preparing for evolving flood risk*
- *Encouraging mitigation planning and developing mitigation strategies that encourage community resilience and smart growth*

- *Encouraging the use of building codes and standards (the American Society of Civil Engineers/Structural Engineering Institute [ASCE/SEI] 24-14, Flood Resistant Design and Construction) wherever possible.*

For additional information, see http://www.fema.gov/climate-change" (FEMA 2015).

1.2.1 Hazard Mitigation Assistance (HMA) Grant Programs

HMA grant program activities include:

Table 1-1 HMA Eligible Activities

Activities	HMGP	PDM	FMA
1. Mitigation Projects	✓	✓	✓
Property Acquisition and Structure Demolition	✓	✓	✓
Property Acquisition and Structure Relocation	✓	✓	✓
Structure Elevation	✓	✓	✓
Mitigation Reconstruction	✓	✓	✓
Dry Floodproofing of Historic Residential Structures	✓	✓	✓
Dry Floodproofing of Non-residential Structures	✓	✓	✓
Generators	✓	✓	
Localized Flood Risk Reduction Projects	✓	✓	✓
Non-localized Flood Risk Reduction Projects	✓	✓	
Structural Retrofitting of Existing Buildings	✓	✓	✓
Non-structural Retrofitting of Existing Buildings and Facilities	✓	✓	✓
Safe Room Construction	✓	✓	
Wind Retrofit for One- and Two-Family Residences	✓	✓	
Infrastructure Retrofit	✓	✓	✓
Soil Stabilization	✓	✓	✓
Wildfire Mitigation	✓	✓	
Post-Disaster Code Enforcement	✓		
Advance Assistance	✓		
5 Percent Initiative Projects	✓		
Miscellaneous/Other[(1)]	✓	✓	✓
2. Hazard Mitigation Planning	✓	✓	✓
Planning Related Activities	✓		
3. Technical Assistance			✓
4. Management Cost	✓	✓	✓

[(1)] Miscellaneous/Other indicates that any proposed action will be evaluated on its own merit against program requirements. Eligible projects will be approved provided funding is available.

(FEMA 2015)

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 Flood Mitigation Assistance (FMA) programs although competitive, rely on specific pre-disaster

grant funding sources, sharing several common elements. The 2015 HMA Guidance Provides the following programmatic information:

HMGP is authorized by Section 404 of the Stafford Act, 42 U.S.C. 5170c. The key purpose of HMGP is to ensure that the opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is not lost during the reconstruction process following a disaster.

HMGP funding is available, when authorized under a Presidential major disaster declaration, in the areas of the State requested by the Governor. Federally-recognized tribes may also submit a request for a Presidential major disaster declaration within their impacted areas (see http://www.fema.gov/media-library/assets/documents/85146). The amount of HMGP funding available to the Applicant is based on the estimated total Federal assistance, subject to the sliding scale formula outlined in Title 44 of the Code of Federal Regulations (CFR) Section 206.432(b) that FEMA provides for disaster recovery under Presidential major disaster declarations. The formula provides for up to 15 percent of the first $2 billion of estimated aggregate amounts of disaster assistance, up to 10 percent for amounts between $2 billion and $10 billion, and up to 7.5 percent for amounts between $10 billion and $35.333 billion. For States with enhanced plans, the eligible assistance is up to 20 percent for estimated aggregate amounts of disaster assistance not to exceed $35.333 billion.

The Period of Performance (POP) for HMGP begins with the opening of the application period and ends no later than 36 months from the close of the application period.

PDM is designed to assist States, territories, federally-recognized tribes, and local communities to implement a sustained pre-disaster natural hazard mitigation program to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding in future disasters. Congressional appropriations provide the funding for PDM.

The total amount of funds distributed for PDM is determined once the appropriation is provided for a given fiscal year. It can be used for mitigation projects and planning activities.

The POP for PDM begins with the opening of the application period and ends no later than 36 months from the date of subapplication selection.

FMA is authorized by Section 1366 of the National Flood Insurance Act of 1968, as amended (NFIA), 42 U.S.C. 4104c, with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FMA was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994. The Biggert-Waters Flood Insurance Reform Act of 2012 (Public Law 112-141) consolidated the Repetitive Flood Claims and Severe Repetitive Loss grant programs into FMA. FMA funding is available through the National Flood Insurance Fund (NFIF) for flood hazard mitigation projects as well as plan development and is appropriated by Congress. States, territories, and federally-recognized tribes are eligible to apply for FMA funds. Local governments are considered subapplicants and must apply to their Applicant State, territory, or federally-recognized tribe.

The City of Kivalina does not directly participate in the NFIP. However, they are included as a Northwest Arctic Borough program included participant. They are therefore eligible for National Flood Insurance Act Grant Programs various program components.

The POP for FMA begins with the opening of the application period and ends no later than 36 months from the date of subapplication selection" (FEMA 2015

As the State Hazard Mitigation plan states:

"The [FMA] provides pre-disaster grants to State and Local Governments for planning and flood mitigation projects. Created by the National Flood Insurance Reform Act of 1994, its goal is to reduce or eliminate NFIP claims. It is an annual nationally competitive program. Residential and non-residential properties may apply for FMA grants through their NFIP community and are required to have NFIP insurance to be eligible. FMA grant funds may be used to develop the flood portions of hazard mitigation plans or to do flood mitigation projects. FMA grants are funded 75% Federal and 25% applicant.

The Biggert-Waters Flood Insurance Reform Act of 2012 eliminated the Repetitive Flood Claims (RFC) and Severe Repetitive Loss (SRL) grant programs. Elements of these flood programs have been incorporated into FMA. The FMA program now allows for additional cost share flexibility:

- *Up to 100-percent Federal cost share for severe repetitive loss properties.*
- *Up to 90-percent Federal cost share for repetitive loss properties.*
- *Up to 75-percent Federal cost share for NFIP insured properties.*

The FMA program is available only to communities participating in the NFIP. In the State of Alaska, the Department of Commerce, Community, and Economic Development (DCCED) manages this program" (SHMP 2013).

HMP Layout Description

The HMP consists of the following sections and appendices:

Section 1 Introduction

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

Section 2 Community Description

Provides a general history and background of the City of Kivalina (City), including historical trends for population and the demographic and economic conditions that have shaped the area.

Section 3 Planning Process

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

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

Section 4 Jurisdictional Adoption

Describes the community's HMP adoption process (support documents are located in Appendix C)

Section 5 Hazard Analysis

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

Section 6 Vulnerability Assessment

Identifies the City's potentially vulnerable assets—people, residential and nonresidential buildings (where available), critical facilities, and critical infrastructure. The resulting information identifies the full range of hazards that the City could face and potential social impacts, damages, and economic losses. Land use and development trends are also discussed.

Section 7 Mitigation Strategy

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

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

Section 8 References

Lists reference materials and resources used to prepare this HMP.

Appendices

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

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

Appendix C: Provides the adoption resolution for the City.

Appendix D: Provides public outreach information, including newsletters.

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

Appendix F: Provides the plan maintenance documents, such as an annual review sheet and the progress report form.

Appendix G: Provides the 2006 USACE's Potential Kivalina Relocation Site Assessment report provides relocation sites' strengths and challenges.

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Section Two provides the City and Native Village of Kivalina's location, geography, history, and demographic information.

2.1 LOCATION, GEOGRAPHY, AND HISTORY

Kivalina is located at the tip of an 8-mile barrier reef between the Chukchi Sea and Kivalina River. It lies 80 air miles northwest of Kotzebue. The community lies at approximately 67.726940° North Latitude and -164.53333° West Longitude. (Sec. 21, T027N, R026W, Kateel River Meridian.)

Figure 2-1 Kivalina's Location Map

Kivalina is located in the Kotzebue Recording District. The area encompasses 1.9 square miles of land and 2.0 square miles of water.

Kivalina is a second-class city organized under Alaska Statute 29, and maintains a 2% sales tax. A second-class city is incorporated under the rules and laws of Alaska and defined as having 400 or fewer permanent residents. Kivalina has two separate local governments: the Native Village of Kivalina (NVA), a federally recognized tribe; and the City of Kivalina, established under the state of Alaska. There is a seven-member city council, out of which a mayor and a city administrator are elected.

Kivalina is within the Northwest Arctic Borough, a Home Rule Borough, formed in 1986. The Northwest Arctic Borough is 83% Alaska Native. The Borough provides programs and services to encourage development, coordination within and outside the region, and to improve employment and education. Kotzebue is the seat of the Borough government (NWAB, 2001).

The Borough is also responsible for the Northwest Arctic School District, which provides education in Kivalina and other communities within the Borough.

There are three Alaska Native organizations in Kivalina; the Native Village of Kivalina (NVA), the NANA Corporation, Inc. (NANA), and the Maniilaq Association. The Native Village of Kivalina is a federally recognized tribe, which has several active, federally funded programs.

NVA has an elected tribal council and has two members on the Kivalina Relocation Planning Committee (KRPC). The community established the KRPC to help with plans to relocate the community. It is comprised of two City Council members, two members of the NVA and two members at large.

Kivalina is located within the NANA Corporation Region. The NANA Corporation, Inc. is a for-profit corporation established by the 1971 Alaska Native Claims Settlement Act (ANSCA) (DCCED, 2004). NANA is a regional corporation acting on social and cultural needs of the Inupiat people of Northwest, Alaska (NANA, 2004). NANA businesses include management services, oil industry support, mining support and hospitality. There are approximately 10,000 shareholders and 3,085,532 acres of ANCSA land conveyed. Total revenues in 2000 were $176.2 million (DCCED, 2004). NANA Corporation also merged with all of the ANCSA village

corporations in the NANA region except Kotzebue. Therefore, NANA owns surface and subsurface lands in the Kivalina area, and is responsible for conveying ANCSA 14(c) 3 lands to the city of Kivalina. NANA will be a major stakeholder in the potential sites for community relocation.

The third native organization, the Maniilaq Association, is a non-profit regional corporation representing twelve federally recognized tribes located in Northwest Alaska. The Maniilaq Association is a social, tribal and health service provider, servicing about 6,500 people and employing a 500-person workforce, and is the region's largest employer (Maniilaq, 2003). Maniilaq manages a hospital in Kotzebue as well as health clinics in all the villages.

The City of Kivalina, located on a barrier island off the Chukchi Sea 80 miles north of the Arctic Circle, has been threatened by erosion caused by wave action and sea storms for several decades. It has long been apparent that the island would eventually succumb to natural forces and that the village would have to be moved. Extensive studies have been undertaken, alternative village sites have been identified, and cost estimates have been prepared.

An increase in the frequency and intensity of sea storms, degradation and melting of permafrost, and accelerated erosion of the shoreline have recently forced the village into a state of emergency. Sea storms have eroded the shoreline out from underneath several structures and threaten the airstrip. Emergency erosion control measures must be constantly repaired and improved.

The scope of work for the Kivalina LHMP pertains to the current state of the community and efforts that may be undertaken to mitigate damage from natural hazards while the community, and the state and federal governments proceed with the relocation effort. USACE Relocation Reports, the most recent dated December 2005, have identified six alternative village sites and costs have been estimated for each of the sites. Appendix G contains the 2006 USACE's Potential Kivalina Relocation Site Assessment which defines the six most viable alternatives. The purpose of this HMP Update is to identify the community's hazards, provide a mitigation strategy to prevent known hazard's damage potential, and define mitigative projects for their current location.

2.2 DEMOGRAPHICS

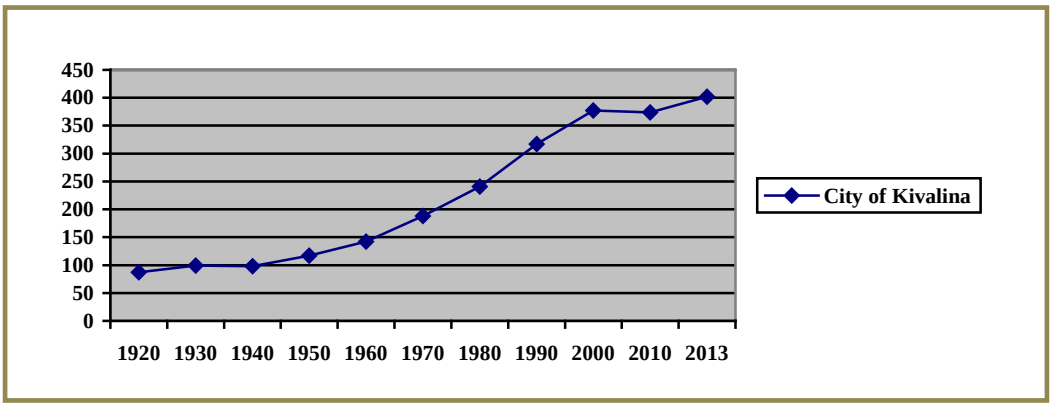

Figure 2-2 Kivalina's Historic Population

The 2010 census recorded 374 residents, of which the median age was 25 indicating a relatively young/old population. Kivalina's population is expected to remain fairly steady because over half of the population is less than 19 years of age. The City population has an Inupiaq heritage. The male and female composition is approximately 47.5 and 52.5 % respectively. The 2010 census revealed that there are 99 households with the average household having approximately five individuals per household. The most recent 2013 DCCED certified population is 402. Figure 2-2 illustrates the City's historic population.

2.3 ECONOMY

The City's economy is primarily based on subsistence, with various employment opportunities that include the following categories. Figure 2-3 depicts the US Census' pie chart depicting Kivalina's 2013 resident worker estimates by industry.

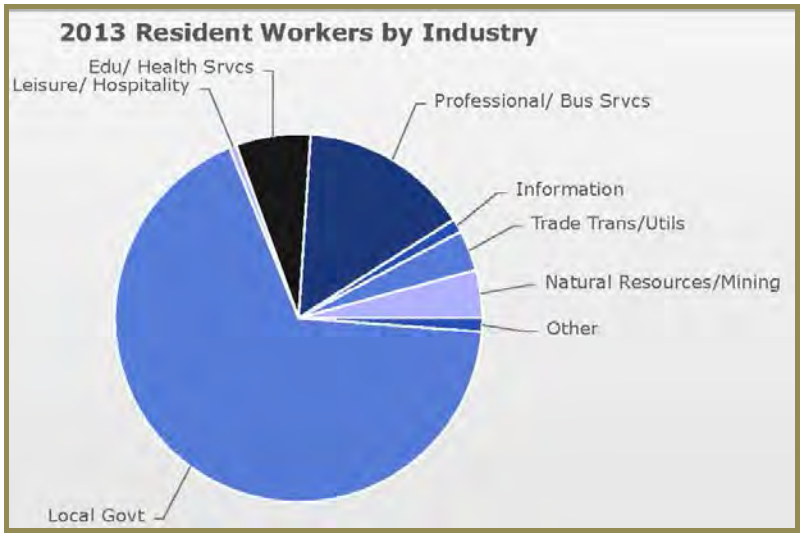

Figure 2-3 Kivalina's Worker by Industry (US Census 2015)

The following tables 2-1 and 2-2 lists the City's worker employment statistics and experience classifications as defined by each table's title.

Table 2-1 2013 Workers by Industry

Job Classification	Number of Workers	Percent of Total employed	Female	Male	Age 45 and over	Age 50 and over
Natural Resources and Mining	7	4.2	3	4	3	2
Trade, Transportation and Utilities	6	3.6	4	2	3	3
Information	2	1.2	1	1	0	0
Professional and Business Services	25	15.0	15	10	7	3
Educational and Health Services	11	6.6	8	3	4	2
Leisure and Hospitality	1	0.6	0	1	0	0
Local Government	113	67.7	58	55	35	24
Other	2	1.2	2	0	0	0

(US Census 2015)

Table 2-2 Workers Experience by Industry, 2009–2013

Job Classification	No.	Job Classification	No.
Accommodation and food services	1	Management of companies and enterprises	8
Administration and support and waste management	58	Manufacturing	2
Agriculture, forestry, fishing and hunting	0	Mining	20
Arts, entertainment and recreation	3	Professional, scientific and technical services	9
Construction	21	Real estate and rental and leasing	1
Educational services	2	State government	11
Finance and insurance	0	Trade	10
Health care and social assistance	42	Transportation and warehousing	4
Information	11	Utilities	1

(US Census 2015)

According to the 2010 census, the median household income in Kivalina was $59,167 with a per capita income of $14,185. Approximately 27.7% were reported to be living below the poverty level. The potential work force (those aged 16 years or older) in the City was estimated to be 294, of which 182 were actively employed. In 2010 the unemployment rate was 20.7%; however, this rate included part-time and seasonal jobs, and practical unemployment or underemployment is likely to be significantly higher.

Figure 2-4 depicts an aerial photograph of the City that identifies a few threatened structures and their relative distance from embankment's edge.

Figure 2-4 Aerial Photograph of the Kivalina (DCRA 2005)

Figure 2-5 further portrays the community's newest USACE rip-rap revetment project. It has proven very effective with minimizing sea storm surge impacts on the Chukchi Sea side.

Figure 2-5 Spacial Contextual View (Relocate 2012)

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

DMA 2000 and its implementing regulations for the planning process:

DMA 2000 Requirements
Local Planning Process §201.6(b): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: Element §201.6(b)(1): An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval; §201.6(b)(2): An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and nonprofit interests to be involved in the planning process; and §201.6(b)(3): Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information. §201.6(c)(1): [The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved. §201.6(c)(4)(i): The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle. §201.6(c)(4)(iii): The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.
1. REGULATION CHECKLIST
ELEMENT A. Planning Process
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1)) A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2)) A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1)) A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3)) A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii)) A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle?) (Requirement §201.6(c)(4)(i))
Does the updated plan document how the planning team reviewed and analyzed each section of the plan and whether each section was revised as part of the update process? (Not applicable until 2013 update).
Source: FEMA, March 2015

3.1 OVERVIEW

The State of Alaska, Division of Homeland Security and Emergency Management (DHS&EM) provided funding and project oversight to AECOM to facilitate and guide Planning Team development and HMP development.

The scope of the Kivalina Local Hazards Mitigation Plan (LHMP) is natural hazards: flooding, erosion, severe weather, and earthquake hazards. However, some of the mitigation projects for the natural hazards would also mitigate impacts from other hazards.

The Kivalina HMP Update continues to focus on the community's efforts to mitigate damage from natural hazards while the community, and the State and Federal governments, proceed with the relocation effort. USACE's most recent Kivalina Relocation Report, dated December 2005, identified six alternative village sites with estimated relocation infrastructure needs and associated costs for each of those sites. Appendix G discusses the six alternatives.

The planning process began on December 11, 2013 with a teleconference with City Administrator Janet Mitchell to explain how their community was selected by the Division of Homeland Security and Emergency Management for a 2014 Pre-Disaster Mitigation Grant award. AECOM staff described the HMP development requirement to enable the City to qualify for Hazard Mitigation Grant Program grants and the overall HMP development process.

Ms. Mitchel was encouraged to develop a community Planning Team to assist the community's efforts to identify available resources and capabilities for HMP development. AECOM explained how the HMP differed from current emergency plans. The Planning Team will assist the City by acting as an advocate for the planning process, assist with gathering information, and provide support during public participation opportunities. AECOM briefly discussed existing hazards that affect the community such as erosion, sediment deposition, and permafrost impacts, which are increasing in intensity due to climate changes.

The Planning Team identified applicable City resources and capabilities during the meeting. AECOM explained how the HMP differed from current emergency plans. The Planning Team then discussed the City's rolls such as: acting as an advocate for the planning process, assisting with gathering information, and supporting public participation opportunities. There was also a brief discussion about hazards that affect the community such as erosion, sediment deposition, and permafrost impacts, which are increasing in intensity.

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

In summary, the following five-step process took place from December 2014 through August 2015.

1. Organize resources: Members of the Planning Team identified resources, including staff, agencies, and local community members, who could provide technical expertise and historical information needed in the development of the hazard mitigation plan.
2. Monitor, evaluate, and update the plan: The Planning Team developed a process to ensure the plan was monitored to ensure it was used as intended while fulfilling community needs. The team then developed a process to evaluate the plan to compare how their decisions affected hazard impacts. They then outlined a method to share their successes with community members to encourage support for mitigation activities and to provide data for incorporating mitigation actions into existing planning mechanisms and to provide data for the plans five year update.

3. Assess risks: The Planning Team identified the hazards specific to Kivalina and with the assistance of a hazard mitigation planning consultant (AECOM), who developed the risk assessment for six identified hazards (Section 5). The Planning Team reviewed the risk assessment, including the vulnerability analysis, prior to and during the development of the mitigation strategy.
4. Assess capabilities: The Planning Team reviewed current administrative and technical, legal and regulatory, and fiscal capabilities to determine whether existing provisions and requirements adequately address relevant hazards.
5. Develop a mitigation strategy: After reviewing the risks posed by each hazard, the Planning Team developed a comprehensive range of potential mitigation goals and actions. Subsequently, the Planning Team identified and prioritized the actions for implementation.

3.2 PLANNING TEAM

The local Planning Team members are Janet Mitchell (Planning Team Leader), with Mayor Austin Swan; and the City Council**.**

Several HMP changes have occurred since the original 2007 HMP received FEMA approval and subsequent City and Tribal implementation. The following table reflects the 2015 HMP Update's current Planning Team's membership and their respective involvement or responsibilities.

Table 3-1 identifies the complete hazard mitigation Planning Team.

3-1 Hazard Mitigation Planning Team

Name	Title	Organization	Key Input
Janet Mitchell	City Administrator	City of Kivalina	Community Plan Contact, HMP review.
The Kivalina Planning Team encompasses the entire City Council:			
Austin Swan	Mayor	City of Kivalina, City Council Chairman	Planning Team Member, data input and HMP review.
Lucy Adams	Vice Mayor	City of Kivalina, City Council Member	Planning Team Member, data input and HMP review.
Alice Adams,	Secretary/ Treasurer	City of Kivalina, City Council Member	Planning Team Member, data input and HMP review.
Colleen Swan, Relocation Project Manager	Member	City Council Member	Planning Team Member, data input and HMP review.
Leroy T. Adams Sr.	Member	City Council Member	Planning Team Member, data input and HMP review.
Ida N. Swan	Member	City Council Member	Planning Team Member, data input and HMP review.
Rhonda Norton	Member	City Council Member	Planning Team Member, data input and HMP review.
Scott G Nelsen	Hazard Mitigation Plan Project Manager	Alaska DHS&EM	State project management, HMP review
Scott Simmons	Senior Emergency Management Planner	AECOM, Alaska	Responsible for HMP development, lead writer, project coordination.

3.3 PUBLIC & AGENCY INVOLVEMENT

AECOM extended an invitation to all individuals and entities identified on the project mailing list describing the planning process and announced the upcoming communities' planning activities. The announcement was emailed to relevant academia, nonprofits, and local, state, and federal agencies on August 6, 2013. The following agencies were invited to participate and review the HMP:

- University of Alaska Fairbanks, Geophysical Institute, Alaska Earthquake Information Center (UAF/GI/AEIC)
- Alaska Native Tribal Health Consortium-Community Development (ANTHC)
- Alaska Volcano Observatory (AVO)
- Association of Village Council Presidents (AVCP)
- Denali Commission
- Alaska Department of Environmental Conservation (DEC)
- DEC Division of Spill Prevention and Response (DSPR)
- DEC Village Safe Water (VSW)
- Alaska Department of Transportation and Public Facilities (DOT/PF)
- Alaska Department of Community, Commerce, and Economic Development (DCCED)
- DCCED, Division of Community Advocacy (DCRA)
- Alaska Department of Military and Veterans Affairs (DMVA)
- DMVA, Division of Homeland Security and Emergency Management (DHS&EM)
- US Environmental Protection Agency (EPA)
- National Weather Service (NWS) Northern Region
- NWS Southeast Region
- NWS Southcentral Region
- Natural Resources Conservation Service (NRCS)
- US Department of Agriculture (USDA)
- USDA Division of Rural Development (RD)
- US Army Corps Of Engineers (USACE)
- US Bureau of Indian Affairs (BIA)
- US Bureau of Land Management (BLM)
- US Department of Housing and Urban Development (HUD)
- US Fish & Wildlife Service (USFWS)

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

Table 3-2 Public Involvement Mechanisms

Mechanism	Description
Agency Involvement eMail (November 20, 2014)	Invited agencies to participate in mitigation planning effort and to review applicable newsletters located on the DHS&EM Local/Tribal All Hazard Mitigation Plan Development website at: http://ready.alaska.gov/plans/localhazmitplans.htm

Table 3-2 Public Involvement Mechanisms

Mechanism	Description
Newsletter #1 Distribution (December 2014)	In December 2014, the jurisdiction distributed a newsletter introducing the upcoming HMP update activity. The newsletter encouraged the whole community to provide hazard and critical facility information. It was posted at the City Office, bulletin boards, and other locations throughout the City to enable the widest possible dissemination.
Planning Team Meetings	City coordinated Planning Team workgroup meeting communication to City Council Members to garner maximum data gathering expertise and participation throughout HMP development duration.
Newsletter #2 Distribution (April, 2015)	In April 15, 2015, the jurisdiction distributed a newsletter describing the HMPs availability and present potential HMP projects for review. The newsletter encouraged the whole community to provide review the HMP and provide comments. It was posted at the City Office, bulletin boards, other locations to encourage communitywide participation

Initial contact was made with Kivalina City Administrator Janet Mitchell, via email on December 2, 2014 and followed with a phone call and project discussion on December 11th. Ms. Mitchell was very enthusiastic that Kivalina was included within DHS&EM's Pre-Disaster Mitigation grant and the prospects of updating their 2007 Hazard Mitigation Plan. She quickly requested we have our first public meeting on December 22, 2014, requesting that we describe the HMP planning update process. Ms. Mitchell provided pertinent information for newsletter inclusion. The newsletter was posted throughout the community (post office, public bulletin boards, etc.) announcing the January 13, 2015 Project Kick-off and Introductory meeting.

The Planning Team identified five natural hazards: earthquake, flood, ground failure, severe weather, and wildland/tundra fire. They decided to include the wildland/tundra fire hazard profile to reflect this threat's impact to the mainland and Kivalina's potential future relocation sites.

AECOM described the specific information needed from the Planning Team to assess critical facility vulnerability and population risk by the location, value, and population within residential properties and critical facilities.

The risk assessment was completed after the community asset data was collected by the Planning Team during 2015, which identified specific hazard impacts to exposed and vulnerable assets. The Planning Team stated:

> *"The entire community could easily be destroyed by any of the identified hazards. A winter storm's winds from telephone pole to topple into a building or a lightning strike could cause a fire which would travel through the community's very quickly because the buildings are so close together.*
>
> *We have needed to move homes tightly together to relocate those that were once next to the water. Those homes became threatened by erosion and needed to be moved to a safer location. There is no space to build much needed new housing because we have lost so much land.*
>
> *A few homes have three families (3 families of 5 = 15 people) in one house. Each family shares a single bedroom. These conditions are unhealthy for our residents; it is too tightly compacted and families continue to be sick because of the unhealthy air.*

Our people worry that a natural hazard event could start in one facility, but quickly spread to adjacent structures – potentially destroying the whole community and losing many lives" (Kivalina 2015).

A Planning Team meeting was held on January 14, 2015 to review, refine, select, and prioritize existing and newly identified mitigation actions based on the results of the risk assessment and the past 2007 HMP's 5-year life cycle. A second newsletter was prepared and delivered during February 2015 describing the process to date, presenting a representative sample of the Updated HMP's prioritized mitigation actions, and announcing the availability of the draft HMP for public review and comment.

3.4 LEGACY 2007 HMP REVIEW

AECOM described the specific information HMP information needs during the initial December 2014 teleconference. Information within this section formed the foundation for updating the 2007 HMP.

The Planning Team did not complete their designated annual HMP reviews or plan maintenance activities. Therefore it became a primary consideration to update the existing 2007 HMP to include all hazards that have or could potentially have impacted the community during the current HMP's 5-year lifecycle.

Table 3-3 delineates Planning Team identified HMP components that necessitated information update. The Team determined how community changes, construction and infrastructure conditions, climate change impacts, and population increases or decreases have influenced hazard risks and/or facility vulnerabilities.

The current HMP Update process included inviting new and existing stakeholders to review the existing HMP to determine what was accomplished versus what was intended to accomplish. Pertinent section data are identified within Table 3-3, which provided the foundation for completing the 2015 HMP Update.

Table 3-3 HMP Review and Update Needs Determination

2007 HMP Section	2007 FHMP Items to be Updated	Status: F: Fulfilled NF: Not Fulfilled	2007 HMP Identified items for Deletion	Newly Identified Items to be Added for HMP Compliance	New Action Commitment
Planning Process	• Planning process • Planning team membership • Mitigation resource list • Public outreach initiatives • Plan Maintenance Activities • Plan Review Obligations	• NF: Did not meet or complete annual HMP review • NF: Adding Manmade/Technological Hazards • NF: Continued Plan Development	• None	• Refine plan maintenance processes and responsibilities	• Planning Team will begin to hold annual review meetings and • Strive to integrate HMP initiatives into other plans, ordinances, and resolutions.

Table 3-3 HMP Review and Update Needs Determination

2007 HMP Section	2007 FHMP Items to be Updated	Status: F: Fulfilled NF: Not Fulfilled	2007 HMP Identified items for Deletion	Newly Identified Items to be Added for HMP Compliance	New Action Commitment
Hazard Profile Update	• Update current hazards' profiles and new event history • Profile newly identified hazard risks	• NF: Update hazard profile and new event history	• Mitigation projects that were deleted or combined due to similarity	• Identify new hazards • Develop new Mitigation Action Plan (MAP) • Update existing hazards' impacts Include Manmade and Technological Hazards identified in former HMP	• Delineate new actions within the MAP
Risk Analysis and Vulnerability Assessment	• Identify development and land use changes • Asset inventory • Vulnerability analysis & summaries	• NF: Identify development and land use changes	• None	• Develop asset inventory • Determine infrastructure vulnerabilities • Determine residential structure vulnerabilities • Identify repetitive loss properties as appropriate	• Fill data gaps • Locate scientific information to augment these data. • Delineate climate change scenario for future development analysis
Mitigation Strategy	• Determine existing mitigation actions' status • Identify existing (2007) mitigation plan actions' status • Define mitigation action implementation successes or barriers to implement	• NF: Did not track project implementation processes	• Delete completed, combined, or deleted actions	• Identify new mitigation actions for newly identified hazards • Develop community specific capability assessment(s)	• Annually review action's status and feasibility

3.5 EXISTING DATA INCORPORATION

During the planning process, the Planning Team reviewed and incorporated information from existing plans, studies, technical reports, and other newly available data into the HMP. The following were available from various sources and were reviewed and used as references for the

jurisdiction information and hazard profiles in the risk assessment of the HMP for the City (Table 3-3).

Table 3-4 Documents Reviewed

Existing plans, studies, reports, ordinances, etc.	Contents Summary (How will this information improve mitigation planning?)
Kivalina Comprehensive Plan w/Ordinances	Not available
Kivalina Relocation Community Layout Plan, 2001	Provides information concerning their potential future community layout desires.
USACE Community Improvement Feasibility Report, 1998	Described the City's relative location and geology.
USACE Relocation Planning Project, Master Plan, 2006	Provided historical impact, geology, and other pertinent information for developing HMP pertinent hazard profiles and vulnerability assessment.
USACE Section 117 Expedited Erosion Control Project, Kivalina, Alaska, 2007	Defined the community's erosion threat, available funding ($420,000) to design and construct protective measures for Kivalina. Provided stipulations for community to prepare and implement a floodplain management plan within one year after the date of signing this Agreement, and project completion respectively. The plan was required to reduce future flood impacts including preserving the provided flood protection level.
US Army Corps of Engineers, AVETA Report Summary - Kivalina, Alaska, 3/26/2009	Defined the community's increased erosion impacts during the past 30 years along with associated protective measure costs.
US Army Corps of Engineers, Alaska Baseline Erosion Assessment, 2009	Defined the area's erosion impacts
US Army Corps of Engineers, Floodplain Manager's Reports, Community Specific 2011	Defined the area's historical flood impacts
State of Alaska, Department of Commerce, Community and Economic Development Community Profile	Provided historical and demographic information
State of Alaska Hazard Mitigation Plan (SHMP), 2013	Defined statewide hazards and their potential locational impacts

A complete list of references provided in Section 8.

3.6 PLAN MAINTENANCE

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

The following three process steps are addressed in detail here:

1. Implementation into existing planning mechanisms
2. Continued public involvement

3. Monitoring, reviewing, evaluating, and updating the HMP

3.6.1 Implement HMP Precepts

DMA 2000 and its implementing regulation for HMP implementation through existing planning mechanisms:

DMA 2000 Requirements
1. REGULATION CHECKLIST
Incorporation into Existing Planning Mechanisms §201.6(b)(3): Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.
ELEMENT A Planning Process (Continued)
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information?
Source: FEMA, March 2015

Once the HMP is community adopted and receives FEMA's final approval, Each Planning Team Member ensures that the HMP, in particular each Mitigation Action Project, is incorporated into existing planning mechanisms whenever possible. Each member of the Planning Team has undertaking the following activities.

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

3.6.2 Continued Public Involvement

DMA 2000 and its implementing regulation for continued public involvement:

DMA 2000 Requirements
Continued Public Involvement §201.6(c)(4)(iii): The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.
1. REGULATION CHECKLIST
ELEMENT A Planning Process (Continued)
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))
Source: FEMA, March 2015

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

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

3.6.3 Monitoring, Reviewing, Evaluating, and Updating the HMP

DMA 2000 and its implementing regulation for monitoring, reviewing, evaluating, and updating the HMP:

DMA 2000 Requirements
Monitoring, Evaluating and Updating the Plan §201.6(c)(4)(i): The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.
1. REGULATION CHECKLIST
ELEMENT A. Planning Process (Continued)
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle?)
Source: FEMA, March 2015

This section provides an explanation of how Kivalina's Planning Team intends to organize their efforts to ensure that improvements and revisions to the HMP occur in a well-managed, efficient, and coordinated manner during this HMPs 5-year life cycle.

The following three process steps are addressed in detail here:

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

3.6.3.1 Monitoring the HMP

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

3.6.3.2 Reviewing the HMP

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

Kivalina's City Administrator will evaluate their HMP annually to determine the effectiveness of programs and to reflect changes in land development, land use status, or other situations that make plan changes necessary. The City Administrator and staff will review the mitigation project items to determine their relevance to the City's changing situations, as well as changes in state or federal policy and to ensure that mitigation continues to address current and expected conditions. The City Administrator will review the hazard profiles information to it should be updated or modified, and provide newly available data or status changes.

Additional hazards not currently covered in the plan, including technological and manmade hazards, will be added, if funding becomes available during the next five-year update cycle. The plan will continue to be developed as resources become available.

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

3.6.3.3 Evaluating the HMP

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

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

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

3.6.3.4 Updating the HMP

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

DMA 2000 Requirements
Reviewing, Evaluating, and Implementing the Plan

§201.6(d)(3): A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit if for approval within 5 years in order to continue to be eligible for mitigation project grant funding.
1. REGULATION CHECKLIST
ELEMENT D. Planning Process (Continued) *Update activities not applicable to the plan version*
D1. Was the Plan revised to reflect changes in development? (Requirement §201.6(d)(3))
D2. Was the Plan revised to reflect progress in local mitigation effort? (Requirement §201.6(d)(3))
D3. Was the Plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))
Source: FEMA, March 2015

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

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

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

- Request grant assistance from DHS&EM to update the HMP (this can take up to one year to obtain and one year to update the plan)
- Ensure that each authority administering a mitigation project will submit a Progress Report to the Planning Team
- Develop a chart to identify those HMP sections that need improvement, the section and page number of their location within the HMP, and describing the proposed changes
- Thoroughly analyze and update the natural hazard risks:
  - Determine the current status of the mitigation projects
  - Identify the proposed Mitigation Plan Actions (projects) that were completed, deleted, or delayed. Each action should include a description of whether the project should remain on the list, be deleted because the action is no longer feasible, or reasons for the delay
  - Describe how each action's priority status has changed since the HMP was originally developed and subsequently approved by FEMA
  - Determine whether or not the project has helped achieve the appropriate goals identified in the plan
  - Describe whether the community has experienced any barriers preventing them from implementing their mitigation actions (projects) such as financial, legal, and/or political restrictions and stating appropriate strategies to overcome them
  - Update ongoing processes, and to change the proposed implementation date/duration timeline for delayed actions the City still desires to implement
  - Prepare a "new" MAP matrix for the 2015 HMP update

- Prepare a new Draft Updated HMP
- Submit the updated draft HMP to the Division of Emergency Management (DHS&EM) and FEMA for review and approval

3.6.3.5 Formal State and FEMA HMP Review

Completed HMPs do not automatically qualify the City or Tribe for mitigation grant program eligibility until they have been reviewed and adopted by the City and Tribal councils and received State and FEMA final approval.

The Native Village of Kivalina, a federally recognized tribe, has participated with this HMP's development and it intends to follow and implement applicable tribal activities to qualify the Village Tribal Council for tribal grant opportunities. The Native Village of Kivalina's Traditional Council supports 44 CFR 201 and assures compliance with all applicable Federal statutes and regulations.

The City of Kivalina and the Native Village of Kivalina councils, with assistance from the State Hazard Mitigation Officer (SHMO) and the State Hazard Mitigation Advisory Committee (SHMAC), are responsible for monitoring, evaluating, and updating their portion of the Kivalina Hazard Mitigation Plan in accordance with 44 CFR §201.7. Their respective councils will monitor the plan to evaluate progress and update the plan every five years, or within 90 days of a Presidential Declared Disaster (as required), to reflect changes in State or Federal law. The Hazard Mitigation Plan Annual Progress Report and Hazard Mitigation Plan Annual Evaluation Forms are plan review tools.

The City and Tribal councils, with assistance from the SHMO and FEMA, determine when significant changes warrant an update prior to the scheduled date.

Upon completion, the City (or its contractor) and Tribe will submit the updated HMP to the DHS&EM for initial review and preliminary approval. Once any corrections are made, DHS&EM will forward the HMP to FEMA for their review and conditional approval.

Once the plan has fulfilled all FEMA criteria, the City of Kivalina and the Native Village of Kivalina will pass HMP Adoption Resolutions and forward to the State and FEMA for final approval. FEMA's final approval assures the City is eligible for applying for appropriate mitigation grant program funding.

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Section Four is included to fulfill the Kivalina's HMP adoption requirements.

4.1 JURISDICTIONAL ADOPTION

DMA 2000 and its implementing regulations for governing body formal HMP adoption:

DMA 2000 Requirements
Local Plan Adoption §201.6(c)(5): [The plan shall include…] Documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County commissioner, Tribal Council). For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.
1. REGULATION CHECKLIST
ELEMENT E. Plan Adoption
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval??) (Requirement §201.6(c)(5))
Source: FEMA, March 2015

The City of Kivalina's City Council and the Native Village of Kivalina's Tribal Council are represented in this HMP; they meet the requirements of Section 409 of the Stafford Act, Section 322 of DMA 2000, and 44 CFR §201.6(c)(5) and §201.7 respectively.

The City of Kivalina's City Council adopted the HMP on November 11, 2015.

The City submitted the final draft HMP to FEMA for formal approval; scanned copies of their formal adoption resolutions are included in Appendix C.

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Section Five identifies and profiles the hazards that could affect Kivalina.

5.1 OVERVIEW

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

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

DMA 2000 and its implementing regulations for hazard identification:

DMA 2000 Requirements
Identifying Hazards §201.6(c)(2)(i): The risk assessment shall include a] description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events. §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.
1. REGULATION CHECKLIST
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction? B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods?
Source: FEMA, March 2015

5.2 HAZARD IDENTIFICATION AND SCREENING

The requirements for hazard identification, as stipulated in DMA 2000 and its implementing regulations are described below. *(NFIP insured Repetitive Loss Structures (RL) are addressed in Section 6.0, Vulnerability Analysis.)*

For the first step of the hazard analysis, on December 22, 2014 the Planning Team reviewed their 2007 FEMA approved HMP; then evaluated and screened the comprehensive list of potential hazards based on a range of factors, including knowledge and threat perception as they pertain to

the hazards' relative risks, the ability to mitigate their impacts, and the known or expected availability of information for those hazards (Table 5-1).

Table 5-1 Identification and Screening of Hazards

Hazard Type	Should It Be Profiled?	Explanation
Natural Hazards		
Earthquake	Yes	The Planning Team state they have experienced low impact earthquakes activity causing items to shake but not fall from shelving or table tops.
Flood (Riverine and/or coastal related flood, scour, and storm surge)	Yes	The City experiences snowmelt run-off, rainfall, storm surge flooding; as well as coastal ice run-up and scour along the shoreline and the area's rivers, streams, and creek embankments from high water flow, ice flows, and wind.
Ground Failure (Avalanche, Landslide/Debris Flow, Permafrost, Subsidence)	Yes	Ground Failure occurs near the City landslides (mud slides), melting permafrost, and ground subsidence. However subsidence and melting permafrost are the primary hazards causing houses to shift due to ground sinking and upheaval.
Severe Weather (Cold, Drought, Rain, Snow, Wind, etc.)	Yes	Severe weather impacts the community with climate change/global warming and changing El Niño/La Niña Southern Oscillation (ENSO) patterns generating increasingly severe weather events such as winter storms, heavy or freezing rain, thunderstorms and with subsequent secondary hazards such as riverine or coastal storm surge floods, landslides, snow, and wind etc.
Tsunami (Seiche)	No	This hazard does not exist for this location.
Volcano	No	This hazard does not exist for this location.
Wildland (Tundra) Fire	Yes	The City's surrounding tundra terrain becomes very dry in summer months. Lightning has increasingly occurred during the past 5 years igniting dry vegetation. Human activity such as burning trash outside their landfill's burn box, camp fires, and other activities can also get out-of-control.
Manmade / Technological Hazards		
Hazardous Materials	Yes	Hazardous materials are present in the community. They need a debris management plan and capability to remove identified materials from their remote barrier island location. The community's recent store fire debris is still in-place with no capacity to remove the debris away from its current location or away from the island.
Economic	Yes	Any identified hazard could prove catastrophic to the community due to their remote location.
Public Health	Yes	Community housing is limited, in some cases multiple families are living in one home. For example one 3 bedroom home has three families totaling 15 family members. Each family occupies one bedroom each and share the common space (kitchen, living room, and a honey bucket). This close proximity is very unhealthy with many common ailments dispersed throughout the home, infecting all inhabitants.

5.3 HAZARD PROFILES

DMA 2000 and its implementing regulations for hazard profiles:

DMA 2000 Requirements
Profiling Hazards Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
1. REGULATION CHECKLIST
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction? (Requirement §201.6(c)(2)(i)) B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction?
Source: FEMA, March 2015

The Planning Team determined that a few of their previously identified hazards can be combined to better describe a more comprehensive impact range. Manmade and Technological hazards although profiled within this HMP they will not be included within Section 6, Vulnerability Assessment due to limited funding for researching and developing a viable vulnerability analysis.

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The 2015 HMP update will address five natural hazard categories: earthquake, flood, ground failure, severe weather, and wildland fire; and three Technological hazards hazardous materials (Hazmat), utility and transportation disruptions, and public health.

They further stated that some of their more recent hazards impacts are influenced by unpredictable, rapidly changing climate conditions such as late ice formation, early thaw conditions; and increased or inconsistent rain patterns over recent years. Table 5-2 delineates the City's natural hazards and manmade and technological hazards for the City.

Table 5-2 Natural Hazard Matrix – City of Kivalina

(Northwest Arctic Borough, State of Alaska Hazard Matrix)

	Earthquake	Flood	Ground Failure	Severe Weather	Wildland Fire
State HMP	*Y - M*	*Y - H*	*N*	*Y - H*	*Y*
Kivalina	**Y-L**	**Y-H**	**Y**	**Y-H**	**Y**
	Tsunami & Seiche	**Volcano**	**Hazmat**	**Utility/ Transportation Disruptions**	**Public Health**
State HMP	*N*	*N*	*Y*	*Y*	*Y*
Kivalina	**N-L**	**N**	**Y**	**Y**	**Y**
Hazard Classification Code Key:					
Y: *N:* *U:*	*Hazard is present in jurisdiction but probability unknown* *Hazard is not present* *Unknown if the hazard occurs in the jurisdiction*				
Risk Classification Code Key:					
L : *M :* *H:*	*Hazard is present with a low occurrence probability* *Hazard is present with a moderate occurrence probability* *Hazard is present with a high occurrence probability*				

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

- Nature (Type)
  - Potential climate change impacts are primarily discussed in the Severe Weather hazard profile but are also identified where deemed appropriate within each hazard's profile.
- History (Previous Occurrences)
- Location
- Extent (to include magnitude and severity)
- Impact (Section 5 provides general impacts associated with each hazard. Section 6 provides detailed impacts to Kivalina's residents and critical facilities)
- Future event recurrence probability

Each hazard is assigned a rating based on the following criteria for magnitude/severity (Table 5-2) and future recurrence probability (Table 5-3).

Estimating magnitude and severity are determined based on historic events using the criteria identified in the introductory narrative description of Section 5.3.

Table 5-3 Hazard Magnitude/Severity Criteria

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

Similar to estimating magnitude and severity, Probability is determined based on historic events, using the criteria identified above, to provide the likelihood of a future event (Table 5-3).

Table 5-4 Hazard Probability Criteria

Probability	Criteria
4 - Highly Likely	• Event is probable within the calendar year. • Event has up to 1 in 1 year chance of occurring (1/1=100 percent). • History of events is greater than 33 percent likely per year. • Event is "Highly Likely" to occur.

Table 5-4 Hazard Probability Criteria

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

The hazards profiled for Kivalina are presented throughout the remainder of Section 5.3.

Note: Each hazard profile is presented in alphabetical order, separated by natural hazard and Manmade/Technological Hazard classifications. The hazard presentation order does not signify their importance or risk level.

5.3.1 Natural Hazards

5.3.1.1 Earthquake

5.3.1.1.1 Nature

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

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

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

- **Surface Faulting** is the differential movement of two sides of a fault at the earth's surface. Displacement along faults, both in terms of length and width, varies but can be

significant (e.g., up to 20 feet [ft]), as can the length of the surface rupture (e.g., up to 200 miles). Surface faulting can cause severe damage to linear structures, including railways, highways, pipelines, and tunnels.

- **Liquefaction** occurs when seismic waves pass through saturated granular soil, distorting its granular structure, and causing some of the empty spaces between granules to collapse. Pore water pressure may also increase sufficiently to cause the soil to behave like a fluid for a brief period and cause deformations. Liquefaction causes lateral spreads (horizontal movements of commonly 10 to 15 ft, but up to 100 ft), flow failures (massive flows of soil, typically hundreds of ft, but up to 12 miles), and loss of bearing strength (soil deformations causing structures to settle or tip). Liquefaction can cause severe damage to property.
- **Landslides/Debris Flows** occur as a result of horizontal seismic inertia forces induced in the slopes by the ground shaking. The most common earthquake-induced landslides include shallow, disrupted landslides such as rock falls, rockslides, and soil slides. Debris flows are created when surface soil on steep slopes becomes totally saturated with water. Once the soil liquefies, it loses the ability to hold together and can flow downhill at very high speeds, taking vegetation and/or structures with it. Slide risks increase after an earthquake during a wet winter.

The severity of an earthquake can be expressed in terms of intensity and magnitude. Intensity is based on the damage and observed effects on people and the natural and built environment. It varies from place to place depending on the location with respect to the earthquake epicenter, which is the point on the earth's surface that is directly above where the earthquake occurred. The severity of intensity generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. The scale most often used in the U.S. to measure intensity is the Modified Mercalli Intensity (MMI) Scale. As shown in Table 5-4, the MMI Scale consists of 12 increasing levels of intensity that range from imperceptible to catastrophic destruction. Peak ground acceleration (PGA) is also used to measure earthquake intensity by quantifying how hard the earth shakes in a given location. PGA can be measured as acceleration due to gravity (g) (MMI 2006).

Magnitude (M) is the measure of the earthquake strength. It is related to the amount of seismic energy released at the earthquake's hypocenter, the actual location of the energy released inside the earth. It is based on the amplitude of the earthquake waves recorded on instruments, known as the Richter magnitude test scales, which have a common calibration (see Figure 5-1).

UPSeis
an educational site for budding seismologists

Modified Mercalli Intensity Scale

Mercalli Intensity	Equivalent Richter Magnitude	Witness Observations
I	1.0 to 2.0	Felt by very few people; barely noticeable.
II	2.0 to 3.0	Felt by a few people, especially on upper floors.
III	3.0 to 4.0	Noticeable indoors, especially on upperfloors, but may not be recognized as an earthquake.
IV	4.0	Felt by many indoors, few outdoors. May feel like heavy truck passing by.
V	4.0 to 5.0	Felt by almost everyone, some people awakened. Small objects moved. trees and poles may shake.
VI	5.0 to 6.0	Felt by everyone. Difficult to stand. Some heavy furniture moved, some plaster falls. Chimneys may be slightly damaged.
VII	6.0	Slight to moderate damage in well built, ordinary structures. Considerable damage to poorly built structures. Some walls may fall.
VIII	6.0 to 7.0	Little damage in specially built structures. Considerable damage to ordinary buildings, severe damage to poorly built structures. Some walls collapse.
IX	7.0	Considerable damage to specially built structures, buildings shifted off foundations. Ground cracked noticeably. Wholesale destruction. Landslides.
X	7.0 to 8.0	Most masonry and frame structures and their foundations destroyed. Ground badly cracked. Landslides. Wholesale destruction.
XI	8.0	Total damage. Few, if any, structures standing. Bridges destroyed. Wide cracks in ground. Waves seen on ground.
XII	8.0 or greater	Total damage. Waves seen on ground. Objects thrown up into air.

Figure 5-1 Modified Mercalli Intensity Scale (MMI 2014).

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5.3.1.1.2 History

Accurate seismology for Alaska is relatively young with historic data beginning in 1973 for most locations. Data is limited for acquiring long-term earthquake event data. The HMP's Alaska earthquake data is based on best available data; obtained from the US Geological Survey (USGS) and the State of Alaska, UAF Geophysical Institute's archives. Research included searching the US Geological Survey (USGS) earthquake database for events spanning from 1973 to present; eight of which exceeded M5.0 located within 100 miles of the City. However the Planning Team stated they have not experienced damage from any of their historic close proximity earthquakes.

The Planning Team determined they have a moderate concern for earthquake damages and only need to be concerned with earthquakes with a magnitude greater than (>) M5.0. Table 5-5 lists 46 historical earthquakes that have occurred since the legacy HMP was approved that were greater than M 4.0 with the largest one (M5.7) occurring on June 16, 2014 located 20 miles of Noatak.

Table 5-5 Historical Earthquakes Within 100 Miles of Kivalina

Date	Time	Latitude	Longitude	Depth	Magnitude	Location
July 18, 2014	5:33:26 AM	67.5922	-161.7637	13.4	4.6	51km E of Noatak
July 18, 2014	2:03:16 AM	67.602	-161.548	10.9	4.4	60km E of Noatak
July 18, 2014	2:01:45 AM	67.6316	-161.8304	21.2	4.2	48km E of Noatak
July 18, 2014	2:00:44 AM	67.6018	-161.7501	8.9	4.2	51km E of Noatak
June 16, 2014	12:01:08 PM	67.6973	-162.6119	24.2	5.7	33km ENE of Noatak
June 16, 2014	12:00:30 PM	67.6829	-162.329	15.4	4.2	29km ENE of Noatak
June 7, 2014	2:33:42 PM	67.7257	-162.3318	9	4.1	31km ENE of Noatak
June 7, 2014	4:47:19 AM	67.718	-162.2306	9.8	4.5	35km ENE of Noatak
June 7, 2014	4:46:18 AM	67.6956	-162.2028	9.8	4	35km ENE of Noatak
June 7, 2014	4:43:32 AM	67.7245	-162.3749	18.6	5.5	36km NE of Noatak
June 7, 2014	3:13:59 AM	67.7391	-162.3196	20.7	4.4	32km ENE of Noatak
June 3, 2014	4:08:33 AM	67.6655	-162.2942	12.3	4.2	30km ENE of Noatak
June 2, 2014	8:32:14 PM	67.6565	-162.2588	14.9	4	31km ENE of Noatak
May 30, 2014	6:27:32 AM	67.6478	-162.2898	14.9	4.7	29km ENE of Noatak
May 12, 2014	10:51:04 PM	67.6627	-162.1369	5.6	4.2	36km ENE of Noatak
May 11, 2014	10:51:58 AM	67.6995	-162.5569	22.3	4	22km NE of Noatak
May 5, 2014	12:12:35 PM	67.7115	-162.6393	22.5	4.6	20km NE of Noatak
May 5, 2014	11:59:14 AM	67.7395	-162.5954	29	4.5	24km NE of Noatak
May 3, 2014	12:29:11 PM	67.7207	-162.6099	10	4	22km NE of Noatak
May 3, 2014	11:54:34 AM	67.738	-162.451	24.5	4.2	28km NE of Noatak
May 3, 2014	11:19:09 AM	67.6884	-162.4078	9.1	4.3	27km ENE of Noatak
May 3, 2014	10:40:53 AM	67.6888	-162.455	10	4.1	26km ENE of Noatak
May 3, 2014	10:11:24 AM	67.6863	-162.6729	25	4.4	17km NE of Noatak
May 3, 2014	10:09:45 AM	67.6554	-162.3812	10	4.3	26km ENE of Noatak
May 3, 2014	9:57:08 AM	67.6958	-162.5743	10	4.7	23km NE of Noatak
May 3, 2014	9:54:19 AM	67.736	-162.405	26.1	4.4	30km NE of Noatak
May 3, 2014	9:51:07 AM	67.6988	-162.3133	20.6	4.7	25km NE of Noatak
May 3, 2014	9:47:48 AM	67.6761	-162.5875	10	4.2	24km ENE of Noatak
May 3, 2014	8:57:12 AM	67.6302	-162.2066	0.9	5.5	32km ENE of Noatak
April 26, 2014	6:11:59 AM	67.7664	-162.5893	25	4.1	26km NE of Noatak
April 19, 2014	11:31:40 AM	67.772	-162.393	18.1	4.4	33km NE of Noatak
April 19, 2014	11:31:06 AM	67.6643	-162.3749	7.7	4.6	27km ENE of Noatak
April 19, 2014	8:49:01 AM	67.6777	-162.4774	17.5	4.7	23km ENE of Noatak
April 18, 2014	9:38:50 PM	67.7828	-162.3807	15.9	4.1	32km NE of Noatak
April 18, 2014	6:56:46 PM	67.7734	-162.6741	33	5.3	18km NE of Noatak
April 18, 2014	6:44:18 PM	67.7185	-162.6679	23.4	5.6	20km NE of Noatak
March 27, 2014	7:28:31 AM	67.9858	-163.4937	15.9	4.1	54km NNW of Noatak
March 2, 2013	11:00:25 AM	67.7088	-167.0938	45.8	4.3	72km SSW of Point Hope
May 5, 2012	2:30:49 AM	67.719	-167.111	19.7	4.2	Bering Strait
April 7, 2012	3:26:45 AM	67.569	-166.652	15.6	4.3	Bering Strait
February 22, 2012	2:32:29 PM	67.8	-167.156	20	4.5	Bering Strait
February 21, 2012	1:50:43 PM	67.744	-167.057	20	5.3	Bering Strait
October 13, 2008	8:18:46 PM	68.174	-162.178	10	4.6	Northern Alaska
October 11, 2008	4:52:35 PM	68.046	-161.659	3.6	4.7	Northern Alaska
May 18, 2008	8:17:49 PM	66.459	-163.776	1.2	4.1	Northern Alaska
April 13, 2008	1:41:40 PM	67.654	-166.741	10	5.2	Bering Strait

(USGS 2012)

North America's strongest recorded earthquake occurred on March 27, 1964 in Prince William Sound measuring M9.2 and was felt by many residents throughout Alaska. Kivalina experienced minimal ground motion from this historic event. Planning Team members further stated that residents experienced no ground shaking from the November 3, 2002 M7.9 Denali EQ.

5.3.1.1.3 Location, Extent, Impact, and Recurrence Probability

Location

The entire geographic area of Alaska is prone to earthquake effects. As such Kivalina has experienced 330 earthquakes since 1973 with an average magnitude of approximately M3.6.

Earthquake damage would be area wide with potential damage to critical infrastructure up to and including complete abandonment of key facilities. Building damage assessors are not available in Kivalina to determine structural integrity following an earthquake. Priority would have to be given to critical infrastructure namely: public safety facilities, health care facilities, shelters and potential shelters, and public utilities.

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

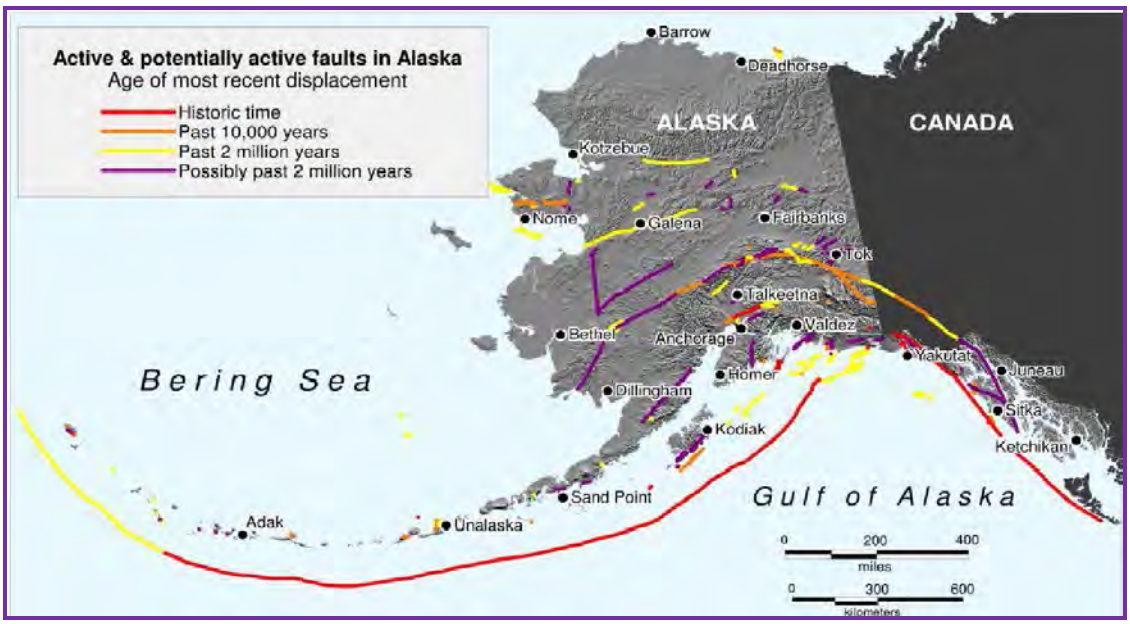

Figure 5-2 Active and Potentially Active Faults in Alaska (UAF 2014)

Extent

Based on historic earthquake events and the criteria identified in Table 5-3, the magnitude and severity of earthquake impacts in the City are considered "Limited" with potential injuries and/or illnesses that do not result in permanent disability; critical facilities could expect to be shut-down for more than one weeks; and more than 10 percent of property is severely damaged with limited long-term damage to transportation, infrastructure, or the economy.

The City is located in close proximity to known yet unnamed earthquake faults as depicted in Figure 5-3:

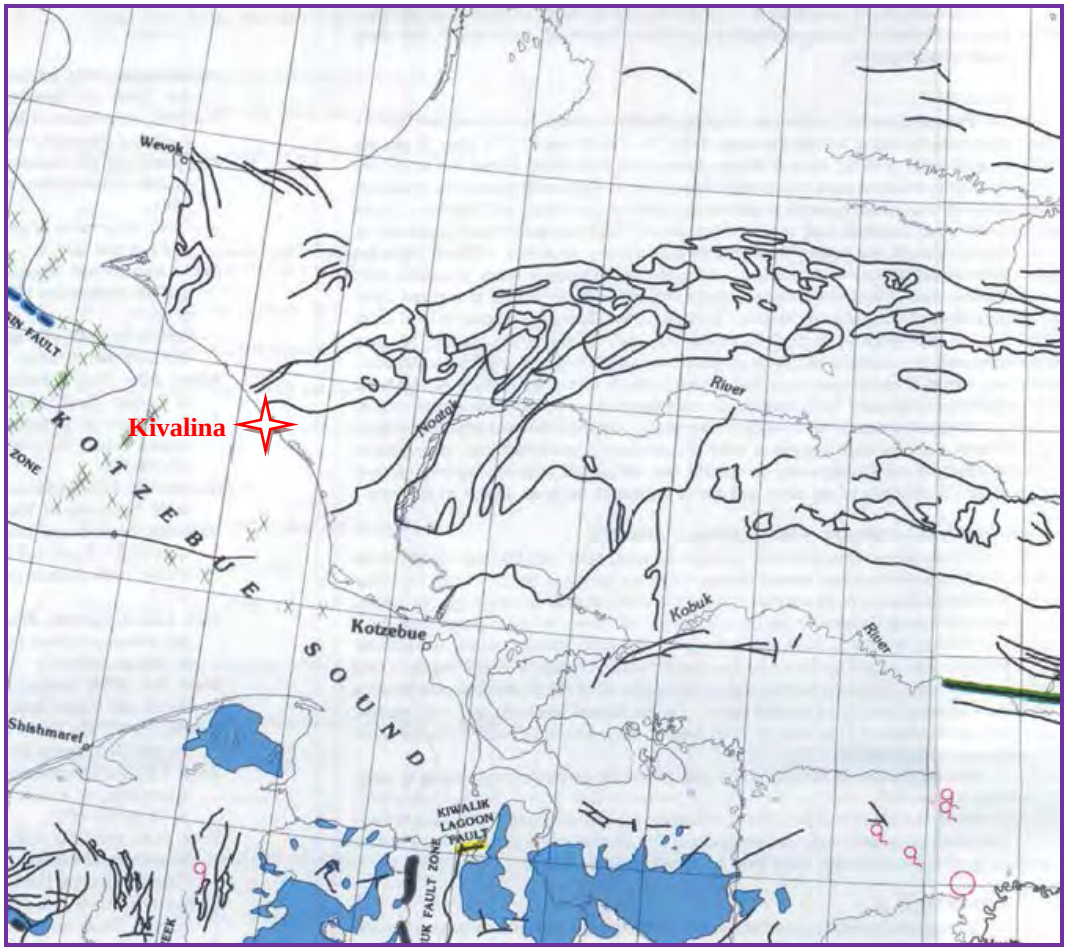

Figure 5-3 Earthquake Fault Proximity to Kivalina (DGGS 2009)

Impact

Impacts to the community such as significant ground movement that may result in infrastructure damage can be expected due to the area's active seismicity. Minor shaking may be seen or felt based on past events. Impacts to future populations, residences, critical facilities, and infrastructure are anticipated to remain the same.

Recurrence Probability

The Shake Map was generated using the United States Geological Survey (USGS) Earthquake Mapping Model. This 2009 Shake Map incorporates current seismicity in its development and is the most current map available for this area. Peter Haeussler, USGS, Alaska Region states, it is a viable representation to support probability inquiries.

> *"The occurrence of various small earthquakes does not change earthquake probabilities. In fact, in the most dramatic case, the probability of an earthquake on the Denali fault was/is the same the day before the 2002 earthquake as the day*

afterward. Those are time-independent probabilities. The things that change the hazard maps is changing the number of active faults or changing their slip rate" (Haeussler, 2009).

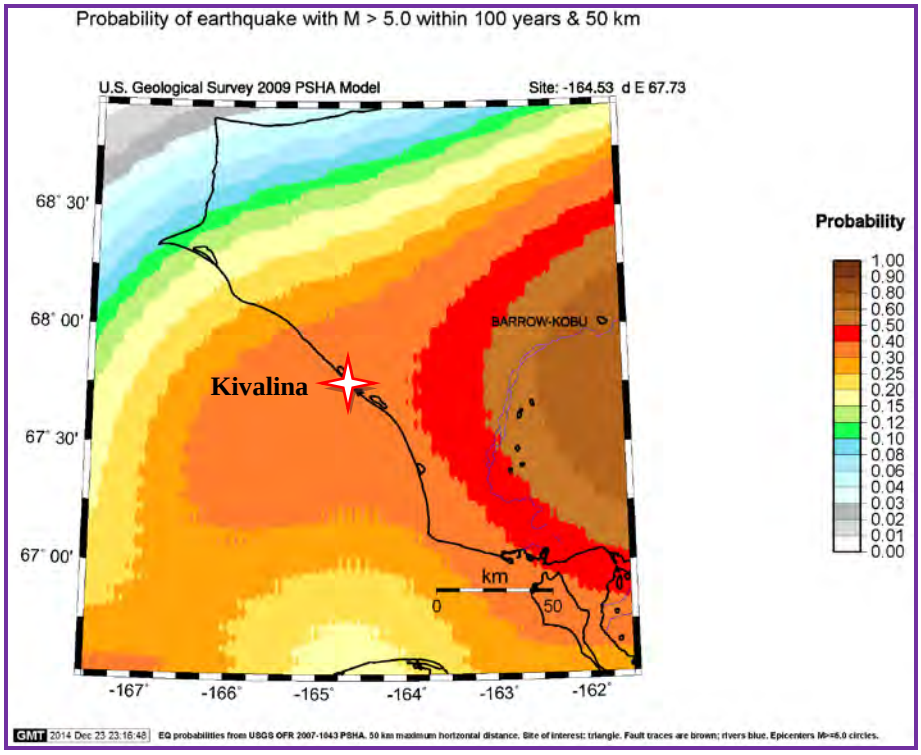

Figure 5-4 Kivalina Area Earthquake Probability (USGS 2014)

As indicated in Figure 5-4, while it is not possible to predict when an earthquake will occur, the map does show that there is a 30% chance a M5.0 or greater earthquake could occur within 100 years and 100 miles of the City. This potential threat is classified as "Highly Likely," with a chance of occurring within the next year (1/1=100 percent); due to an event history that is less than 33 percent likely per year.

5.3.1.2 Flood

5.3.1.2.1 Nature

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

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

Four primary types of flooding occur around the Kivalina area: rainfall run-off, snow-melt, storm surge, and ice override floods.

Rainfall-Runoff Flooding occurs in from approximately May to September, with rain becoming more frequent into December and January due to changing climatic weather conditions. The rainfall intensity, duration, distribution, and geomorphic characteristics of the watershed all play a role in determining the magnitude of seasonal storms that exacerbate flooding. Rainfall runoff flooding is a common flood type.

Snowmelt Floods typically occur from April through June. The depths of the snowpack and spring weather patterns influence the magnitude of flooding.

Ice-Jam floods occur when warming temperatures and rising water flows causes the ice to break-up and disconnect from the embankment. The large ice chunks begin to flow and move down river. The ice does not flow easily, often impacting with adjacent blocks resulting in occasional ice jams. Some ice jams quickly break apart, however, larger jams occur which create small dams causing the water to exert increasing pressure on the jam creating a damming effect. Water subsequently begins to build depth and often overtops adjacent embankments which flood upstream communities.

When the ice-jam breaks the built-up water rushes downstream with great force. Ice blocks scour the embankment, destroying infrastructure such as fuel headers, barge landings, and boat mooring structures. Large house sized ice blocks may even be driven above the embankment destroying any structure in its path. Communities are virtually helpless against such devastation.

Storm Surges, or coastal floods, occur when the sea is driven inland above the high-tide level onto normally dry land. Often, heavy surf conditions driven by high winds accompany a storm surge adding to the destructive-flooding water's force. The conditions that cause coastal floods also can cause significant shoreline scour (erosion) as the flood waters undercut roads and other structures. Storm surge is a leading cause of property damage and loss in Alaska.

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

Communities that are situated on low-lying coastal lands with gradually sloping bathymetry near the shore and exposure to strong winds with a long fetch over the water are particularly susceptible to coastal flooding. Several communities and villages along the Bering Sea, the Arctic Sea, and Beaufort Sea Coasts have experienced significant damage from coastal floods over the past several decades. Most coastal flooding occurs during the late summer or early fall season in these locations. As shore-fast ice forms along the coast before winter, the risk of coastal flooding abates, but later freeze-ups greatly increase the risk from storm surge flooding, scour, and ice override events.

Ice Override Scour is a phenomenon that occurs when wind stress causes sheet ice movement by acting on the surface of ice that is not confined or shore fast. Onshore wind, coupled with conditions such as a smooth gradual sloping beach and high tides can cause ice sheets to slide up or "override" the beach and move inland as much as several hundreds of feet. Ice override

typically occurs in fall and early winter (though events have been reported at other times) and is usually associated with coastal storms and storm surge but may also happen in calm weather.

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

Coastal Scour (used interchangeably with erosion) rarely causes death or injury. However, erosion causes property destruction, prohibits development, and impacts community infrastructure. Erosion is typically gradual land loss through wind or water scour. However, erosion can occur rapidly as the result of floods, storms or other event or slowly as the result of long-term environmental changes such as melting permafrost. Erosion is a natural process, but its effects can be easily exacerbated by human activity.

Coastal and riverine erosion threaten the Dillingham area's infrastructure, built environment, and utilities adjacent embankments and shorelines.

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

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

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

Coastal scour may also be due to multi-year impacts and long-term climatic change such as sea-level rise, lack of sediment supply, subsidence, or long-term human factors such as aquifer depletion or the construction of shore protection structures and dams. Attempts to control erosion using shoreline protective measures such as groins, jetties, seawalls, or revetments can lead to increased erosion.

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

scour episodes may only occasionally occur from human activities including boat wakes and dredging.

Attempts to control scour using shoreline protective measures such as groins, jetties, levees, or revetments can lead to increased embankment loss or damage.

Land surface loss results from high flowing surface water across roads due to poor or improper drainage. These events typically occur from rain and snowmelt run-off.

Event Recurrence Intervals

Many flood damages are predictable based on rainfall and seasonal thaw patterns. Most of the annual precipitation is received from April through October with August being the wettest. This rainfall leads to flooding in early/late summer and/or fall. Spring snowmelt increases runoff, which can cause excessive surface flooding. It also breaks riverine winter ice cover, exacerbating localized ice-jam flood or coastal ice override damage impacts.

5.3.1.2.2 History

Figure 5-4 depicts the City's typical storm surge flood sour impact areas. Successive colored lines depict the coastline's historic damage – locational timelines.

Figure 5-5 City of Kivalina's Storm Surge Scour Locations (USACE 2009)

The US Army Corp of Engineers reported:

> ***Flood or high water flow induced erosion events.*** *The Army Corp of Engineers (USACE) completed an erosion survey for Kivalina during their 2009 Baseline Erosion Assessment. The report listed the community as one of 26 Priority Action Communities. These communities are defined by the report as:*
>
> > *"A Priority Action Community has reported erosion threatening community viability, significant resources are being expended to minimize the threats, or both conditions are present. The erosion issue likely warrants immediate and substantial Federal, State, or other intervention. Priority Action Communities should be considered for immediate action in either initiating an investigation or continuing with ongoing efforts to manage erosion" (USACE 2011).*

The USACE completed a coastal erosion improvement project that spanned 1,200 feet (Figure 5-6) using rock revetment costing $13, 428,774. The USACE engineering design shows the protection extent provided by this vitally important project.

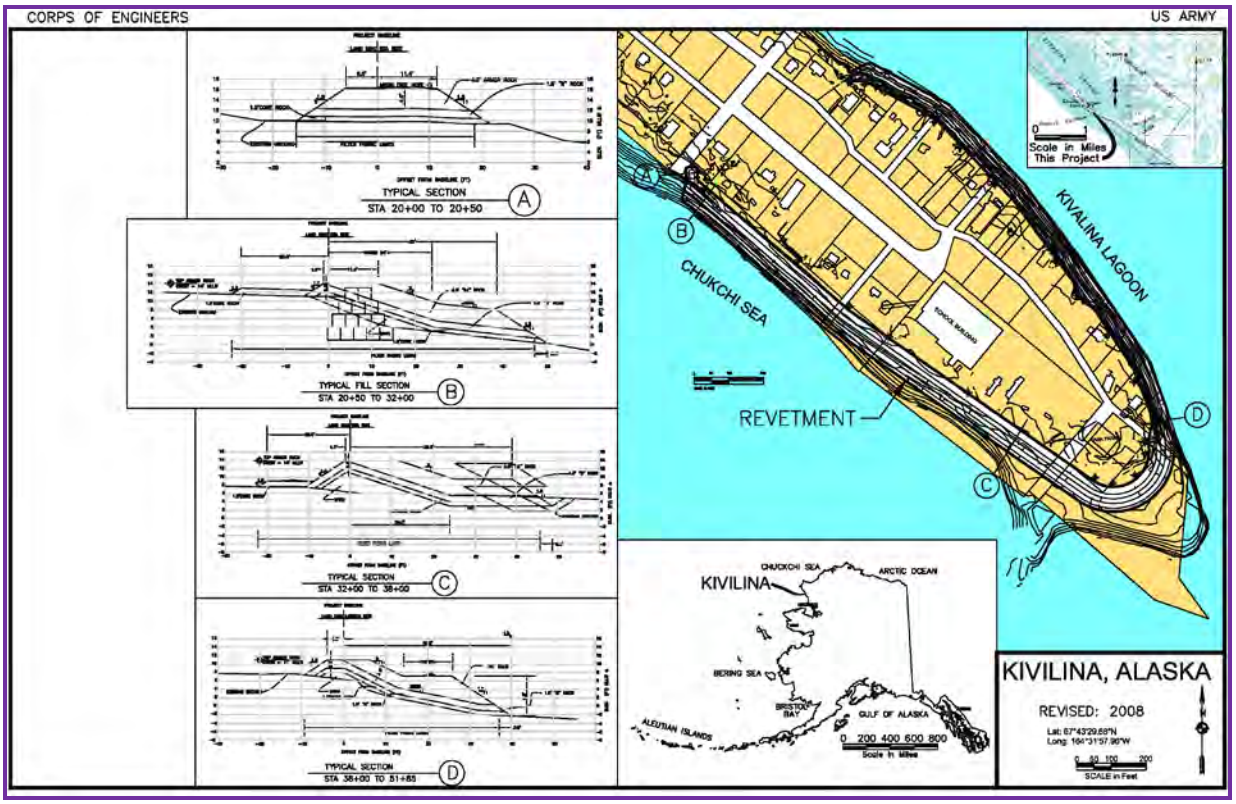

Figure 5-6 USACE Kivalina Coastal Erosion Improvement Project (USACE 2009)

Figure 5-7 portrays the Re-Locate Kivalina initiative's great aerial photo of the completed revetment project as it appeared in 2012.

Figure 5-7 Re-Locate Kivalina Photo (Relocate 2012)

The City Planning Team stated they experience severe road surface damages and erosive scour from heavy rainfall, snowmelt, and spring run-off flooding. Spring run-off causes the most damages to the community's road surfaces.

The DHS&EM 2014 Disaster Cost Index delineates historical flood events affecting the City. The index lists the following events:

> *"**03-201 Northwest Fall Sea Storm Declared October 23, 2002.** Coastal storm surge flooding occurred in communities on the Northwestern coast of Alaska commencing on October, 8, 2002. A fall sea storm with 18-20 foot seas, extremely high winds, and strong tidal action caused severe damage. This storm was caused by a low pressure system moving down from the Arctic Ocean and settling over the Chukchi Sea and the Kotzebue Sound resulting in widespread damage and coastal flooding, including damage to public roads and other public real property. The Governor declared a disaster for the cities of Kotzebue and **Kivalina** in the Northwest Arctic Borough. On November 6, 2002, an amendment was made to the original declaration to include the community of Shishmaref. The Northwest Arctic Borough (NWAB) provided funds to the City of Kotzebue ($10,000) and the **City of Kivalina ($5,000)**. NWAB was provided a grant to reimburse funds given to those communities. Shishmaref did not have any eligible damage or expenses. The total for this disaster is $382K. This is only for Public Assistance totaling $344K for 4 potential applicants with 1 PW...*
>
> ***04-211 2004 Bering Strait Sea Storm declared October 28, 2004 by Governor Murkowski then FEMA declared (DR-1571) on November 15, 2004. Amended declaration to extend incident to October 24, 2004.** Between October 18 and 20, 2004, a severe winter storm with strong winds and extreme tidal surges occurred along the Western Alaska coastline, which resulted in severe damage and threat to life and property, specifically in the Bering Strait Regional Educational Attendance Area (REAA),*

including Elim, Nome, Koyuk, Shaktoolik, Unalakleet, and other communities; in the Northwest Artic Borough, including ***Kivalina,*** *Kotzebue, and other communities; and in the City of Mekoryuk; with potentially unidentified damages in adjacent areas, and additional storm surges likely from continuing weather patterns in this area Alaska. Conditions that exist in the coastal communities of the Northwest Artic Borough as a result of this disaster: severe damage to roadways, power distribution systems, and drain fields. Conditions that exist in the coastal communities of the Bering Strait REAA as a result of this disaster: severe damage to gabions (used to protect shoreline), major damage to coastal highways and roads, damage to water and septic systems, damage to a bridge, damage to power distribution systems, damage to fuel storage tanks, fuel spills, and property damage. Conditions that exist in the City of Mekoryuk as a result of this disaster: major damage to sea wall and damage to roadways. On November 16, 2004, the declaration was amended to reflect a more accurate timeframe of the disaster. The City of St. George appealed the denial of funding decision for the breakwater. The appeal was granted, which increased the original estimate for total funding of this disaster by more than $3 million. The dates of the severe storm were changed to October 18 through October 24, 2004. Individual assistance totaled $1 million for 271 applicants. Public Assistance total $13 million for 60 potential applicants with 125 PW's. Hazard Mitigation totaled $800K. The total for this disaster is $17 million…*

5

06-215 2005 West Coast Storm declared October 24, 2005 by Governor Murkowski then FEMA declared (DR-1618) on December 9, 2005. *Beginning on September 22, 2005 and continuing through September 26, 2005, a powerful fall sea storm produced high winds combined with wind-driven tidal surges resulting in severe and widespread coastal flooding and a threat to life and property in the Northwest Arctic Borough, and numerous communities within the Bering Strait (REAA 7), the Kashunamiut (REAA 55), the Lower Yukon (REAA 32) and the Lower Kuskokwim (REAA 31) Rural Education Attendance Areas including the cities of Nome,* ***Kivalina,*** *Unalakleet, Golovin, Tununak, Hooper Bay, Chevak, Mekoryuk and Napakiak. The following conditions existed as a result of this disaster: sever damage to personal residences requiring evacuation and sheltering of the residents; to businesses; to drinking water systems, electrical distribution systems, local road systems, airports, seawalls, and other public infrastructure; and to individual personal and real property; necessitating emergency protective measures and temporary and permanent repairs. On October 25, 2005, a request for a federal time extension was submitted. On December 9, 2005 a presidential disaster was declared (DR-1618) for Public Assistance for the Northwest Arctic Boro, Bering Strait REAA, Kashunamiut REAA (Chevak) and the Lower Kuskokwim REAA however, they failed to include the Lower Yukon REAA in the federal declaration. The State will write Project Worksheets for the Lower Yukon REAA under or State Public Assistance Declaration. Individual Assistance total is estimated at $209K, with 220 applicants. Public Assistance is around $3.63 million for 16 potential applicants with around 20 PW's. Hazard Mitigation total is $254K. The total cost for disaster is estimated at $5.33 million.*

07-222 2006 October Kivalina Storm, Administrative Order #231, issued November 19, 2006 by Governor Frank H. Murkowski. *October 11, 2006 through October 13, 2006 a fall sea storm with sustained high surf and storm surge caused severe wave damage and coastal erosion in the* ***City of Kivalina.*** *Through local declarations on October 19, 2006 the Northwest Arctic Borough and the City of Kivalina requested assistance to repair the seawall and protect community infrastructure. The Alaska village Electric Cooperative also requested state disaster emergency. In accordance with AS*

26.23.020(h) assistance from the disaster relief fund was found appropriate by Governor Murkowski to cover eligible emergency response costs and emergency protective measures. Permanent repairs to or replacement of the seawall were not found to be appropriate for funding. The amount of funding was not to exceed $235,000 including administrative fees. Governor Murkowski also directed the Department of Commerce, Community, and Economic Development (consistent with AO#175) to coordinate with other state and federal agencies to propose long-term solutions to the ongoing erosion issues in Kivalina and other coastal communities in the state of Alaska.

08-225 2007 Kivalina Storm Admin Order # 239 issued by Governor Palin on January 22, 2008. *On September 12 and 13, 2007, a low pressure system from the Bering Sea generated storm conditions and coastal flood warnings for communities along the Chukchi Sea coast, including the* **Cities of Kivalina,** *Shishmaref, and Point Hope. Substantial coastal erosion by high winds, storm surge, and high waves generated by the storm further damaged the existing sea wall adjacent to the Alaska Village Electric Corporation (AVEC) bulk fuel facility. The Northwest Arctic Borough (NWAB) sent a disaster declaration to the Division of Homeland Security and Emergency Management (DHS&EM) on September 25 that included AVEC's response and tank farm relocation costs.*

12-239 Kivalina Water Issue declared by Governor Parnell on September 7, 2012. *On August 13th, a week of record rainfall began in* **Kivalina** *which resulted in record flows on the Wulik River. The high water washed several sections of the surface water piping into the river and overtopped the City's landfill, washing landfill debris into the community. The City of Kivalina and NWAB declared a disaster emergency to make repairs "to the water and landfill infrastructure" and "technical assistance and funding to evaluate damage and perform needed repairs" (DHS&EM 2013).*

Table 5-6 summarizes historical flood impacts for the Kivalina area.

Table 5-6 Historic Flood Events and impacts

Date	Event Type	Magnitude
10/8-23/2002	Fall Storm w/Coastal Storm Surge	State declared disaster, 2002 Northwest Fall Sea Storm; with 18-20 foot seas, extremely high winds, and strong tidal action caused severe damage.
10/18-24/2004	Severe Winter Storm w/Coastal Storm Surge	Federally declared disaster, 2004 Bering Strait Sea Storm; a severe winter storm with strong winds and extreme tidal surges occurred along the Western Alaska coastline, which resulted in severe damage and threat to life and property
9/22-25/2005	Severe Fall Storm w/Coastal Storm Surge	Federally declared disaster, 2005 West Coast Storm; a powerful fall sea storm produced high winds combined with wind-driven tidal surges resulting in severe and widespread coastal flooding and a threat to life and property
10/11-13/2006	Severe Fall Storm w/Coastal Storm Surge	State declared disaster, 2006 Kivalina Storm; a fall sea storm with sustained high surf and storm surge caused severe wave damage and coastal erosion
9/12-12/2007	Fall Storm w/Coastal Storm Surge	State declared disaster, 2007 Kivalina Storm; substantial coastal erosion by high winds, storm surge, and high waves generated by the storm further damaged the existing sea wall adjacent to the Alaska Village Electric Corporation (AVEC) bulk fuel facility.

Table 5-6 Historic Flood Events and impacts

Date	Event Type	Magnitude
8/13-18/2012	Record Rainfall Flood	State declared disaster, Kivalina High Water; a week of record rainfall began in Kivalina which resulted in record flows on the Wulik River. The high water washed several sections of the surface water piping into the river and overtopped the City's landfill, washing landfill debris into the community.

(DHS&EM 2014)

The 2009 Baseline Erosion Assessment described northwest Alaska's high water flow scour (erosion) impact damages which are threatening several identified communities longevity. Scour control efforts are quickly becoming unsustainable as explained below:

> *"According to the Alaska Department of Community Commerce and Economic Development (DCCED), Division of Community and Regional Affairs (DCRA). Capital Projects Database (2009), several communities have received grants or initiated capital projects to address erosion. Some of these projects have been State-funded, and some have been funded through Federal agencies. In either case, the State has played a substantial role in the success of these projects. The following is a sampling of past erosion efforts the State has undertaken for communities prone to erosion damage…*
>
> - ***Kivalina** has had nine erosion control projects completed from 1992 to 2007— most dealing with community relocation. All were funded by DCCED, and the combined total cost was approximately $325,000. Kivalina has one project under construction: a shoreline protection project with a total cost of approximately $1.65 million, funded by DCCED. An additional erosion protection project for Kivalina is in the preliminary stage, with a cost of approximately $3.3 million, funded by DCCED."*
>
> ***2.3.1. U.S. Army Corps of Engineers***
>
> *The Corps, with multiple programs to assist communities with coastal and riverine erosion planning, design, and construction, has received dozens of requests over the years for assistance with Alaska erosion problems. The Corps has received approximately 50 requests for action—most during the last 10 years—for river erosion or coastal storm damage.*
>
> *During the past several years, the U.S. Congress has authorized the Corps to conduct studies related to erosion issues for several communities. In 2003, Congress authorized the Corps to examine the costs of ongoing erosion, the costs to relocate, and the amount of time left before erosion would destroy the communities at Bethel, Dillingham, Galena, Kaktovik, **Kivalina,** Newtok, Shishmaref, and Unalakleet.2 Findings of these studies were documented in the Alaska Village Erosion Technical Assistance (AVETA) Program Report (Corps, 2006)…*
>
> *Under Section 117, the Corps was authorized to investigate erosion at Barrow, Bethel, Kaktovik, **Kivalina,** Koyukuk, Newtok, Point Hope, and Shishmaref. Projects were approved for construction at **Kivalina,** Newtok, Shishmaref, and Unalakleet. Significant construction has occurred at **Kivalina** and Shishmaref to provide revetments that are slowing the rates of erosion. Because of the repeal of Section 117, it is unknown whether those projects can be completed as planned…*

2.4.2. [NRCS] Immediate Action Working Group

Most recently, a collaborative effort, a component of which is examining erosion issues, has developed to address climate change and erosion resulting from climate change within Alaska. The IAWG consists of senior leaders from several State and Federal agencies and is co-chaired by the DCCED Deputy Commissioner and the Chief of Engineering Division of the Corps Alaska District.

Primarily focusing on Kivalina, Koyukuk, Newtok, Shaktoolik, Shishmaref, and Unalakleet, IAWG is recommending a series of actions to assist communities with managing the effects of climate change. IAWG will publish a report in April 2009 that will explain its accomplishments and discuss the need for future actions. The report will include accomplishments and plans of ADOT&PF, DHS, DCCED, NOAA, the Corps, and others. (USACE 2009)

The 2009 USACE Baseline Erosion Assessment Study's AVETA Report Summary – Kivalina, Alaska, stated:

"The winter storms of 2004 and 2005 eroded 70 to 80 feet of uplands behind the school. The bank line is now within 25 feet of the main school structure. Erosion in the vicinity of the AVEC tank farm is similar, with only 5 feet of uplands remaining between the nearest tanks and the bank line. Without the construction of emergency erosion control structures, the school and tank farm will begin to fail within the next year if erosion continues at the same rate as it has during recent months,. Even if erosion slows, these critical structures are in imminent danger and are unlikely to survive for any extended period of time. Due to the physical lack of open land in the Kivalina community, these structures cannot be relocated, and their failure would render the community uninhabitable." (USACE 2009)

5.3.1.2.3 Location, Extent, Impact, and Recurrence Probability

Location

The Planning Team indicated that Kivalina has a major flood threat; mostly from climate change related storm surge impacts. The DCCED's 1999 Community Map, Map Notes for Kivalina are reproduced in Figure 5-8 for readability:

MAP NOTES

This map was prepared under the direction of the Northwest Arctic Borough by McClintock Land Associates, Inc. It was funded by the Alaska Coastal Management Program, Office of the Governor, pursuant to National Oceanic and Atmospheric Administration Award No. NA97020153 and the NANA Regional Corporation. The grant has been administered by the Alaska Office of the Governor, Division of Governmental Coordination, and the Department of Community and Economic Development, Municipal and Regional Assistance Division.

This map is based upon a digital orthophoto prepared to National Map Accuracy Standards from August 17, 1999 photography (original scale 1" = 500').

The orthophoto is an aerial photo which has been corrected, by rectification to ground control stations, to remove distortions and warpage due to ground topography and aircraft tilt and trim.

This map should not be construed as a survey. On-site surveys should be conducted prior to engineering or construction.

Property and utility information has been generated from readily available sources with limited accuracy checks. Property information does not include a search of Recorders Office records. Utility location is particularly imprecise and shows only the main lines as the service lines have been omitted for clarity. Generally, the information is current as of November 15, 1999.

ELEVATION DATA

The datum for the elevation on this map is feet above mean high water (MHW). The State of Alaska, Department of Natural Resources, established several tidal bench marks on this datum at Kivalina, in 1984 in coordination with NOAA. These bench marks were not found in 1999 and are presumed to have been destroyed by erosion since that time. However; during a separate survey project in 1990, McClintock Land Associates tied these bench marks into a brass cap monument at the Witness Corner to the bench mark for this 1999 mapping project and has an elevation of 6.92 feet (MHW).

FLOOD DATA

The U.S. Army Corps of Engineers report "Community Improvement Feasibility Report Kivalina, AK" (April 1998), estimates the 100-year water level to be 10.6 feet above mean lower low water, including wave setup. This is equivalent to 9.83 feet above mean high water (MHW), which was the datum used on this map.(see ELEVATION DATA)

Figure 5-8 1999 Community Map Notes (DCCED 1999)

The community of Kivalina is located on a 700-foot wide, five-mile long barrier island bordered by the Chukchi Sea on the west and the Kivalina Lagoon on the east. The highest elevation point on the island is ten feet above sea level. The community itself is located at the southeast end of the island at the Singauk Entrance to Kivalina Lagoon, where the Wulik River flows into the Chukchi Sea. Northwest end of the island is bound by the Kivalik Inlet, which has been formed by Kivalina River flow.

Flood hazards in Kivalina result almost exclusively from storm surges from south to southeasterly winds. Storm flooding has historically occurred in early fall, before the formation of shore-fast or sea ice. However, Kivalina is subject to storms at any time of year. During summer and fall months, sea storms bring high winds of 40 to 70 knots from the southwest. Winter storms usually bring winds from the northeast. Storm surges, ice override, and coastal flooding can occur in Kivalina due to storms.

Shore-fast ice creates a barrier of grounded ice along the shore; waves break against the ice or are reduced in energy, rather than striking directly against the shore where erosion occurs. Local observations indicate that in recent years, shorefast ice has formed later in the year than usual, leaving the village without protection from fall sea storm flooding.

For nearly two decades, the steady erosion of the shoreline at Kivalina has been viewed with growing alarm (Figure 5-4). The potential loss of the town site to the encroaching sea provides ample justification for its relocation. Moreover, there is no reason to believe that this trend will cease in light of the global forces that appear to be contributing to it. While causes of global

warming are a matter for scientific debate, it is an indisputable fact that climates are changing over most of the planet, and that some of these changes are most evident in the Arctic.

Without addressing global scale effects on the Arctic climate, it is sufficient to note that some of the end effects have potentially dire consequences for Kivalina and other villages located on or near Arctic Ocean shorelines. The steady diminution of the Arctic Ocean ice pack enhances the potential for increased coastal erosion in at least two ways:

- Larger expanses of ice-free water provide longer fetches over which winds can generate ocean waves that are higher, longer, and thus potentially more destructive to the shorelines where they ultimately dissipate their energy.
- Since the early 1980s the time between spring break-up of land-fast sea ice and autumn freeze-up along Arctic shorelines has increased from barely three months to as much as five months. This substantially extends the "season" for coastal erosion.

Extent

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

The following factors contribute to riverine flooding frequency and severity:

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

The City experiences severe storm surge flooding and scour and the Wulik River experiences extensive high water flow flooding and erosion with impacts to their potable water capture site. Therefore, based on past high water flow event history and the criteria identified in Table 5-3, the extent of flooding and resultant damages to infrastructure and their protective embankments in the City are considered "Critical" where critical facilities would shut-down for at least two weeks and potentially severely impacting and damaging more than 25 percent of property.

Impact

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

- Structure flood inundation, causing water damage to structural elements and contents
- High water flow storm surge floods scour (erode) coastal embankments, coastal protection barriers, and result in infrastructure and residential property losses. Additional impacts can include roadway embankment collapse, foundations exposure, and damaging impacts
- Damage to structures, roads, bridges, culverts, and other features from high-velocity flow and debris carried by floodwaters. Such debris may also accumulate on bridge piers and in culverts, decreasing water conveyance and increasing loads which may cause feature overtopping or backwater damages
- Sewage, hazardous or toxic materials release, materials transport from wastewater treatment plant or sewage lagoon inundation, storage tank damages, and/or severed pipeline damages can be catastrophic to rural remote communities

Floods also result in economic losses through business and government facility closure, communications, utility (such as water and sewer), and transportation services disruptions. Floods result in excessive expenditures for emergency response, and generally disrupt the normal function of a community.

Impacts and problems also related to flooding are deposition as well as embankment, coastal erosion, and/or wind. Deposition is the accumulation of soil, silt, and other particles on a river bottom or delta. Deposition leads to the destruction of fish habitat, presents a challenge for navigational purposes, and prevents access to historical boat and barge landing areas. Deposition also reduces channel capacity, resulting in increased flooding or bank erosion. Embankment erosion involves material removal from the stream or river banks, coastal bluffs, and dune areas. When bank erosion is excessive, it becomes a concern because it results in loss of embankment vegetation, fish habitat, and land, property, and essential infrastructure (BKP 1988).

A short-term implication of these facts is that the present town site will require coastal erosion protection until relocation is completed. Statistics indicate that the interval of occurrence for a 4-foot elevation storm surge, as occurred on 20 October 2004, is once a year. According to Wise et al. (1981), a 6-foot storm surge would have a recurrence interval of less than 5 years. The approximate island height of 5.5 feet would indicate that a 6 foot storm would only result in 6 inches of water cover. Modeling indicates that the 100-year storm surge event would have a water surface of 3.2 meters (10.5 feet) with no ice cover. The status of ice cover during a storm surge event will play a major role in determining how much flooding could occur.

Climate Change Flood Impacts to Kivalina

It is possible that observed trends related to delays in formation of shore-fast ice and sea ice are resulting in fall storms that 1) have more wave energy, and 2) cause damage later in the fall because the period of open water is greater. Recent beach erosion and sediment deposition patterns may also allow storm generated waves and surges to reach the community, resulting in a higher potential for flooding.

The extent of sea ice cover reduces the effective fetch by “dampening” the ocean surface and limiting the formation of wind generated waves. According to the storm surge climatology assessment produced by Wise et al. (1981), the 4-foot surge that occurred on October 20, 2004

and caused flooding in Kivalina has a statistical probability of occurrence, also called "recurrence interval," of about one year. That is, a storm surge of this magnitude should be expected to occur annually. However, prior to October 2004, there had been only two recorded storms to date that have overtopped portions of the island since the establishment of the current Kivalina town site in 1905.

Fall storms and storm surges can result in beach and shoreline erosion. Significant beach erosion resulted from the 18-20 October 2004 storm, causing a loss of shoreline and damage to some structures along the beach. The teacher housing building had to be relocated due to storm surge erosion that turned the once slow-sloping beach into a drop-off. It is reasonable to deduce that beach erosion events, such as the one in October 2004, are occurring more frequently for reasons similar to those discussed in proceeding sections. The marked reduction of beach width adjacent to Kivalina since the early 1980s attests to the greater frequency and severity of these erosion events.

Ocean waters adjacent to Kivalina are subject to the complex dynamics associated with Bering Strait flows between the Chukchi and Bering Seas. While the net oceanic flow along the Chukchi Sea's southeastern coast is generally northward, it is subject to short-term temporal fluctuations of both oceanographic and atmospheric origin, as well as localized spatial variations due to the presence of headlands, straits, and the influence of major rivers.

Of greater oceanographic relevance to the present Kivalina village site, however, is its exposure to wind-generated waves. Winds from the south to southwest generate waves that expend their full energy directly onto Kivalina's beaches, resulting in accelerated erosion and a redistribution of beach sediments approximately perpendicular to the coastline. While these storm waves can be destructive, the sediments that are moved offshore remain available to re-build the beach under the action of smaller waves that occur under lighter winds from the southwest.

Waves produced by south to southeasterly winds are not as high or long as those from the southwest, because of the shorter fetch. However, these waves are more destructive to Kivalina beaches because they may ride atop a storm surge that can raise sea level by several feet along Kivalina's barrier island. Also, due to their oblique assault on the shoreline, these waves provide the energy for long-shore currents that sweep the sediment away to the north.

The effects of this combination of destructive forces is illustrated by the storm of 18-20 October 2004 which flooded the community in several locations, significantly eroded the shoreline, and damaged property at the school site. Forty-knot southeasterly winds (gusting to nearly 60 knots) produced a 4-foot storm surge, as measured at the Red Dog Mine dock a few miles to the northeast of Kivalina.

Although less common than waves from the southerly quadrant, waves from the northwest can potentially be higher, longer, and more destructive than waves from other directions. Patterns of sediment transport near Singauk Entrance provide evidence of the influence of these waves on local beach dynamics. Although sea level would be depressed slightly (i.e. "negative" storm surge) due to northwest winds along the southeast Chukchi Sea coastline, waves generated over the much longer fetch could be much more destructive than those that occur under the more frequent southerly winds.

The island is subject to severe erosion on three sides: along the ocean side, near the Signauk Entrance at the south tip of the village, and on the lagoon side where the flow from the Wulik and Kivalina Rivers converge. Erosion has been occurring steadily for over two decades, with signs of acceleration in recent years.

Recurrence Probability

There is better than a 50-50 chance of seeing a 6-foot storm surge before the relocation is completed; some provisions should be made to prepare for that occurrence. Other consequences of global warming that are relevant to the community include sea level rise and permafrost degradation.

Relocating the Kivalina town site to an inland area would alleviate concerns regarding potential island site flooding as well as providing relief from shoreline erosion. However, the relocation effort is predicted by [USACE] to be 15 to 20 years away.

The USACE 2006 Kivalina Relocation Master Plan states:

> *"The revised evaluation of storm surge indicates that existing 1970 storm of record resulted in a 13.57 foot surge that inundated portions of the existing site. Results of modeling calculated that the 50 year occurrence storm surge would reach and elevation of 13.5 feet and the 100 year occurrence storm surge would reach an elevation of 16.1 feet.*
>
> *It is important to recognize that there is a 70% chance that an event with a 5 year recurrence interval will occur during the five-year period that will be required for relocation of Kivalina. There is better than a 50% chance of seeing a 6 foot storm surge before the relocation is completed; some provisions should be made to prepare for that occurrence. (Re-Locate Kivalina 2006)*

Based on previous occurrences, USACE reports, and criteria in Table 5-4, there is a 1 in 1 year (1/1=100 percent) chance of occurring. History of events is greater than 33 percent likely per year. It is "Highly Likely" that continued storm surge events will impact Kivalina.

5.3.1.3 Ground Failure

5.3.1.3.1 Nature

Ground failure describes avalanche, landslide, subsidence, and unstable soils gravitational or other soil movement mechanisms. Soil movement influences can include rain, snow, and/or water saturation induced avalanches or landslides; as well as from seismic activity, melting permafrost, river or coastal embankment undercutting, or in combination with steep slope conditions.

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

Additionally, avalanches, landslides, and other ground failure incidents often occur secondary to other natural hazard events, thereby exacerbating conditions, such as:

- Earthquake ground movement can trigger events ranging from rock falls and topples to massive slides
- Intense or prolonged precipitation can cause slope over-saturation and subsequent destabilization failures such as avalanches and landslides.
- Climate change related drought conditions may increase wildfire conditions where a wildland fire consumes essential stabilizing vegetation from hillsides significantly increasing runoff and ground failure potential

Development, construction, and other human activities can also provoke ground failure events. Increased runoff, excavation, shocks and vibrations from construction, non-engineered fill places excess surface stresses, and changes in vegetation have all led to ground failure events. Broken underground water mains and melting permafrost can also saturate and destabilize soil, initiating subsidence and or frost heaves. Something as simple as a blocked culvert can increase and alter water flow, thereby increasing the potential for a ground failure event in an area with high natural risk. Geologic material weathering and decomposition and surface or ground water flow alterations can further increase the potential for landslides.

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

Seasonal freezing can cause frost heaves and frost jacking. Frost heaves occur when ice forms in the ground and separates sediment pores, causing ground displacement. Frost jacking causes unheated structures to move upwards. Permafrost is frozen ground in which a naturally occurring temperature below 32ºF has existed for two or more years. (DHS&EM 2013).

Indicators of a possible ground failure include:

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

- Sticking doors and windows, visible spaces indicating frames out of plumb

The State of Alaska 2013 State Hazard Mitigation Plan provides additional ground failure information defining mass movement types, topographic and geologic factors which influence ground failure.

5.3.1.3.2 History

USACE has performed extensive site investigations for the Kivalina area, at the current location as well as numerous potential relocation sites. Their research has determined that the area is fraught with extensive potential ground failure, namely permafrost, impact areas. However, the DHS&EM Disaster Cost Index lists one historical ground failure event affecting the City: The following information will detail this data.

5.3.1.3.3 Location, Extent, Impact, and Recurrence Probability

Location

The 1976 DCCED Community Map for Kivalina states the entire community is located on continuous permafrost. This soil condition supports the City's statements that the community is continually fighting ground failure impacts from land subsidence and frost heaving. This creates very unstable buildings and construction conditions throughout the community.

The 1976 DCCED Community Map for Kivalina provides detailed soils data. For example: a Map inset panel portrays ice wedge growth patterns (Figure 5-9):

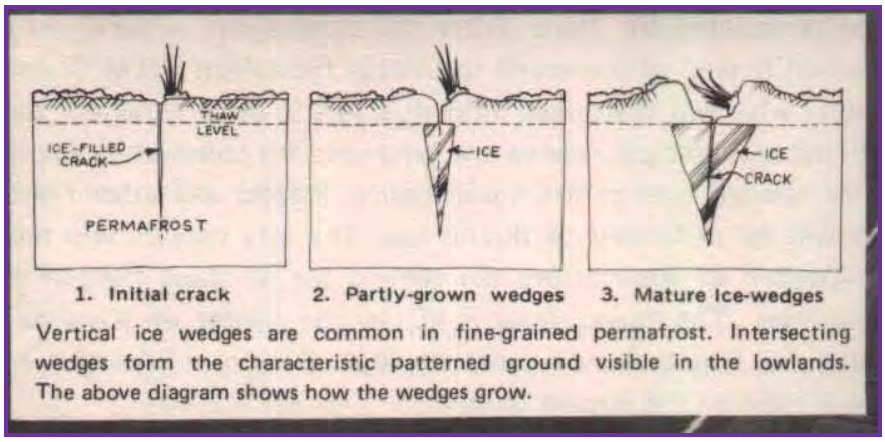

Figure 5-9 Kivalina Soil Ice Wedge Growth (DCCED 1976).

Other ground failure impacts continually affect the community, as evidenced in additional 1976 Community Map provided information: (Figure 5-10)

Topography and Soils

Kivalina lies on a flat sand and gravel spit. The spit is 11 feet above sea level at the airport. A well log indicates that sand and fine gravel exist to a depth of 18 feet and are underlain by frozen clay and gravel.

Permafrost—Permafrost (permanently frozen ground) is present on the mainland as well as beneath the thawed spit. Vertical ice lenses occur in frozen silts southeast of the village and throughout much of the lowland east of Kivalina Lagoon. If the village were ever expanded to the mainland, permafrost would have to be protected from thawing. The most common methods of protecting permafrost are to place a thick gravel pad between the structure and the frozen ground to limit heat transfer or to raise buildings on pilings to allow air circulation under the structure. Utility pipes should be properly insulated or placed in utilidors so that a minimum of heat would transfer from the pipes to the adjacent ground. Frozen clays beneath the village are naturally protected by the thick layer of sand and fine gravel in the spit.

Erosion and Flooding—Storm surges and wind-driven waves can cause coastal flooding at Kivalina. According to the U.S. Army Corps of Engineers, 20 to 30 percent of the village was flooded in 1970. In spite of flooding and storms, very little beach erosion has occurred. In order to maintain the stability of the coastline, removal of sand and gravel should be restricted to the mainland side of the spit.

The most important thing to remember when building in the Arctic is that successful design requires site investigation and the advice of competent engineers because of the special conditions in the North. Neglecting these considerations can lead to complete failure of structures.

Figure 5-10 Kivalina Topography and Soils (DCCED 1976).

The USACE June 2006, Kivalina Relocation Planning Project Master Plan describes the area's geologic conditions to include ground failure events such as poor soil geology, melting permafrost, and various ocean scour impacts:

5

*"**Executive Summary***

The village of Kivalina, on a barrier island off the Chukchi Sea 80 miles north of the Arctic Circle, has been threatened by erosion caused by wave action and sea storms for several decades. It has long been apparent that the island would eventually succumb to natural forces, and that the village would have to be moved. To this end, village residents have pursued relocation for the last twenty years. Their efforts have been stymied by difficulties in choosing a new village site, funding the relocation effort, and social problems within the village stemming from overcrowding, poverty, and other difficult living conditions.

An increase in the frequency and intensity of sea storms, degradation and melting of permafrost, and accelerated erosion of the shoreline have recently forced the village into a state of emergency. Sea storms have eroded the shoreline out from underneath several structures and threatens the airstrip. Emergency erosion control measures are in place, but will only slow the sea's inevitable reclamation of the island. The relocation effort is now critical to the survival of the community…

1.5 PROBLEMS AND OPPORTUNITIES

Permafrost degradation can result in lowering the elevation of the surface elevation and increasing the rates of erosion of ice rich soils along the coast...

2 PLANNING AREA

2.1 PLANNING AREA PHYSICAL SETTING

The highest elevation point on the island is ten feet above sea level…

2.1.3 Geology

Kivalina is located in a coastal area of low topographic relief, consisting of gentle sloping, rubble-covered hills, separated by broad expanses of tundra. Test holes indicate that the soils appear to be gravel and sands at the beach, with ice-rich frozen silts farther inland. The areas around Kivalina have an elevation near sea level, while the hills located to the northeast rise to an elevation of a few hundred feet. Bedrock of limestone and dolomite is found in outcrops along river-cut bluffs of the Kivalina River. Marine deposits lie over bedrock near the mouth of the Kivalina River. Pleistocene glaciers originating in the mountains of the western Brooks Range covered the upper reaches of

the Wulik and Kivalina Rivers, but did not advance into the lower elevations. Low-lying portions of land surrounding Kivalina are covered with unconsolidated quarternary deposits of unknown thickness, ranging in size from clay to gravel. The floodplains of both rivers are broad and braided. ***The region has continuous permafrost, which may be found within a few feet below the ground surface. Permafrost may be as thick as 600 feet, with the potential for thaw bulbs in the vicinity of the Wulik and Kivalina Rivers.*** *(U.S. Army Corps of Engineers 1998 Community Improvement Feasibility Study). Limited soils investigations were conducted as part of this study.*

2.1.5.2 Erosion

Soils at the existing town site are permanently frozen except in the active layer and at the active beach zones, which allows beach erosion where tides and ocean waves can affect unfrozen ground. The erosion stability of the Kivalina spit relies on the integrity of the vegetative mat that keeps surface soil from washing away and insulates the underlying permafrost beneath the active layer. The absence of sea ice during recent fall storms has left the beaches vulnerable to erosion in the form of undercutting… the vegetative mat, which in turn creates a small bluff on the ocean side that exposes the vegetative mat to further undercutting and increasingly severe erosion. This process is further accelerated by destabliz[ing] the underlying permafrost due to climate change…

2.1.5.3 Seismic

…The presence of generally continuous permafrost precludes a liquefaction hazard at undeveloped sites, except within the thaw bulbs of rivers and lakes. Ground thawing induced by site development could result in a liquefaction hazard. The sites most prone to liquefaction upon thawing would be those in low-lying areas with a high water table…

3.2 Non Site Specific Alternatives

3.2.1 Site Preparation

…Kivalina has land that needs to be raised above 100 year storm surge level, which would require 6.5 feet of fill.

Techniques to keep ice-rich permafrost frozen include: gravel pads, gravel pads with insulation, thermosyphen installation, and thermopile installation. Thermosyphen and thermopile designs are usually considered for buildings and/or tank farms. In order to have buried utilities on the sites, a gravel pad is recommended so that water, sewer, and other utilities can be located below grade. Thermopile or thermosyphens may still be used for individual buildings, however this will be decided during future design phases" (USACE 2006).

The *Permafrost and Ice Conditions Map of Alaska* (Figure 5-11) developed for the National Snow and Ice Data Center/World Data Center for Glaciology, shows that Kivalina has continuous permafrost. This is supported by soil investigations during various USACE geological studies where permafrost was encountered at very shallow depths throughout the City and potential community relocation sites.

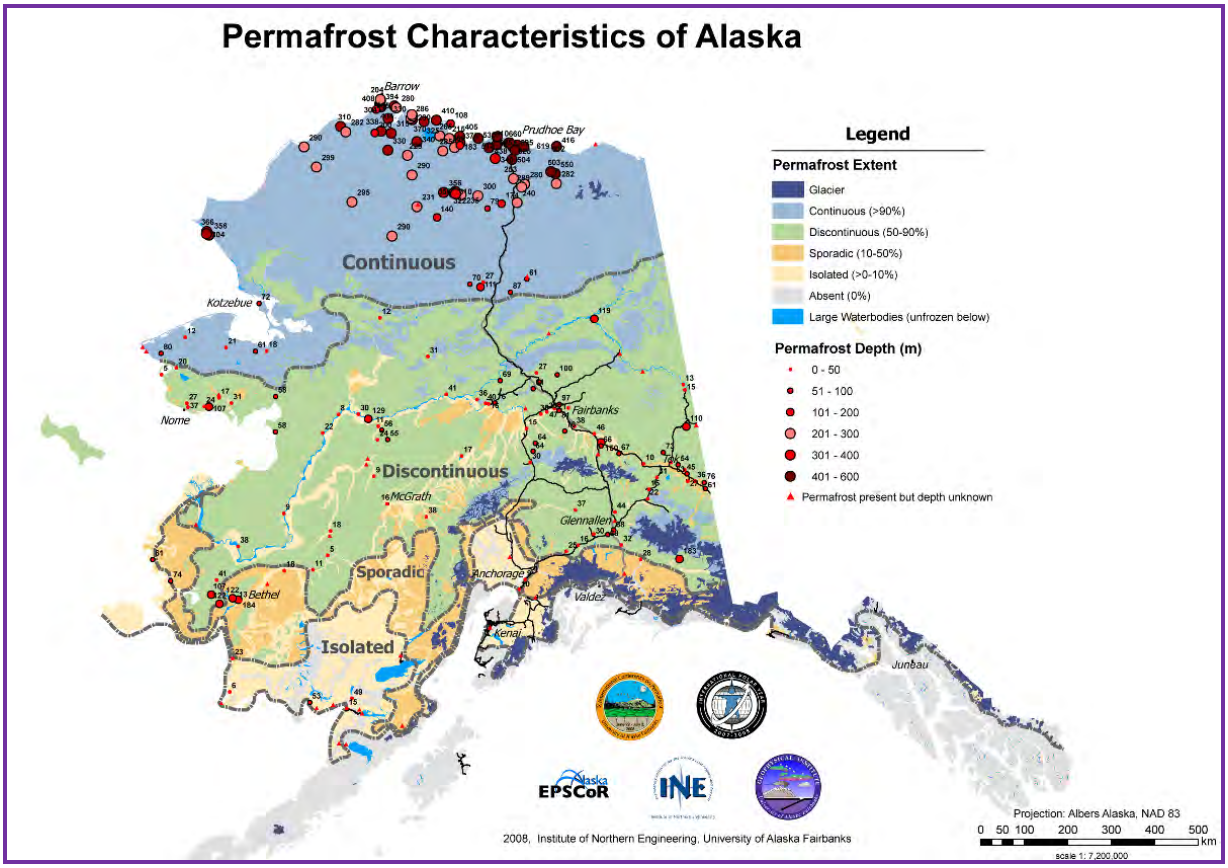

Figure 5-11 Permafrost and Ground Ice Map of Alaska (Jorgenson et al 2008)

Extent

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

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

Impact

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

Recurrence Probability

Even though there are few written records defining ground failure impacts for the City, the USACE investigations reveal that permafrost needs to be considered during all construction and City relocation activities because subsequent ground failure damages would most like occur from poorly designed site preparation to structures, roads, harbor areas, and the airport.

Therefore the probability for ground failure follows the criteria in Table 5-4, the future damage probability resulting from ground failure is "Highly Likely" within any calendar year (event has up a 1 in 1 years chance of occurring (1/1=100 percent), as the history of events is greater than 33 percent likely per year.

5.3.1.4 Severe Weather

5.3.1.4.1 Nature

Severe weather occur throughout Alaska with extremes experienced by the Kivalina that includes rain/ freezing rain/ice storm, hail, heavy and drifting snow, extreme cold, and high winds. The City experiences periodic severe weather events.

Climate Change influences the environment, particularly historical weather patterns. Climate change and El Niño/La Niña Southern Oscillation (ENSO) influences create increased weather volatility such as hotter summers (drought) and colder winters, intense thunderstorms, lightning, hail, snow storms, freezing rain/ice storms, high winds and even a few tornadoes within and around Alaska.

ENSO is comprised of two weather phenomena known as El Niño and La Niña. While ENSO activities are not a hazard, they can lead to severe weather events and large-scale damage throughout Alaska's varied jurisdictions. Direct correlations were found linking ENSO events to severe weather across the Pacific Northwest, particularly increased flooding (riverine, coastal storm surge) and severe winter storms. Therefore, increased awareness and understanding how ENSO events potentially impact Alaska's vastly differing regional weather.

Climate change is described as a phenomena of water vapor, carbon dioxide, and other gases in the earth's atmosphere acting like a blanket over the earth, absorbing some of the heat of the sunlight-warmed surfaces instead of allowing it to escape into space. The more gasses, the thicker the blanket, and the warmer the earth. Trees and other plants cannot absorb carbon dioxide through photosynthesis if foliage growth is inhibited. Therefor 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.

The governor's Alaska's Climate, Ecosystems & Human Health Work Group is tasked with determining how the changing ecosystems may impact human health and to identify, prioritize, and educate Alaskan's about the connection between their health and changing environmental patterns.

The National Oceanic and Atmospheric Administration (NOAA) has been producing the Arctic Report Card since 2006, providing peer reviewed climate change data that describes the current

arctic environmental system as an indication of climate change impacts. The Arctic Report Card Update for 2014 states:

> *"… Mean annual air temperature continues to increase in the Arctic, at a rate of warming that is more than twice that at lower latitudes… In Alaska this led to statewide temperature anomalies of +10°C in January, due to warm air advection from the south, while temperature anomalies in eastern North America and Russian were -5°C, due to cold air advection from the North…*
>
> *As the sea ice retreats in summer and previously ice-covered water is exposed to solar radiation, sea surface temperature (SST) and upper ocean temperatures in all the marginal seas of the Arctic Ocean are increasing; the most significan linear trend is in the Chukchi Sea, where SST is increasing at a rate of 0.5°C/decade. In summer of 2014, the largest SST anomalies, as much as 4°C above the 1982-2010 average, occurred in the Barents Sea and the Bering Strait region, which includes the Chukshi Sea.*
>
> *Declining summer sea ice extent is also leading to increasng ocean primary production due to solar radiation being available over a larger area of open water. The greatest increases in primary production during the period of SeaWiFS and MODIS satellite observation (1998-2010) occurred in the East Siberian Sea (+112.7%), Laptev Sea (+54.6%) and Chukchi Sea (+57.2%)…*
>
> *In August 2014, the warmest SST anomalies were observed in the vicinity of the Bering Strait and the northern region of the Laptev Sea . SSTs in those regions were the warmest since 2007, with values as much as -4°C warmer than the 1982-2010 August mean…*
>
> *Cold anomalies have also been observed in some regions in recent summers (Timmermans et al. 2013, 2014). For example, cooler SSTs in the Chukchi and East Siberian seas in August 2012 and August 2013 were linked to later and less-extensive sea-ice retreat in these regions in those years. In addition, a strong cyclonic storm during the first week of August 2012 (Simmonds 2013), which moved eastward across the East Siberian Sea and the Chukchi and Beaufort seas, caused anomalously cool SSTs as a result of mixing of warm surface waters with cooler deeper waters (Zhang et al. 2013)…*
>
> *Recent declines in minimum Arctic sea ice extent (see the essay on Sea Ice) have contributed substantially to shifts in primary productivity throughout the Arctic Ocean. Studies using Seaviewing Wide Field-of-view Sensor (SeaWiFS) and Moderate Resolution Imaging Spectroradiometer (MODIS) across the entire Arctic Ocean reveal that the Barents and Greenland seas are the most productive marine environments in the Arctic, whereas the East Siberian and Chukchi seas are the least productive (Petrenko et al. 2013). However, the greatest increases in primary production during 1998-2010 occurred in the East Siberian Sea (+112.7%), Laptev Sea (+54.6%) and Chukchi Sea (+57.2%) (Petrenko et al. 2013)…*
>
> *Loss of sea ice, facilitating the increased availability of solar radiation will not affect primary productivity rates in the absence of sufficient nutrients for production. Better knowledge of nutrient distributions across the Arctic Ocean is critical for understanding how climate warming,*
>
> *Recent seasonal sea ice retreat has shown important impacts on the timing of phytoplankton blooms across the Arctic, including the remarkable inter-annual differences in small-cell phytoplankton community structure across the northern Chukchi Sea (Fujiwara et al. 2014), where haptophytes (e.g., unicellular algae, including*

coccolithophorids) dominated in warm surface waters during 2008 1 while prasinophytes (e.g., unicellular green algae, including flagellates) dominated in cold water during 2009 and 2010 (when sea ice retreated -1-2 months later than in 2008). Interestingly, Ji et al. (2013) have found that the timing of sea ice retreat has a strong effect on the timing of pelagic phytoplankton peaks over a large portion of the Arctic marginal seas, but weak or no impact on the timing of ice-algae peaks in the same regions.

Recent observed shifts in the timing of phytoplankton blooms also include the unexpected development of a secondary bloom in the autumn (Ardyna et al. 2014). This secondary bloom coincides with delayed formation of sea ice and longer exposure of the sea surface to wind stress, which presumably weakened vertical stratification and allowed nutrients to return to the euphotic zone" (Jeffries et al. 2014).

Heavy Rain occurs rather frequently over the coastal areas along the Bering Sea and the Gulf of Alaska. Heavy rain is a severe threat.

Heavy Snow generally means snowfall accumulating to four inches or more in depth in 12 hours or less or six inches or more in depth in 24 hours or less.

Drifting Snow is the uneven distribution of snowfall and snow depth caused by strong surface winds. Drifting snow may occur during or after a snowfall.

Freezing Rain and Ice Storms occur when rain or drizzle freezes on surfaces, accumulating 12 inches in less than 24 hours. Ice accumulations can damage trees, utility poles, and communication towers which disrupts transportation, power, and communications.

Extreme Cold is the definition of extreme cold varies according to the normal climate of a region. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme". In Alaska, extreme cold usually involves temperatures between -20 to -50°F. Excessive cold may accompany winter storms, be left in their wake, or can occur without storm activity. Extreme cold accompanied by wind exacerbates exposure injuries such as frostbite and hypothermia.

High Winds occur in Alaska when there are winter low-pressure systems in the North Pacific Ocean and the Gulf of Alaska. Alaska's high wind can equal hurricane force but fall under a different classification because they are not cyclonic nor possess other hurricane characteristics. In Alaska, high winds (winds in excess of 60 mph) occur rather frequently over Kivalina's coastal areas.

Winter Storms include a variety of phenomena described above and as previously stated may include several components; wind, snow, and ice storms. Ice storms, which include freezing rain, sleet, and hail, can be the most devastating of winter weather phenomena and are often the cause of automobile accidents, power outages, and personal injury. Ice storms result in the accumulation of ice from freezing rain, which coats every surface it falls on with a glaze of ice. Freezing rain is most commonly found in a narrow band on the cold side of a warm front, where surface temperatures are at or just below freezing temperatures. Typically, ice crystals high in the atmosphere grow by collecting water vapor molecules, which are sometimes supplied by evaporating cloud droplets. As the crystals fall, they encounter a layer of warm air where they particles melt and collapse into raindrops. As the raindrops approach the ground, they encounter a layer of cold air and cool to temperatures below freezing. However, since the cold layer is so

shallow, the drops themselves do not freeze, but rather, are supercooled, that is, in liquid state at below-freezing temperature. These supercooled raindrops freeze on contact when they strike the ground or other cold surfaces.

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

Winter storm floods are discussed in Section 5.3.2.

Figure 5-12 displays Natural Resources Conservation Service's (NRCS) Alaska annual rainfall map based on Parameter-elevation Regressions on Independent Slopes Model (PRISM) that combines climate data from NOAA and NRCS climate stations with a digital elevation model to generate annual, monthly, and event-based climatic element estimates such as precipitation and temperature.

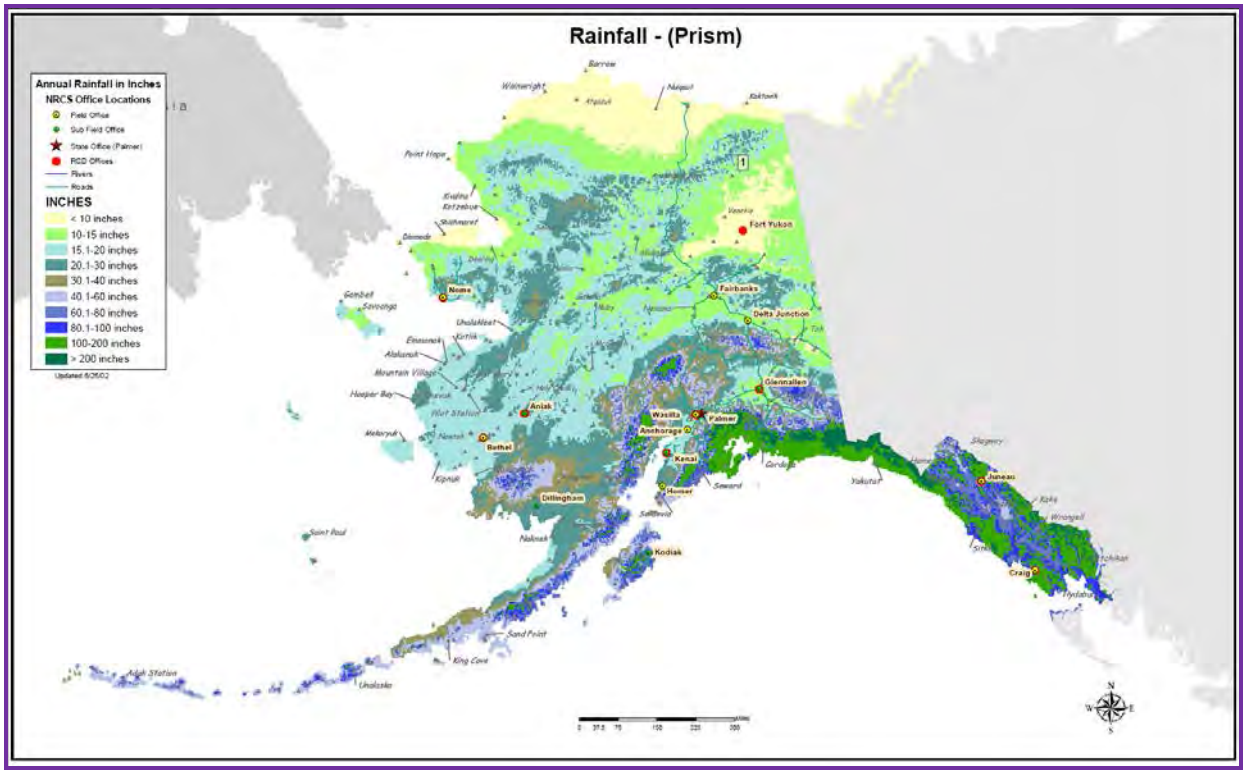

Figure 5-12 Statewide PRISM Rainfall Map (NRCS 2014)

5.3.1.4.2 History

Kivalina is continually impacted by severe weather events. Hurricane force wind, storm surge, and cold typically have disastrous results. Table 5-8 summarizes precipitation and snowfall trends for the Kivalina area providing a representation of the typical weather events which may have historically impacted the City.

Climate Change. The University of Alaska Fairbanks (UAF) Arctic Climate Impact Assessment describes recent weather changes and how they impact Alaska:

> *"**18.3.3.1. Changes in climate***
>
> *Alaska experienced an increase in mean annual temperature of about 2 to 3 ºC between 1954 and 2003…Winter temperatures over the same period increased by up to 3 to 4 ºC in Alaska and the western Canadian Arctic, but Chukotka experienced winter cooling of between 1 and 2 ºC…*
>
> *The entire region, but particularly Alaska and the western Canadian Arctic, has undergone a marked change over the last three decades, including a sharp reduction in snow-cover extent and duration, shorter river- and lake ice seasons, melting of mountain glaciers, sea-ice retreat and thinning, permafrost retreat, and increased active layer depth. These changes have caused major ecological and socio-economic impacts, which are likely to continue or worsen under projected future climate change. Thawing permafrost and northward movement of the permafrost boundary are likely to increase slope instabilities, which will lead to costly road replacement and increased maintenance costs for pipelines and other infrastructure. The projected shift in climate is likely to convert some forested areas into bogs when ice-rich permafrost thaws. Other areas of Alaska, such as the North Slope, are expected to continue drying. Reduced sea-ice extent and thickness, rising sea level, and increases in the length of the open-water season in the region will increase the frequency and intensity of storm surges and wave development, which in turn will increase coastal erosion and flooding…*
>
> *18.3.3.4. Impacts on people's lives*
>
> *Traditional lifestyles are already being threatened by multiple climate-related factors, including reduced or displaced populations of marine mammals, seabirds, and other wildlife, and reductions in the extent and thickness of sea ice, making hunting more difficult and dangerous. Indigenous communities depend on fish, marine mammals, and other wildlife, through hunting, trapping, fishing, and caribou/reindeer herding. These activities play social and cultural roles that may be far greater than their contribution to monetary incomes. Also, these foods from the land and sea make significant contributions to the daily diet and nutritional status of many indigenous populations and represent important opportunities for physical activity among populations that are increasingly sedentary…" (ACIA 2014)*

Figure 5-13 delineates the Weather Service Office's (WSO) weather data. Actual community temperatures and depths may vary due to their relative proximity to the WSO.

KOTZEBUE 25 N, ALASKA (505051)

1981-2010 Monthly Climate Summary

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	2.2	2.0	8.7	24.8	46.2	62.8	66.3	58.9	46.1	26.5	9.9	6.2	30.2
Average Min. Temperature (F)	-15.0	-15.6	-13.0	3.4	25.3	39.1	44.8	40.0	29.6	12.0	-5.3	-11.4	11.2
Average Total Precipitation (in.)	0.76	0.70	0.82	0.55	0.50	0.59	2.03	3.02	2.57	2.02	1.02	0.98	15.54

Unofficial values based on averages/sums of smoothed daily data. Information is computed from available daily data during the 1981-2010 period. Smoothing, missing data and observation-time changes may cause these 1981-2010 values to differ from official NCDC values. This table is presented for use at locations that don't have official NCDC data. No adjustments are made for missing data or time of observation. Check NCDC normals table for official data.

Western Regional Climate Center, wrcc@dri.edu

5

Figure 5-13 Kotzebue WSO Monthly Climate Summaries (WRCC 2014)

DHS&EM's Disaster Cost Index records the following severe weather disaster events which may have affected the area:

> *"83. **Omega Block Disaster, January 28, 1989 & FEMA declared (DR-00826) on May 10, 1989** The Governor declared a statewide disaster to provide emergency relief to communities suffering adverse effects of a record breaking cold spell, with temperatures as low as -85 degrees. The State conducted a wide variety of emergency actions, which included: emergency repairs to maintain & prevent damage to water, sewer & electrical systems, emergency resupply of essential fuels & food, & DOT/PF support in maintaining access to isolated communities" (DHS&EM 2014).*

Kivalina area is continually impacted by severe weather. Figures 5-14 and 5-15 depict the City's historic and future predicted precipitation and temperatures. **Note**: the projected decreasing precipitation due to climate changes. Decreased rain and snow could dramatically increase wildland fire potential as well as wildlife habitat.

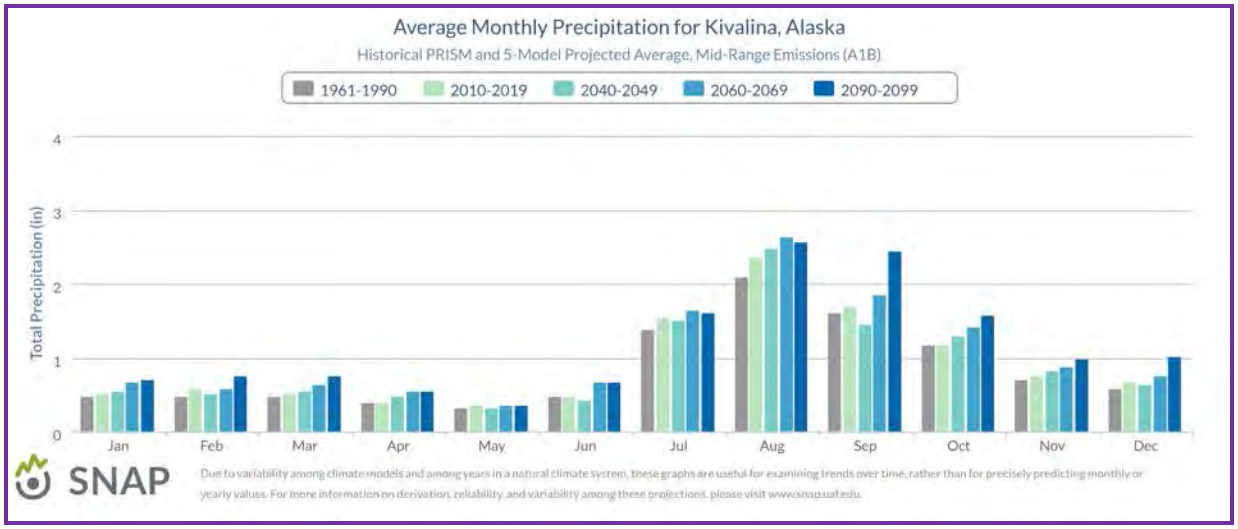

Figure 5-14 Kivalina's Historic and Predicted Precipitation (SNAP 2014).

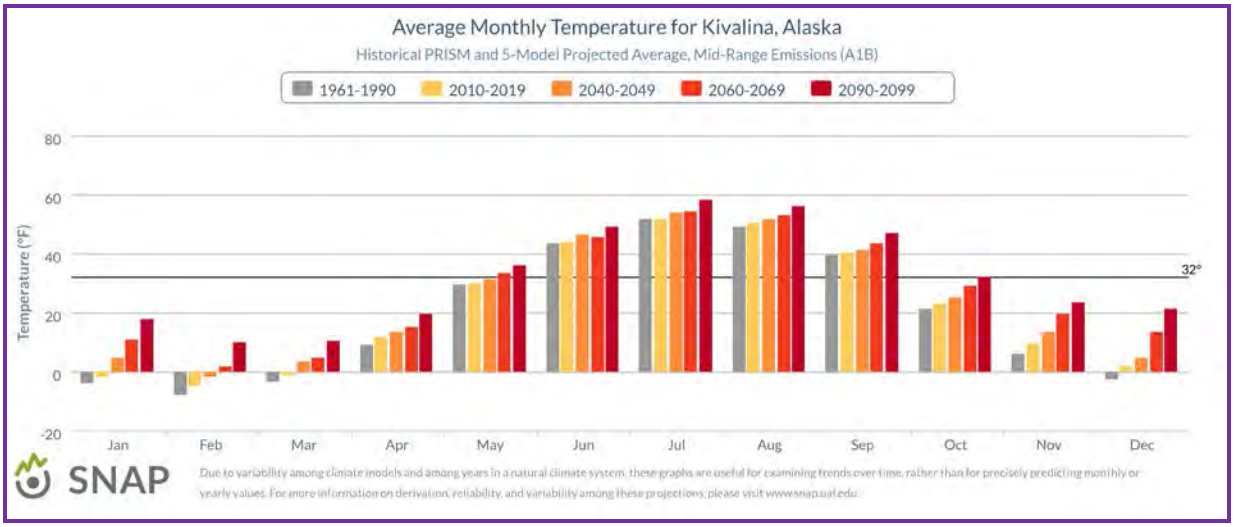

Figure 5-15 Kivalina's Historic and Predicted Temperatures (SNAP 2014)

The mean annual snowfall for the Kivalina area is 50 inches (Environmental Atlas of Alaska). Snow is possible in Kivalina throughout the year, but is most common from October through April. During the winter months, blowing snow from the prevailing northeasterly winds creates large snowdrifts across the community, resulting in transportation and housing access problems. Because the airstrip is perpendicular to the prevailing winds, it is subject to heavy drifting during storms. A snowstorm in April 2001 resulted in 20-foot snowdrifts throughout the community, trapping some residents in their homes until neighbors were able to rescue them. Drifting also creates hazards to the residents when snow accumulates near windows and doors that can provide emergency egress, and covers fuel tanks and other above ground facilities (Figure 5-16).

Figure 5-16 Winter 2008, Aerial Photo by Tim Matsui (Matsui 2008)

Prevailing winds at Kivalina are from the northeast, according to preliminary data collected by the Alaska Department of Transportation & Public Facilities (DOT&PF) and the National Weather Service. However, the highest wind velocities are from the southeast, with the highest recorded wind speed of 54 mph. Strong northerly and southeasterly winds have also been recorded at Kivalina.

Kivalina has long cold winters and relatively cool summers. Temperatures range from 58° F in the summer to -17° F in the winter. The Chukchi Sea is generally ice-free in the summer and open to boat traffic from mid-June to the first of November. Ice starts forming on the open ocean during the fall, and becomes shore fast as the temperature drops. Areas of open water may occur during the winter depending on changes in wind, currents, and temperature.

Table 5-7 lists a representative sample of Kivalina's major storm events the reported by the National Weather Service (NWS) for the Chukchi Sea's Weather Zone. Each weather event may not have specifically impacted the area. These storm events are listed due to their close proximity to listed communities or by location within the identified zone.

Table 5-7 Severe Weather Events

Location	Date	Event Type	Magnitude
Chukchi Sea Coast (Zone)	4/7/2011	Blizzard, Wind 41 mph	Zone 207: Blizzard conditions were observed at Kivalina from 0816 hours (hrs) Alaska Standard Time (AKST) through 1333 hrs AKST on the 7th. The visibility was reduced to one quarter mile in snow and blowing snow. There was a peak wind gust of 41 miles per hour [mph] (36 knots [kts.]) at the Kivalina ASOS.
Chukchi Sea Coast (Zone)	2/24/2011	Coastal Flood	Zone 207: At least 32 musk oxen perished, likely due to coastal flooding in the Bering Sea Land Bridge National Preserve along the northern Seward Peninsula Coast. The musk oxen were found about three weeks after the storm by researchers in the area. There are no tide gages [in the area], but based on the gage at Red Dog Dock on the other side of the Kotzebue Sound the inundation likely occurred on the 24th.
Chukchi Sea Coast (Zone)	2/17/2011	Blizzard. Wind 57 mph	Zone 207: Blizzard conditions were observed at Kivalina, from approximately 0100AKST through 1700AKST on the 17th. The visibility was frequently reduced to one quarter mile or less in snow and blowing snow. There were reports of snow drifts of up to 12 feet in the village, and both the school and airfield were closed. There were several search and rescues required for missing persons. A peak wind gust of 57 mph (49 kts.) was observed at the Kivalina ASOS
Chukchi Sea Coast (Zone)	10/24/2010	High Surf, Wind 52 mph	Zone 207: A few periods of strong north wind at Point Hope during the last week of the month produced significant **beach erosion at Point Hope. A total of 12 feet of beach along the north shore of the village** was lost. At times the north wind gusted as high as 52 mph (45 kts.) at the Point Hope AWOS.
Chukchi Sea Coast (Zone)	7/21/2010	High Surf	Zone 207: Tides of 1 to 2 feet above normal combined with high surf to produce **minor beach erosion** in the vicinity of Kivalina. Some rocks were lost along the beach, but there was no other known property damage
Chukchi Sea Coast (Zone)	4/10/2010	Blizzard, Wind 49 mph	Zone 207: Blizzard conditions were also observed at Kivalina from approximately 1430 AKST until 1900 AKST. The visibility was frequently reduced to one quarter mile or less in snow and blowing snow. A peak wind gust of 49 mph (43 kts.) was observed during this event.
Chukchi Sea Coast (Zone 207)	2/27/2009	Blizzard, Wind 49 mph	Zone 207: Blizzard conditions were observed along the Chukchi Sea coast from the morning hours on the 27th through the afternoon hours on the 28th... Kivalina visibility was reduced to zero at times in heavy snow and blowing snow. The Kivalina ASOS reported wind gusts to 49 mph (43 kts.).
Chukchi Sea Coast (Zone 207)	2/21/2009	Blizzard, Wind 55 mph	Zone 207: The Kivalina ASOS had sustained winds of 35 mph with gusts to 55 mph (48 kts.), and the visibility was occasionally reduced to one quarter mile in snow and blowing snow.
Chukchi Sea Coast (Zone 207)	2/18/2009	Blizzard, Wind 40 mph	Zone 207: Blizzard conditions were observed at Kivalina and Point Hope on the 18th. At the Kivalina ASOS the visibility was frequently reduced to one quarter mile or less in heavy snow and blowing snow from late in the morning through late in the afternoon. An east to southeast wind of 25 to 35 mph with gusts to 40 mph was observed.
Chukchi Sea Coast (Zone)	3/19/2008	Blizzard, Wind 60 mph	Zone 207:...strong winds at Point Hope... blizzard conditions. One report from an airplane pilot landing there was that no one would travel from the village to the airstrip to assist him in tying down the plane, due to the strong winds and blowing snow hampering travel to the airstrip. AWOS Wind speeds gusted between 50 and 60 mph
Chukchi Sea Coast (Zone)	3/23/2008	High Wind 64 mph	High Wind 64 mph (56 kts.) Blizzard conditions and blowing snow.
Chukchi Sea Coast (Zone)	4/7/2011	Blizzard, Wind 41 mph	Zone 207: Blizzard conditions were observed at Kivalina from 0816AKST through 1333AKST on the 7th. The visibility was reduced to one quarter mile in snow and blowing snow. There was a peak wind gust of 41 mph (36 kts.) at the Kivalina ASOS.

(NWS 2013, WRCC 2013)

5.3.1.4.3 Location, Extent, Impact, and Recurrence Probability

Location

The entire Kivalina area experiences periodic severe weather impacts. The most common to the area are severely high (hurricane force) winds, extreme cold, many times combined with high tide sea storm surge. Table 5-11 lists weather events that have impacted the area since 2006 and are provided as a representative sample for the community's recurrent weather impacts.

Extent

The entire City is equally vulnerable to the severe weather effects. The City experiences severe storm conditions with moderate snow depths; wind speeds exceeding 90 mph; and extreme low temperatures that reach -50ºF.

Based on past severe weather events and the criteria identified in Table 5-3, the extent of severe weather in the City are considered "Limited" where injuries do not result in permanent disability, complete shutdown of critical facilities occurs for more than one week, and more than 10 percent of property is severely damaged.

Impacts

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

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

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

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

The studies identified in this section were compiled to illustrate that Kivalina's location and the land's topography determine seasonal weather impacts and variations. As such, hurricane force

winds, rain, snow, and storm surge can be expected to continue impacting the Kivalina area well into the future.

Climate Change Related Impacts

Climate change influences, weather intensity, community location and topography all shape the impact of severe weather on a community as well as influence future land use planning. Climate change impacts are mostly consistent with those expected in in much of the Arctic region.

Philip W. Mote Northwest Science Journal article stated the Pacific Northwest, temperature and precipitation increased over the 20th century at a rate greater than the global value. A temperature increase of 1.5°F has been observed since 1920. Climate models project an average increase of about 6°F by 2080 in this region, a rate almost three times the observed 20th century warming. Precipitation is also projected to increase, though less substantially than temperature, at an average rate of 3.8 percent by 2080. The actual magnitude of these increases is dependent on future greenhouse gas emissions (Mote 2003).

Several issues were identified by the Planning Team during data gathering meetings and telephonic discussions. The following describes a few of the community's concerns:

> *"There is very little snow cover on the surrounding tundra to allow overland travel. Residents are forces to travel along rivers and creeks. But warm the winter weather is too warm. Winter freeze-up occurs much later in the season and the normal winter weather doesn't last as long as in the past. Warm weather causes the frozen rivers to thaw early, preventing access to our essential hunting areas…*
>
> *Caribou herd are traveling in different patterns, fewer are accessible for hunters. The herd is also getting smaller because the wolf packs are getting more numerous. The young caribou and musk ox (babies and yearlings) are being killed by the wolves which have become too numerous. The wolves are even venturing closer to the village seeking prey…*
>
> *Open water causes many damaging impacts to our Kivalina families, both economically as well as survivability. Shore-fast sea ice protects the community from severe winter storms. However, the warm weather keeps the sea ice from forming leaving the community exposed to coastal storm surge high water damages. The lack of ice prevents residents from accessing migrating sea mammals and fish because of the thin or lack of ice. The mammals avoid locations with no protective ice cover… this pushes the community's subsistence food sources further out-to-sea, far away from hunters and fishermen.*
>
> *The accompanying sea spray leaves an oily substance on the walls, windows, and utilities (satellite dishes, towers, utility lines, etc. This substance is unidentifiable, and difficult to remove…*
>
> *Late forming sea-ice threatens Kivalina's economy, health, and future" (Kivalina 2015).*

Recurrence Probability

Based on previous occurrences and the criteria identified in Table 5-4, it is event is "Highly-Likely" that a severe storm will occur in the next year (with a 1/1 years = 100 percent) chance of occurring with a history of events greater than 33 percent likely per year.

5.3.1.5 Wildland Fire

5.3.1.5.1 Nature

It is important to note the entire City **is NOT** located within a wildland fire impact area. However, several resident's own mainland fishing and hunting camps are all threatened by potential wildland/tundra fire impacts and potential destruction; the community's critical subsistence resource. All residents rely heavily on subsistence food sources. Therefore these camp locations are essential to the community's survival.

The Wildland Fire hazard profile was developed to define the risk to this vital infrastructure.

A wildland fire is a wildfire type that spreads through vegetation consumption. It often begins unnoticed, spreads quickly, and is usually signaled by dense smoke that may be visible from miles around. Wildland fires can be caused by human activities (such as unattended burns or 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 describes slope increases, which influences 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, ridge tops may mark the end of wildland fire spread since fire spreads more slowly or may even be unable to spread downhill.

Fuel is 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 is 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. Climate change increases the susceptibility of vegetation to fire due to longer dry seasons. By contrast, cooling and higher humidity often signal reduced wildland fire occurrence and easier containment.

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 infestations). 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. 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 enhancing flood potential, harming aquatic life, and degrading water quality. Lands stripped of vegetation are also subject to increased debris flow hazards.

5.3.1.5.2 History

Table 5-8 lists 29 Alaska Interagency Coordination Center (AICC) identified fires occurring within 50 miles of Kivalina. These fires exceeded 40 acres with the largest one burning 130,000 acres in 1977 and another burning 88,345 acres in 1999.

Table 5-8 Wildfire Locations Since 1939 within 50 Miles of Kivalina

Fire Name	Fire Year	Estimated Acres	Latitude	Longitude	Cause
Uvgoon Creek #1	2012	49,305	67.605	-162.7483333	Lightning, Tundra
Kivalina River	2012	535	67.9497222	-163.0805556	Lightning, Tundra
Kayat	2012	114	68.0847222	-164.4136111	Lightning, Tundra
Eli River	2010	13,216	67.715	-162.4808333	Lightning, Tundra
Evaingiknuk	2010	5,298	67.6433334	-162.4861145	Lightning, Tundra
Avan River	2010	656	67.9024963	-162.6583405	Lightning
Noatak River	2010	103	68.0541687	-162.1674957	Lightning, Tundra
Uvgoon Creek	2004	11,231	67.1536102	-162.4672241	Human, Tundra
Eli River	2004	102	67.76667	-162.3167	Lightning, Tundra
Kivalina River	1999	3,920	67.68333	-162.5	Lightning, Tundra
Uvgoon Creek #2	1999	88,345	68.08334	-164.2167	Lightning
Uvgoon Creek #1	1999	85	67.81667	-162.4333	Lightning
OTZ N 70	1994	250	67.81667	-162.35	Lightning
OTZ NW 70	1994	2,280	67.4166641	-163.1999969	Lightning
OTZ NE 35	1992	600	68.0166702	-162.1666718	Lightning
OTZ N 55	1988	14,167	67.4333344	-163.1166687	Lightning
731015	1987	7,000	67.7666702	-162.1999969	Lightning
Noatak	1977	70	67.8000031	-163.6833344	Lightning
OTZ N 90	1977	1,000	67.2333298	-162.9333344	Lightning
OTZ NNW 38	1977	130,000	67.5166702	-162.0833282	Lightning
NOATAK #2	1956	850	67.4499969	-162.75	Lightning
NOATAK #4	1956	40	67.5833359	-162.5666656	Lightning
NOATAK #3	1956	120	67.5666656	-162.5500031	Undefined
NOATAK #1	1956	1,200	67.5999985	-162.5833282	Lightning
SHESHNALER	1956	210	67.6666641	-162.5500031	Lightning
NOATAK #5	1956	90	67.0999985	-162.9333344	Lightning

(AICC 2014)

Figure 5-17 depicts Kivalina area fire locations and Figure 5-16 depicts the largest fires perimeters to display relative size and threat from those that occurred within 50 miles of the City.

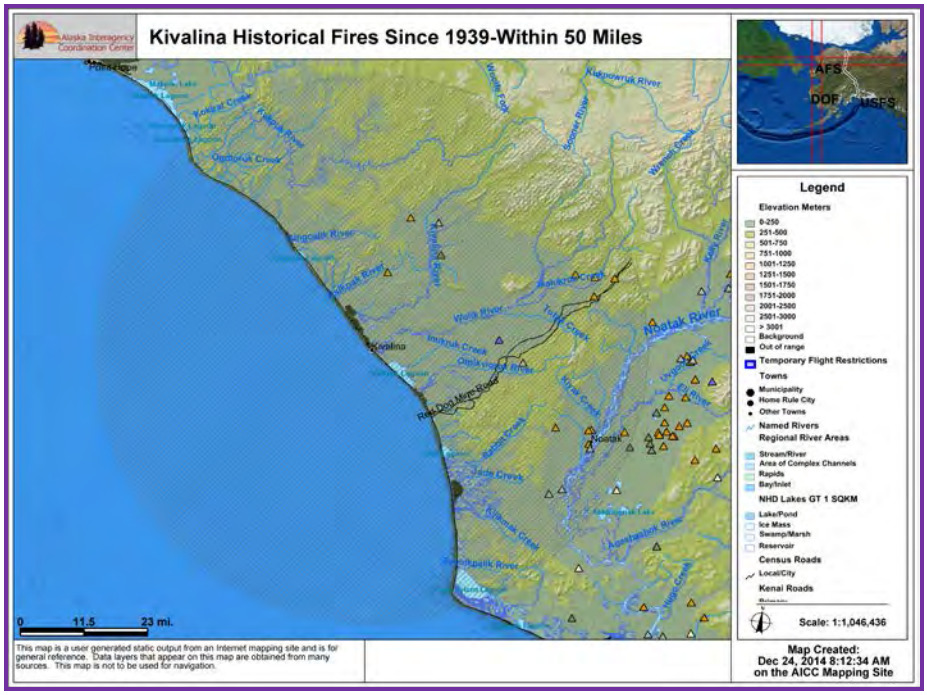

Figure 5-17 Kivalina's Historical Wildfire Locations (AICC 2014)

Figure 5-18 depicts Kivalina area's historical fire's perimeters to illustrate their relative location and potential threat to area residents. Lightning is the most prevalent cause for the area's tundra fires.

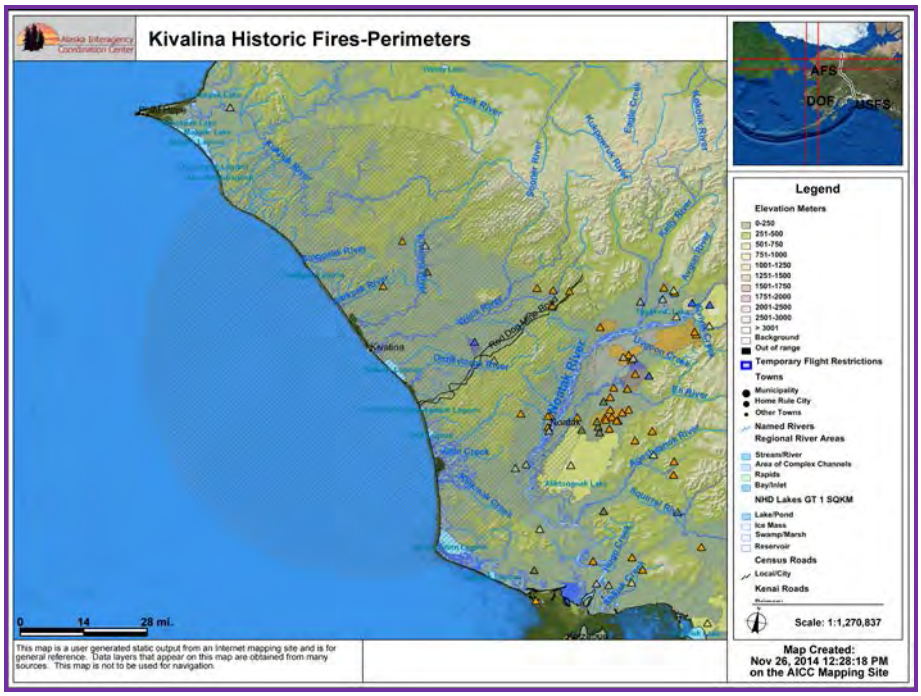

Figure 5-18 Kivalina's Historical Wildfire Perimeters (AICC 2014)

5.3.1.5.3 Location, Extent, Impact, and Recurrence Probability

Location

The City is located on a barrier island with no wildland or tundra fire sources. However, numerous residents own fishing and hunting camps on the mainland. Under certain conditions wildland fires may occur near those locations when weather, fuel availability, topography, and ignition sources combine. For the purposes of this plan, and since fuels data is not readily available for the area, all areas on the adjacent mainland are considered to be vulnerable to wildland/tundra fire impacts.

Extent

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

Fuel, weather, and topography influence wildland fire behavior. Fuel determines how much energy the fire releases, how quickly the fire spreads, and how much effort is needed to contain the fire. Weather is the most variable factor. High temperatures and low humidity encourage fire activity while low temperatures and high humidity retard fire spread. Wind affects the speed and direction of fire spread. Topography directs 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 1977fire burned approximately 180,000 acres. It is difficult to determine the average number of acres burned as the fires were vastly different for each of these wildland fire events identified in Table 5-9 (DOF 2014). An average based on such diverse data would easily be overstated.

Based on the limited number of past wildland fire events and the criteria identified in Table 5-3, the magnitude and severity of impacts in the Kivalina area are considered negligible with minor injuries, there is potential for critical facilities to be shut down for less than 24 hours, less than 10 percent of property or critical infrastructure being severely damaged, and little to no permanent damage to transportation or infrastructure or the economy.

Impact

Indirect wildland fire impacts 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.

Fire is recognized as a critical feature of the natural history of many ecosystems. It is essential to maintain the biodiversity and long-term ecological health of the land. The role of wildland fire as an essential ecological process and natural change agent has been incorporated into the fire management planning process and the full range of fire management activities is exercised in Alaska, to help achieve ecosystem sustainability, including its interrelated ecological, economic, and social consequences on firefighters, public safety and welfare; natural and cultural resources

threatened; and the other values to be protected dictate the appropriate management response to the fire. In Alaska, and within 50 miles of Kivalina, the natural fire regime is characterized by a return interval of approximately 150 due to their tundra vegetation, gently rolling topography.

Recurrence Probability

An important issue related to the wildland or tundra fire probability is increased development where an accumulation of hazardous wildfire fuels and the uncertainty of weather patterns that may accompany climate change. These combined elements are reason for concern and heightened mitigation management for future community relocation sites where the city and wildland may interface with natural areas and other open spaces.

Based on the fact that the current City location on a relatively barren barrier island, Kivalina's wildland or tundra fire threat is categorized as "Unlikely" to occur within in the next ten years. The event has less than 1 in 10 years (1/10=10 percent) chance of occurring with a history of events is less than 10 percent likely each year. Climate change and flammable vegetation species are prolific throughout Alaska's forests and tundra locations. Fire frequency may increase for Kivalina residents if they relocate to an area with higher wildland or tundra fire fuels.

5.3.2 Manmade / Technological Hazards

5.3.2.1 Hazardous Materials

5.3.2.1.1 Nature

Hazardous materials can be simply defined as any materials having a negative impact on the community's health; human, animal, aquatic, or environment. Hazardous materials exposure may cause injury, illness, or death. Exposure impacts may be evident within seconds, minutes, or hours; in fact, impacts may not surface until days, weeks, or even years after exposure. It is also important to note that harmful effects can be short- or long-term.

Some hazardous materials are highly toxic; even brief exposures to minute amounts may be dangerous or even fatal. Other hazardous materials are much less toxic; negative effects may occur only after a significant exposure to large quantities of a substance, or exposure to smaller quantities for a prolonged time period. The technical term "toxic," or "toxicity," which is widely used to describe hazardous materials, is simply a synonym for the more common terms "poison" or "poisonous." A toxin is thus defined as any substance that causes injury, illness, or death to living tissue by chemical activity.

The Institute of Hazardous Materials defines hazardous materials according to several regulatory agencies:

> *". . . any item or agent (biological, chemical, physical) which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. Hazardous materials professionals are responsible for and properly qualified to manage such materials. This includes managing and/or advising other managers on such items at any point in their life-cycle, from process planning and development of new products; through manufacture, distribution and use; to disposal, cleanup and remediation.*

Hazardous materials are defined and regulated in the United States primarily by laws and regulations administered by the U.S. Environmental Protection Agency (EPA), the U.S. Occupational Safety and Health Administration (OSHA), the U.S. Department of Transportation (DOT), and the U.S. Nuclear Regulatory Commission (NRC). Each has its own definition of a "hazardous material."

OSHA's definition includes any substance or chemical which is a "health hazard" or "physical hazard," including: chemicals which are carcinogens, toxic agents, irritants, corrosives, sensitizers; agents which act on the hematopoietic system; agents which damage the lungs, skin, eyes, or mucous membranes; chemicals which are combustible, explosive, flammable, oxidizers, pyrophorics, unstable-reactive or water-reactive; and chemicals which in the course of normal handling, use, or storage may produce or release dusts, gases, fumes, vapors, mists or smoke which may have any of the previously mentioned characteristics. (Full definitions can be found at 29 Code of Federal Regulations (CFR) 1910.1200.)

EPA incorporates the OSHA definition, and adds any item or chemical which can cause harm to people, plants, or animals when released by spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping or disposing into the environment. (40 CFR 355 contains a list of over 350 hazardous and extremely hazardous substances.)

DOT defines a hazardous material as any item or chemical which, when being transported or moved, is a risk to public safety or the environment, and is regulated as such under the: Hazardous Materials Regulations (49 CFR 100-180); International Maritime Dangerous Goods Code; Dangerous Goods Regulations of the International Air Transport Association; Technical Instructions of the International Civil Aviation Organization; U.S. Air Force Joint Manual, Preparing Hazardous Materials for Military Air Shipments.

The NRC regulates items or chemicals which are "special nuclear source" or by-product materials or radioactive substances. (See 10 CFR 20)" (IHMM 2015).

Both Federal and State of Alaska statutes govern hazardous materials. Federal regulations include the Clean Air Act, Emergency Planning and Community Right to Know Act, and Superfund Amendments and Reauthorization Act. Oregon statutes found in Article 08: Hazardous Chemicals, Materials, and Wastes are listed below:

- Section 29.35.500. Reporting.
- Section 29.35.510. Inspections; penalties.
- Section 29.35.520. Fees.
- Section 29.35.530. Duties of municipalities; powers of other agencies.
- Section 29.35.540. Public access to information.
- Section 29.35.550. Application.
- Section 29.35.560. Municipal liability.
- Section 29.35.590. Definitions..

Hazards are found nearly everywhere; petroleum products, natural and synthetic gas, acids, and other acutely toxic chemicals found in everyday products such as paints, solvents, adhesives, household cleaners, pesticides and herbicides, batteries, and even medicines.

This plan does not focus on the hazards in everyday products, but rather on the larger quantities of hazardous materials classified as Hazardous Substances (HS) or Extremely Hazardous Substances (EHS) that are present in the planning area or transported by water or air. Hazardous substances can present problems when spilled, however EHS potentially pose the most catastrophic threat as the category includes substances, such as chlorine and ammonia, which pose an acute inhalable toxic threat to humans and animals. (DHS&EM, 2013)

The toxicity of a specific substance is one important factor in determining the risk it poses, but there are other factors that can be just as if not more significant. Factors affecting the severity of an accidental release include toxicity, quantity, dispersal characteristics, release location, population density, environmental sensitivity; and, efficacy of response and recovery actions.

Hazardous materials are generally classified by their primary health effects on humans. Some common types include the following:

- Anesthetics and narcotics: depress the central nervous system.
- Asphyxiants: interfere with normal breathing and can cause suffocation.
- Explosives: pose explosion, fire, and chemical danger.
- Flammable materials: catch fire easily, although they may pose other dangers such as explosion or chemical effects. Gasoline, propane, and diesel fuel are common examples in this category.
- Irritants: cause burns or irritation to body tissues such as eyes, nose, throat, lungs, or skin.

Hazardous substance exposure generally takes place by one, or a combination of the following mechanisms:

- Direct contact with skin or eyes
- Ingestion via contaminated food or water
- Particulate or gas inhalation via contaminated air

Unless exempted, facilities that use, manufacture, or store hazardous materials in the US fall under the regulatory requirements of the Emergency Planning and Community Right-to-Know Act, and must report to the United States Environmental Protection Agency (EPA). Releases of HS and EHS can occur at facilities or during transport. Transportation-related releases are generally more troublesome because they may occur anywhere, including close to human populations, critical facilities, or environmentally sensitive areas. Transportation-related EHS releases can also be more difficult to mitigate due to the great area over which any given incident might occur, and the potential distance from response resources.

Natural phenomena may also cause a hazardous materials release and complicate response activities from not only the primary but also subsequent or combined secondary events. For instance, earthquakes pose a particular risk, because they can damage or destroy facilities, fires

can develop, explosions can occur, and high winds can disperse the released chemical. The threat of any hazardous material event may be further amplified by restricted access, reduced fire suppression, and spill containment capability. Response personnel and equipment may have their access cutoff as roads, waterways, and aircraft landing strip access is impeded. EHS releases can trigger evacuation and short- or long-term displacement creating social and business disruptions.

5.3.2.1.2 History

The National Response Center (NRC) compiles ha hazardous materials report data (Table 5-9) from various agencies including the Environmental Protection Agency, (EPA), Department of Transportation (DOT), and others. They serve as the point of contact for reporting oil, chemical, radiological, biological, and etiological discharges within the US.

Table 5-9 National Response Center "Incidents" 1997-2015

Entity	Toxic Releases Reported	Air Releases Reported	Transport Accident	Rail	Pipeline	Tank Farm
McQueen School, Kivalina, Alaska	0	0	0	0	0	3

(DEC 2015a)

5.3.2.1.3 Location, Extent, Impact, and Recurrence Probability

Location

Hazardous Substances can be found throughout Alaska. Department of Environmental Conservation (DEC) has documented 2,905 incident/spill releases in the Northwest Arctic Region. The 10-Year Statewide Summary, Oil and Hazardous Substance Spill Data (July 1, 1995 – June 30, 2005) states that "In terms of total volume spilled… the Northwest Arctic spilled over 1,000,000 gallons of oil and hazardous substances during this period" (DEC 2015b)

The DEC's Division of Spill Prevention and Response. Spills Database Online Query data(Table 5-10) shows that since 1998 only three fuel oil spills have occurred in Kivalina; all of which involved the Northwest Arctic Borough's McQueen School tank farm (Table 5-14). However, there were over 2,900 reported hazardous materials releases reported for Alaska's Northwest Region; approximately 1,129 of which occurred at Red Dog Mine facilities located approximately 55 miles from the Chukchi Sea within the Wulik River Watershed.

The largest "significant" Hazardous Substance spill at the Red Dog mine was 200,000 gallons of magnesium oxide slurry. The largest spill of Structural and Mechanical related causes occurred at the Red Dog Mine with 158,398 gallons of zinc and lead tailings. (DEC 2015b)

Table 5-10 Hazardous Substance Listed Sites in the Northwest Arctic

Incident Name	Date	Product	Quantity
Red Dog Mine	08/16/2014	600gal Acid Rock Drainage (Spill No: 14389922801)	600 gallons
Red Dog Mine	04/07/2013	Mine Site- Under 2011 Module, Process Water	3,700 gallons

Table 5-10 Hazardous Substance Listed Sites in the Northwest Arctic

Incident Name	Date	Product	Quantity
Red Dog Mine	10/14/2012	Red Dog Mine, Port Dock 1,000lbs Ammonium Nitrate	1,000 pounds
Red Dog Mine	08/12/2012	Red Dog Mine 250,000 lbs Zinc Concentrate	31,250 gallons
Red Dog Mine	08/11/2004	Nana-Lynden Red Dog Truck Rollover, Diesel (Spill No: 04389922401)	2,700 gallons
Red Dog Mine	01/24/2004	Red Dog Process Water and Propylene Glycol (Spill No: 04389902401)	21,000 gallons 1,200 gallons (Respectively)
Red Dog Mine	11/24/2003	Zinc/Lead Tailings	158,398 gallons
Red Dog Mine	7/20/2001	Red Dog Mine Zinc Spill (Spill Number: 01389920101)	20,000 gallons
Red Dog Mine	02/16/2001	42 Mile Red Dog Mine Zinc Spill (Spill No: 01389904701)	12,000 gallons
Red Dog Mine	10/10/2000	Lead Concentrate (Spill Number: 00389928301)	60,000 pounds
Red Dog Mine	12/28/2000	Zinc Concentrate (Spill Number 00389936301)	80,000 gallons
Red Dog Mine	05/31/1998	Magnesium Oxide (Slurry)	200,000 gallons
Red Dog Mine	04/09/1996	Acid, Other	125,000 gallons

(DEC 2015b)

Kivalina is a very small community supporting approximately 600 residents. All events such as structure fires, storm surge floods, water collection in low terrain, and severe cold, wind, and freezing rain could potentially initiate

Extent

The Kivalina area has a serious hazardous materials risk from any given incident because the community facilities share a very compacted location as seen in Section 2, Figures 2-4 and 2-5.

Future impact determination depends heavily on materials dispersed, dispersal mechanism, weather conditions, and water presence. Some materials tend to have localized impacts. Many hazardous liquids and gases depend on wind for dispersal. Water can compound material dispersing; complicating hazard response and short-term recovery.

Particular hazardous materials toxicity is an important measure of the potential hazardous materials impact on threatened communities, but not the only important measure. Other hazardous materials characteristics, especially material quantity and potential dispersal methods may be as important, or more important, in governing the potential threat level to a community.

Impacts

In addition to accidental, human-caused hazardous material events, natural phenomena may cause hazardous materials release and if occurring in conjunction with severe weather events, could complicate response activities for Kivalina.

Earthquakes pose a particular risk, because they can damage or destroy facilities containing hazardous substances such as bulk fuel storage tanks, fuel headers, water treatment facilities, etc.

The threat of any hazardous material event may be amplified by restricted access, reduced fire suppression and spill containment capability, and even complete cutoff to response personnel and their essential equipment.

Hazardous materials events or releases can also cause a host of secondary effects, depending on the nature and size of the incident. Fuel spills can create fires and essential potable water source contamination, halt or impede services, or trigger evacuation and short or long-term displacement and social disruption.

Recurrence Probability

Comprehensive probability and magnitude information for potential hazardous material events, from all source types, is not available. Wide variations among hazardous material source characteristics, and among the materials themselves, make such an evaluation difficult. While it is beyond the scope of this HMP to make detailed hazardous materials probability and magnitude evaluations for the Kivalina area, it is possible to determine that all buildings and facilities are critical for the community's survival. Residents and visitors are exposed to each identified hazard.

It is highly likely due to Kivalina's close structural proximity to each other, that damages from a routine hazard event such as lightning strikes or storm surge floods would quickly disperse any released hazardous materials throughout the community.

Therefore, it is "Possible a small oil or material spill will occur within 50 miles of Kivalina. An event has up to 1 in 5 years chance of occurring (1/5=20 percent) with a history of events greater than 10 percent but less than or equal to 20 percent likely per year.

5.3.2.2 Utility and Transportation Systems Disruption

Infrastructure systems disruptions are treated as a separate hazard because, while such disruptions from identified natural hazards could prevent air or ocean access to the island. The ramifications are far-reaching and much broader than direct damage and direct service loss.

It is important to remember, in considering any of the other hazards profiled in this plan, that utility and transportation system disruptions should be viewed as secondary impacts from each natural hazard's impacts. The probability, duration, extent, and risk associated with infrastructure system disruption is described below, and in some cases quantified. Electric power outages are dealt with in more detail than other disruptions because electric power outages have the most widespread effects on other utilities.

5.3.2.2.1 Nature

Kivalina has few roads. The main transportation access is via aircraft and ocean transport. Both are subject to disruption from the hazards profiled in this plan; earthquake, flood, ground failure, severe weather, public health (quarantine, public transit restrictions), and hazardous materials incidents.

The ramifications of transportation system disruption range from effects on life, health, and safety (emergency vehicle mobility, community evacuation, and vital supply's delivery if

transportation systems are seriously disrupted for an extended time period) to the economic effects of delays, lost commerce, and lost time.

Similarly, utility systems disruption can affect the entire community because they survive on generator power. Electric power is essential to maintain health and safety and sustain commerce. Analyzing potential utility disruptions is complicated because utilities like electric power, potable water, wastewater, fuel oil transfer, natural gas, and telecommunications all depend on some form of electrical power. There is no electrical power redundancy available in Kivalina.

The water treatment plant is aging. Water is pumped through a flexible hose from their collection site to the City water storage tanks during summer months once the ice melts and the spring run-off turbidity dissipates. However, the water at their current collection site is of very poor quality; many residents refuse to drink the water and only use it for washing.

Earthquakes can damage water storage, treatment, and transport systems. Water systems are also extremely vulnerable to power outages. Storage tanks typically contain approximately six months of water for the entire community. Long duration power outages can result in a shortage of access to this vitally important resource.

Wastewater management is also crucial for public health, and wastewater systems are similarly vulnerable to floods, earthquake damages, and power outages. The City's waste treatment regimen is to collect honey buckets and transport to the sewage lagoon which is threatened due to the City's relatively low elevation related storm surge flood impacts.

Bulk fuel storage and fuel transfer lines are vulnerable to seismic, flood, and severe weather events (earthquake, wind, and freezing rain damage, power loss, potential leaks or materials releases present a health hazard. Gasoline and diesel fuel are flammable and explosive, attributes which are addressed in the Hazardous Materials section.

Telecommunications systems (including telephone and satellite towers are generally also vulnerable to hazards such as flood zones or ground failure areas. Above-ground lines are vulnerable to severe weather impacts or the poles fail because the ground that supports them is over water saturated. Telecommunication disruptions are about ten times less common than electrical line failures partly because communication lines require much less voltage making them much less vulnerable to arcing or shorting-out if lines. Telecommunications failures can have be devastating to a community if they are not able to access emergency or disaster-responders.

5.3.2.2.2 History

System disruptions are deemed a secondary hazard or a result of a primary hazard event and receive discussion in the natural hazards section through this document.

5.3.2.2.3 Location, Extent, Impact, and Event Probability

Location

Kivalina relies upon modern infrastructure: transportation and utility systems as the foundation for everyday life in their very remote rural location.

All facilities within Kivalina are critical for the community's survival; any of their infrastructure systems may experience critical failure. To that end, they have or are working to acquire an emergency generator, harden utility poles and suspension lines. It is also critical the community ensures fuel deliveries are received and they fill their water storage tanks before the adjacent waterways freeze for the long winter. Each of these facilities determine the community's sustainability. The community has identified the need to work with their utility supplier to encourage them to consider mitigating power line failure projects such as installing quick disconnect features to facilitate more expedient power line reconnection after a freezing rain event occurs.

Extent

The vulnerability extent of this hazard is community wide. Virtually every hazard profiled in this plan can result in transportation or utility service disruptions.

Recurrence Probability

Because virtually every hazard profiled in this plan can result in disruption of transportation or utility service, future events are highly possible for an event to occur within the next five years with a 1 in 5 year (1/5=20 percent) chance of occurring. Event history is greater than 10 percent but less than or equal to 20 percent likely per year.

5.3.2.3 Public Health

5.3.2.3.1 Nature

Infectious diseases impair or damage bodily functions. They are caused by foreign organisms entering the human body and multiplying; including bacteria, viruses, fungi, and protozoa. Infections range from mild to deadly. Organisms enter the body via means such as: skin contact; inhalation; ingestion; blood (intravenous contact, bites, or punctures); sexual contact; and transmission from mothers to unborn children.

While infectious diseases pose a threat to people of any age and health condition, they are often a greater hazard to very young children, older adults, or people with compromised health. Vaccines and other advances in medical technology have reduced risks of some infectious diseases; however, new diseases emerge, new strains of existing diseases appear, and diseases that have been previously eliminated may reemerge.

Non-communicable, vector-borne diseases (such as those carried by mosquitoes or ticks) are important in community education, but generally would not lead to an epidemic in their current forms. It is worth noting that there is an association between climate and many infectious diseases, and global climate change will affect the range and prevalence of certain epidemics. In 2005, the World Health Organization published a report on using climate, and climate change models, to predict infectious disease epidemics. A climate-base early warning system may become an important tool for public health officials. (Khun *et al*. 2005)

Three diseases that occur or have potential to be introduced to Kivalina residents are: norovirus and influenza. These diseases have been documented within the State of Alaska.

- Norovirus was documented during the 2004 Iditarod from infected race supporters

- Influenza: Alaska typically has sporadic flu activity year round with peak activity occurring as early as January or as late as March.

The Alaska Department of Health and Social Services, Epidemiology. The state also tracks other infectious diseases that could become a hazard to the community in the future.

The Centers for Disease Control and Prevention (CDC) states:

Norovirus

"Norovirus is a very contagious virus. You can get norovirus from an infected person, contaminated food or water, or by touching contaminated surfaces. The virus causes your stomach or intestines or both to get inflamed (acute gastroenteritis). This leads you to have stomach pain, nausea, and diarrhea and to throw up.

Anyone can be infected with norovirus and get sick. Also, you can have norovirus illness many times in your life. Norovirus illness can be serious, especially for young children and older adults.

Norovirus is the most common cause of acute gastroenteritis in the United States. Each year, it causes 19-21 million illnesses and contributes to 56,000-71,000 hospitalizations and 570-800 deaths. Norovirus is also the most common cause of foodborne-disease outbreaks in the United States.

The best way to help prevent norovirus is to practice proper hand washing and general cleanliness…

Norovirus Symptoms

Norovirus causes inflammation of the stomach or intestines or both. This is called acute gastroenteritis.

The most common symptoms—

- *diarrhea*
- *throwing up*
- *nausea*
- *stomach pain*

Other symptoms—

- *fever*
- *headache*
- *body aches*

If you have norovirus illness, you can feel extremely ill and throw up or have diarrhea many times a day. This can lead to dehydration, especially in young children, older adults, and people with other illnesses.

Most people with norovirus illness get better within 1 to 3 days.

Symptoms of dehydration—

- *decrease in urination*
- *dry mouth and throat*
- *feeling dizzy when standing up*

Children who are dehydrated may cry with few or no tears and be unusually sleepy or fussy.

Norovirus Transmission

orovirus is a highly contagious virus. Anyone can get infected with norovirus and get sick. Also, you can get norovirus illness many times in your life. One reason for this is that there are many different types of noroviruses. Being infected with one type of norovirus may not protect you against other types.

Norovirus can be found in your stool (feces) even before you start feeling sick. The virus can stay in your stool for 2 weeks or more after you feel better.

You are most contagious

- *when you are sick with norovirus illness, and*
- *during the first few days after you recover from norovirus illness.*

You can become infected with norovirus by accidentally getting stool or vomit from infected people in your mouth. This usually happens by

Norovirus outbreaks can also occur from foods, such as oysters, fruits, and vegetables, that are contaminated at their source.

- *eating food or drinking liquids that are contaminated with norovirus,*
- *touching surfaces or objects contaminated with norovirus then putting your fingers in your mouth, or*
- *having contact with someone who is infected with norovirus (for example, caring for or sharing food or eating utensils with someone with norovirus illness).*

Norovirus can spread quickly in closed places like daycare centers, nursing homes, schools, and cruise ships. Most norovirus outbreaks happen from November to April in the United States" (CDC 2015).

Influenza

"Influenza (flu) is a contagious respiratory illness caused by influenza viruses. It can cause mild to severe illness. Serious outcomes of flu infection can result in hospitalization or death. Some people, such as older people, young children, and people with certain health conditions, are at high risk for serious flu complications. The best way to prevent the flu is by getting vaccinated each year…

Influenza Symptoms

Influenza (also known as the flu) is a contagious respiratory illness caused by flu viruses. It can cause mild to severe illness, and at times can lead to death. The flu is different from a cold. The flu usually comes on suddenly. People who have the flu often feel some or all of these symptoms:

- *Fever* or feeling feverish/chills*
- *Cough*
- *Sore throat*
- *Runny or stuffy nose*
- *Muscle or body aches*
- *Headaches*
- *Fatigue (tiredness)*

Some people may have vomiting and diarrhea, though this is more common in children than adults.

** It's important to note that not everyone with flu will have a fever.*

Flu Complications

Most people who get influenza will recover in a few days to less than two weeks, but some people will develop complications (such as pneumonia) as a result of the flu, some of which can be life-threatening and result in death.

Pneumonia, bronchitis, sinus and ear infections are examples of complications from flu. The flu can make chronic health problems worse. For example, people with asthma may experience asthma attacks while they have the flu, and people with chronic congestive heart failure may experience worsening of this condition that is triggered by the flu.

People at High Risk from Flu

Anyone can get the flu (even healthy people), and serious problems related to the flu can happen at any age, but some people are at high risk of developing serious flu-related complications if they get sick. This includes people 65 years and older, people of any age with certain chronic medical conditions (such as asthma, diabetes, or heart disease), pregnant women, and young children.

Flu Severity

Flu is unpredictable and how severe it is can vary widely from one season to the next depending on many things, including:

- *what flu viruses are spreading,*
- *how much flu vaccine is available,*
- *when vaccine is available,*
- *how many people get vaccinated, and*
- *how well the flu vaccine is matched to flu viruses that are causing illness.*

Over a period of 30 years between 1976 and 2006, estimates of flu-associated deaths in the United States range from a low of about 3,000 to a high of about 49,000 people. During a regular flu season, about 90 percent of deaths occur in people 65 years and older" (CDC 2015)

5.3.2.3.2 History

There have been no epidemics in recent history. To give an idea of the current infectious disease level within Alaska, the DHSS, Epidemiology provides an annual infectious disease summary delineating the total number of Alaska's infection disease cases spanning 2009 to 2013, last updated July 11, 2014 is provided in Table 5-11 to provide awareness as to how easily diseases can be passed on to those around us.

Table 5-11 2009-2013 Summary – Infectious Diseases

Causal agent	2009	20104	2011	2012	2013
Botulism	1	5	6	5	6
Campylobacter	80	118	127	94	107
Chlamydia	5,225	6,033	5,809	5,482	5,793
Giardiasis	110	99	102	96	82
Gonorrhea	1,003	1,276	994	731	1,137
Haemophilus Influenzae	21	30	26	15	21

Table 5-11 2009-2013 Summary – Infectious Diseases

Causal agent	2009	20104	2011	2012	2013
Hepatitis C Virus (HCV)	824	629	952	936	943
Human Immunodeficiency Virus (HIV)	~56	~80	~60	~50	59
Paralytic Shellfish Poisoning (PSP)	1	6	26	6	5
Pertussis	58	45	26	356	308
Animal Rabies	15	12	14	6	7
Salmonella	68	80	55	59	84
Syphilis	5	7	11	20	32
Tuberculosis (TB)	37	57	67	66	71
Varicella	56	50	64	57	61

(DHSS 2014)

5.3.2.3.3 Location, Extent, Impact, and Recurrence Probability

Location

The entire population of Kivalina is potentially susceptible to infectious diseases. Infectious diseases may occur throughout the nation, can spread to the state, the community, a home, business, or the school. Disease transmission is often greatest in high density or highly compacted situations such as Kivalina's community layout, multi-family occupied homes, and schools.

Extent

Everyone would be susceptible to many commonly infectious diseases; it cannot be known in advance which, if any, particular population segment would be most affected. Although pharmaceutical companies have prepared a vaccine directed at the present disease versions, it is unknown to what extent, if any, a particular vaccine would apply to a new strain.

Immunity or resistance largely depends on genetics and exposure extent.

Recurrence Probability

Based on historical events, Kivalina can expect that is "Unlikely" but possible that an infectious diseases outbreak will occur from food-borne viral and bacterial pathogens, measles, pertussis, hepatitis, and influenza, among others. The likelihood of any of these diseases reaching epidemic proportions in any given year is very negligible.

As mentioned above, a changing climate has an effect on communicable disease, and climate change could alter the repertoire of diseases that exist in Alaska, as well as outbreak frequency.

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Section Six outlines the vulnerability process for determining potential losses for the community from various hazard impacts.

6.1 OVERVIEW

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

1. Asset Inventory such as historic, cultural and natural resource areas, and other jurisdiction-determined essential facilities
2. Economic elements, areas that require special considerations
3. Exposure analysis for current assets
4. Repetitive loss properties
5. Land use and development trends
6. Vulnerability analysis methodology
7. Data limitations
8. Vulnerability exposure analysis
9. Future development

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

DMA 2000 Recommendations
Assessing Risk and Vulnerability, and Analyzing Development Trends §201.6(c)(2)(ii): The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. *All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods.* The plan should describe vulnerability in terms of: §201.6(c)(2)(ii)(A): The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; §201.6(c)(2)(ii)(B): An estimate of the potential dollar losses to vulnerable structures identified in … this section and a description of the methodology used to prepare the estimate. §201.6(c)(2)(ii)(C): Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.
1. REGULATION CHECKLIST
ELEMENT B. Risk Assessment, Assessing Vulnerability, Analyzing Development Trends
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))
B4. Does the Plan address NFIP insured structures within each jurisdiction that have been repetitively damaged by floods?
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))
Source: FEMA, March 2015

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

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

Table 6-1 lists Kivalina area infrastructures' overall hazard vulnerabilities.

Table 6-1 Vulnerability Overview

Hazard	Area's Hazard Vulnerability			
	Percent of Jurisdiction's Geographic Area	Percent of Population	Percent of Building Stock	Percent of Critical Facilities and Utilities
Earthquake	100	100	100	100
Flood	100	100	100	100
Ground Failure	100	100	100	100
Weather	100	100	100	100
Wildland Fire	100	100	100	100

6.2 LAND USE AND DEVELOPMENT TRENDS

6.2.1 Land Use

Land use in the City is predominately residential with limited area for commercial services and community (or institutional) facilities. Suitable developable vacant land is in short supply within the boundaries of the City, and open space and various hydrological bodies surround the community. One area of town is classified as airport land use.

The 1999 DCCED Community Map (Figure 6-1), Kivalina depicts the community's facility locations as well as infrastructure placement. Most critical facilities are in close proximity to the Chukchi Sea, whereas many residential structures are close to the Kivalina Lagoon

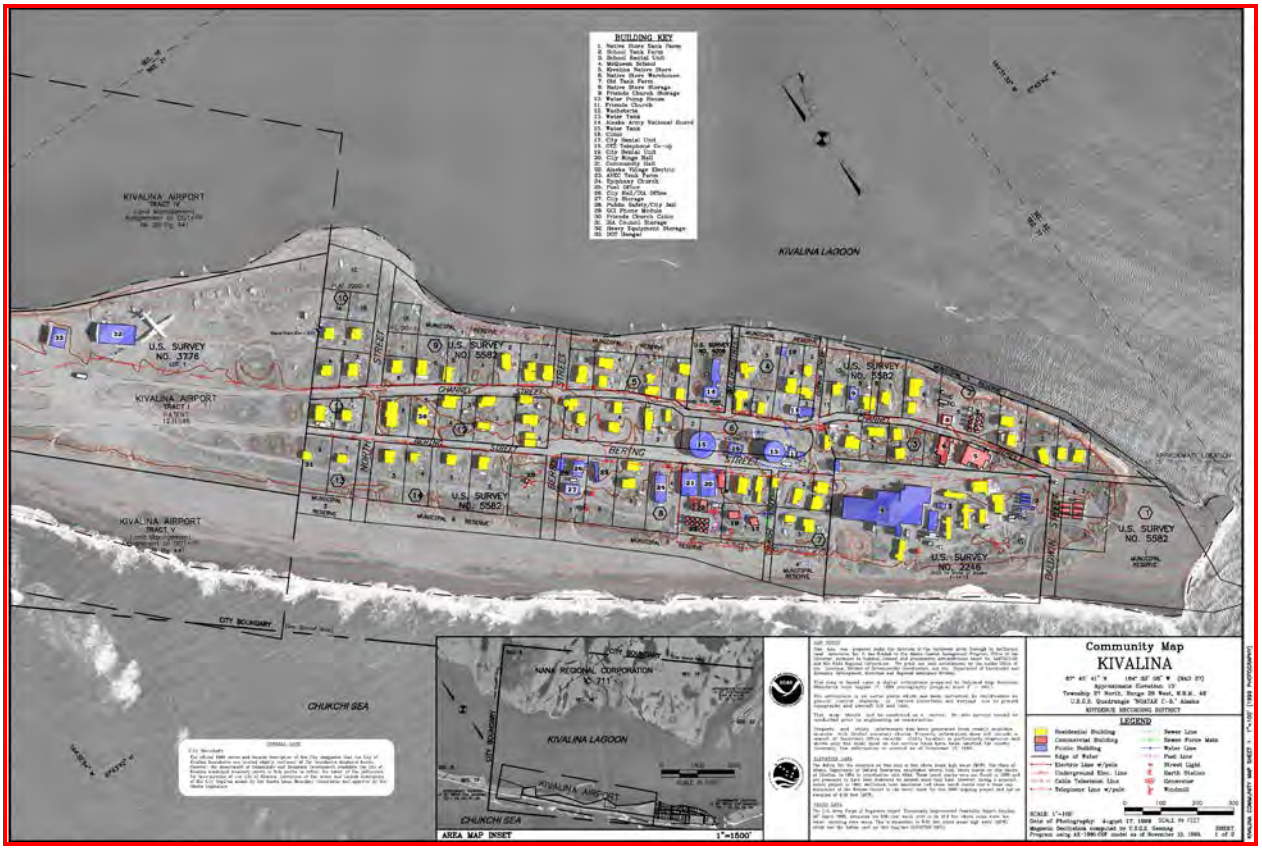

Figure 6-1 Community Layout (DCCED 1999)

DCCED describes Kivalina's location "at the tip of an 8-mile barrier reef located between the Chukchi Sea and Kivalina River *[at its Kivalina Lagoon terminus]*" (DCCED). Consequently, land use capability is very limited and continually experiences flood related hazard impacts (e.g. scour, land loss, structure losses, infrastructure disruptions, building use).

The City's location has become very hazardous for residents during the past 20 years. Changing weather patterns associated with Climate Change ENSO events has necessitated the City seek relocation to a more safe environment for their residents' future longevity. By far, the greatest threat to the community is storm surge induced flooding.

Flood hazards in Kivalina result almost exclusively from storm surges from south to southeasterly winds. Storm flooding has historically occurred in early fall, before the formation of shore-fast or sea ice. However, Kivalina is subject to storms at any time of year. During summer and fall months, sea storms bring high winds of 40 to 70 knots from the southwest. Winter storms usually bring winds from the northeast. Storm surges, ice override, and coastal flooding can occur in Kivalina due to storms.

Shore-fast ice creates a barrier of grounded ice along the shore; waves break against the ice or are reduced in energy, rather than striking directly against the shore where erosion occurs. Local observations indicate that in recent years, shore-fast ice has formed later in the year than usual, leaving the village without protection from fall sea storm flooding.

For nearly two decades, the steady erosion of the shoreline at Kivalina has been viewed with growing alarm. The potential loss of the town site to the encroaching sea provides ample justification for its relocation. Moreover, there is no reason to believe that this trend will cease in light of the global forces that appear to be contributing to it. While causes of global warming are a matter for scientific debate, it is an indisputable fact that climates are changing over most of the planet, and that some of these changes are most evident in the Arctic.

Without addressing global scale effects on the Arctic climate, it is sufficient to note that some of the end effects have potentially dire consequences for Kivalina and other villages located on or near Arctic Ocean shorelines. The steady diminution of the Arctic Ocean ice pack enhances the potential for increased coastal erosion in at least two ways:

- Larger expanses of ice-free water provide longer fetches over which winds can generate ocean waves that are higher, longer, and thus potentially more destructive to the shorelines where they ultimately dissipate their energy.
- Since the early 1980s the time between spring break-up of land-fast sea ice and autumn freeze-up along Arctic shorelines has increased from barely three months to as much as five months. This substantially extends the "season" for coastal erosion.

A short-term implication of these facts is that the present town site will require coastal erosion protection until relocation is completed. Statistics indicate that the interval of occurrence for a 4-foot elevation storm surge, as occurred on 20 October 2004, is once a year. According to Wise et al. (1981), a 6-foot storm surge would have a recurrence interval of less than 5 years. The approximate island height of 5.5 feet would indicate that a 6 foot storm would only result in 6 inches of water cover. Modeling indicates that the 100-year storm surge event would have a water surface of 3.2 meters (10.5 feet) with no ice cover. The status of ice cover during a storm surge event will play a major role in determining how much flooding could occur.

6.3 EXPOSURE ANALYSIS FOR CURRENT ASSETS

6.3.1 Asset Inventory

Asset inventory is the first step of a vulnerability analysis. Assets that may be affected by hazard events include population (for community-wide hazards), residential buildings (where data is available), and critical facilities and infrastructure. The critical facility and infrastructure assets and associated values throughout the City are addressed in Section 6.3.1.3.

Inventorying the jurisdiction's assets to determine the number of buildings, their value, and population in hazard areas can also help determine vulnerability. A jurisdiction with many high-value buildings in a high-hazard zone will be extremely vulnerable to financial devastation brought on by a disaster event.

Identifying hazard prone critical facilities is vital because they are necessary during response and recovery phases. Typical critical facilities include:

- Essential facilities, which are necessary for the health and welfare of an area and are essential during response to a disaster, including hospitals, fire stations, police stations, and other emergency facilities;

- Transportation systems such as highways, airways and waterways;
- Utilities; water treatment plants, communications systems, power facilities;
- High potential loss facilities such as the levee and bulk fuel storage facilities; and
- Hazardous materials sites.

Other items to identify include economic elements, areas that require special considerations, historic, cultural and natural resource areas and other jurisdiction-determined important facilities.

6.3.1.1 Population and Building Stock

Population data for the City were obtained from the 2010 U.S. Census and the Department of Labor's (DOL) 2014 Certified population data. The U.S. Census reports the City's total population for 2010 as 374 and DOL's 2014 data reported a population of 402 (Table 6-2).

Table 6-2 Estimated Population and Building Inventory

Population		Residential Buildings	
2010 Census	DOL 2014 Data	Total Building Count	Total Value of Buildings[1]
374	402	99	U.S. Census $97,500 City: 250,000

1 Sources: U.S. Census 2010, and 2014 DOL Certified population data. US Census listed housing value at $97,500. The Project Team determined that the average structural replacement value of all single-family residential buildings is $250,000.

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Estimated replacement values for those structures, as shown in Table 6-2, were obtained from the 2010 U.S. Census, and 2014 DCCED/DCRA certified estimate.

The Planning Team stated that residential replacement values are generally understated because replacement costs exceed Census structure estimates due to material purchasing, barge or airplane delivery, and construction in rural Alaska. The Planning Team estimates an average 30ft by 40 ft (1,200 sq ft) residential structure costs $250,000. A total of 99 single-family residential buildings were considered in this analysis.

6.3.1.2 Existing Infrastructure

The 1999 DCCED Land Use Map is the most current map available for Kivalina. The following facilities were categorized using the map and after discussions with the community.

Critical Response Facilities: (Critical for emergency response efforts)

- *Kivalina Airport*
- *Kivalina Clinic*

Critical Utility Infrastructure: (Kivalina's service facilities)

- *Alaska Village Electric*
- *Water Tank*
- *Tank Farms:*
  - *Old Tank Farm*
  - *AVEC Tank Farm*
  - *Native Storage Tank Farm*

- *School Tank Farm*
- *Telephone lines*
- *Power lines*
- *McQueen School wastewater collection*
- *OTZ Telephone Co-op*
- *GCI Phone Mobile*

Essential Facilities: (Fulfill essential services for community survival)

- *City Hall/IRA Office*
- *Public Safety/City Jail*
- *Community Hall*
- *Kivalina Native Store*
- *Native Store Warehouse*
- *DOT Hanger*

Special Needs Populations: (Those that require special considerations).

- *McQueen School*
- *Churches*
- *Elder Residences*

Historical Assets: (Culturally significant – would represent a significant loss for the community.

- *Kivalina Community Hall*

All of the above City's facilities are vulnerable to HMP identified natural hazards. The following provides additional location as well as other pertinent information.

Facility Locations

The school, school storage, store, and store storage area are on the south side of the island. The Army National Guard, clinic, city offices, two churches, community center, post office, jail and fire hall are centrally located. Residential structures are generally scattered throughout the community. The airport and airstrip are on the north end of the island

Pertinent Information

The McQueen School is operated by the Northwest Arctic School District. Built in 1970, it has 127 students and, due to its age and condition, would be considered a candidate for replacement. The public school complex is fully plumbed and has its own distribution system that serves the school building, shop, and teacher housing. A 1,965-gallon storage tank is used to buffer the school system from operational failure in the WTP. The storage tank, equipped with a level sensor, is filled automatically from the TWST as needed. The school system has a single canister filter, changed once a month, for additional treatment. Two 350-gallon pressure tanks maintain pressure for the cold water system and two 100-gallon pressure tanks supply the hot water system.

The community presently has an Alaska National Guard (ANG) facility. The ANG is an important organization in many communities throughout rural Alaska. The residents would like to keep an ANG presence. This includes ensuring an ANG facility is constructed at a future City relocation site.

The existing clinic is too small to adequately serve the community of Kivalina (Appendix A). It consists of a reception area, two examining rooms, office/communications/storage room and a boiler room. The current design and layout of the clinic creates impediments for working physicians. Sanitary facilities for the clinic are simple. The clinic contains two sinks, but no flush toilets. All gray-water wastewater effluent is conveyed from the clinic to its lift station. Community wide honey bucket system is used for all Human waste.

The city building houses the City Administration, the IRA Administration, and space for meetings.

The Kivalina public utilities and infrastructure, located towards the center portion of the island, consist of a water system and treatment plant, power generation, and bulk fuel utilities.

Currently, the community receives barged fuel oil deliveries once per year, usually in the fall. Delivery quantities are between 50,000-60,000 gallons. Fuel oil is stored in vertical cylindrical steel storage tanks of approximately 6,000 gallons each.

The power plant is operated by AVEC. It has four diesel fuel fired generators.

Figure 6-2 **Kivalina Tank Farm** (WHP 2007)

Potable Water

Kivalina has no community piped water distribution system. The only buildings with piped water are the washeteria, school, and clinic.

Kivalina's primary water source is a remote location, approximately two miles upriver from the mouth of the Wulik River. The river is frozen for about 7 months. Freeze up generally occurs in October with break-up coming in late May or June. Water is also pumped in October, prior to Wulik River freeze-up. **Note:** Although the Wulik River is ice free in May or June, water is normally not pumped until July due to high river water turbidity (high silt content) immediately after break up.

When the tide is low, 14,000 feet [nearly 3 miles] of 4-inch diameter fire hose is temporarily installed between the Wulik River and the raw water storage tank (RWST). A 15- 20 horsepower (Hp) engine driven, pallet-mounted, pump is transported to the collection point upriver by boat. The pump is capable of delivering approximately 85 gallons per minute (gpm) to the 692,000 gallon RWST, and runs 24 hours a day (over approximately five to six days) until the tank is filled.

Treatment involves purifying the raw water through a small water treatment plant (WTP) located in the water treatment building attached to the north end of the washeteria. The WTP equipment is capable of treating 80 gallons per minute (gpm).

Treated water is pumped from the plant into a 500,000-gallon Treated Water Storage Tank (TWST). Raw water treatment involves the use of a 54-inch pressure sand filter and a *Giardia* barrier micro-filter. When the 500,000-gallon storage tank is filled with treated water, the RWST is refilled and the pumping and transmission equipment is disassembled and stored.

Residents obtain treated water from the washeteria watering point. They use various water collection container; typically 30-gallon garbage cans, and self-haul to their homes. They pay for water using a pay box located on the east side of the washeteria. Water rates average $0.50 for 30 gallons. The individual collecting the water must keep a flow switch depressed until the 30 gallons has been pumped. Individuals transported water to their homes using a small trailer towed by an all-terrain vehicle (ATV) or snow-machine. Information from DCCED indicates only about one-third of residents have water tanks in their homes to provide running water for the kitchen.

Many of the newest U.S. Department of Housing and Urban Development (HUD) homes have 30-gallon storage tanks and are fully plumbed, ready for connection to a piped water service. These gravity feed storage tanks are filled manually. An attempt to install a piped water distribution system is evident in Kivalina. **Note:** An arctic pipe water system was unsuccessfully installed in the village around 1988. Remnants of the old looped arctic pipe distribution system are still attached to some houses.

Wastewater Disposal

The only facilities served by on-site wastewater disposal systems are the school buildings, washeteria, and clinic. Residents dispose of gray water (non-septic wastewater) by dumping it on the ground outside their houses.

Kivalina residents currently rely on self-haul honey buckets for septic waste collection and a honey bucket bunker for disposal of most human waste. Honey buckets are 5-gallon buckets lined with plastic garbage bags. The bags are tied off and removed when full, and hauled to the honey bucket bunker. The honey bucket bunker is north of the airstrip, approximately a mile and a half from Kivalina City center. The bunker is a 60’x 60’ x 8’ galvanized H-pile and corrugated sheet steel containment basin with a capacity of approximately 215,000 gallons.

Note: A potentially unsanitary condition arises in the village when the filled plastic garbage bags are not taken the full distance from the village to the honey bucket bunker disposal. Bags deposited at the hatch of the already full wood bunkers in the village and along the way to the landfill bunker create a high likelihood for community pathogen transfer.

The washeteria and clinic each have a lift station that receives effluent by gravity, which pumps into a shared 4,000-gallon septic tank that has a pumped force main discharge going into a drain field located on the western beach. The washeteria and clinic drain field measured about 93 feet long by 18 feet wide before it was destroyed during the October 2004 presidentially declared Bering Sea Storm. **Note:** The drain field was deemed infeasible for rebuilding after the storm.

The McQueen School wastewater treatment system was installed in 1992. Wastewater travels via a gravity fed sump and duplex lift station through an aeration chamber, clarifying tank, sand filters, and a chlorine contact chamber. **Note:** A mound drain field at the school is inoperable. Treated wastewater is discharged through an insulated 2-inch piped outfall onto the beach of the Chukchi Sea.

In summary, the identified hazards are area wide. The principal hazards of flood, flood scour (erosion), severe weather, and earthquake could potentially impact any part of Kivalina.

A severe weather event would create an area-wide impact and could damage structures and potentially isolate Kivalina from the rest of the state. All Kivalina residents, even those with properties unaffected directly, will suffer flooding impacts due to:

- Difficulties in getting around the community by 4-wheeler or snow machine (the primary methods for motorized travel)
- Public safety (access and response capabilities)
- Limited perishable commodity availability, and
- Isolation

The City of Kivalina has benefited from numerous funding opportunities to assist them with upgrading their infrastructure. Table 6-3 provides a representative sample of Kivalina's "completed" infrastructure improvement projects. They provide a depiction of the community's ongoing development trends and focus toward improving aging infrastructure.

Table 6-3 Kivalina's Completed Capital Improvement Project List

Recipient	Award Year	Project Description/Comments	Project Status	Award Amount	End Date
City of Kivalina	2005	Renovation of Bingo Hall for Fire Equipment Storage	Closed	$7,769	6/30/2009
City of Kivalina	2004	Temporary Fiscal Relief Grant	Closed	$40,000	Undefined
City of Kivalina	2003	State Revenue Sharing	Closed	$45,779	3/31/2004
City of Kivalina	2003	Community Facilities and Equipment	Closed	$2,531	12/21/2006
City of Kivalina	2003	Water & Sewer Upgrades/Equipment Purchases & Repairs	Closed	$25,000	11/30/2004
City of Kivalina	2003	Safe Communities	Closed	$6,687	3/31/2004
City of Kivalina	2002	State Revenue Sharing	Closed	$30,054	3/31/2003
City of Kivalina	2002	Community Relocation Phase 3	Closed	$25,000	6/30/2004
City of Kivalina	2001	Community Relocation Engineering and Design	Closed	$25,000	6/30/2004
City of Kivalina	2000	Community Facilities and Equipment	Closed	$25,000	6/30/2004
City of Kivalina	2000	Public Facility Design Concept	Closed	$38,893	12/31/2003

Table 6-3 Kivalina's Completed Capital Improvement Project List

Recipient	Award Year	Project Description/Comments	Project Status	Award Amount	End Date
City of Kivalina	1999	Erosion Control	Closed	$25,000	6/30/2003
City of Kivalina	1998	Community Facilities and Equipment	Closed	$22,469	6/30/2002
City of Kivalina	1997	Planning and Design for Relocation of Community	Closed	$17,231	6/29/2004
City of Kivalina	1996	Engineering Design for Community Relocation	Closed	$25,000	6/30/2000
City of Kivalina	1995	Community Facilities & Equipment	Closed	$25,000	6/30/1999
City of Kivalina	1994	Facilities and Equipment Repairs	Closed	$25,000	Undefined
City of Kivalina	1994	Emergency Erosion Control	Closed	$25,000	6/30/1998
City of Kivalina	1993	Relocation Alternatives Assessment	Closed	$50,000	6/30/1997
City of Kivalina	1992	Water and Sewer System Expansion	Closed	$243,474	Undefined
City of Kivalina	1990	Erosion control	Closed	$75,378	Undefined
City of Kivalina	1990	Community Facility Improvements, Dumpsite Relocation	Closed	$34,500	Undefined
City of Kivalina	1988	Landfill Improvements and Sewer Bunker Project	Closed	$60,000	Undefined
City of Kivalina	1987	Water and Sewer Expansion	Closed	$556,526	Undefined
City of Kivalina	1985	Erosion Control Project	Closed	$59,622	Undefined
City of Kivalina	1985	Heavy Equipment Building	Closed	$249,355	Undefined
City of Kivalina	1984	Water and Sewer System	Closed	$150,000	Undefined
City of Kivalina	1983	Warm Equipment Storage	Closed	$42,810	Undefined
City of Kivalina	1983	Heavy Equipment	Closed	$150,000	Undefined
City of Kivalina	1982	Kivalina Combined Facility	Closed	$70,020	Undefined

(DCRA 2013)

The Northwest Arctic Regional Energy Plan, August 2013, describes general challenges for Kivalina such as fuel costs, energy, and the most importantly: significant road blocks to repairing or replacing aging infrastructure:

> *"The Noatak Valley Sub-region includes the communities of Kivalina and Noatak…*
>
> *As is the case across the Northwest Arctic Region, the cost of fuel is the driving energy issue in Noatak Valley Sub-Region. Energy is produced in each village at a local power plant, creating a redundancy of facilities and staffing, which could be reduced through consolidation of power generation. The proximity of the Red Dog Port site allows for the potential to consolidate energy production. No interties currently exist, so if energy is to be shared across the sub-region Noatak will need to be connected to the Port site and subsequently Kivalina will need to be tied in.*

Kivalina has been considering relocation for some time as the barrier island on which it is situated is eroding. Because of this, further investment in the community by funding agencies has been stalled and many improvements have been deferred.

Roads are also needed to facilitate fuel sharing. The river near Noatak has been too low for fuel to be barged to the community. Fuel flown in is much more costly than barged fuel. To alleviate the expense, some residents travel overland via snowmachine in winter to purchase fuel from Red Dog…

[Alaska Energy Authority] AEA granted funding to AVEC to produce a Concept Design Report and feasibility study for a transmission line and wind development at both Kivalina and the Red Dog Mine, however, economic feasibility remains the primary obstacle to ascertaining feasibility. The Kivalina power plant site is vulnerable as it is located near the beach which is subject to erosion; the tank farm is located far from power plant. ***Future funding might be hard to secure at the 'old' site and the new site is undefined.***

Department of Interior Secretary Sally Jewell visited the City of Kivalina to view climate change impacts as well as talk with the community about their concerns. The February 14, 2015 Alaska Dispatch News (AND) article , "Rare visit from Interior Secretary, top politicians puts Kivalina in the Spotlight," noted one of the City's infrastructure improvement challenges, namely a new school and funding barriers to obtaining it:

"With state and national media in tow, the 10 lawmakers and Jewell will travel 600 miles from Anchorage to the Northwest hub city of Kotzebue, then fly to Kivalina on Monday. The visit will give the 400 or so residents in the village a chance to share their concerns about climate change.

The trip is an unusual opportunity for the area, said Reggie Joule, mayor of the Northwest Arctic Borough. "It's a chance for people to lend their voice to these officials," he said.

To prepare for the visit in Kivalina, residents are digging up old and new photos to highlight the effects of warming temperatures on the barrier island beside the Chukchi Sea, including to illustrate how weakened sea ice has made spring whaling more dangerous, said Janet Mitchell, city administrator.

"We need to prove to her that we are living the changes and it's real," said Mitchell, referring to Sally Jewell.

The residents also plan a potluck with subsistence foods, including caribou, bearded seal, trout and other fish. Whale and walrus might not be available, she said. "We're hardly getting any nowadays," she said. "As soon as we get them we eat them."

Of course, with the ground frozen and blanketed in snow, now is not the ideal season for a climate change tour. "The best time to come is when it's flooding and we're having erosion problems," she said with a laugh.

That has happened often, including in 2012, when floodwaters scattered garbage and human waste from the landfill into the lagoon because the village lacks a sewer system.

There's also the predicament facing the village's overcrowded school, which is first on the state's new school construction list, thanks to a lawsuit settlement in 2011 that forced the state to build five rural schools.

But a catch in the settlement essentially required that Kivalina's school be built on dry ground. That means before the state can build the $60 million facility, the community must figure out how to fund a seven-mile evacuation road with a causeway to the mainland. The road and causeway could cost roughly $40 million to $60 million, said Millie Hawley, president of the Kivalina tribal government.

Gov. Bill Walker's proposed capital budget provides "legally obligated" funds for the school, with $4.6 million for school design. He also included $2.5 million for the road, on top of $2.5 million provided last year. They were the only projects in the slimmed-down capital budget not matched by federal or other funds.

Despite that support, it's not certain who will pay for the full cost of the road.

That is a "contentious" issue, said Suzanne Armstrong, chief of staff for Senate President Kevin Meyer, R-Anchorage. "It has to be built for the new school to be built, so there's a considerable amount of discussion among policymakers about who's responsible for building it," she said.

With the state suddenly losing money, some are looking to the Northwest Arctic Borough for support. But the borough doesn't have the money, said Joule. He's hoping the trip will lead to a commitment for funding from the state or even the federal government" (ADN 2015).

6.3.1.3 Existing Critical Facilities

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

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

The City's critical facilities and infrastructure are listed in Table 6-4.

Table 6-4 Critical Facilities and Infrastructure

Facility Categories	Number of Occupants	Facilities	Address	Latitude	Longitude	Estimated Value	Building Type	Earthquake	Flood	Ground Failure	Weather (Severe)
Government	6	City Hall / IRA Office / NANA Resource Specialist	Bering Street	67.72799	-164.53687	$750,000	W2	X	X	X	X
	2	Post Office	Bering Street	67.7279	-164.53658	$200,000	W1	X	X	X	X
Emergency Response	0	Public Safety/City Jail	Beray Street	67.72811	-164.53709	$200,000	W1	X	X	X	X
Educational	127	McQueen School	Bering Street	67.72631	-164.5324	$17,000,000	S1L	X	X	X	X
Medical	5	Maniilaq Clinic	Bering Street	67.7274	-164.53411	$350,000	W1	X	X	X	X
Community	1	Epiphany Church (Episcopal)	Bering Street	67.72751	-164.53577	$300,000	W1	X	X	X	X
	1	Friends Church	Channel Street	67.72734	-164.53265	$250,000	W1	X	X	X	X
	2	Friends Church Cabin	Channel Street	Undefined	Undefined	$150,000	W1	X	X	X	X
	0	Friends Church Storage	Channel Street	Undefined	Undefined	$25,000	W1	X	X	X	X
	0	City Storage	Beray Street	67.7279	-164.53719	$25,000	W1	X	X	X	X
	10	Boy's and Girls Club	Wulik Street	67.72788	-164.53373	$200,000	W1	X	X	X	X
	2	Community (Bingo) Hall	Bering Street	67.7274	-164.53526	$350,000	W1	X	X	X	X
	0	Community Storage Conex		67.72796	-164.53705	$4,000	Connex	X	X	X	X
	0	Kivalina Native Store	Channel Street	67.72626	-164.53041		W1	X	X	X	X
	0	Native Store Storage (Destroyed by fire 2013)	Channel Street	Undefined	Undefined		W1	X	X	X	X
	0	Native Store Warehouse	Channel Street	Undefined	Undefined	Undefined	--	X	X	X	X
	0	Community Freezer	Bering Street	67.73615	-164.56349	$30,000	--	X	X	X	X

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Table 6-4 Critical Facilities and Infrastructure

Facility Categories	Number of Occupants	Facilities	Address	Latitude	Longitude	Estimated Value	Building Type	Earthquake	Flood	Ground Failure	Weather (Severe)
	6	School Rental Unit	Bering Street	67.72595	-164.53131	$250,000	W1	X	X	X	X
	2	City Rental Unit #1	Church Street	Unknown	Unknown	$250,000	W1	X	X	X	X
	6	City Rental Unit #2	Church Street	Unknown	Unknown	$250,000	W1	X	X	X	X
	12	City Rental Duplex Unit #3	Church Street	Unknown	Unknown	$250,000	W1	X	X	X	X
	1	City Rental Unit #4	Church Street	Unknown	Unknown	$250,000	W1	X	X	X	X
	0	Resident's mainland Fishing and Hunting Camps	N/A	Undefined	Undefined	$500,000	W1	X	X	X	X
	0	Cemetery-active	N/A	67.73023	-164.54256	N/A	N/A	X	X	X	X
	0	Cemetery-inactive	N/A	67.72768	-164.53438	N/A	N/A	X	X	X	X
Roads	0	Approximate Total Miles:	1.61miles	N/A	N/A	$50,000	Gravel	X	X	X	X
		Baldwin Street	0.07								
		Bering Street	0.29								
		Berry Street	0.11								
		Channel Street	0.45								
		Chukchi Street	0.07								
		North Street	0.14								
		Ocean Side street	0.42								
		Wulik Street	0.06								
Bridge	None										
Transporation	0	Airport Runway	Airport	67.73615	-164.56349	$12,000,000	AFO	X	X	X	X
	1	DOT Hangar	Airport	67.73117	-164.54351	$650,000	SiL	X	X	X	X
	1	Heavy Equipment Maintenance & Storage Area	Airport	67.73093	-164.54254	$850,000	N/A	X	X	X	X
	10	Boat Launching Area	Kivalina Inlet	N/A	N/A	$40,000	N/A	X	X	X	X
Utilities	1	AVEC Power Plant	Bering Street	67.72721	-164.53532	$1,200,000	EPPS	X	X	X	X

Table 6-4 Critical Facilities and Infrastructure

Facility Categories	Number of Occupants	Facilities	Address	Latitude	Longitude	Estimated Value	Building Type	Earthquake	Flood	Ground Failure	Weather (Severe)
	0	AVEC Tank Farm	Bering Street	67.72712	-164.53562	$250,000	OTF	X	X	X	X
	0	School Generator	Bering Street	67.72628	-164.53287	$75,000	EPPS	X	X	X	X
	0	School Tank Farm	Baldwin Street	67.72574	-164.53021	$150,000	OTF	X	X	X	X
	0	Native Store Tank Farm	Baldwin Street	67.7255	-164.5295	$35,000	OTF	X	X	X	X
	0	Old Tank Farm	Channel Street	N/A	N/A	N/A	OTF	X	X	X	X
	3	Washeteria	Bering Street	67.7271	-164.53323	$1,000,000	PWTS	X	X	X	X
	0	Water pump house	Corwin Street	67.72777	-164.53219	$150,000	PW Pump	X	X	X	X
	0	Washeteria Water Tank	Bering Street	67.7272	-164.53352	$80,000	PWST	X	X	X	X
	0	Kivalina Water System	Bering Street	67.72976	-164.5373	Unknown	N/A	X	X	X	X
	0	Large Water Tank	Bering Street	67.72757	-164.5346	$35,000	PWST	X	X	X	X
	0	Sewage Dump	At end of airport	67.73615	-164.56349	$35,000	N/A	X	X	X	X
	0	Landfill/Incinerator	At end of airport	67.73615	-164.56349	$60,000	N/A	X	X	X	X
	0	School Satellite Dish	Bering Street	67.7262	-164.53268	$35,000	CBO	X	X	X	X
	0	GCI Satellite Dish	Bering Street	67.72813	-164.53784	$15,000	CBO	X	X	X	X
	0	City Building Satellite Dishes (2)	Bering Street	67.72796	-164.53698	$10,000	CBO	X	X	X	X
	0	GCI Telephone Module	Beray Street	67.72817	-164.53779	$225,000	CBO	X	X	X	X
	0	OTZ Telephone Co-op	Church Street	67.72701	-164.53495	$110,000	CBO	X	X	X	X
	1	AVEC Power Plant	Bering Street	67.72721	-164.53532	$1,200,000	EPPS	X	X	X	X
	174	Estimated Occupants			**Potential Damages**	**$37,889,000**					

(Kivalina 2015, DHS&EM 2014)

6.4 REPETITIVE LOSS PROPERTIES

DMA 2000 and its implementing regulations for estimating the number and type of structures at risk to repetitive flooding:

DMA 2000 Requirements
Addressing Risk and Vulnerability to NFIP Insured Structures §201.6(c)(2)(ii): The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. *All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods.* The plan should describe vulnerability in terms of: §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of] the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; §201.6(c)(2)(ii)(B): The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate; §201.6(c)(2)(ii)(C): The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. §201.6(c)(3)(ii): The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.
1. REGULATION CHECKLIST
ELEMENT B. NFIP Insured Structures
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods?
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate?
Source: FEMA, March 2015

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6.4.1.1 NFIP Participation

The function of the NFIP is to provide flood insurance to homes and businesses located in floodplains at a reasonable cost. In trade, the City of Kivalina would agree to regulate new development and substantial improvement to existing structures in the floodplain, or to build safely above flood heights to reduce future damage to new construction. The program is based upon mapped flood risk areas; requiring local implementation to reduce flood damage primarily through requiring elevating structures above the base (100-year) flood elevations. At this time, due to lack of public services and the inevitable relocation of the village, implementing flood regulations in the village is unlikely.

The Northwest Arctic Borough includes the City of Kivalina as a National Flood Insurance Program (NFIP) participating community. Flood regulations are not implemented in the community as a practical matter because they do not require building permits or site review.

Repetitive loss properties are defined by FEMA as properties that have claimed two losses in the last ten years. Since Kivalina did not join the NFIP until 2005, under the Northwest Arctic Borough, there are no repetitive loss properties in the village as defined by FEMA.

6.5 VULNERABILITY ANALYSIS METHODOLOGY

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

The Community Planning Team determined their facility locations within identified hazard impact zones. This data was used to develop a vulnerability assessment for those hazards.

Combined structure and contents replacement values were determined by the community for their physical assets. The community's aggregate exposure was calculated by assuming the worst-case scenario (that is, the asset would be completely destroyed and would have to be replaced) for each physical asset located within a hazard area. A similar analysis was used to evaluate the proportion of the population at risk. However, the analysis simply represents the number of people at risk; no estimate of the number of potential injuries or deaths was prepared.

6.6 DATA LIMITATIONS

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

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

6.7 VULNERABILITY EXPOSURE ANALYSIS

There is limited GIS data available for the City of Kivalina. The following discussion contains data obtained from the Project Team and their subsequent analysis. The results of the exposure analysis for loss estimations in the community are summarized in Tables 6-5 and 6-6 with narrative descriptions provided in Section 6.7.1

Table 6-5 Potential Hazard Exposure Analysis – Critical Facilities

		Government and Emergency Response		Educational		Medical		Community	
Hazard Type	Methodology	* # Bldgs / # Occ	Value ($)	* # Bldgs / # Occ	Value ($)	* # Bldgs / # Occ	Value ($)	* # Bldgs / # Occ	Value ($)
Earthquake	Descriptive	3/8	1,150,000	1/127	17,000,000	1/5	500,000	20/44	3,099,000
Flood	Descriptive	3/8	1,150,000	1/127	17,000,000	1/5	500,000	20/44	3,099,000
Ground Failure	Descriptive	3/8	1,150,000	1/127	17,000,000	1/5	500,000	20/44	3,099,000
Weather, Severe	Descriptive	3/8	1,150,000	1/127	17,000,000	1/5	500,000	20/44	3,099,000

Table 6-6 Potential Hazard Exposure Analysis – Critical Infrastructure

		Highway		Bridges		Transportation Facilities		Utilities	
Hazard Type	Methodology	Miles	Value ($)	No.	Value ($)	# Bldgs / # Occ	Value ($)	# Bldgs / # Occ	Value ($)
Earthquake	Descriptive	1.61	500,000	0	0	4/0	13,540,000	18/4	3,465,000
Flood	Descriptive	1.61	500,000	0	0	4/0	13,540,000	18/4	3,465,000
Ground Failure	Descriptive	1.61	500,000	0	0	4/0	13,540,000	18/4	3,465,000
Weather, Severe	Descriptive	1.61	500,000	0	0	4/0	13,540,000	18/4	3,465,000

6.7.1 Exposure Analysis – Hazard Narrative Summaries

Earthquake

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

Based on earthquake probability (PGA) maps produced by the USGS, the entire City area is at risk of experiencing moderate earthquake impacts as a result of its close proximity to known earthquake faults.

The probability is moderate (see Section 5.3.1.3) that impacts to the community such as "moderate" ground movement may result in minor infrastructure damage and personal injury.

The entire existing, transient, and future population, residential structures, and critical facilities are exposed to the effects of potential earthquake events. This includes approximately:

- 402 people in 99 residences (approximate value $24,750,000)
- Eight people in three government and emergency response facilities (approximate value $1,150,000)
- 127 people in one educational facilities (approximate value $17,000,000)
- Five people in one medical facility (approximate value $500,000)
- 44 people in 16 community facilities (approximate value $3,099,000)
- 1.61 gravel road system miles (approximate value $500,000)
- Four transportation facilities (approximate value $13,540,000)
- Four people in 18 utility facilities (approximate value $3,465,000)

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

Flood

Typical flood impacts associated include structures and contents water damage, roadbed, embankment, and coastal and riverine sour, boat strandings, areas of standing water in roadways. Flood events may also damage or displace fuel tanks, power lines, or other infrastructure. The City elevates all buildings to withstand flooding events (e.g., to allow water pass-through the open areas under the main floor of a building) allowing the building to be more flood impact resistant (see Section 5.3.2.3).

However, there has been no detailed 100 year floodplain analysis prepared for Kivalina. The USACE Floodplain Manager provides limited flood information but no 100 year floodplain map. However, the 2009 USACE Baseline Erosion Assessment does provide substantive flood and high water flow scour damage data. These damages may impact the following:

- 402 people in 99 residences (approximate value $24,750,000)
- Eight people in three government and emergency response facilities (approximate value $1,150,000)
- 127 people in one educational facilities (approximate value $17,000,000)
- Five people in one medical facility (approximate value $500,000)
- 44 people in 16 community facilities (approximate value $3,099,000)
- 1.61 gravel road system miles (approximate value $500,000)
- Four transportation facilities (approximate value $13,540,000)
- Four people in 18 utility facilities (approximate value $3,465,000)

The City anticipates that impacts to future populations, residential structures, critical facilities, and infrastructure will be at the same historical impact level.

Ground Failure

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

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

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

Ground Failure hazards periodically cause structure and infrastructure displacement due to ground shifting, sinking, and upheaval. According to mapping completed by the DGGS, Kivalina has continuous permafrost (see Section 5.3.3.3).

There have been periodic ground failure incidents associated with melting permafrost and embankment failure in Kivalina. Threatened facilities include:

- 402 people in 99 residences (approximate value $24,750,000)
- Eight people in three government and emergency response facilities (approximate value $1,150,000)

- 127 people in one educational facilities (approximate value $17,000,000)
- Five people in one medical facility (approximate value $500,000)
- 44 people in 16 community facilities (approximate value $3,099,000)
- 1.61 gravel road system miles (approximate value $500,000)
- Four transportation facilities (approximate value $13,540,000)
- Four people in 18 utility facilities (approximate value $3,465,000)

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

Severe Weather

Impacts associated with severe weather events includes roof collapse, trees and power lines falling, damage to light aircraft and sinking small boats, injury and death resulting from snow machine or vehicle accidents, overexertion while shoveling all due to heavy snow. A quick thaw after a heavy snow can also cause substantial flooding. Impacts from extreme cold include hypothermia, halting transportation from fog and ice, congealed fuel, frozen pipes, utility disruptions, frozen pipes, and carbon monoxide poisoning. Additional impacts may occur from secondary weather hazards or complex storms such as extreme high winds combined with freezing rain, high seas, and storm surge. Section 5.3.4.3 provides additional detail regarding severe weather impacts. Buildings that are older and/or not constructed with materials designed to withstand heavy snow and wind (e.g., hurricane ties on crossbeams) are more vulnerable to the severe weather damage.

Based on historical information and Kivalina's HMP Planning Team comments, Kivalina's entire existing, transient, and future population, residential structures, and critical facilities are exposed to future severe weather impacts. This includes approximately:

- 402 people in 99 residences (approximate value $24,750,000)
- Eight people in three government and emergency response facilities (approximate value $1,150,000)
- 127 people in one educational facilities (approximate value $17,000,000)
- Five people in one medical facility (approximate value $500,000)
- 44 people in 16 community facilities (approximate value $3,099,000)
- 1.61 gravel road system miles (approximate value $500,000)
- Four transportation facilities (approximate value $13,540,000)
- Four people in 18 utility facilities (approximate value $3,465,000)

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

All Manmade and Technological Hazards

The Planning Team stated that due to the communities residential and public structures' close proximity to each other; the entire community would be impacted by all identified non-natural hazards. That includes Kivalina's entire existing, transient, and future population, residential structures, and critical facilities:

- 402 people in 99 residences (approximate value $24,750,000)
- Eight people in three government and emergency response facilities (approximate value $1,150,000)
- 127 people in one educational facilities (approximate value $17,000,000)
- Five people in one medical facility (approximate value $500,000)
- 44 people in 16 community facilities (approximate value $3,0994,000)
- 1.61 gravel road system miles (approximate value $500,000)
- Four transportation facilities (approximate value $13,540,000)
- Four people in 18 utility facilities (approximate value $3,465,000)

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

6.8 FUTURE DEVELOPMENT

Table 6-7 delineates Kivalina's future projects some are funded but many remain unfunded.

Table 6-7 Planned Projects

Grant Recipient	Award Year	Project Description/Comments	Project Status
Northwest Arctic Borough	2005	Evacuation/Relocation Road feasibility study ($2,5M)	In-Progress
DCRA	2013	Kivalina Strategic Management Plan (completed by HDR)	In-Progress
Undefined	Undefined	Kivalina Community Relocation	Unfunded
Undefined	Undefined	Revetment continuation to protect community until relocation is finalized	Unfunded
Undefined	Undefined	Drill potable water well to avoid contaminants at current water collection site	Unfunded
Undefined	Undefined	Construct DEC approved sewage lagoon	Unfunded
Undefined	Undefined	Construct new DEC and DOT/PF approved landfill to fulfill both agencies regulatory requirements	Unfunded
Undefined	Undefined	Construct safe boat harbor for fishing fleet	Unfunded
Undefined	Undefined	Complete Emergency Operations Plan	Unfunded
Undefined	Undefined	Construct new school at Kisimagiuqtuq Hill (the end of the proposed evacuation/relocation road) to assure long-term sustainability ($35M to $40M)	Unfunded

(DCRA 20114)

Section Seven delineates the City's HMP mitigation strategy.

7.1 OVERVIEW

The mitigation strategy provides the blueprint for implementing desired activities that will enable the community to continue to save lives and preserve infrastructure by systematically reducing hazard impacts, damages, and community disruption. A vulnerability analysis is divided into six steps:

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

DMA 2000 and its implementing regulations for comprehensive mitigation strategy development:

7

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

DMA 2000 Requirements
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards?
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure?
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction?
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate?
Source: FEMA, March 2015

7.2 CITY OF KIVALINA'S CAPABILITY ASSESSMENT

DMA 2000 and its implementing regulations for technical and fiscal resources available to the community for HMP project implantation and management:

DMA 2000 Requirements
Incorporation into Existing Planning Mechanisms §201.6(c)(3): [The plan shall include the following:] A *mitigation strategy* that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools.
1. REGULATION CHECKLIST
ELEMENT C. Incorporate into Other Planning Mechanisms
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs?
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate?
Source: FEMA, March 2015

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

Table 7-1 Kivalina's Regulatory Tools

Regulatory Tools (ordinances, codes, plans)	Existing Yes/No	Comments (Year of most recent update; problems administering it, etc.)
Comprehensive Plan	No	Currently under development – in draft form
Land Use Plan	No	Currently under development – in draft form
Tribal Land Use Plan	No	
Emergency Response Plan	No	
Wildland Fire Protection Plan	No	
Building code	No	The City can exercise this authority.
Zoning ordinances	No	Currently under development – in draft form
Subdivision ordinances or regulations	No	The City can exercise this authority.
Special purpose ordinances	Yes	Kivalina is included in the National Flood Insurance Program because it is part of the Northwest Arctic Borough. However, no flood regulations are implemented in the village.

Local Resources

The City 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 hazard mitigation Planning Team, and are summarized below.

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

Staff/Personnel Resources	Yes / No	Department/Agency and Position
City Mayor	Yes	
City Administrator	Yes	
City Clerk	Yes	
Emergency Response	Yes	Village Public Safety Officer, Volunteer Fire Responders, Volunteer Fire Chief
Planner or engineer with knowledge of land development and land management practices	No	The City hires planners and engineering consultants
Engineer or professional trained in construction practices related to buildings and/or infrastructure	No	The City hires engineering consultants
Planner or engineer with an understanding of natural and/or human-caused hazards	No	The City hires planners and engineering consultants
Floodplain Management	No	The City does not have this capability but can easily access State Floodplain Management guidance. Kivalina is included in the National Flood Insurance Program because it is part of the Northwest Arctic Borough. However, no flood regulations are implemented in the village.
Surveyors	No	The City hires consultants when they need a surveyor.
Staff with education or expertise to assess the jurisdiction's vulnerability to hazards	Yes	Elders with extensive knowledge of hazards affecting the community
Personnel skilled in Geospatial Information System (GIS) and/or Hazards Us-Multi Hazard (Hazus-MH) software	No	The City hires consultants when they need a surveyor.
Scientists familiar with the hazards of the jurisdiction	No	City can work with U.S. Fish & Wildlife Service (USFWS) and Fish & Game (ADF&G), and the Alaska Department of Transportation and Public Facilities
Emergency Manager	Yes	The City Mayor, City Administrator, or Tribal President as applicable
Finance (Grant writers)	Yes	City or Tribal Bookkeeper as applicable
Public Information Officer	Yes	The City Mayor, City Administrator, or Tribal President

Table 7-3 Kivalina Financial Resources for Hazard Mitigation

Financial Resource	Accessible or Eligible to Use for Mitigation Activities
General funds	Can exercise this authority with voter approval
Community Development Block Grants (CDBG)	Can exercise this authority with voter approval
Capital Improvement Project Funding	Can exercise this authority with voter approval
Authority to levy taxes for specific purposes	Can exercise this authority with voter approval
Incur debt through general obligation bonds	Can exercise this authority with voter approval
Incur debt through special tax and revenue bonds	Can exercise this authority with voter approval

Table 7-3 Kivalina Financial Resources for Hazard Mitigation

Financial Resource	Accessible or Eligible to Use for Mitigation Activities
Incur debt through private activity bonds	Can exercise this authority with voter approval
Hazard Mitigation Grant Program (HMGP)	FEMA funding is available to local communities via a pass through grant. Funds are available after a Presidentially-declared disaster. This grant follows a statewide competitive grant application process to fund both pre- and post-disaster mitigation plans and projects.
Pre-Disaster Mitigation (PDM) grant program	FEMA funding available on an annual basis. This grant follows a nationally competitive grant application process to fund pre-disaster mitigation plans and projects only. The successful applicant receives grant funds as a pass through recipient as a sub-grantee to the State.
Flood Mitigation Assistance (FMA) grant program	FEMA funding which is available on an annual basis. This grant can be used to mitigate repetitively flooded structures and infrastructure to protect repetitive flood structures. ***Kivalina potentially qualifies for this funding source through the Northwest Arctic Borough.***
United State Fire Administration (USFA) Grants	The purpose of these grants is to assist state, regional, national or local organizations to address fire prevention and safety. The primary goal is to reach high-risk target groups including children, seniors and firefighters.
Fire Mitigation Fees	Finance future fire protection facilities and fire capital expenditures required because of new development within Special Districts.

The Planning Team developed the mitigation goals and potential mitigation actions to address identified potential hazard impacts for the Kivalina within Section 5.3.

7.3 DEVELOPING MITIGATION GOALS

DMA 2000 stipulated and implementing regulations for developing hazard mitigation goals:

DMA 2000 Requirements
Local Hazard Mitigation Goals §201.6(c)(3)(i): The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
1. REGULATION CHECKLIST
ELEMENT C. Mitigation Goals
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards?
Source: FEMA, March 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, eleven goals were developed to reduce or avoid long-term vulnerabilities to the identified hazards (Table 7-4). The Planning Team decided not to identify specific mitigation goals or action items because they

deemed manmade and technological hazards would result as a secondary (2nd) or tertiary (3rd) level event resulting from natural hazard impacts.

Table 7-4 Mitigation Goals

No.	Goal Description
Multi-Hazards (MH)	
MH 1	Provide **outreach** activities to educate and promote recognizing and mitigating all natural and manmade hazards that affect the City of Kivalina (City) and Kivalina IRA Tribe (Tribe).
MH 2	**Cross-reference** or coordinate mitigation goals and actions with other City/Village planning mechanisms and projects.
MH 3	Develop **construction** activities that reduce possibility of losses from all natural and manmade hazards that affect the City/Tribe.
Natural Hazards	
EQ 4	Reduce structural vulnerability to earthquake (EQ) damage.
FL 5	Reduce flood and scour (FL) damage and loss possibility.
GF 6	Reduce ground failure (GF) damage and loss possibility.
SW 7	Reduce structural vulnerability to severe weather (SW) damage.
WF 8	Reduce structural vulnerability to Tundra/Wildland Fire (WF) damage.
Manmade /Technological Hazards	
HZ 9	Reduce hazardous materials (HZ) impacts to the community.
T/U 10	Reduce transportation and utility (T/U) system impacts to the community.
PH 11	Reduce public health (PH) impacts to the community.

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7.4 IDENTIFYING MITIGATION ACTIONS

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

DMA 2000 Requirements
Identification and Analysis of Mitigation Actions §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.
1. REGULATION CHECKLIST
ELEMENT C. Mitigation Actions
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure?
Source: FEMA, March 2015

After developing mitigation goals, the Planning Team reviewed a comprehensive list of 2007 HMP listed and newly identified potential mitigation actions to determine how to best mitigate Kivalina's ongoing hazard impacts during this HMP development process.

The Planning Team assessed the potential mitigation actions to carry forward into the mitigation strategy. Mitigation actions are activities, measures, or projects that help achieve the goals of a

mitigation plan. Mitigation actions are usually grouped into three broad categories: public education and awareness, community plan coordination, and property protection and structural projects.

On January 14, 2015, the Planning Team selected 31 natural hazard mitigation actions for potential Mitigation Action Plan (MAP) implementation during the five-year life cycle of this HMP. The Planning Team placed particular emphasis on projects and programs that reduce the effects of hazards on both new and existing buildings and infrastructure as well as facilities located in potential flood zones to comply with **NFIP requirements** should the City join the **NFIP**.

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

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

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the legacy HMP Identified Mitigation Action Items and their respective status determinations)

Goals		Status		Actions
No.	**Description**	**New** *Considered, Selected* **Brought Forward** *Complete, Deferred, Deleted, or Ongoing*	**Explain Status** *(N/A= Not Applicable)*	**Description**
Multi-Hazards (MH)				
MH 1	*Provide outreach activities to educate and promote recognizing and mitigating all natural and manmade hazards that affect the City / Village of (City) / (Village).*	*Combined Project #12, 14, &19*	*Combined due to similarity Education is a continuous process*	***Project 12 .*** *Public Education* *Increase public knowledgeable about mitigation opportunities, floodplain functions, emergency service procedures, and potential hazards.* *This would include advising property owners, potential property owners, and visitors about the hazards. In addition, dissemination of a brochure or flyer on flood hazards in Kivalina could be developed and distributed to all households.*
				(Delete) Project 14: *Conduct special a awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc.*
				(Delete) Project 19: *Enhance public awareness of potential risk to life and personal property due to natural hazards. Encourage mitigation measures in the immediate vicinity of their property.*
		Ongoing/ Reworded	*Split into separate projects*	***Project 10.*** *Structure Elevation and Floodproofing, and continued participation in the* ***NFIP***
		Ongoing	*Seeking funding agency support and*	***Project 11.*** *Kivalina Hazard Maps* *(i.e. Develop Kivalina Flood Map to fulfill FEMA NFIP requirements.)*

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Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the legacy HMP Identified Mitigation Action Items and their respective status determinations)

Goals		Status		Actions
No.	**Description**	**New** *Considered, Selected* **Brought Forward** *Complete, Deferred, Deleted, or Ongoing*	**Explain Status** *(N/A= Not Applicable)*	**Description**
			prioritization	
		Ongoing	*Ongoing*	***Project 13:*** *Research and consider instituting the National Weather Service program of "Storm Ready".*
		Ongoing	*Education is a continuous process*	***Project 15:*** *Expand public awareness about NOAA Weather Radio for continuous weather broadcasts and warning tone alert capability.*
		Ongoing	*Edited to better reflect current needs*	***Project 16:*** *Encourage weather resistant building construction materials and practices. (Encourage hazard-resistant building, construction materials, and practices, i.e. flood, weather, earthquake, etc.)*
		New/Selected	N/A	Identify and pursue funding opportunities to implement mitigation Actions.
		New/Selected	N/A	Disseminate FEMA pamphlets to educate and encourage homeowners concerning structural and non-structural retrofit benefits.
		Considered	N/A	Identify evacuation routes away from high hazard areas and develop outreach program to educate the public concerning warnings and evacuation procedures.
MH 2	***Cross-reference*** *mitigation goals and actions with other City/Tribal planning mechanisms and projects.*	*Ongoing*	N/A	***Project 22:*** *Develop an agreement with a consultant to provide technical assistance and administer funds that would be funneled into the community after a major disaster.*
		New/Selected	N/A	The City will strive to manage their existing plans to coordinate and incorporate mitigation provisions into all community planning processes such as comprehensive, capital improvement, economic development, business, transportation, and land use plans, etc. to demonstrate multi-benefit and facilitate using multiple funding source considerations.
		New/Selected	N/A	Prohibit new construction in identified mitigatable hazard impact areas (erosion, flood, ground failure (permafrost), etc.) or require building to applicable building codes for other hazard impacts (earthquake, volcanic ash, weather, etc.).
		New/Selected	N/A	Drill fresh water well. Current water source at Wulik River location is eroding, located downriver from the Red Dog Mine (susceptible to mine discharge impacts), and experiences severe turbidity. Well is essential to community longevity, sustainability, and public health.
		New Selected	N/A	Research water desalination plant options. The Red Dog Mine desalination plant located approximately five miles from Kivalina has operated successfully for approximately 15 years producing near equivalent to Kivalina's water requirements.
MH 3	*Develop construction activities that reduce possibility of*	*Ongoing*	*Project is in design stage*	***Project 8.*** *Construct a Kivalina Evacuation Road. The proposed route begins in the village, crosses Kivalina Lagoon with a causeway and bridge, crosses the tundra, and terminates at Kisimigiuktuk Hill.* *This road would serve as a satisfactory evacuation route, while at the same time accessing a much needed gravel source.*

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the legacy HMP Identified Mitigation Action Items and their respective status determinations)

Goals		Status		Actions
No.	**Description**	**New** *Considered, Selected* **Brought Forward** *Complete, Deferred, Deleted, or Ongoing*	**Explain Status** *(N/A= Not Applicable)*	**Description**
	losses from all natural and manmade hazards that affect the City/Village.			*Depending on where the future village relocation site is located, it is likely that all or part of this road can be used in the relocation efforts. The road also accesses a potential airport site. The estimated cost of evacuation route, in 2005 dollars, is $21,300,000.*
		New/Selected	N/A	Acquire (buy-out), demolish, or relocate structures from hazard prone area (erosion, flood, ground failure, etc.) Property deeds "must be" restricted for open space uses for perpetuity to keep people from rebuilding in known hazard areas. The following 2007 HMP projects support this initiative:
		Delete	*The City no longer has a Sewer Tx. Plant only a honey bucket lagoon*	***Project 1:*** *Relocate Sewage Treatment (Tx.) Plant*
		Ongoing/ Deferred	*Coordinating with responsible agency*	***Project 2:*** *Relocate fuel lines to school*
		Ongoing/ Deferred	*Seeking funding*	***Project 3:*** *Remove exposed sewage bunkers on shoreline*
		Ongoing/ Reworded	*To reflect all hazards acquisition, elevation or relocation*	***Project 4:*** *Relocate homes threatened by winter storm, flood, and erosion*
		Complete	*N/A*	***Project 5:*** *Repair wind and ice damaged public water tank skins*
		Deleted	*Community only has water line, no sewer line.*	***Project 6:*** *Repair exposed underground water lines from lagoon to community*
		New Selected	N/A	Relocate community to Kiniktuuraq. The existing location has no space for growth, new homes construction. It experiences impacts from all natural hazards and is susceptible to rapid urban fire damages due to the entire community's buildings close proximity to each other.
		New/Selected	N/A	Encourage utility companies to evaluate and harden vulnerable infrastructure elements for sustainability.
		New/Selected	N/A	Increase power line wire size and incorporate quick disconnects (break---away devices) to reduce ice load and windstorm power-line failure during severe wind or winter ice storm events.
		Ongoing/	*Seeking*	***Project 17:*** *Install a siren to warn people of a severe weather*

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the legacy HMP Identified Mitigation Action Items and their respective status determinations)

Goals		Status		Actions
No.	**Description**	**New** *Considered, Selected* **Brought Forward** *Complete, Deferred, Deleted, or Ongoing*	**Explain Status** *(N/A= Not Applicable)*	**Description**
		Deferred	*funding*	*or disaster event.*
		New/Selected	N/A	Develop disaster debris management plan
		New/Selected	N/A	Identify close proximity gravel source essential to current projects and future relocation site development
EQ4	*Reduce vulnerability, damage, or loss of structures from earthquake damage*	*Combined and Reworded*	*To better reflect community needs*	***Project 20:*** *Identify buildings and facilities that must be able to remain operable during and following an earthquake event.*
				Delete Project 21: *Contract a structural engineering firm to assess the identified buildings and facilities to determine their structural integrity and strategy to improve their earthquake resistance.*
FL 5	*Reduce vulnerability, damage, or loss of structures from erosion.*	*Ongoing*	*Seeking funding*	***Project 7:*** *Kivalina Lagoon erosion control project. Continue revetment to encapsulate the lagoon side of the community to eliminate current and future erosion impacts. This will be essential if the Kivalina Evacuation Road project's causeway is constructed. This will focus all Wulik River's devastating water flow impacts directly at the lagoon side of the island.*
		Reworded/ Ongoing	*To reflect inspection vs. construction.*	***Project 9:*** *Seawall Inspection and Maintenance. A seawall was constructed in 2005 to protect the community. The 2009 constructed seawall requires continual inspection and potential maintenance of the seawall to protect the community until community relocation occurs.*
		Reworded/ Ongoing	*To reflect developing a threatened property inventory...*	***Project 10:*** ~~*Structure Elevation and/or Relocation*~~ *A list of homes, commercial structures and critical facilities that are in danger of flooding and in erosion danger should be identified and mitigation projects for elevating and/or relocating the structures determined.*
		Ongoing	*Deferred seeking funding*	***Project 18:*** *Install automated weather sensors. Automated weather sensors are the chief method by which the National Weather Service detects the occurrence of incoming severe weather.*
		New/Selected	N/A	Protect wastewater treatment systems to prevent erosion or flooding damage and sewage lagoon out-wash.
		New/Selected	N/A	Replace water sump pumps damaged from silt damage. These pumps are vital for removing storm and floodwater collection in town center. Pumps will need filter screens to prevent future failure.
		New/Selected	N/A	Build berm around landfill to reduce flood water intrusion. Flood waters outflow into the Kivalina Lagoon creating a high chloroform contamination from constant flooding and subsequent outflow.
GF 6	*Reduce vulnerability,*	New/Selected	N/A	Promote ground failure (such as permafrost) sensitive construction practices in hazard impact areas.

Table 7-5 Mitigation Goals and Potential Actions

(Blue text items are the legacy HMP Identified Mitigation Action Items and their respective status determinations)

Goals		Status		Actions
No.	**Description**	**New** *Considered, Selected* **Brought Forward** *Complete, Deferred, Deleted, or Ongoing*	**Explain Status** *(N/A= Not Applicable)*	**Description**
	damage, or loss of structures from flooding.			
SW 7	*Reduce vulnerability, damage, or loss of structures from ground failure.*	*Ongoing*	*Deferred as low priority task*	*Project 13: Research and consider instituting the National Weather Service program of "Storm Ready".*
		New/Selected	N/A	Develop and implement programs to coordinate maintenance and mitigation activities (such as utility line quick-disconnects) to reduce risk to public infrastructure from severe winter storms (snow load, ice, and wind).
		New/Selected	N/A	Increase power line wire size and incorporate quick disconnects (break---away devices) to reduce ice load and windstorm power-line failure during severe wind or winter ice storm events.
WF 8	*Reduce vulnerability, damage, or loss of structures from wildland or tundra fires.*	*Minimal threat to current community location*		

7

7.5 EVALUATING AND PRIORITIZING MITIGATION ACTIONS

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

DMA 2000 Requirements: Mitigation Strategy - Implementation of Mitigation Actions
Implementation of Mitigation Actions §201.6(c)(3)(iii): [The hazard mitigation strategy shall include an] action plan, describing how the action identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.
1. REGULATION CHECKLIST
ELEMENT C. MITIGATION STRATEGY
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))
Source: FEMA, March 2015

The Planning Team evaluated and prioritized each of the mitigation actions in May, 2015 to determine which actions would be included in the Mitigation Action Plan. The Mitigation Action Plan represents mitigation projects and programs to be implemented through the cooperation of multiple entities in the City. To complete this task, the Planning Team first prioritized the hazards that were regarded as the most significant within the community (earthquake, flood, ground failure, and severe weather).

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

Table 7-6 Evaluation Criteria for Mitigation Actions

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

In May, 2015, the hazard mitigation Planning Team prioritized 31 natural hazard mitigation actions (16 were updated and carried forward from the 2007 HMP; 15 newly selected actions)

were selected to carry forward for Mitigation Action Plan (MAP) implementation during the Updated HMP's 5-year life cycle.

The hazard mitigation Planning Team considered each hazard's history, extent, and probability to determine each potential actions priority. A rating system based on high, medium, or low was used.

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

Prioritizing the mitigation actions within the MAP matrix (Table 7-8) was completed to provide the City with an implementation approach.

7.6 MITIGATION ACTION PLAN

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

Table 7-7 Potential Funding Source Acronym List

(See complete funding resource description in Appendix A)

City of Kivalina (City Mayor's Office)
Kivalina IRA Tribal Council (Tribal Council Office)
US Department of Homeland Security (DHS)
Citizens Corp Program (CCP)
Emergency Operations Center (EOC)
Homeland Security Grant Program (HSGP)
Emergency Management Performance Grant (EMPG)
State Homeland Security Program (SHSP)
Federal Management Agency (FEMA) /
Hazard Mitigation Assistance Grant Programs (HMA)
Emergency Management Program Grant (EMPG)
Debris Management Grant (DM)
Flood Mitigation Assistance Grants (FMA)
National Earthquake Hazards Reduction Program (NEHRP)
National Dam Safety Program (NDS)
US Department of Commerce (DOC) /
Remote Community Alert Systems Program (RCASP)
National Oceanic and Atmospheric Administration (NOAA)
US Department of Agriculture (USDA) /
USDA, Farm Service Agency
Emergency Conservation Program (ECF)
Rural Development (RD)
USDA, Natural Resources Conservation Service (NRCS)
Conservation Technical Assistance Program (DCT)
Conservation Innovation Grants (CIG)
Environmental Quality Incentives Program (EQIP)
Emergency Watershed Protection Program (EWP)
Watershed Planning (WSP)

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

Assistance to Native Americans (ANA)
*Native American Housing Assistance and Self Determination Act (NA*FSMA),

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

Alaska Department of Military and Veterans Affairs (DMVA), Division of Homeland Security and Emergency Management (DHSEM)
Mitigation Section (for PDM & HMGP projects and plan development)
Preparedness Section (for community planning)
State Emergency Operations Center (SEOC for emergency response)

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

Alaska Department of Transportation
State road repair funding

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

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

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

Denali Commission (Denali)
Energy Program (EP
Solid Waste Program (SWP)

Lindbergh Foundation Grant Programs (LFGP)

Rasmuson Foundation Grants (LFG)

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

Table 7-8 City of Kivalina's Mitigation Action Plan (MAP)

*(**Blue italicized** initiatives were brought forward from existing HMP or other identified plans)*
(See acronym and abbreviations list for complete titles)

Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
MH 1.1	*(Formerly Projects 12& 14) Public Education* *Increase public knowledgeable about mitigation opportunities, floodplain functions, emergency service procedures, and potential hazards.* *This would include advising property owners, potential property owners, and visitors about the hazards. In addition, dissemination of a brochure or flyer on flood hazards in Kivalina could be developed and distributed to all households.*	*High*	*City of Kivalina Mayor' Kivalina IRA Tribal Council as applicable* *(The Tribal Council is included as a viable responsible entity in order to obtain Administration for Native Americans (ANA) funding, the Tribe would need to be the applicant for those projects)*	*City, Tribe, DHSEM, FEMA*	*Ongoing (1-3 years)*	*B/C: This ongoing activity is essential for the City as there are limited funds available to accomplish effective mitigation actions.* *T/F: This activity is ongoing using existing community volunteers and city staff demonstrating its feasibility.*
MH 1.2	*(Formerly Project 1) Kivalina Hazard Maps* *(i.e. Develop Kivalina Flood Map to fulfill FEMA NFIP requirements.)*	*High*	*City Manger, Tribal Council*	*>$10,000* *FEMA, NRCS, DCCED, DHS*	*Ongoing (> 5 years)*	*B/C: FEMA recognizes that accurate flood maps are essential to identify flood prone facilities to enable a community to prepare for and mitigation flood threats.* *TF: DCRA and FEMA staffs support this activity as prioritized within State and FEMA as determined by need and funding is availability.*

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(See acronym and abbreviations list for complete titles)

Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
MH 1.3	*(Formerly Project 13) Research and consider instituting the National Weather Service program of "Storm Ready".*	*Low*	*City Manager, Tribal Council*	*City, Tribe, DHS&EM, NOAA/NWS*	*Ongoing (1-5 years)*	*B/C: Sustained emergency response planning, mitigation outreach, and emergency notification programs have minimal cost and will help build and support community capacity enabling the public to prepare for, respond to, and recover from disasters.* *T/F: This project is technically feasible using existing City staff*
MH 1.4	*(Formerly Project 15) Expand public awareness about NOAA Weather Radio for continuous weather broadcasts and warning tone alert capability.*	*Low*	*City Manager, Tribal Council*	*City, Tribe, NOAA*	*2-4 years*	*B/C: Sustained mitigation outreach programs have minimal cost and will help build and support area-wide capacity. This type activity enables the public to prepare for, respond to, and recover from disasters.* *T/F: This low cost activity can be combined with recurring community meetings where hazard specific information can be presented in small increments. This activity is ongoing demonstrating its feasibility.*
MH 1.5	*(Formerly Project 16) Encourage weather resistant building construction materials and practices.*	*Medium*	*City Manager, Tribal Council*	*City, Tribe, DHSEM, FEMA, FireWise*	*Ongoing (3-5 years)*	*B/C: This activity could potentially decrease damage to buildings. Structural sustainability is essential to longevity and resident survivability.* *T/F: Technically feasible as the community is currently working with UAF and other entities to determine most viable construction practices.*
MH 1.6	Identify and pursue funding opportunities to implement mitigation	High	City Manager, Tribal Council	City, Tribe	Ongoing	B/C: This ongoing activity is essential for the City as there are limited funds

Table 7-8 City of Kivalina's Mitigation Action Plan (MAP)

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Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
	Actions.					available to accomplish effective mitigation actions. T/F: This activity is ongoing demonstrating its feasibility.
MH 1.7	Disseminate FEMA pamphlets to educate and encourage homeowners concerning structural and non-structural retrofit benefits.	Medium	City Manager, Tribal Council	City, Tribe, FEMA HMA programs, AFG, FP&S, and SAFER	1-3 years	B/C: Sustained mitigation outreach programs have minimal cost and will help build and support area-wide capacity. This type activity enables the public to prepare for, respond to, and recover from disasters. T/F: This low cost activity can be combined with recurring community meetings where hazard specific information can be presented in small increments. This activity is ongoing demonstrating its feasibility.
MH 2.1	*(Formerly Project 22) Develop an agreement with a consultant to provide technical assistance and administer funds that would be funneled into the community after a major disaster.*	*High*	*City Manager, Tribal Council*	*City, Tribe, DCRA, DHSEM, FEMA, Denali Commission, DHS*	*Ongoing (1-5 years)*	*B/C: Accurate project management is essential for grant compliance. Rural Alaska communities do not typically have capacity to fulfill stringent regulatory requirements.* *T/F: Grant fund management is feasible via skilled and knowledgeable outside resources. Stringent consultant reviews will be critical for the success of this initiative to assure they possess and follow FEMA's stringent accounting and reporting processes.*
MH 2.2	The City will strive to manage their existing plans to coordinate and incorporate mitigation provisions into	Medium	City Manager, Tribal Council	City, Tribe, Denali Commission, DCRA	1-3 years	B/C: Coordinated planning ensures effective damage abatement and ensures proper attention is assigned to reduce

Table 7-8 City of Kivalina's Mitigation Action Plan (MAP)

(Blue italicized initiatives were brought forward from existing HMP or other identified plans)
(See acronym and abbreviations list for complete titles)

Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
	all community planning processes such as comprehensive, capital improvement, economic development, business, transportation, and land use plans, etc. to demonstrate multi-benefit and facilitate using multiple funding source considerations.					losses and damage to structures and residents. T/F: This is feasible to accomplish as cost can be associated with plan reviews and updates. The action relies on staff and review committee availability and willingness to serve their community.
MH 2.3	Prohibit new construction in identified mitigatable hazard impact areas (erosion, flood, ground failure (permafrost), etc.) or require building to applicable building codes for other hazard impacts (earthquake, volcanic ash, weather, etc.).	High	City Manager, Tribal Council	City, Tribe, DCRA, Denali Commission	3-5 years	B/C: Building code development, implementation and enforcement can effectively reduce future losses to hazardous events. Building codes can actually assist bush communities through making maximum use of materials and shipping costs the first time. T/F: This project is technically feasible as the community need only demonstrate cost savings by demonstrating losses from history utility impacts and down time.
MH 3.1	Relocate community to Kiniktuuraq. The existing location has no space for growth, new homes construction. It experiences impacts from all natural hazards and is susceptible to rapid urban fire damages due to the entire community's buildings close proximity to each other.	High	City Manager, Tribal Council	City, Tribe, HMA, NRCS, ANA, USACE, USDA, Lindbergh	Ongoing 1-5 years	B/C: This project would remove the entire threatened community's structures from the barrier island location prone to continuous hazard impacts, potentially eliminating future damages. T/F: This project is feasible using existing staff skills, equipment, and materials. Acquiring contractor expertise may be required for large facilities.
MH 3.2	Drill fresh water well. Current water source Wulik River location is eroding, located downriver from the Red Dog	High	City Manager, Tribal Council	FEMA HMGP,PDM, & FMA Program grants, ANTHC, DEC/VSW, ANA Funding as	Ongoing 1-3 years	B/C: Improving water, availability, quality, and flow capability will greatly reduce potential infrastructure and residential

Table 7-8 City of Kivalina's Mitigation Action Plan (MAP)

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Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
	Mine (susceptible to mine discharge impacts), and experiences severe turbidity. Well is essential to community longevity, sustainability, and public health.			applicable		losses. Project costs would outweigh replacement costs of lost facilities. T/F: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
MH 3.3	*(Formerly Project 4) Acquire (buy-out), demolish, or relocate structures from hazard prone area (erosion, flood, ground failure, etc.)* *The following 2007 HMP projects support this initiative: MH 3.2-3.6*	*High*	*City Manager, Tribal Council*	*City, Tribe, HMA, NRCS, ANA, USACE, USDA, Lindbergh*	*Ongoing* *1-5 years*	*B/C: This project would remove threatened structures from hazard areas, eliminating future damage.* *F: This project is feasible using existing staff skills, equipment, and materials. Acquiring contractor expertise may be required for large facilities.*
MH 3.4	*(Formerly Project 10-reworded)* *Inventory homes, commercial structures, and critical facilities that are threatened by hazard impacts such as flooding, erosive scour, storm surge, etc.)*	*High*	*City Manager, Tribal Council*	*City, Tribe, Denali Commission, DCRA*	*Ongoing* *2-5 years*	*B/C: Inventorying repetitively damaged or threatened structures is critical to reducing impacts is a high priority for FEMA and will therefore benefit the community greatly. Identifying RL and SRL properties is the first step to reducing losses. Coordinated planning ensures effective damage abatement and ensures proper attention is assigned to reduce losses and damage to structures and City residents.* *T/F: This is feasible to accomplish as no cost is associated with the action until appropriate mitigation actions are identified. This activity relies on community member availability and willingness to serve their community.*

Table 7-8 City of Kivalina's Mitigation Action Plan (MAP)

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(See acronym and abbreviations list for complete titles)

Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
MH 3.5	*(Formerly Project 2- reworded) Redesign and relocate "temporary" fuel lines to school to assure code compliance*	*High*	*City Manager, Tribal Council*	*>$150,000; City, NANA, ANTHC, NWAB, Denali Commission*	*Ongoing (1-2 years)*	*B/C This project originated to connect fuel lines to the school from the original bulk fuel tank location. However, the lines were temporarily strung. They are not believed to be code compliant and need to be constructed and routed properly.* *T/F: City staff is capable of accomplishing once regulatory staff inform them of proper design compliance standards.*
MH 3.6	*(Formerly Project 8) Construct a Kivalina Evacuation Road. The proposed route begins in the village, crosses Kivalina Lagoon with a causeway and bridge, crosses the tundra, and terminates at Kisimigiuktuk Hill.*	*High*	*City Manager, Tribal Council*	*$21,000,000; City, Tribe, Denali Commission, Division of Community and Regional Affairs (DCRA)*	*Currently under study*	*B/C: This road would serve as a satisfactory evacuation route, while at the same time accessing a much needed gravel source. Depending on where the future village relocation site is located, it is likely that all or part of this road can be used in the relocation efforts. The road also accesses a potential airport site. The estimated cost of evacuation route, in 2005 dollars, is $21,300,000.* *T/F: This is technically feasible to the applicable agencies tasked with completing this initiative.*
MH 3.7	*(Formerly Project 17) Install a siren to warn people of a severe weather or disaster event.*	*Medium*	*City Manager, Tribal Council*	*City, Tribe, DHS, DOC/RCASP, Denali Commission,*	*Ongoing (2-4 years)*	*B/C: Sustained emergency response planning and response capability programs will provide community capacity. This activity will enable the public to prepare for and respond to local disasters.* *T/F: This project is technically feasible using existing City staff with funding assistance from outside agency programs.*

Table 7-8 City of Kivalina's Mitigation Action Plan (MAP)

(Blue italicized initiatives were brought forward from existing HMP or other identified plans)
(See acronym and abbreviations list for complete titles)

Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
MH 3.8	*(Formerly Project 18) Install automated weather sensors. Automated weather sensors are the chief method by which the National Weather Service detects the occurrence of incoming severe weather.*	*Medium*	*City Manager, Tribal Council*	*City, Tribe*	*3-8 years*	*B/C: This project would potentially provide near-term storm threat warning, enabling responders to mitigate potential damages.* *T/F: This project is feasible using existing staff skills, equipment, and materials.*
MH 3.9	*(Formerly Project 3) Remove exposed sewage bunkers on shoreline*	*City, Tribe*	*City Manager, Tribal Council*	*>$150,000; City, NANA, NWAB, FEMA, DEC, City*	*Ongoing*	*B/C: Removing threatened infrastructure from high hazard areas preserves community health and safety.* *TF: This is technically feasible with guidance from regulatory agencies.*
MH 3.10	Encourage utility companies to evaluate and harden vulnerable infrastructure elements for sustainability.	Medium	City Manager, Tribal Council	City, Tribe, HMA, AFG, FP&S, SAFER, ANA, EFSP	3-5 years	B/C: This project would ensure threatened infrastructures are available for use – their loss would exacerbate potential damages and further threaten survivability. F: This project is feasible using existing staff skills, equipment, and materials.
MH 3.11	Work with AVEC or AEA to increase power line wire size and incorporate quick disconnects (break away devices) to reduce ice load and wind storm power line failure during severe wind or winter ice storm events.	Low	City Manager, Tribal Council	City, Tribe, HMA, NRCS, ANA, USACE, US USDA, Lindbergh	1-5 years	B/C: This project would ensure threatened infrastructures are available for use – there loss would exacerbate potential damages and further threaten survivability. F: This project is feasible using existing staff skills, equipment, and materials.
MH 3.12	Develop and implement disaster debris management plan.	Low	City Manager, Tribal Council	City, Tribe, HMA, AFG, FP&S, SAFER, ANA, EFSP	1-4 years	B/C: Debris management plans are an essential disaster management tool. Focused and coordinated planning enables effective damage abatement and ensures proper attention is assigned to

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Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
						reduce losses, damage, and materials management. T/F: This action is feasible with limited fund expenditures.
MH 3.13	Identify close proximity gravel source essential to current projects and future relocation site development.	High	City Manager, Tribal Council	City, Tribe, HMA, ANA, Denali Commission, NRCS, USACE	3-5 years	B/C: Pre-identifying potential resources will facilitate upcoming mitigation projects, reduce implementation costs, as well as potentially providing a future income source for community longevity. Project costs would outweigh feasibility study costs. T/F: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
EQ 4.1	*(Formerly Project 20 & 21-Reworded) Contract a structural engineering firm to inspect, prioritize, and retrofit any critical facility or public infrastructure that does not meet earthquake safety standards.*	*Medium*	*City Manager, Tribal Council*	*City, Tribe, HMA, ANA, EFSP, DEC/MG&LP*	*2-4 years*	*B/C: Retrofit projects can be very cost effective. Project viability depends on the cost and extent of the modifications.* *A comprehensive BCA needs to be conducted to validate this activity.* *T/F: The City will need phase funding to obtain engineering and design expertise to determine project viability.*
FL 5.1	*(Formerly Project 7) Kivalina Lagoon erosion control project. Continue revetment to encapsulate the lagoon side of the community to eliminate current and future erosion impacts.*	***High***	*City Manager, Tribal Council*	*City, Tribe, NANA, NWAB, Denali Commission, USACE, NRCS*	*Ongoing*	*B/C: This will be essential if the Kivalina Evacuation Road project's causeway is constructed. This will reduce coastal impacts from the Wulik River's devastating water flow impacts directly at the lagoon side of the island because the proposed causeway may direct the entire*

Table 7-8 City of Kivalina's Mitigation Action Plan (MAP)

(Blue italicized initiatives were brought forward from existing HMP or other identified plans)
(See acronym and abbreviations list for complete titles)

Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
						flow towards the community. *T/F: This will be feasible only if constructed by the USACE or equivalent construction company experience.*
FL 5.2	*(Formerly Project 9) Seawall inspection and maintenance.*	***High***	*City Manager, Tribal Council*	*City, Tribe, NANA, NWAB, Denali Commission, USACE, NRCS*	*Ongoing*	*B/C: The current seawall was re-constructed in 2009. It requires periodic inspection and potential maintenance to continue to protect the community until community relocation occurs.* *T/F*
FL 5.3	Protect landfill (such as a raised berm with hardening) to prevent erosion, flooding damage, and flood water intrusion out flow.	High	City Manager, Tribal Council	City, Tribe, HMA, ANA, Denali Commission, DEC, NRCS, USACE	3-5 years	B/C: Flood water intrusion into the landfill currently overflows into the Kivalina Lagoon creating high chloroform contamination during each flood event. Improving embankment height and stability will greatly improve the health of residents from contaminant outflow into their water source. Project costs would outweigh replacement costs of lost facilities. T/F: The community has the skill to implement this action. Specialized skills may need to be contracted-out with materials and equipment barged in depending on the method selected.
FL 5.4	Replace water sump pumps damaged from silt damage. These pumps are vital for removing storm and floodwater collection in town center. Pumps will need filter screens to prevent future failure.	Medium	City Manager, Tribal Council	City, Tribe, HMA, NRC, ANA, USACE, USDA, Lindbergh	1-5 years	B/C: This project would reduce damages and improve community safety from water collecting in the City's few but critical traffic routes and access to critical infrastructure. F: This project is feasible using existing

Table 7-8 City of Kivalina's Mitigation Action Plan (MAP)

(Blue italicized initiatives were brought forward from existing HMP or other identified plans)
(See acronym and abbreviations list for complete titles)

Goal / Action ID	Description	Priority (High, Medium, Low)	Responsible Office or Agency	Potential Funding Source(s)	Timeframe (Ongoing 1-3 Years 2-4 Years 3-5 Years)	Benefit-Costs (B/C) / Technical Feasibility (T/F)
						staff skills, equipment, and materials. Acquiring contractor expertise may be required for large facilities.
GF 6.1	Promote ground failure (such as permafrost) sensitive construction practices in hazard impact areas.	Medium	City Manager, Tribal Council	City, Tribe, HMA, ANA	2-4 years	B/C: This outreach project would decrease damage to facilities if they were sited and used the most appropriate construction practices. T/F: Technically feasible as the community is currently working with UAF and other entities to determine most viable permafrost construction practices.
SW 7.1	Develop and implement programs to coordinate maintenance and mitigation activities (such as utility line quick-disconnects) to reduce risk to public infrastructure from severe winter storms (snow load, ice, and wind).	Low	City Manager, Tribal Council	City, Tribe, DCCED/CDBG, Denali Commission	3-5 years	B/C: Scheduling maintenance and implementing mitigation activities will potentially reduce severe winter storm damages caused by heavy snow loads, wind, and freezing rain. TF: This type activity is technically feasible within the community typically using existing labor, equipment, and materials. Specialized methods are not new to rural communities as they are used to importing required contractors.

7.7 IMPLEMENTING MITIGATION STRATEGY INTO EXISTING PLANNING MECHANISMS

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

DMA 2000 Requirements
Incorporation into Existing Planning Mechanisms §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.
ELEMENT C. Incorporate into Other Planning Mechanisms
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate?
Source: FEMA, March 2015

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

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

Section Eight provides a comprehensive reference list used to develop the HMP.

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Appendix A

Funding Resources

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Federal Funding Resources

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

- FEMA, through its Emergency Management Institute, offers training in many aspects of emergency management, including hazard mitigation. FEMA has also developed a large number of documents that address implementing hazard mitigation at the local level. Five key resource documents are available from FEMA Publication Warehouse (1-800-480-2520) and are briefly described here:
    - How-to Guides. FEMA has developed a series of how-to guides to assist states, communities, and tribes in enhancing their hazard mitigation planning capabilities. The first four guides describe the four major phases of hazard mitigation planning. The last five how-to guides address special topics that arise in hazard mitigation planning such as conducting cost-benefit analysis and preparing multi-jurisdictional plans. The use of worksheets, checklists, and tables make these guides a practical source of guidance to address all stages of the hazard mitigation planning process. They also include special tips on meeting DMA 2000 requirements (http://www.fema.gov/hazard-mitigation-planning-resources#1).
    - Local Mitigation Planning Handbook, March 2013. This handbook explains the basic concepts of hazard mitigation and provides guidance to local governments on developing or updating hazard mitigation plans to meet the requirements of Title 44 Code of Federal Regulations (CFR) §201.6 for FEMA approval and eligibility to apply for FEMA Hazard Mitigation Assistance grant programs. (http://www.fema.gov/library/viewRecord.do?id=7209)
    - A Guide to Recovery Programs FEMA 229(4), September 2005. The programs described in this guide may all be of assistance during disaster incident recovery. Some are available only after a Presidential declaration of disaster, but others are available without a declaration. Please see the individual program descriptions for details. (http://www.fema.gov/txt/rebuild/ltrc/recoveryprograms229.txt)
    - The Emergency Management Guide for Business and Industry. FEMA 141, October 1993. This guide provides a step-by-step approach to emergency management planning, response, and recovery. It also details a planning process that businesses can follow to better prepare for a wide range of hazards and emergency events. This effort can enhance a business's ability to recover from financial losses, loss of market share, damages to equipment, and product or business interruptions. This guide could be of great assistance to a community's industries and businesses located in hazard prone areas. (https://www.fema.gov/media-library/assets/documents/3412)
    - The 2015 Hazard Mitigation Assistance (HMA) Guidance and Addendum, February 27 and March 3, 2015 respectively. Part I of the Hazard Mitigation Assistance (HMA)

Guidance introduces the three HMA programs, identifies roles and responsibilities, and outlines the organization of the document. This guidance applies to Hazard Mitigation Grant Program (HMGP) disasters declared on or after the date of publication unless indicated otherwise. This guidance is also applicable to the Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) Programs; the application cycles are announced via http://www.grants.gov/. The guidance in this document is subject to change based on new laws or regulations enacted after publication.

- FEMA, http://www.fema.gov - includes links to information, resources, and grants that communities can use in planning and implementing community resilience and sustainability measures.
- FEMA also administers emergency management grants (http://www.fema.gov/help/site.shtm) and various firefighter grant programs (http://www.firegrantsupport.com/) such as
  - Emergency Management Performance Grant (EMPG). This is a pass through grant. The amount is determined by the State. The grant is intended to support critical assistance to sustain and enhance State and local emergency management capabilities at the State and local levels for all-hazard mitigation, preparedness, response, and recovery including coordination of inter-governmental (Federal, State, regional, local, and tribal) resources, joint operations, and mutual aid compacts state-to-state and nationwide. Sub-recipients must be compliant with National Incident Management System (NIMS) implementation as a condition for receiving funds. Requires 50% match. (https://www.fema.gov/fiscal-year-2015-emergency-management-performance-grant-program)
  - National Earthquake Hazards Reduction Program (NEHRP). The National Earthquake Hazards Reduction Program (NEHRP) seeks to mitigate earthquake losses in the United States through both basic and directed research and implementation activities in the fields of earthquake science and engineering. (https://www.fema.gov/national-earthquake-hazards-reduction-program)

    The NEHRP agencies pursue the goals of the program through collaboration with each other and numerous partners. In addition to other federal agencies, program partners include state and local governments, universities, research centers, professional societies, trade associations and businesses, as well as associated councils, commissions and consortia.

    NEHRP's work encompasses research, development and implementation activities. Program research helps to advance our understanding of why and how earthquakes occur and impact the natural and built environments. The program develops strategies, tools, techniques and other measures that can reduce the adverse effects of earthquakes and facilitates and promotes implementation of these measures, thereby strengthening earthquake resilience among at-risk communities.

    Detailed information about the program is available at NEHRP.gov, which is maintained by NIST, the lead agency for NEHRP. For additional agency-specific information, visit FEMA Earthquake, the USGS Earthquake Hazards Program, the NIST NEHRP Office and the National Science Foundation.

- Assistance to Fire Fighters Grant (AFG), Fire Prevention and Safety (FP&S), Staffing for Adequate Fire and Emergency Response Grants (SAFER), and Assistance to Firefighters Station Construction Grant programs. Information can be found at: (http://forestry.alaska.gov/fire/vfa.htm).

- Department of Homeland Security (DHS) provides the following grants:
  - Homeland Security Grant Program (HSGP), State Homeland Security Program (SHSP) are 80% pass through grants. SHSP supports implementing the State Homeland Security Strategies to address identified planning, organization, equipment, training, and exercise needs for acts of terrorism and other catastrophic events. In addition, SHSP supports implementing the National Preparedness Guidelines, the NIMS, and the National Response Framework (NRF). Must ensure at least 25% of funds are dedicated towards law enforcement terrorism prevention-oriented activities. (https://www.dhs.gov/homeland-security-grant-program-hsgp)
  - Citizen Corps Program (CCP). The Citizen Corps mission is to bring community and government leaders together to coordinate involving community members in emergency preparedness, planning, mitigation, response, and recovery activities. (http://www.dhs.gov/citizen-corps)
  - Emergency Operations Center (EOC) Guidance. This program is intended to improve emergency management and preparedness capabilities by supporting flexible, sustainable, secure, strategically located, and fully interoperable Emergency Operations Centers (EOCs) with a focus on addressing identified deficiencies and needs. Fully capable emergency operations facilities at the State and local levels are an essential element of a comprehensive national emergency management system and are necessary to ensure continuity of operations and continuity of government in major disasters or emergencies caused by any hazard. Requires 25% match. (https://www.fema.gov/media-library/assets/documents/20622)
  - Emergency Alert System (EAS). Resilient public alert and warning tools are essential to save lives and protect property during times of national, state, regional, and local emergencies. The Emergency Alert System (EAS) is used by alerting authorities to send warnings via broadcast, cable, satellite, and wireline communications pathways. Emergency Alert System participants, which consist of broadcast, cable, satellite, and wireline providers, are the stewards of this important public service in close partnership with alerting officials at all levels of government. The EAS is also used when all other means of alerting the public are unavailable, providing an added layer of resiliency to the suite of available emergency communication tools. The EAS is in a constant state of improvement to ensure seamless integration of CAP-based and emerging technologies. (https://www.fema.gov/emergency-alert-system)

- U.S. Department of Commerce's grant programs include:
  - National Oceanic and Atmospheric Administration (NOAA), provides funds to the State of Alaska due to Alaska's high threat for tsunami. The allocation supports the promotion of local, regional, and state level tsunami mitigation and preparedness; installation of warning communications systems; installation of warning

communications systems; installation of tsunami signage; promotion of the Tsunami Ready Program in Alaska; development of inundation models; and delivery of inundation maps and decision-support tools to communities in Alaska. (http://www.tsunami.noaa.gov/warning_system_works.html)

- Remote Community Alert Systems (RCASP) grant for outdoor alerting technologies in remote communities effectively underserved by commercial mobile service for the purpose of enabling residents of those communities to receive emergency messages. (http://www.federalgrants.com/Remote-Community-Alert-Systems-Program-11966.html) This program is a contributing element of the Warning, Alert, and Response Network (WARN) Act.
- Public Works and Development Facilities Program. This program provides assistance to help distressed communities attract new industry, encourage business expansion, diversify local economies, and generate long-term, private sector jobs. Among the types of projects funded are water and sewer facilities, primarily serving industry and commerce; access roads to industrial parks or sites; port improvements; business incubator facilities; technology infrastructure; sustainable development activities; export programs; brownfields redevelopment; aquaculture facilities; and other infrastructure projects. Specific activities may include demolition, renovation, and construction of public facilities; provision of water or sewer infrastructure; or the development of stormwater control mechanisms (e.g., a retention pond) as part of an industrial park or other eligible project. (http://cfpub.epa.gov/fedfund/program.cfm?prog_num=51)
- US Environmental Protection Agency (EPA). Under EPA's Clean Water State Revolving Fund (CWSRF) program, each state maintains a revolving loan fund to provide independent and permanent sources of low-cost financing for a wide range of water quality infrastructure projects, including: municipal wastewater treatment projects; non-point source projects; watershed protection or restoration projects; and estuary management projects. (http://yosemite.epa.gov/R10/ecocomm.nsf/6da048b9966d22518825662d00729a35/7b68c420b668ada5882569ab00720988!OpenDocument)
  - Indian Environmental General Assistance Program (IGAP). 1992, Congress passed the Indian Environmental General Assistance Program Act (42 U.S.C. 4368b) which authorizes EPA to provide General Assistance Program (GAP) grants to federally-recognized tribes and tribal consortia for planning, developing, and establishing environmental protection programs in Indian country, as well as for developing and implementing solid and hazardous waste programs on tribal lands.

    The goal of this program is to assist tribes in developing the capacity to manage their own environmental protection programs, and to develop and implement solid and hazardous waste programs in accordance with individual tribal needs and applicable federal laws and regulations.

    http://www.epa.gov/Indian/gap.htm

- Department of Agriculture (USDA). Provides diverse funding opportunities; providing a wide benefit range. Their grants and loans website provides a brief programmatic overview with links to specific programs and services. (http://www.rd.usda.gov/programs-services)
    - Farm Service Agency: Emergency Conservation Program, Non-Insured Assistance, Emergency Forest Restoration Program, Emergency Watershed Protection, Rural Housing Service, Rural Utilities Service, and Rural Business and Cooperative Service. (http://www.fsa.usda.gov/FSA/stateoffapp?mystate=ak&area=home&subject=landing&topic=landing)
    - Natural Resources Conservation Service (NRCS) has several funding sources to fulfill mitigation needs. (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/alphabetical/)
        - Conservation Technical Assistance Program (CTA) is voluntary program available to any group or individual interested in conserving their natural resources and sustaining agricultural production. The program assists land users with addressing opportunities, concerns, and problems related to using their natural resources enabling them to make sound natural resource management decisions on private, tribal, and other non-federal lands. (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical/)
        - Conservation Innovation Grants (CIG) is a voluntary program intended to stimulate developing and adopting innovative conservation approaches and technologies while leveraging Federal investment in environmental enhancement and protection, in conjunction with agricultural production. Under CIG, Environmental Quality Incentives Program funds are used to award competitive grants to non-Federal governmental or nongovernmental organizations, Tribes, or individuals.

          CIG enables NRCS to work with other public and private entities to accelerate technology transfer and adoption of promising technologies and approaches to address some of the Nation's most pressing natural resource concerns. CIG will benefit agricultural producers by providing more options for environmental enhancement and compliance with Federal, State, and local regulations. (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/)
        - The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length. These contracts provide financial assistance to help plan and implement conservation practices that address natural resource concerns and for opportunities to improve soil, water, plant, animal, air and related resources on agricultural land and non-industrial private forestland. In addition, a purpose of EQIP is to help producers meet Federal, State, Tribal and local environmental regulations. (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=stelprdb1242633)

- The Emergency Watershed Protection Program (EWP) is designed is to undertake emergency measures, including the purchase of flood plain easements, for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood or any other natural occurrence is causing or has caused a sudden impairment of the watershed. (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/)
- Watershed Surveys and Planning. NRCS watershed activities in Alaska are voluntary efforts requested through conservation districts and units of government and/or tribes. The purpose of the program is to assist Federal, State, and local agencies and tribal governments to protect watersheds from damage caused by erosion, floodwater, and sediment and to conserve and develop water and land resources. Resource concerns addressed by the program include water quality, opportunities for water conservation, wetland and water storage capacity, agricultural drought problems, rural development, municipal and industrial water needs, upstream flood damages, and water needs for fish, wildlife, and forest-based industries. (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wsp/)

- 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. (http://www1.eere.energy.gov/wip/wap.html)
  - The Tribal Energy Program offers financial and technical assistance to Indian tribes to help them create sustainable renewable energy installations on their lands. This program promotes tribal energy self-sufficiency and fosters employment and economic development on America's tribal lands. (http://energy.gov/eere/wipo/tribal-energy-program)
- 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 application information. (http://www.acf.hhs.gov/grants/open/foa/)
- Department of Housing and Urban Development (HUD) provides a variety of disaster resources. They also partner with Federal and state agencies to help implement disaster recovery assistance. Under the *National Response Framework* the FEMA and the Small Business Administration (SBA) offer initial recovery assistance. (http://www.hud.gov/info/disasterresources_dev.cfm)

- HUD, Office of Homes and Communities, Section 108 Loan Guarantee Programs. This program provides loan guarantees as security for Federal loans for acquisition, rehabilitation, relocation, clearance, site preparation, special economic development activities, and construction of certain public facilities and housing. (http://www.hud.gov/offices/cpd/communitydevelopment/programs/108/index.cfm)
- HUD, Office of Homes and Communities, Section 184 Indian Home Loan Guarantee Programs (IHLGP). The Section 184 Indian Home Loan Guarantee Program is a home mortgage specifically designed for American Indian and Alaska Native families, Alaska Villages, Tribes, or Tribally Designated Housing Entities. Section 184 loans can be used, both on and off native lands, for new construction, rehabilitation, purchase of an existing home, or refinance.
- Because of the unique status of Indian lands being held in Trust, Native American homeownership has historically been an underserved market. Working with an expanding network of private sector and tribal partners, the Section 184 Program endeavors to increase access to capital for Native Americans and provide private funding opportunities for tribal housing agencies with the Section 184 Program. (http://www.hud.gov/offices/pih/ih/homeownership/184/)
- Indian Housing Block Grant / Native American Housing Assistance and Self Determination Act (IHBG/NAHASDA) administration, operating & construction funds. The act is separated into seven sections:

  The Indian Housing Block Grant Program (IHBG) is a formula grant that provides a range of affordable housing activities on Indian reservations and Indian areas. The block grant approach to housing for Native Americans was enabled by the Native American Housing Assistance and Self Determination Act of 1996 (NAHASDA).

  Eligible IHBG recipients are Federally recognized Indian tribes or their tribally designated housing entity (TDHE), and a limited number of state recognized tribes who were funded under the Indian Housing Program authorized by the United States Housing Act of 1937 (USHA). With the enactment of NAHASDA, Indian tribes are no longer eligible for assistance under the USHA.

  An eligible recipient must submit to HUD an Indian Housing Plan (IHP) each year to receive funding. At the end of each year, recipients must submit to HUD an Annual Performance Report (APR) reporting on their progress in meeting the goals and objectives included in their IHPs.

  Eligible activities include housing development, assistance to housing developed under the Indian Housing Program, housing services to eligible families and individuals, crime prevention and safety, and model activities that provide creative approaches to solving affordable housing problems. (http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/ih/grants/ihbg)
- HUD/CDBG provides grant assistance and technical assistance to aid communities in planning activities that address issues detrimental to the health and safety of local residents, such as housing rehabilitation, public services, community facilities, and

infrastructure improvements that would primarily benefit low-and moderate-income. persons (http://www.hud.gov/offices/cpd/communitydevelopment/programs/)

  - HUD/Indian Community Development Block Grants (ICDBG) provide grant assistance and technical assistance to aid communities or Indian tribes in planning activities that address issues detrimental to the health and safety of local residents, such as housing rehabilitation, public services, community facilities, and infrastructure improvements that would primarily benefit low-and moderate-income. persons (http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/ih/grants/icdbg)

- Department of Labor (DOL), Employment and Training Administration, Disaster Unemployment Assistance (DUA). Provides weekly unemployment subsistence grants for those who become unemployed because of a major disaster or emergency. Applicants must have exhausted all benefits for which they would normally be eligible. (http://www.workforcesecurity.doleta.gov/unemploy/disaster.asp)
  - The Workforce Investment Act contains provisions aimed at supporting employment and training activities for Indian, Alaska Native, and Native Hawaiian individuals. The Department of Labor's Indian and Native American Programs (INAP) funds grant programs that provide training opportunities at the local level for this target population. (http://www.dol.gov/dol/topic/training/indianprograms.htm)
- U.S. Department of Transportation (DOT), Hazardous Materials Emergency Preparedness (HMEP) Grant. The Hazardous Materials Transportation Safety and Security Reauthorization Act of 2005 authorizes the U.S. DOT to provide assistance to public sector employees through training and planning grants to States, Territories, and Native American tribes for emergency response. The purpose of this grant program is to increase State, Territorial, Tribal, and local effectiveness in safely and efficiently handling hazardous materials accidents and incidents, enhance implementation of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), and encourage a comprehensive approach to emergency training and planning by incorporating the unique challenges of responses to transportation situations. (http://www.phmsa.dot.gov/hazmat/grants)
- Federal Financial Institutions. Member banks of Federal Deposit Insurance Corporation, Financial Reporting Standards or Federal Home Loan Bank Board may be permitted to waive early withdrawal penalties for Certificates of Deposit and Individual Retirement Accounts.
- Internal Revenue Service (IRS), Disaster Tax Relief. Provides extensions to current year's tax return, allows deductions for disaster losses, and allows amendment of previous year’s tax returns (http://www.irs.gov/Businesses/Small-Businesses-%26-Self-Employed/Disaster-Assistance-and-Emergency-Relief-for-Individuals-and-Businesses-1).
- U.S. Small Business Administration (SBA) Disaster Assistance Loans and Grants program provides information concerning disaster assistance, preparedness, planning, cleanup, and recovery planning. (https://www.sba.gov/category/navigation-structure/loans-grants)

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

- United States Army Corps of Engineers (USACE) Alaska District's Civil Works Branch studies potential water resource projects in Alaska. These studies analyze and solve water resource issues of concern to the local communities. These issues may involve navigational improvements, flood control or ecosystem restoration. The agency also tracks flood hazard data for over 300 Alaskan communities on floodplains or the sea coast. These data help local communities assess the risk of floods to their communities and prepare for potential future floods. The USACE is a member and co-chair of the Alaska Climate Change Sub-Cabinet.
  - Civil Works and Planning (http://www.poa.usace.army.mil/Missions/CivilWorksandPlanning.aspx)
  - Environmental Resources Section (http://www.poa.usace.army.mil/About/Offices/Engineering/EnvironmentalResources.aspx)
  - USACE Alaska District Grants (http://search.usa.gov/search?affiliate=alaska_district&query=grants)

- The Grants.gov program management office was established, in 2002, as a part of the President's Management Agenda. Managed by the Department of Health and Human Services, Grants.gov is an E-Government initiative operating under the governance of the Office of Management and Budget.

  Under the President's Management Agenda, the office was chartered to deliver a system that provides a centralized location for grant seekers to find and apply for federal funding opportunities. Today, the Grants.gov system houses information on over 1,000 grant programs and vets grant applications for 26 federal grant-making agencies.

State Funding Resources

- Department of Military and Veterans Affairs (DMVA): Provides damage appraisals and settlements for VA-insured homes, and assists with filing of survivor benefits. (http://veterans.alaska.gov/links.htm)
  - DHS&EM within DMVA is responsible for improving hazard mitigation technical assistance for local governments for the State of Alaska. Providing hazard mitigation training, current hazard information and communication facilitation with other agencies will enhance local hazard mitigation efforts. DHS&EM administers FEMA mitigation grants to mitigate future disaster damages such as those that may affect infrastructure including elevating, relocating, or acquiring hazard-prone properties. (http://ready.alaska.gov/plans/mitigation.htm)

    DHS&EM also provides mitigation funding resources for mitigation planning on their Web site at http://ready.alaska.gov/grants.

- Division of Health and Social Services (DHSS): On this site you will find information intended to assist all who are interested in DHSS grants and services they support. (http://dhss.alaska.gov/fms/grants/Pages/grants.aspx and http://dhss.alaska.gov/fms/Documents/FY15GrantBook.pdf)
- Division of Health and Social Services (DSS): Provides special outreach services for seniors, including food, shelter and clothing. (http://dhss.alaska.gov/dsds/Pages/hcb/hcb.aspx)
- Division of Insurance (DOI): Provides assistance in obtaining copies of policies and provides information regarding filing claims. (http://commerce.state.ak.us/dnn/ins/Consumers/AlaskaConsumerGuide.aspx)
- DCRA within the DCCED 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 division also administers programs for State's" distressed" and "targeted" communities. (http://www.commerce.state.ak.us/dca/)
    - DCRA Planning and Land Management staff provide Alaska Climate Change Impact Mitigation Program (ACCIMP) funding to Alaskan communities that meet one or more of the following criteria related to flooding, erosion, melting permafrost, or other climate change-related phenomena: Life/safety risk during storm/flood events; loss of critical infrastructure; public health threats; and loss of 10% of residential dwellings. (http://commerce.state.ak.us/dnn/dcra/PlanningLandManagement/ACCIMP.aspx)

      The Hazard Impact Assessment is the first step in the ACCIMP process. The HIA identifies and defines the climate change-related hazards in the community, establishes current and predicted impacts, and provides recommendations to the community on alternatives to mitigate the impact. (http://commerce.alaska.gov/dca/planning/accimp/hazard_impact.html)
- Department of Environmental Conservation (DEC). 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. (http://dec.alaska.gov/)
    - The Division of Water's Village Safe Water (VSW) Program works with rural communities to develop sustainable sanitation facilities. Communities apply each year to VSW for grants for sanitation projects. Federal and state funding for this program is administered and managed by the VSW program. VSW provides technical and financial support to Alaska's smallest communities to design and construct water and wastewater systems. In some cases, funding is awarded by VSW through the Alaska Native Tribal Health Consortium (ANTHC), who in turn assist communities in design and construct of sanitation projects.

- Municipal Grants and Loans (MGL) Program. The Department of Environmental Conservation / Division of Water administer the Alaska Clean Water Fund (ACWF) and the Alaska Drinking Water Fund (ADWF). The division is fiscally responsible to the Environmental Protection Agency (EPA) to administer the loan funds as the EPA provides capitalization grants to the division for each of the loan funds. In addition, it is prudent upon the division to administer the funds in a manner that ensures their continued viability. (http://dec.alaska.gov/water/MuniGrantsLoans/loanoverview.html
- Under EPA's Clean Water State Revolving Fund (CWSRF) program, each state maintains a revolving loan fund to provide independent and permanent sources of low-cost financing for a wide range of water quality infrastructure projects, including: municipal wastewater treatment projects; non-point source projects; watershed protection or restoration projects; and estuary management, [and stormwater management] projects. (http://yosemite.epa.gov/R10/ecocomm.nsf/6da048b9966d22518825662d00729a35/7b68c420b668ada5882569ab00720988!OpenDocument)

  Alaska's Revolving Loan Fund Program, prescribed by Title VI of the Clean Water Act as amended by the Water Quality Act of 1987, Public Law 100-4. DEC will use the ACWF account to administer the loan fund. This Agreement will continue from year-to-year and will be incorporated by reference into the annual capitalization grant agreement between EPA and the DEC. DEC will use a fiscal year of July 1 to June 30 for reporting purposes. (http://www.epa.gov/region10/pdf/water/srf/cwsrf_alaska_operating_agreement.pdf)

- Department of Transportation and Public Facilities (DOT/PF) personnel provide technical assistance to the various emergency management programs, to include mitigation. This assistance is addressed in the DHS&EM-DOT/PF Memorandum of Agreement and includes but is not limited to: environmental reviews, archaeological surveys, and historic preservation reviews.
  - DOT/PF and DHS&EM coordinate buy-out projects to ensure that there are no potential right-of-way conflicts with future use of land for bridge and highway projects, and collaborate on earthquake mitigation.
  - Additionally, DOT/PF provides the safe, efficient, economical, and effective State highway, harbor, and airport operation. DOT/PF uses it's Planning, Design and Engineering, Maintenance and Operations, and Intelligent Transportation Systems resources to identify hazards, plan and initiate mitigation activities to meet the transportation needs of Alaskans, and make Alaska a better place to live and work. DOT/PF budgets for temporary bridge replacements and materials necessary to make the multi-modal transportation system operational following natural disaster events.
- DNR administers various projects designed to reduce stream bank erosion, reduce localized flooding, improve drainage, and improve discharge water quality through the stormwater grant program funds. Within DNR,
  - The Division of Geological and Geophysical Survey (DGGS) is responsible Alaska's mineral, land, and water resources use, development, and earthquake mitigation collaboration.

Their geologists and support staff are leaders in researching Alaska's geology and implementing technological tools to most efficiently collect, interpret, publish, archive, and disseminate information to the public. (http://dggs.alaska.gov/pubs/advanced-search)

- The DNR's Division of Forestry (DOF) participates in a statewide wildfire control program in cooperation with the forest industry, rural fire departments and other agencies. Prescribed burning may increase the risks of fire hazards; however, prescribed burning reduces the availability of fire fuels and therefore the potential for future, more serious fires. (http://forestry.alaska.gov/pdfs/08FireSuppressionMediaGuide.pdf)
- DOF also manages various wildland fire programs, activities, and grant programs such as the FireWise Program (http://forestry.alaska.gov/fire/firewise.htm), Community Forestry Program (CFP) (http://forestry.alaska.gov/community/), Assistance to Fire Fighters Grant (AFG), Fire Prevention and Safety (FP&S), Staffing for Adequate Fire and Emergency Response Grants (SAFER), and Volunteer Fire Assistance and Rural Fire Assistance Grant (VFA-RFA) programs (http://forestry.alaska.gov/fire/vfarfa.htm). Information can be found at http://forestry.alaska.gov/fire/current.htm.
- The Alaska Interagency Coordination Center (AICC) is the Geographic Area Coordination Center for Alaska. AICC serves as the focal point for initial attack resource coordination, logistics support, and predictive services for all state and federal agencies involved in wildland fire management and suppression in Alaska.

  Fire management planning, preparedness, suppression operations, prescribed burning, and related activities are coordinated on an interagency basis. DOF has cooperative agreements with the Departments of Agriculture and Interior, and numerous local government and volunteer fire departments to respond to wildland fires, reduce duplication of efforts, and share resources.
- In 1984 the State of Alaska adopted the National Interagency Incident Management System Incident Command System concept for managing fire suppression. The Incident Command System (ICS) guiding principles are followed in all wildland fire management operations. All State of Alaska Departments adopted ICS in 1996 through the Governor's administrative order.

Other Funding Resources

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

- Rural Alaska Community Action Program Inc. (RurAL CAP) In the nearly 50 years since it began, it is difficult to imagine any aspect of rural Alaskan lives which has not been touched in some way by the people and programs of RurAL CAP. From Head Start, parent education, adult basic education, and elder-youth programs, to Native land claims and subsistence rights, energy and weatherization programs, and alcohol and substance abuse prevention, RurAL CAP has left a lasting mark on the history and development of Alaska and its rural Peoples. (http://ruralcap.com/?page_id=334)

- Weatherization Assistance Program assists low to moderate income households in weatherization needs. The program is available to homeowners as well as renters and includes; single family homes, cabins, mobile homes, condominiums and multifamily dwellings. (http://ruralcap.com/?page_id=794)
- Solid Waste Management. RurAL CAP continues to host an expert solid waste liaison, Ted Jacobson, through funding provided by the Environmental Protection Agency (EPA) and Senior Services America, Inc. The liaison provides solid waste management technical assistance to rural communities through training, site visits, hands-on demonstrations, and remote contact. Resources are provided for dump management activities, collaborating with funders for funding and technical assistance on solid waste management, recycling, and backhaul. (http://ruralcap.com/?page_id=198

- 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), an initiative of the insurance industry to reduce deaths, injuries, property damage, economic losses, and human suffering caused by natural disasters. (http://www.disastersafety.org/)
- 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. (http://www.redcross.org/find-help)
- Catalog of Federal Domestic Assistance (DFDA) Crisis Counseling Program (CCP). Provides grants to State and Borough Mental Health Departments, which in turn provide training for screening, diagnosing and counseling techniques. Also provides funds for counseling, outreach, and consultation for those affected by disaster. (http://dialoguemakers.org/Resourses4states+Nonprofits.htm)
- Denali Commission. Introduced by Congress in 1998, the Denali Commission is an independent federal agency designed to provide critical utilities, infrastructure, and economic support throughout Alaska. With the creation of the Denali Commission, Congress acknowledged the need for increased inter-agency cooperation and focus on Alaska's remote communities. Since its first meeting in April 1999, the Commission is credited with providing numerous cost-shared infrastructure projects across the State that exemplifies effective and efficient partnership between federal and state agencies, and the private sector. (http://www.denali.gov/grants)
    - The Energy Program primarily funds design and construction of replacement bulk fuel storage facilities, upgrades to community power generation and distribution systems, alternative-renewable energy projects, and some energy cost reduction projects. The Commission works with the Alaska Energy Authority (AEA), Alaska Village Electric Cooperative (AVEC), Alaska Power and Telephone and other partners to meet rural communities' fuel storage and power generation needs.

- The goal of the solid waste program at the Denali Commission is to provide funding to address deficiencies in solid waste disposal sites which threaten to contaminate rural drinking water supplies.

- Lindbergh Foundation Grants. Each year, The Charles A. and Anne Morrow Lindbergh Foundation provides grants of up to $10,580 (a symbolic amount representing the cost of the Spirit of St. Louis) to men and women whose individual initiative and work in a wide spectrum of disciplines furthers the Lindberghs' vision of a balance between the advance of technology and the preservation of the natural/human environment. (http://www.thelindberghfoundation.org/awards)

- Rasmuson Foundation Grants. The Rasmuson foundation invests both in individuals and well-managed 501(c)(3) organizations dedicated to improving the quality of life for Alaskans.

  Rasmuson Foundation awards grants both to organizations serving Alaskans through a base of operations in Alaska, and to individuals for projects, fellowships and sabbaticals. To be considered for a grant award, grant seekers must meet specific criteria and complete and submit the required application according to the specific guidelines of each program. (http://www.rasmuson.org/index.php?switch=viewpage&pageid=5)

  - Tier 1 Awards: Grants of up to $25,000 for capital projects, technology updates, capacity building, program expansion, and creative works.
  - Tier 2 Awards: Grants over $25,000 for projects of demonstrable strategic importance or innovative nature.
  - Pre-Development Program: Guidance and technical resources for planning new, sustainable capital projects.

  The Foundation trustees believe successful organizations can sustain their basic operations through other means of support and prefer to assist organizations with specific needs, focusing on requests which allow the organizations to become more efficient and effective. The trustees look favorably on organizations which demonstrate broad community support, superior fiscal management and matching project support. (http://www.rasmuson.org/index.php)

Appendix B

FEMA Hazard Mitigation Plan (HMP) Review Tool

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APPENDIX A:
LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: **City of Kivalina**	**Title of Plan:** **City of Kivalina Hazard Mitigation Plan Update**	**Date of Plan:** August 2015
Local Point of Contact: **Janet Mitchell**	**Address:** City of Kivalina P.O. Box 50079 Kivalina, Alaska 99750	
Title: **City Administrator**		
Agency: **City of Kivalina**		
Phone Number: 907.645.2137	**E-Mail:** kivalinacity@aol.com	

State Reviewer: **Scott Nelsen**	**Title:** **Mitigation Planner**	**Date:** **28 August 2015**

FEMA Reviewer: David Freeborn Kristen Meyers	**Title:** Mitigation Champion (FEMA Contractor) Mitigation Planner	**Date:** 28 September 2015 9 October 2015: 24 Oct 2015
Date Received in FEMA Region X	27 August 2015	
Plan Not Approved		
Plan Approvable Pending Adoption	24 Oct 2015	
Plan Approved	20 November 2015	

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Acknowledgements, Sections 3.1, 3.2, 3.3, Appendix D	X	
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Section 3.3	X	
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Sections 3.3, 3.4	X	
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Sections 3.4, 3.5, 3.6	X	
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Section 3.6; Appendix F	X	
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Section 3.6.3	X	
ELEMENT A: REQUIRED REVISIONS			
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Chapter 5	X	

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Chapter 5	**X**	
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Chapter 5, Chapter 6	**X**	
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Page 1-5, Section 6.4	**X**	
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Section 7.2	**X**	
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Page 1-5, Section 6.4	**X**	
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Section 7.3, 7.6	**X**	
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Section 7.4, 7.6	**X**	
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Section 7.5, 7.6	**X**	
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Section 7.7, Table 7-1	**X**	
ELEMENT C: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Table 3-3, Section 6.8	**X**	
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Table 3-3, Table 7-5, Sections 3.4, 7.4, 7.5	**X**	
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Table 3-3, Table 7-5, Sections 3.4, 7.4, 7.5	**X**	
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))		**X**	
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	N/A	N/A	
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT
A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

- The plan addresses the planning area and is thorough. There is a large volume of research and a good public outreach effort. However, many of the maps do not detail the planning area.
- The plan indicates that the public was involved and provides the newsletters that were developed, however details about how their feedback was incorporated into the plan is not included. Please include this in the next plan update.

Element B: Hazard Identification and Risk Assessment

- The plan states that Kivalina is 100% vulnerable to all hazards. Consider identifying a way to delineate hazards in order to prioritize in the future.

Element C: Mitigation Strategy

- There is an opportunity to better detail how actions from this plan will be integrated into other planning mechanisms.

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

- Table 3-3 clearly shows changes from previous plan to this plan.

B. Resources for Implementing Your Approved Plan

- **Region 10 Integrating Natural Hazard Mitigation into Comprehensive Planning**: This resource is specific to Region 10 states and provides examples of how communities are integrating natural hazard mitigation strategies into comprehensive planning. It expected to be released later this year. You can find it in the FEMA Library at http://www.fema.gov/media-library/assets/documents/89725.

- The **Integrating Hazard Mitigation Into Local Planning: Case Studies and Tools for Community Officials** resource provides practical guidance on how to incorporate risk reduction strategies into existing local plans, policies, codes, and programs that guide community development or redevelopment patterns. It includes recommended steps and tools to assist with local integration efforts, along with ideas for overcoming possible impediments, and presents a series of case studies to demonstrate successful integration in practice. You can find it in the FEMA Library at http://www.fema.gov/library/viewRecord.do?id=7130.

- The **Mitigation Ideas: A Resource for Reducing Risk from Natural Hazards** resource presents ideas for how to mitigate the impacts of different natural hazards, from drought and sea level rise, to severe winter weather and wildfire. The document also includes ideas for actions that communities can take to reduce risk to multiple hazards, such as incorporating a hazard risk assessment into the local development review process. You can find it in the FEMA Library at http://www.fema.gov/library/viewRecord.do?id=6938.

- The **Local Mitigation Planning Handbook** provides guidance to local governments on developing or updating hazard mitigation plans to meet and go above the requirements. You can find it in the FEMA Library at http://www.fema.gov/library/viewRecord.do?id=7209.

- The **Local Mitigation Plan Review Guide and Tool** resource is available through FEMA's Library and should be referred to for the next plan update. http://www.fema.gov/library/viewRecord.do?id=4859

- The mitigation strategy includes projects that are eligible for FEMA's grant programs. Contact the State Hazard Mitigation Officer, Ann Gravier, at ann.gravier@alaska.gov for application information.

Appendix C

Community HMP Adoption Resolution

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KIVALINA CITY COUNCIL

P.O. Box 50079
Kivalina, Alaska 99750

Phone: 907-645-2137
Fax: 907-645-2175

email: kivalinacity@aol.com

RESOLUTION 15-10

THE ADOPTION OF THE CITY OF KIVALINA, STATE OF ALASKA, HAZARD MITIGATION PLAN!

WHEREAS the City of Kivalina is vulnerable to damages from natural hazard events which pose a threat to public health and safety and could result in property loss and economic hardship;

WHEREAS a Hazard Mitigation Plan (HMP) was developed through the work of City of Kivalina's Planning Team, and interested parties within the planning area;

WHEREAS the Plan recommends hazard mitigation actions that will protect people and property affected by natural hazards that face the City, that will reduce future public, private, community, and personal costs of disaster response and recovery; and that will reinforce City of Kivalina's leadership in emergency preparedness efforts;

WHEREAS the Disaster Mitigation Act of 2000 (P.L. 106-390) (DMA 2000) and associated Federal regulations published under 44 CFR Part 201.6 require the City Council to formally adopt a Hazard Mitigation Plan subject to the approval of the Federal Emergency Management Agency to be eligible for federal hazard mitigation projects and activities funds;

WHEREAS the City held public meetings to receive Plan comment as required by DMA 2000;

NOW THEREFORE BE IT RESOLVED by the City Council that:

1. The Plan is hereby adopted as an official plan of the City.

2. The City's officials identified in the Planning Process (Section 3) and the Mitigation Action Plan (Section 7) will implement the recommended actions described within the HMP. These officials will report quarterly on their activities, accomplishments, and progress to the City council.

3. The City's Hazard Mitigation Planning Team will provide annual progress reports on the status of the implemented Mitigation Action Plan's projects to the Planning Team Leader. The Planning Team shall submit this report to the City Council annually by the Plan's adoption anniversary date.

4. The Planning Team will complete periodic updates of the Plan as indicated in the Plan Maintenance Section (Section 3) as needed, but no less frequently than every five years.

NOW THEREFORE, BE IT RESOLVED by City Council that the City of Kivalina adopts the Hazard Mitigation Plan, dated Nov. 10, 2015 as this jurisdiction's Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

ADOPTED this 10th DAY OF November, 2015 by the City Council.

SIGNED: _____
Austin Swan Sr., Mayor

SIGNED: _____
Marilyn Swan, City Clerk

Appendix D

Public Outreach Activities

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From:	Simmons, Scott
To:	"mewest@alaska.edu"; "hdenny@anthc.org"; "tneal@usgs.gov"; "swhite@avcp.org"; "steve.heppner.bia.ak@gmail.com"; "kato_howard@ak.blm.gov"; "jneimeyer@denali.gov"; "leslie.pearson@alaska.gov"; "ryan.anderson@alaska.gov"; "Alice.Edwards@alaska.gov"; "taunnie.boothby@alaska.gov"; "scott.nelsen@alaska.gov"; "alan.wien@alaska.gov"; "terri.lomax@alaska.gov"; "Soderlund.Dianne@epamail.epa.gov"; "john.lingaas@noaa.gov"; "joel.curtis@noaa.gov"; "sam.albanese@noaa.gov"; "meg.mueller@ak.usda.gov"; "merlaine.kruse@ak.usda.gov"; "greg.magee@alaska.gov"; "Anna_Plager@dnr.state.ak.us"; "kerry_walsh@dnr.state.ak.us"; "John_Dunker@dnr.state.ak.us"; "Steve_Clautice@dnr.state.ak.us"; "patricia_burns@dnr.state.ak.us"; "Steve_McGroarty@dnr.state.ak.us"; "Mac_McLean@dnr.state.ak.us"; "Margie_Goatley@dnr.state.ak.us"; "Bruce.R.Sexauer@poa02.usace.army.mil"; "colleen.bickford@hud.gov"; "ak_le@fws.gov"
Cc:	Eileen Bechtol (erbechtol@gmail.com); DHSEM Scott Nelsen; Evans, Jessica; Appleby, Elizabeth; URS Evan Wasserman
Subject:	Hazard Mitigation Plan Development Project Initial Notice
Date:	Thursday, November 20, 2014 11:18:00 AM
Attachments:	image002.png

Dear Potential HMP Development Participants,
URS Corporation has received a 2014 contract from the State Division of Homeland Security and Emergency Management (DHS&EM) to develop 21 Local/Tribal All-Hazard Mitigation Plans for the following communities:

New HMP Development

- Atmautlauk (Unorganized)
- Chitina (Unorganized)
- Copper Center (Unorganized)
- Grayling (Unorganized)
- Kongiganak (Unorganized)
- Kwigillingok (Unorganized)
- City of Merkoryuk (2nd Class City)
- City of Nightmute (2nd Class City)
- Tuntutuliak (Unorganized)
- Tununak (Unorganized)
- City of Wales (2nd Class city)

HMP Update Required

- Newtok (Unorganized)
- City of Aniak (2nd Class City)
- City of Dillingham (1st Class City)
- City of Golovin (2nd Class City)
- Lake and Peninsula Borough, MJHMP
- City of Hooper Bay (2nd Class City)
- City of Kivalina (2nd Class City)
- City of Saint Paul (2nd Class City)
- City of Unalakleet (2nd Class City)
- City and Borough of Yakutat

The Lake and Peninsula Borough (L&PB) Multi-Jurisdictional HMP (MJHMP) consists of six organized cities and 12 unorganized communities:

The Lake and Peninsula Borough, MJHMP

Organized Cities

- City of Chignik (2nd Class City)
- City of Egegik (2nd Class City)
- City of Newhalen (2nd Class City)
- City of Nondalton (2nd Class City)
- City of Pilot Point (2nd Class City)
- City of Port Heiden (2nd Class City)

Unorganized Communities

- Chignik Lagoon
- Chignik Lake
- Igiugig
- Iliamna
- Ivanof Bay
- Kokhanok

We invite you to participate in this important community planning effort during the development process. Community newsletters will be located on the DHS&EM Local/Tribal All Hazard Mitigation Plan Development website at:
http://ready.alaska.gov/plans/localhazmitplans as the communities finalize them.

Please feel free to contact me and to forward this email to the most appropriate person within your agency involved with hazard assessments, hazard mitigation plan development or community specific hazard information or planning suggestions. (Please cc me so I may update the contact list)

I encourage you to acknowledge receiving this invitation at your earliest convenience to allow me to include your participation (with appropriate acknowledgments) within the Draft and Final HMPs prior to State and FEMA review and subsequent approvals.

Kind Regards
-Scott-

R. Scott Simmons, CFM, CPM
AECOM + URS
700 G Street, Suite 500 | Anchorage, AK 99501
Ph: 907.261.9706 | 800.909.6787 | Personal Mobile: 841.1832 | Fax: 907.562.1297
eMail Address: scott.simmons@urs.com

This e-mail and any attachments contain URS Corporation confidential information that may be proprietary or privileged. If you receive this message in error or are not the intended recipient, you should not retain, distribute, disclose or use any of this information and you should destroy the e-mail and any attachments or copies.

From:	Simmons, Scott
To:	"kivalinacity@aol.com"
Subject:	Kivalina HMP update project
Date:	Tuesday, December 02, 2014 1:41:00 PM
Attachments:	image002.png KivalinaDraftNewsletter1_12022014.pdf

Hello Ms. Mitchell,

I am writing to introduce myself, Scott Simons, AECOM+URS (formerly known as URS Corporation). I work with your long-time acquaintance, Laura Young. I took over her hazard mitigation planning and emergency management tasks in early 2009. I'm also the former State Hazard Mitigation Officer working with Kivalina to respond to and mitigate sea storm erosion impacts to the community such as the school and residences in 2004.

URS was contracted by the Division of Homeland Security and Emergency Management (DHS&EM) to update your 2007 Multi-Hazard Mitigation Plan. Kivalina is one of 21 selected jurisdictions. It is important to note that the City does not have to pay anything for this project. This is an important project for your community, funded by FEMA through DHS&EM. I have worked with over 90 rural communities in Alaska and 30 in Oregon and Washington to assist them with their hazard mitigation plan development needs since I started with URS in mid-2008.

As you are aware, our role is to ensure that the Updated HMP meets state and federal requirements. We will update your plan while guiding you through the HMP Update process; maximizing your Planning Team's talent and local knowledge. Your Community Planning Team will assist the process by working with us to identify changes since your current HMP received FEMA approval in 2007. We will use the original plan and make change within it to describe how the HMP has changed:

- New Planning Team membership and processes
- HMP update participation and plan reviewers,
- Identify new hazards not formerly addressed, update existing hazards with event data from 2008 forward;
- Help us explain your hazard impacts since 2009,
- Identify changes to new and existing participating community's critical facilities and their relative location within each identified hazard's impact area,
- Determine their "estimated" replacement costs,
- Define the community's population risk and critical facility vulnerabilities,
- Review current and update the existing hazard mitigation goals if applicable,
- Determine the current status of each project within the Mitigation Strategy; was it completed, deleted, delayed, combined/changed, or is it still viable and ongoing? We will need to provide a brief explanation for any changes.
- Update the HMP Maintenance section to reflect how the (City or Borough) completed HMP annual review commitments and identify whether it was effective or not, then update the process to make it more effective for future use.

There will be opportunities for the entire community to review the team's work during various public involvement processes because FEMA requires at least two public involvement activities. We will provide planning team meeting minutes and two newsletters for

distribution or posting to enable community wide knowledge, providing information during Planning Team Meetings, or other public meetings, and working with us over the phone as we capture needed information.

We will provide two (2) newsletters. The first newsletter will introduce the project and explain the planning process, encourage public involvement; ask the community to identify known hazards, and to confirm your critical infrastructure data.

The second newsletter will introduce the updated draft HMP and encourage the community to review and provide comments to make the plan better or more usable to mitigate your hazards. I have attached the draft Newsletter for your review.

Please write me back sometime this week with your Planning Team Member's names so I can place them I the blank spaces near the bottom of the 2nd page to update the draft newsletter and return it to you for community posting or distribution throughout your community.

I would like to schedule an introductory meeting to introduce the project and the process letting participants know what information we will need to allow us to proceed. Participants will be able to call into a teleconference using a speaker phone to simplify the discussions.

We would like to schedule this teleconference to occur within two weeks, if feasible. Please let me know which day and time is convenient for you. We will then provide you the toll-free number which you can pass to essential participants.

Please provide me a list of names for your current Planning Team as soon as possible to include on the first newsletter. I assume you will continue as the Planning Team Leader?

I look forward to working with you and your Team. Thank you for your time.

Kind Regards
-Scott-

R. Scott Simmons, CFM, CPM
AECOM + URS
700 G Street, Suite 500 | Anchorage, AK 99501
Ph: 907.261.9706 | 800.909.6787 | Personal Mobile: 841.1832 | Fax: 907.562.1297
eMail Address: scott.simmons@urs.com

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Memorandum

700 G Street, Suite 500
Anchorage, AK 99501
Toll Free: 800.909.6787
Phone: 907.261.9709
Fax: 907.562.1297

SUBJECT: Division of Homeland Security and Emergency Management (DHS&EM) Hazard Mitigation Plan (HMP) – City of Kivalina Kick-Off Team Meeting and HMP Work Session

Community: City of Kivalina, Alaska; (907.645.2137)

Date/Time: January 14, 2015

From: R. Scott Simmons

Attendees:
- DHS&EM: Scott Nelsen, HMP Development Coordinator
- AECOM: Scott Simmons, HMP Consultant

Community Members:
- Austin Swan, Sr., Mayor
- Lucy Adams, Vice Mayor
- Janet Mitchell, City Administrator / Planning Team Lead
- Alice Adams, Secretary/Treasurer
- Colleen Swan, Relocation Project Manager
- Leroy T. Adams, Sr.
- Ida N. Swan
- Rhonda Norton

- **Subjects covered included:**
  - AECOM was contracted to update the City's 2008 hazard mitigation plan by reviewing and annotating what has changed during the HMP's life cycle.
  - It is AECOM' responsibility to write the plan and take on the bulk of the work to guarantee FEMA compliance.
  - The AECOM and DHS&EM encouraged the team to take-on HMP data gathering – to spread the work among the team members reducing the workload on the Team Leader, and to have periodic meetings to check progress and to discuss continued needs.
  - Teams are far more successful than any individual as one idea can lead to several – increasing the success of the Team.
  - It is essential the Community Planning Team reviews the existing HMP to guide us through the update process. AECOM provided a draft worksheet to depict typical review areas identified by FEMA's HMP Review Tool. AECOM will review the plan and annotate where appropriate all required update requirements.
  - The following subjects were covered during the teleconference/work session:
    - The attendees are familiar with the HMP and readily agreed to provide up-to-date information for the update
    - Ms. Seitz introduced her Planning Team and provided a brief overview of their hazard threats emphasizing that severe weather and devastating high water flow erosion are their greatest threats.
    - Attendees agreed to consolidate a few hazards for simplicity as well as remove a few that pose no substantial threat.

    Consolidate
      - Multi-Hazard (MH) 1: Group all outreach or educational initiatives
      - MH 2: Group all plan coordinating initiatives
      - MH 3: Group projects that reduce impacts from multiple hazard threats (such as a project that alleviates weather impacts resulting in flooding and erosion)

        - Flood: with ice run-up and scour (erosion).
        - Ground Failure: permafrost, landslide, ground water erosion

    Remove or no longer profile:
        - Earthquake: considered a very minor threat to Dillingham
        - Volcano: considered a very minor threat to Dillingham, however more distant events halts air traffic access to Dillingham. This aspect was wrapped into a Transportation Disruption Hazard

    New Hazards
        - Transportation Disruptions
        - Utility Disruptions
    - The Planning Team discussed the need to review and refine their Critical Facilities Inventory for accuracy, facilities' physical locations (street addresses and GPS coordinates as available), estimated values, and estimated number of occupants to enable AECOM to complete an updated risk assessment and vulnerability analysis.
    - The Capability Assessment Data Sheet lists community resources for implementing and administering projects
- The importance of public involvement during development and draft HMP review is a FEMA focus and essential for HMP compliance. There will be several opportunities for the public to participate, review progress, and the access the draft HMP prior to state and FEMA reviews.
- There will be two newsletters defining the HMP update initiative as well as its progress.

CITY OF KIVALINA HAZARD MITIGATION PLAN

Newsletter #1 **December 2014**

This newsletter describes the City of Kivalina's Hazard Mitigation Planning project development processes to all interested agencies, stakeholders, and the public and to solicit comments. It can also be viewed on the State of Alaska Division of Homeland Security and Emergency Management Website at http://ready.alaska.gov/plans/localhazmitplans.

The State of Alaska, Department of Military and Veterans Affairs, Division of Homeland Security and Emergency Management (DHS&EM) was awarded a Pre-Disaster Mitigation Program grant from the Federal Emergency Management Agency (FEMA) to prepare Hazard Mitigation Plans (HMP) for fifteen Alaskan Communities. The City of Kivalina was selected for participation in this effort.

URS was contracted to assist the community with preparing a FEMA approvable hazard mitigation plan and subsequent hazard mitigation grant program application during 2012 and 2013.

The Akiak Hazard Mitigation Plan will identify all natural hazards, such as earthquake, erosion, flood, severe weather, and wildland fire hazards, etc. The plan will also identify the people and facilities potentially at risk and ways to mitigate damage from future hazard impacts. The public participation and planning process is documented as part of these projects.

What is Hazard Mitigation?

Across the United States, natural and human-caused disasters have increasingly caused injury, death, property damage, and business and government service interruptions. The toll on individuals, families, and businesses can be very high. The time, money, and emotional effort required to respond to and recover from these disasters takes public resources and attention away from other important programs and problems.

The people and property in the State of Alaska are at risk from a variety of natural hazards that can potentially cause human injury, property damage, or environmental harm.

Hazard mitigation projects eliminate the risk or reduce the hazard impact severity to people and property. Projects may include short- or long-term activities to reduce exposure to or the effects of known hazards. Hazard mitigation activities include relocating or elevating buildings, replacing insufficiently sized culverts, using alternative construction techniques, or developing, implementing, or enforcing building codes, and education.

Why Do We Need A Hazard Mitigation Plan?

Communities must have a State, FEMA approved, and community adopted mitigation plan to receive a project grant from FEMA's pre- and post- disaster grants identified in their Hazard Mitigation Assistance and other agency's mitigation grant programs. The City of Kivalina plans to apply for mitigation funds after our plan is complete.

A FEMA approved and community adopted HMP enables the Local government to apply for the Hazard Mitigation Grant Program (HMGP), a disaster related assistance program. Applicants typically compete on a statewide basis.

The Pre-Disaster Mitigation (PDM) and the National Insurance Program's Flood Mitigation Assistance (FMA), grant programs are nationally competitive funding programs. These grants use the same application process and eligibility requirements.

The Planning Process

There are very specific federal requirements that must be met when preparing a hazard mitigation plan. These requirements are commonly referred to as the Disaster Mitigation Act of 2000, or DMA2000 criteria. Information about the criteria and other applicable laws and regulations may be found at: http://www.fema.gov/mitigation-planning-laws-regulations-guidance.

The DMA2000 requires the plan to include and document the following topics:

- Plan development process
- Identify hazards specific to the community
- Identify the population's and structures' risks
- Define the jurisdiction's mitigation goals
- List the community's mitigation strategy, selected actions, and implemented projects
- Provide a copy of the community's HMP Adoption Resolution

FEMA has prepared Local and Tribal Planning Guidance (respectively available at: http://emilms.fema.gov/is318/assets/local_mtgtn_plan_gdnce_0708.pdf and http://emilms.fema.gov/is318/assets/tribal_planning_guidance_may2010.pdf. they explains how the HMPs meets each of the DMA2000 requirements.

FEMA has prepared and "Mitigation Planning "How to" Guides (available at: https://www.fema.gov/media-library/resources-documents/collections/6. The City's Hazard Mitigation Plan will follow those guidelines.

We are currently in the very beginning stages of preparing the plan. We will be conducting a public meeting to introduce the project and planning team, and to gather comments from our community residents. Specifically we will complete the hazard identification task, and collect data to conduct the risk assessment.

DHS&EM has previously identified natural hazards that occur in the Northwest Arctic Borough that may also occur specifically in Kivalina.

We Need Your Help

Please use the following table to identify any hazards you have observed in your area that DHS&EM is not aware of AND any additional natural hazards that may not be on the list.

City of Kivalina Hazard Worksheet		
Hazard	Northwest Arctic Borough	City of Kivalina
Earthquake	Yes/No	Yes
Erosion	Yes/No	Yes
Flood	Yes/No	Yes
Ground Failure (Avalanche, Landslide, Permafrost)	Yes/No	No
Severe Weather	Yes/No	Yes
Tsunami & Seiche	Yes/No	No
Volcanic Ash	Yes/No	No
Wildland / Tundra Fire	Yes/No	No
*Hazard Matrix from the 2010 State of Alaska Hazard Mitigation Plan for the NWAB. (Parentheses indicate threat level and number of historical events)		

DHS&EM identified critical facilities within the City of Kivalina as part of the Alaska Critical Facilities Inventory, but the list of critical facilities needs to be updated and the estimated value and location (latitude/longitude) determined.

In addition, the number and value of structures, and the number of people living in each structure will need to be documented. Once this information is collected we will determine which critical facilities, residences, and populations are vulnerable to specific hazards in Kivalina. Please add additional facilities if needed.

Kivalina's Critical Facilities*	
City Hall / IRA Office / NANA Resource Specialist	Heavy equipment storage
Post Office	AVEC Power Plant
Public Safety/City Jail	School Generator
National Guard Armory	AVEC Tank Farm
McQueen School	School Tank Farm
Maniilaq Clinic	Native Store Tank Farm
Epiphany Church (Episcopal)	Washeteria
Friends Church	Water pump house
City Storage	Washeteria Water Tank
Community Hall	Kivalina Water System
Community Storage Conex	Large Water Tank
Kivalina Native Store	Sewage Dump
Community Freezer	Landfill/Incinerator
Teachers Quarters	School Satellite Dish
Cemetery-active	GCI Satellite Dish
Cemetery-inactive	City Building Satellite Dishes (2)
Airport Runway	GCI Telephone Module
DOT Hangar	OTZ Telephone Co-op
* Alaska Critical Facilities Inventory	

Please email or fax updated hazard and critical facility information directly to URS or provide it to your community planning & project team leader.

The Planning Team

The planning team is being led by Janet Mitchell with assistance from , , and the City and Tribal Councils. URS Corporation has been contracted by DHS&EM to provide assistance and guidance to the planning team throughout the planning process.

Public Participation

Public involvement will continue throughout the project. The goal is to receive comments, identify key issues or concerns, and improve ideas for mitigation. When the Draft Kivalina Hazard Mitigation Plan Update is complete, the results will be presented to the community before DHS&EM and FEMA approval and community adoption.

We encourage you to take an active part in preparing the City of Kivalina's Hazard Mitigation Plan development effort. The purpose of this newsletter is to keep you informed and to allow you every opportunity to voice your opinion regarding these important projects. Please contact your community HMP Team Leader or Scott Simmons, URS directly if you have any questions, comments, or requests for more information:

City of Kivalina
Planning Team Leader
Janet Mitchell, City Manager
P.O. Box 50079
Kivalina, AK 99750
Phone: 645.2137
eMail: kivalinacity@aol.com

URS Corporation
Scott Simmons, Hazard Mitigation, Emergency Management, and Climate Change Planner
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Scott Nelsen, State Support
PO Box 5750
Anchorage, AK 99505-5750
428.7010 or 800.478.2337
eMail: scott.nelsen@alaska.gov

April 15, 2015

City of Kivalina
P.O. Box 50079
Kivalina, AK 99750

RE: Kivalina's 2015 Draft Hazard Mitigation Plan Review

Dear Mayor Swan,

Please give me a call when you receive this package.

There are two ways you may make changes in the document.

- You may write directly on one copy and send it back to me with the changes indicated by inserting slips of paper to direct me to specific pages. or
- If there are only a few changes or corrections, you can call me and we can make the changes over the phone.

Here is your Draft Hazard Mitigation Plan for your review. This plan is not completed yet. Please make it available for the public to also review. You may desire to place a copy in the City and maybe the Tribal Office or some other location more suitable for your community. You may want to punch holes and place it in a 3-ring binder to make it easier for people to review. Also, please make a log sheet, have people sign it, and keep track of any comments to help us make the changes that may be beneficial to the community. Please send me the log sheet so I may insert it into the plan to demonstrate the public review process.

I have also enclosed the second newsletter for posting in the community informing every one of its availability for review.

We would like to have the draft reviewed and returned by 1 May 2015.

R. Scott Simmons
Emergency Management, Hazard Mitigation, and
Climate Change Adaptation Planner

Direct: 907.261.9706
Scott_simmons@aecom.com

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700 G Street, Suite 500
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CITY OF KIVALINA HAZARD MITIGATION PLAN (HMP)

April 2015 **Newsletter 2**

This newsletter discusses the preparation of the City of Kivalina Hazard Mitigation Plan. It has been prepared to inform interested agencies, stakeholders, and the public about the project and to solicit comments. This newsletter can also be viewed on the State of Alaska Division of Homeland Security and Emergency Management Website at: *http://www.ready.alaska.gov/plans/localhazmitplans.htm*.

HMP Development

The City of Kivalina was one of 21 communities selected by the State of Alaska, Division of Homeland Security and Emergency Management (DHS&EM) for a Hazard Mitigation Planning (HMP) development project. The plan identifies natural hazards that affect the community including earthquake, flood, ground failure, severe weather, and tundra/wildland fire. The HMP also identifies the people and facilities potentially at risk and potential actions to mitigate community hazards. The public participation and planning process is documented as part of the project.

What is Hazard Mitigation?

Across the United States, natural disasters have increasingly caused injury, death, property damage, and business and government service interruptions. The toll on individuals, families, and businesses can be very high. The time, money, and emotional effort required to respond to and recover from these disasters take public resources and attention away from other important programs and problems.

People and property throughout Alaska are at risk from a variety of hazards that have the potential for causing human injury, property damage, or environmental harm.

The purpose of hazard mitigation is to implement projects that reduce the risk severity of hazards on people and property. Mitigation programs may include short-term and long-term activities to reduce hazard impacts or exposure to hazards. Mitigation could include education, construction or planning projects. Hazard mitigation activity examples include relocating buildings, developing or strengthening building codes, and educating residents and building owners.

Why Do We Need A Hazard Mitigation Plan?

A community is only eligible to receive grant money for mitigation programs by preparing and adopting a hazard mitigation plan. Communities must have an approved mitigation plan to receive grant funding from the Federal Emergency Management Agency (FEMA) for eligible mitigation projects.

The Planning Process

There are very specific federal requirements that must be met when preparing a HMP. These requirements are commonly referred to as the Disaster Mitigation Act of 2000, or DMA2000 criteria. Information about the criteria may be found on the Internet at: http://www.fema.gov/mitigation-planning-laws-regulations-guidance.

The DMA2000 requires the plan to document the following topics:

- Planning process
- Community Involvement and HMP review
- Hazard identification
- Risk assessment
- Mitigation Goals
- Mitigation programs, actions, and projects
- A resolution from the community adopting the plan

FEMA has prepared a Local Planning Review Guide) and (available at: http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=4859). It explains how the HMP meets each of the DMA2000 requirements. FEMA has prepared and "Mitigation Planning Guidance" and "How to Guides" (available at: http://www.fema.gov/hazard-mitigation-planning-resources). The City's Hazard Mitigation Plan will follow those guidelines.

The planning process kicked-off on December 2, 2014 by establishing a local planning committee and holding a public meeting. The planning committee examined the full spectrum of hazards listed in the State Hazard Mitigation Plan and identified five natural and three manmade/ technological hazards the HMP would address.

After the first public meeting, City staff and DHS&EM's contractor AECOM began identifying critical facilities, compiling the hazard profiles, assessing capabilities, and conducting the risk assessment for the identified hazards. Critical facilities are facilities that are critical to the recovery of a community in the event of a disaster. After collection of this information, AECOM helped to determine which critical facilities and estimated populations are vulnerable to the identified hazards in Kivalina.

A mitigation strategy was the next component of the plan to be developed. Understanding the community's local

capabilities and using information gathered from the public and the local planning committee and the expertise of the consultants and agency staff, a mitigation strategy was developed. The mitigation strategy is based on an evaluation of the hazards, and the assets at risk from those hazards. Mitigation goals and a list of potential actions/projects were developed as the foundation of the mitigation strategy.

Mitigation goals are defined as general guidelines that explain what a community wants to achieve in terms of hazard and loss prevention. Goals are positively stated future situations that are typically long-range, policy-oriented statements representing community-wide visions. Mitigation actions and projects are undertaken in order to achieve your stated objectives. In April, 2015, the local planning committee identified projects and/or actions for each hazard that focus on six categories: prevention, property protection, public education and awareness, natural resource protection, emergency services, and structural projects. A representative sample of the mitigation actions identified as a priority by the planning team are listed below, and explained in more detail in the plan.

The selected projects and/or actions will potentially be implemented over the next five years as funding becomes available. A maintenance plan was also been developed for the hazard mitigation plan. It outlines how the community will monitor progress on achieving the projects and actions that will help meet the stated goals and objectives, as well as an outline for continued public involvement.

The draft plan is available in the City and Tribal offices for public review and comment. Comments should be made via email, fax, or phone to Scott Simmons (listed below) and be received no later than May 1, 2015. The plan will be provided to DHS&EM and FEMA for their preliminary approval and returned to Kivalina's City and Tribal Councils for formal adoption.

The Planning Committee

The plan was developed with the assistance from the community's planning committee consisting of a cross section from the community. Planning Team members who helped with developing the plan include City Administrator and Planning Team Leader, Janet Mitchell, with assistance from the City Council, and DHS&EM's contractor, AECOM.

Sample of the City of Kivalina's Newly Identified Mitigation Actions. Review the draft HMP for a complete list.		
Identify and pursue funding opportunities to implement mitigation Actions.	Disseminate FEMA pamphlets to educate and encourage homeowners concerning structural and nonstructural retrofit benefits.	Encourage utility companies to evaluate and harden vulnerable infrastructure elements for sustainability.
The City will strive to manage their existing plans to ensure they incorporate mitigation planning provisions into all community planning processes such as comprehensive, capital improvement, and land use plans, etc. to demonstrate multi-benefit considerations and facilitate using multiple funding source consideration.	Relocate community to Kiniktuuraq. The existing location has no space for growth, new homes construction. It experiences impacts from all natural hazards and is susceptible to rapid urban fire damages due to the entire community's buildings close proximity to each other.	Drill fresh water well. Current water source Wulik River location is eroding, located downriver from the Red Dog Mine (susceptible to mine discharge impacts), and experiences severe turbidity. Well is essential to community longevity, sustainability, and public health.
Prohibit new construction in identified mitigatable hazard impact areas (erosion, flood, ground failure (permafrost), etc.) or require building to applicable building codes for other hazard impacts (earthquake, volcanic ash, weather, etc.).	Replace water sump pumps damaged from silt damage. These pumps are vital for removing storm and floodwater collection in town center. Pumps will need filter screens to prevent future failure.	Develop and implement programs to coordinate maintenance and mitigation activities (such as utility line quick-disconnects) to reduce risk to public infrastructure from severe winter storms (snow load, ice, and wind).
Develop and implement disaster debris management plan.	Protect landfill (such as a raised berm with hardening) to prevent erosion, flooding damage, and flood water intrusion out flow.	Identify close proximity gravel source essential to current projects and future relocation site development.

We encourage you to learn more about the City of Kivalina's Hazard Mitigation Plan. The purpose of this newsletter is to keep you informed and to allow you every opportunity to voice your opinion regarding this important project. If you have any questions, comments, or requests for more information, please contact:

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Appendix E

Benefit–Cost Analysis Fact Sheet

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Benefit-Cost Analysis Fact Sheet

Hazard mitigation projects are specifically aimed at reducing or eliminating future damages. Although hazard mitigation projects may sometimes be implemented in conjunction with the repair of damages from a declared disaster, the focus of hazard mitigation projects is on strengthening, elevating, relocating, or otherwise improving buildings, infrastructure, or other facilities to enhance their ability to withstand the damaging impacts of future disasters. In some cases, hazard mitigation projects may also include training or public-education programs if such programs can be demonstrated to reduce future expected damages.

A Benefit-Cost Analysis (BCA) provides an estimate of the "benefits" and "costs" of a proposed hazard mitigation project. The benefits considered are avoided future damages and losses that are expected to accrue as a result of the mitigation project. In other words, benefits are the reduction in expected future damages and losses (i.e., the difference in expected future damages before and after the mitigation project). The costs considered are those necessary to implement the specific mitigation project under evaluation. Costs are generally well determined for specific projects for which engineering design studies have been completed. Benefits, however, must be estimated probabilistically because they depend on the improved performance of the building or facility in future hazard events, the timing and severity of which must be estimated probabilistically.

All Benefit-Costs must be:

- Credible and well documented
- Prepared in accordance with accepted BCA practices
- Cost-effective (BCR $\geq$ 1.0)

General Data Requirements:

- All data entries (other than Federal Emergency Management Agency [FEMA] standard or default values) MUST be documented in the application.
- Data MUST be from a credible source.
- Provide complete copies of reports and engineering analyses.
- Detailed cost estimate.
- Identify the hazard (flood, wind, seismic, etc.).
- Discuss how the proposed measure will mitigate against future damages.
- Document the Project Useful Life.
- Document the proposed Level of Protection.
- The Very Limited Data (VLD) BCA module cannot be used to support cost-effectiveness (screening purposes only).
- Alternative BCA software MUST be approved in writing by FEMA HQ and the Region prior to submittal of the application.

Damage and Benefit Data

- Well documented for each damage event.
- Include estimated frequency and method of determination per damage event.
- Data used in place of FEMA standard or default values MUST be documented and justified.

- The Level of Protection MUST be documented and readily apparent.
- When using the Limited Data (LD) BCA module, users cannot extrapolate data for higher frequency events for unknown lower frequency events.

Building Data

- Should include FEMA Elevation Certificates for elevation projects or projects using First Floor Elevations (FFEs).
- Include data for building type (tax records or photos).
- Contents claims that exceed 30 percent of building replacement value (BRV) MUST be fully documented.
- Method for determining BRVs MUST be documented. BRVs based on tax records MUST include the multiplier from the County Tax Assessor.
- Identify the amount of damage that will result in demolition of the structure (FEMA standard is 50 percent of pre-damage structure value).
- Include the site location (i.e., miles inland) for the Hurricane module.

Use Correct Occupancy Data

- Design occupancy for Hurricane shelter portion of Tornado module.
- Average occupancy per hour for the Tornado shelter portion of the Tornado module.
- Average occupancy for Seismic modules.

Questions to Be Answered

- Has the level of risk been identified?
- Are all hazards identified?
- Is the BCA fully documented and accompanied by technical support data?
- Will residual risk occur after the mitigation project is implemented?

Common Shortcomings

- Incomplete documentation.
- Inconsistencies among data in the application, BCA module runs, and the technical support data.
- Lack of technical support data.
- Lack of a detailed cost estimate.
- Use of discount rate other than FEMA-required amount of 7 percent.
- Overriding FEMA default values without providing documentation and justification.
- Lack of information on building type, size, number of stories, and value.
- Lack of documentation and credibility for FFEs.
- Use of incorrect Project Useful Life (not every mitigation measure = 100 years).

Appendix F

Plan Maintenance Documents

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Annual Review Questionnaire

PLAN SECTION	QUESTIONS	YES	NO	COMMENTS
PLANNING PROCESS	Are there internal or external organizations and agencies that have been invaluable to the planning process or to mitigation action			
	Are there procedures (e.g. meeting announcements, plan updates) that can be done more efficiently?			
	Has the Planning Team undertaken any public outreach activities regarding the HMP or implementation of mitigation actions?			
HAZARD PROFILES	Has a natural and/or manmade/ technologically caused disaster occurred during this reporting period?			
	Are there natural and/or manmade/ technologically caused hazards that have not been addressed in this HMP and should be?			
	Are additional maps or new hazard studies available? If so, what have they revealed?			
VULNERABILITY ANALYSIS	Do any critical facilities or infrastructure need to be added to the asset lists?			
	Have there been development patterns changes that could influence the effects of hazards or create additional risks?			
MITIGATION STRATEGY	Are there different or additional resources (financial, technical, and human) that are now available for mitigation planning within the City or Village as applicable?			
	Are the goals still applicable?			
	Should new mitigation actions be added to the Mitigation Action Plan (MAP)?			
	Do existing mitigation actions listed in the Mitigation Strategies' MAP need to be reprioritized			
	Are the mitigation actions listed in the MAP appropriate for available resources?			

MITIGATION ACTION PROGRESS REPORT

Progress Report Period: _____ **To** _____
(Date) **(Date)**

Project Title: _____ **Project ID#:** _____

Responsible Agency: _____

Address: _____

: _____

Contact Person: **Title:**

Phone #(s): _____ **eMail Address(s):** _____

_____ _____

List Supporting Agencies and Contacts:

_____

_____

Total Project Cost: _____

Anticipated Cost Overrun/Underrun: _____

Project Approval Date: _____ **Project Start Date:** _____

Anticipated Completion Date: _____

Description of Project (describe each phase, if applicable, and the time frame for completing each phase:

_____

_____

Milestones	Complete	Projected Completion Date

MITIGATION ACTION PROGRESS REPORT

Plan Goal(s) Addressed: _____

Goal: _____

Success Indicators: _____

Project Status

- ☐ **On Schedule**
- ☐ **Completed**
- ☐ **Delayed***

*** Explain:** _____

- ☐ **Canceled**

Project Cost Status

- ☐ **Cost Unchanged**
- ☐ **Cost Overrun****

**** Explain:**

- ☐ **Cost Underrun*****

***** Explain:** _____

Summary of progress on project for this report:

A. What was accomplished during this reporting period? _____

B. What obstacles, problems, or delays did you encounter, if any? _____

C. How was each problem resolved? _____

Next Steps: What is/are the next step(s) to accomplish over the next reporting period?

Other Comments: _____

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Appendix G

USACE's Relocation Planning Project, Master Plan's Potential Kivalina Relocation Site Assessments

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LEGEND

RELOCATION SITE

TNH

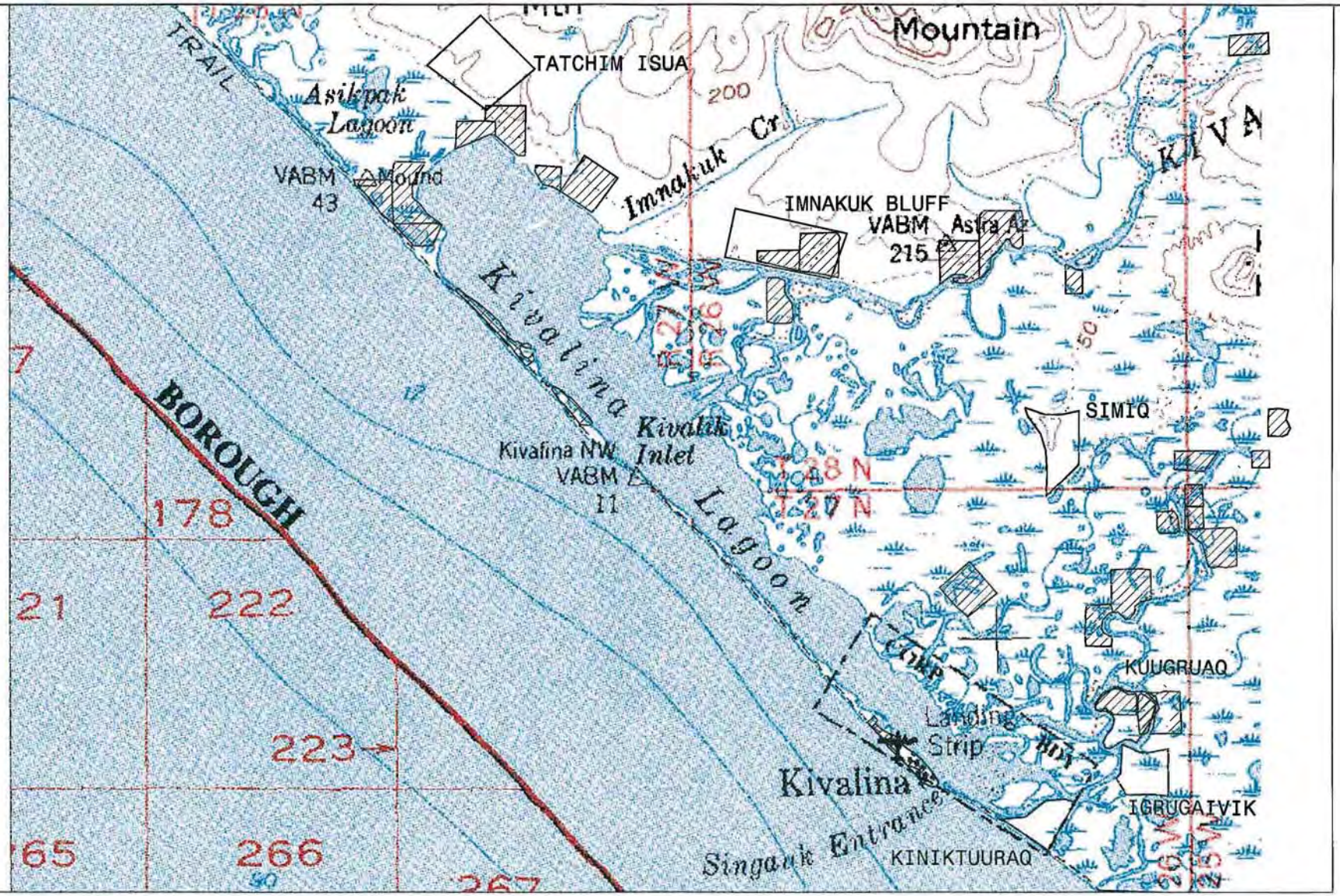
SCALE: 1 INCH = 1 MILE

TNH ENGINEERING/SURVEYING & LANDSCAPE ARCHITECTURE Tryck Nyman Hayes, Inc.

FIGURE 1
KIVALINA RELOCATION SITE MAP

SHEET 1 / 1

FILE NO. 03003.007



LEGEND

NATIVE ALLOTMENT

RELOCATION SITE

SCALE: 1 INCH = 1 MILE

KIVALINA VILLAGE
RELOCATION PROJECT

FIGURE 2 RELOCATION MAP

ALL TOPO MAPS ALASKA, IGAGE, 2000
KIVALINA, ALASKA

SHEET 1 of 1

FILE NAME: KIVALINA_ALLOTMENTS.DWG

REV.	DATE	BY	REVISION

FIELD BOOKS
DESIGN
STAKING
AS-BUILT
HOR. SCALE AS SHOWN
VER. SCALE

DESIGNED GFC
DRAWN GFC
CHECKED MEW
DATE 10/10/05
GRID
JOB NO. 03003.007

PLOT SCALE: 1:1

GRAPHIC SCALE

8400 0 4200 8400 16800

(IN FEET)
SCALE: 1"=8400'

NATIVE ALLOMENT

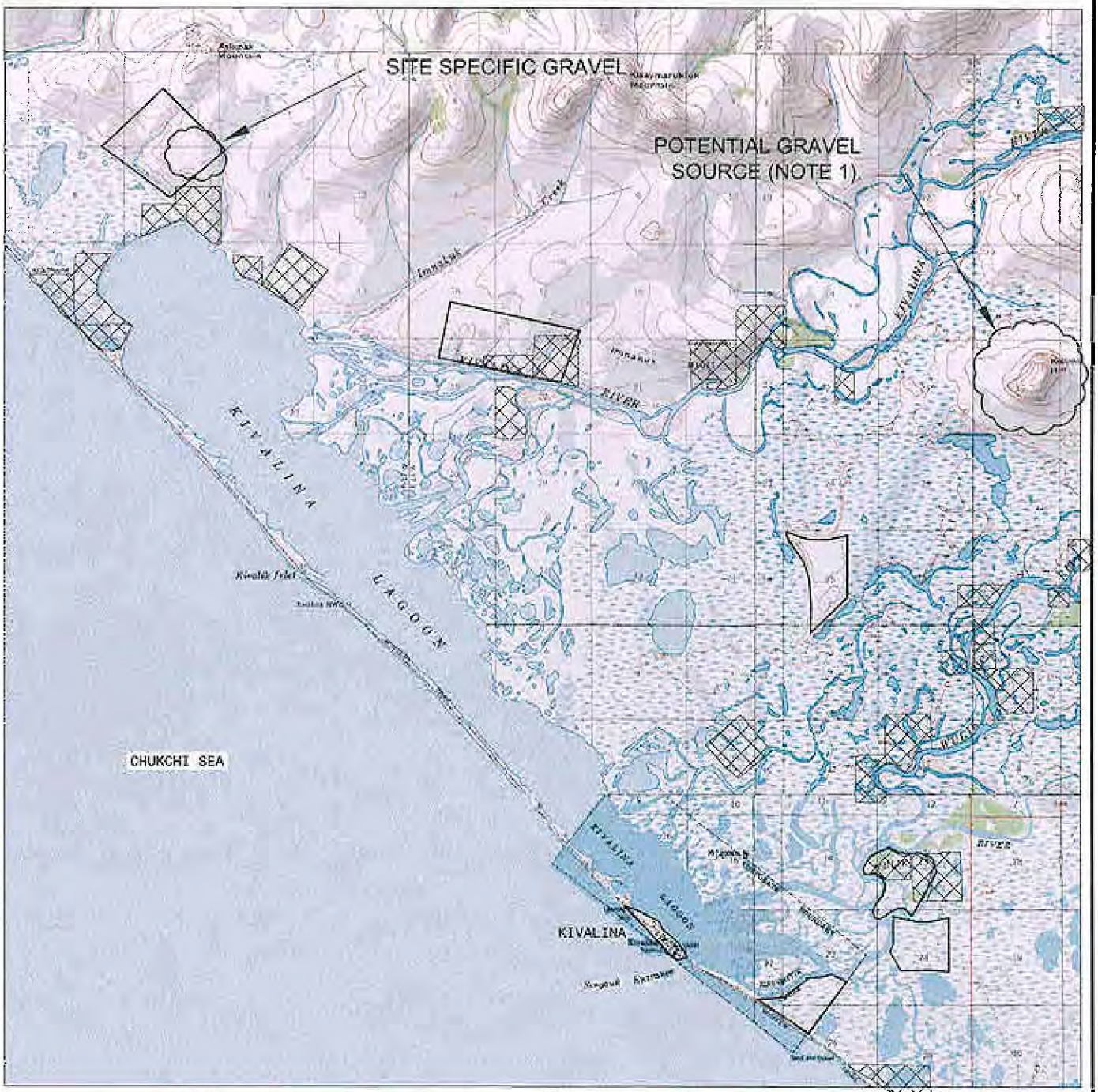
POTENTIAL GRAVEL SOURCE

VILLAGE SITES

TNH

NOTES:

1. POTENTIAL GRAVEL FOR ALL SITES EXCEPT TATCHIM ISUA.
2. IT IS ASSUMED THAT LOCAL GRAVEL CAN BE MINED FOR TATCHIM ISUA SITE.
3. VARIOUS LOCATIONS EXIST FOR SMALL QUANTITIES OF GRAVEL TO BE MINED FROM THE WULIK AND KIVALINA RIVERS.



XREF's/IMAGES USED FOR THIS DWG:

PLOTTED: 06/16/06 TIME: 4:32 pm

LAYER MGR: *.lay CTB FILE: *.ctb

DRAWING NAME: village site infrastructure maps.dwg

TNH

ENGINEERING/SURVEYING & LANDSCAPE ARCHITECTURE

TRYCK NYMAN HAYES, INC.

911 W. 8TH AVENUE, SUITE 300
ANCHORAGE, AK 99501-3497
TEL: (907)279-0543 • FAX: (907)276-7679

FIGURE 3

POTENTIAL GRAVEL SOURCE

LOCATIONS TO EXPLORE FOR GRAVEL

DESIGN BY: MEW	DATE: 6/16/06
DRAWN BY: DH	PROJECT No: 03003.007
SCALE: 1" = 8400'	REV. –
CAD DWG FILE: M:\03003.007Kivalina\WRP\Mapping\DrainageBasin	
FIELD BOOK: –	SHEET 1 OF 1
GRID: –	

3.3 EXISTING SITE – KIVALINA "DO NOTHING"

Evaluation of the existing village site has two alternatives: 1) the 'Do Nothing' Option, where the existing conditions are allowed to remain without alteration, and 2) a site modification program, whereby the site is raised to elevate it above the level of the storm surge, the seaward side of the spit is armored against storm wave erosion, and the lagoon side of the spit is armored against further erosion on that side.

The "Do Nothing" alternative will leave the village in the same condition it is currently in. The shoreline will continue to erode, shrinking the village until residents are forced to move or be displaced by the ocean. Residents will almost certainly be forced to abandon the village as the ocean reclaims the barrier island.

The "Do Nothing" option would leave the existing water and wastewater utilities unchanged. The ability of the residents to maintain sanitary and healthy conditions is restricted by a limited supply of water that must be individually hauled to each home. Only the school and clinic have running water and sewer systems. Furthermore, government funding agencies will not fund sanitation projects in quite justified fear that the investment will be destroyed by the village's exposure to storms, erosion, and flooding.

Clearly the "Do Nothing" option is not a viable alternative for the people of Kivalina. The imminent threat of erosion and flooding, the village's overcrowding and lack of room to expand, and the health dangers associated with the existing water and sewer systems eliminate the possibility of leaving the village in its current state. Rebuilding the existing site presents problems with funding and infrastructure development and protection. The village of Kivalina should be relocated to a new site for the health and well-being of its population.

3.4 EXISTING SITE – KIVALINA IMPROVEMENTS

3.4.1 Location and Site Description – Kivalina Improvements

See Section 2 for a description of the village location.

3.4.2 Site Development – Kivalina Improvements

Alternatives to make the Kivalina site habitable involve a program of engineered improvements to raise the elevation of the village above the storm surge, install erosion protection and armoring along the seaside of the village, and construct needed grading, sanitation, and building improvements. It should be noted that the existing Kivalina townsite has little potential for community expansion in response to community growth, compared to any of the other sites. Developable land is restricted on three sides by water, and by the airport on the north side of the townsite. There is insufficient land to meet community growth needs at this site.

The high point of the village is at a 10 ft. elevation. To be above the projected storm surge, the village would have to be raised to elevation 16.5 feet. In rough numbers, and assuming that no improvements will be made to elevate the runway, the amount of gravel needed to raise the entire village 6.5 feet would involve an area 1,800 ft long by 600 ft. wide. This includes the area from the runway to the north to Singauk Entrance, as well as filling part of the lagoon. The outside of the spit for the entire perimeter of the village would be armored for about 4,285 lf and would require over 31,000 yards of rock. Twenty-four new homes can then be added.

With the village site raised above the storm surge and the edges armored against wave

erosion, a buried utility system could be installed in the village to carry water to every building and convey sewage away to a treatment plant. Utility piping buried below the storm surge elevation would be anchored to prevent floating and constructed of a watertight material to ensure no infiltration occurs.

Placing gravel over an already developed site requires the work to be done in phases. Completing the work in a single construction season requires coordination of gravel delivery and offloading, placement and relocation of buildings. Gravel would be barged to the site, offloaded, and placed concurrently. Gravel deliveries would be spaced out to allow time for the buildings to be moved onto the newly raised gravel section.

Optimally, each building would only be moved once. Raising the village could potentially be done by placing gravel and armor rock from the north to the south in sections. As each section of gravel is installed, the nearby houses can then be moved onto the gravel pad, leaving an area with no structures for installation of the next section of gravel. At the same time, armor rock could be placed along the water edges. This "leapfrog" method of raising the finished grade elevation and moving the buildings would continue to the south end of the site.

However, some buildings in the village are not structurally sound enough to be moved and would need to be replaced. Other structures, such as the water tanks, store, school, and power plant either provide essential services or are too large to move easily. These buildings must be moved or elevated by more complicated means.

The economic implications of moving the existing water tanks must be analyzed. It may be more economically feasible to install a temporary water storage system, dismantle the existing tanks, raise the site, and erect new tanks that would be larger, better insulated and more well-protected.

The same is true for the school. The existing structure was constructed in the mid '70's, and is due for replacement. A local site raising could be performed after the existing school is torn down. The raising and armoring of the existing site should take place over the period of a single summer, so the existing school may not need to remain in service during construction. Since a new school would take more than a single year to construct, a replacement, such as modular units, would have to be installed while the new school is under construction.

It may be possible to raise the existing school and install a new foundation as described above. This would allow the existing school to remain in service while a new school is being constructed. Because of the tight space on the spit, any new school would have to be built on an area raised to the finished grade elevation of the village and extended to the west to add additional buildable land. This process would involve removing the existing teacher housing and replacing it with new, consolidated housing.

The modular units could then be moved and used for other purposes in the village, whether it is housing or public/community buildings.

Immediately after the gravel is placed and the buildings moved onto the new gravel pad, excavation for water and sewer lines in the new pad could begin. A system of water and sewer mains and services could be installed and remain unused until a water treatment system and sewer treatment system could be constructed and connected, probably in the year following the gravel/armor rock placement.

The process of raising the existing village site may require an enormous amount of

cooperation, coordination, and funding to ensure a continually efficient construction process.

3.4.3 Infrastructure Development – Kivalina Improvements

3.4.3.1 Water – Kivalina Improvements

A piped water system has been selected for any new town site, including improvements to Kivalina. Based on developing a system in Kivalina, continued use of the Wulik River is proposed as the water source. An infiltration gallery located approximately 2 miles east of Kivalina could be developed to ensure year round water. For a piped distribution system, a year around water source, with storage, treatment plant, and distribution mains are proposed per Section 3.1, Non Site Specific Alternatives. Water mains within the village site could be buried below ground, while water transmission mains from the water source would have to be constructed above ground away from any ice-rich permafrost. Circulation and the addition of heat is required to keep the water lines from freezing.

3.4.3.2 Wastewater – Kivalina Improvements

Improvements to the current site's sanitation facilities are limited by funding restrictions; the U.S. Environmental Protection Agency (EPA) and VSW will not fund any sanitation facilities that cannot be relocated to the new town site. Because piped utilities are being planned for the new town site, a flush and haul system would not be relocated; therefore the EPA and VSW have cancelled existing funds planned for upgrading the existing sewage lagoon to prepare for the installation of a flush and haul system at the existing town site.

Limited space on the island makes it difficult to place a lagoon system. In addition, flooding from storms would affect a lagoon system. Due to space constraints at the village site, this report recommends pretreatment using a package treatment plant, followed by discharged to a buried drain field. An alternative to a drain field is discharging directly to the Chukchi Sea. Sludge could be discharged to a sludge disposal pit located at the landfill. Refer to Section 3.1, Non Site Specific Alternatives for more detailed discussion of each component of the system. Discharging to a buried drain field has been a problem in the past.

The soils consist of sandy soil or beach sand typical of barrier islands in the region. Golder (1997) found the top of the permafrost approximately 12 ft below the surface. A well drilling log (1976) indicates permafrost between 18 and 58 ft. Due to the high permeability of the soil, depth of permafrost, and the failure of currently installed systems serving Kivalina, a subsurface disposal field should not be considered.

USACE (1998) discusses sizing and location of the disposal field. From EPA recommended application rate, the disposal field would be 20,000 sq. ft, or approximately one-half acre. The proposed location of the disposal field would be in the northern half of the proposed new landfill.

3.4.3.3 Solid Waste – Kivalina Improvements

Kivalina's current Class III municipal solid waste landfill does not comply with ADEC or FAA regulations. Specifically, the landfill is located approximately 1,984 feet to the north end of the Kivalina Airport runway. 18 AAC 60.305 requires a minimum 5,000 feet set back limit separating the airport runway end from a municipal solid waste landfill. This close proximity to the runway creates a hazard to aircraft when scavenging birds are attracted to the landfill. Bird strikes are extremely dangerous to aircraft and can quite easily cause an airplane to crash.

Limited space and continued erosion at the existing site makes it impossible to meet the minimum 5,000 feet set back requirement.

3.4.3.4 Fuel – Kivalina Improvements

Except for the location of marine headers and fill pipeline routings, the information in 3.2.6: Fuel applies to all potential sites equally.

3.4.3.5 Heating – Kivalina Improvements

The information in 3.2.7: Heating applies equally to all sites.

3.4.3.6 Electricity – Kivalina Improvements

3.4.3.6.1 Generation

Electricity for the community is supplied by AVEC. Electric usage (2002 statistics) for the existing community was 1.17 M kWH with peak load of 263 kW and an average load of 134 kW at any given hour. The usage numbers are based upon a community of 383 persons without plumbing. The usage numbers include the power for private buildings, community buildings, commercial buildings, school buildings, churches, the community clinic, the National Guard Amory, the community Washeteria and the AVEC station power.

Presently, AVEC serves the community with three generators: 229 kW, 203 kW, and 271 kW. The Washeteria also has its own 12 kW backup generator. A fourth 337 kW generator is currently not being used for power generation and is in need of replacement. Of the three other generators on line, the 229 kW is the newest and was installed in 1996. The 229 kW generator has clocked about 33,000 hours; typical retirement time for generator drivers has been 100,000 hours at best. Extrapolating actual usage hours from the typical retirement time, there are about eight years of life remaining on the newest of the AVEC generators.

3.4.3.6.2 Distribution

Overhead primary distribution is used throughout the community. Pole-mounted transformers convert 3-phase primary voltage to secondary 3-phase and single phase low voltage (208/120 volts 3-phase or 240/120 volts single phase) for building electrical services. All electrical services are metered, with demand type metering used for commercial and larger community buildings.

3.4.4 Access – Kivalina Improvements

The only access to the village is by boat, air, and snow machine (during the winter). There are no roads to the village. Regularly scheduled air transportation service is provided by several small air carriers local to the region.

Access by boat is from the Chukchi Sea. There are no dock facilities at the existing village site. All boats either anchor in the lagoon or the Chukchi sea, or tie up to shoreside deadmen.

3.4.4.1 Access for Subsistence Activities – Kivalina Improvements

The community has immediate access to the sea and all points inside the lagoon by boat. Singauk Inlet at the South end of the village spit affords a passage between the lagoon and the sea. Generally rougher waves on the sea side of the village make tying up in the lagoon the safer choice.

The lagoon is the main access to the Kivalina river to the north of the village and the Wulik River immediately south of the site. The lagoon itself is approximately 14 miles long and an average of 1 mile wide. Since the lagoon fronts the entire length of the existing village, direct access is available to all members of the community.

3.4.4.2 Goods & Supplies – Kivalina Improvements

All goods and supplies, including bulk fuel, are brought into the village by barge or aircraft. During the summer months when the sea is ice free, shallow draft barges can access the lagoon through Singauk Inlet and offload cargo in the relatively protected saltwater inlet. Vessels with too deep a draft to enter the inlet can tie up on the shore near the village. The seaside mooring is exposed to the wind, waves and storms off the Chukchi Sea, so delivery that must be made to this side is weather dependent. All cargo off loaded can be taken directly into the village, which fronts the barge mooring area.

Barge service for goods and bulk fuel is delivered once a year during the summer.

Small packages and mail are brought in daily by air. The airstrip also serves as a means of emergency evacuation in case of illness or injury. During periods of fuel shortages, fuel has been flown into the community.

3.4.4.3 Air Transportation – Kivalina Improvements

The village has a 3,300 ft long gravel runway, maintained by the ADOT&PF, at the immediate north end of the village. The runway's location is convenient, but it restricts expansion of the village. Currently, the runway is in violation of FAA regulations as it abuts the existing solid waste dumpsite to the north without the required 5,000 feet distance between the two facilities. There is no immediate solution to this problem.

3.4.4.4 Roads & Streets within Community – Kivalina Improvements

The road layout within the community is essentially an 'oval,' with two roads running parallel to each other at the third points of the width of the village. These roads are joined at the south end by a curved gravel trail that has become banked as years of four-wheeler traffic has pushed the loose sands and gravels to the outside of the turn. The rest of the roads have no distinct layout and were formed as residents simply took the shortest path to their destination.

3.4.4.5 Roads Outside the Community – Kivalina Improvements

There are no roads outside the community. There is a trail that is an extension of the North end of the gravel runway that provides access to the solid waste dump site. Beyond that there are primitive four-wheeler trails that allow access to the north end of the lagoon and points beyond.

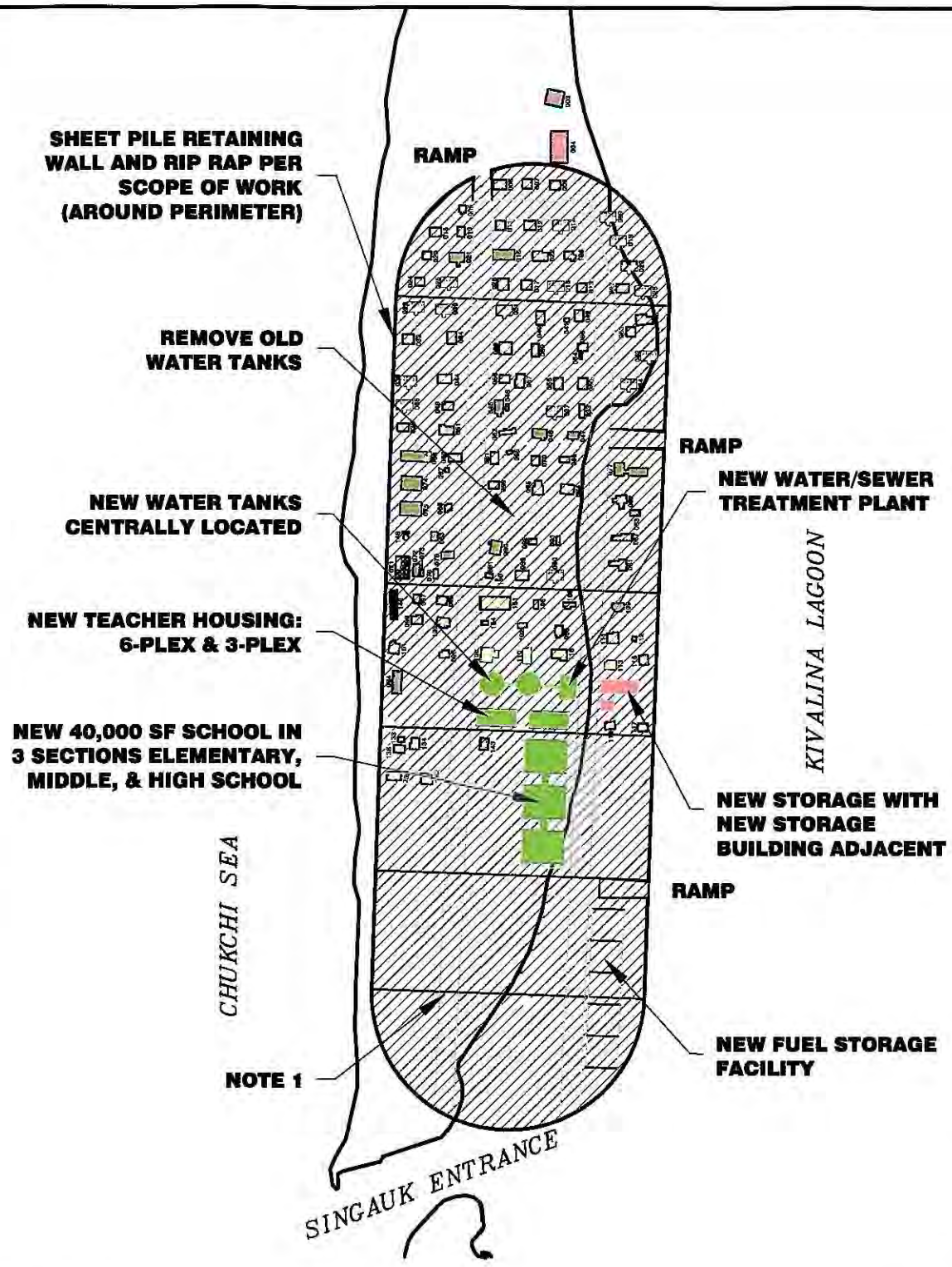
3.4.5 Native Allotments

There are no Native allotments in the vicinity of the existing townsite (see Figure 2). Expansion of the existing Kivalina townsite is not constrained by Native Allotments.

3.4.6 Site Costs – Kivalina Improvements

A construction cost estimate to redevelop the existing site has been prepared. Design and construction administration are not included in the costs. The estimate includes adding fill to the entire village site, adding erosion projection, creating new fill sections for immediate growth, and adding infrastructure similar to the proposed relocation sites. The cost estimate to rebuild Kivalina within the existing site is **$196.2 million.** Detailed costs are included in Appendix A. A summary is included below:

Site work and Airport Construction	$109,600,000
Erosion Protection	$7,151,550
Construction Camp	$902,670
Power and Fuel	$5,292,000
Move Buildings	$1,125,000
New Buildings	$52,690,000
Water/Sewer System and Landfill	$19,473,814
Transportation System	N/A
Total Cost	**$196,200,000**



NOTES:
1. PHASED CONSTRUCTION TO ALLOW BUILDINGS TO BE MOVED TO NEW FILL SECTIONS.

TNH

GRAPHIC SCALE
250 0 175 250 500
(IN FEET)
SCALE: 1" = 500'

TNH
ENGINEERING/SURVEYING & LANDSCAPE ARCHITECTURE
TRYCK NYMAN HAYES, INC.
911 W. 8TH AVENUE, SUITE 300
ANCHORAGE, AK 99501-3497
TEL: (907)279-0543 • FAX: (907)276-7679

Figure 5

KIVALINA IMPROVEMENTS

DESIGN BY: MEW	DATE: 6/16/06
DRAWN BY: RH	PROJECT No: 03003.007
SCALE: 1" = 500'	REV. –
CAD DWG FILE:	
FIELD BOOK: –	SHEET 1 OF 1
GRID: –	

XREF's/IMAGES USED FOR THIS DWG:
PLOTTED: 06/19/06 TIME: 5:05 pm
LAYER MGR: *.lay CTB FILE: *.ctb
DRAWING NAME: KIVALINA Improvements.dwg

Simiq, Photo 1

View NE from E edge of Simiq site

Simiq, Photo 2

Looking E from Simiq landing site

Simiq, Photo 3

View of pond SE of landing site at Simiq

Simiq, Photo 4

View of Kivalina from Simiq site

Simiq, Photo 5

Wet drainage swale on E side of Simiq site

Simiq, Photo 6

Aerial view of Simiq site

KIVALINA VILLAGE
RELOCATION PROJECT

FIGURE 6 SIMIQ

PHOTOS BY TRYCK NYMAN HAYES, INC., AUGUST 24, 2004
KIVALINA, ALASKA

SHEET 1 of 1

FILE NAME KIVALINA_SIMIQ.DWG

DESIGNED OFC
DRAWN OFC
CHECKED MEW
DATE 10/10/05
GRID
JOB NO. 03003.007

FIELD BOOKS
DESIGN
STAKING
AS-BUILT

SCALE
HOR. AS SHOWN
VER.

REV.	DATE	BY	REVISION

PLOT SCALE: 1:1

3.5 SIMIQ

3.5.1 Location and Site Description – Simiq

The Simiq site is located approximately 4 miles north-northeast of the existing village and 2.5 miles north-northeast of the west side of the lagoon, over muskeg terrain. The maximum extents of the elevated portions of the site are ½ mile wide in the east-west direction and between ¾ and 1 mile long in the north-south direction. The site is raised above the tundra pond terrain to the west by about 20 ft. Its highest elevation is in the approximate center of the site about 200 yards from the west shoulder. The site grade tapers off in all directions from this area at slopes of less than 5%. To the west and southwest, the gradual slope extends for several hundred yards.

The north and west sides of the site terminate into bluffs that drop off a maximum of 30 ft and 20 ft, respectively. The west face of the site tapers from the middle to each end, blending into the tundra pond/muskeg very gradually. The north face of the site is shorter than the west face, with a slope that drops off to the muskeg below at approximately 45 degrees.

Reference the geotechnical portions of this report for the composition and temperatures of the site soils.

The site is covered in low tundra growth characterized by sedges, scrub alder, and Arctic Willow. Berries, such as crowberries, blueberries and cranberries, along with tundra flowers and arctic cotton grass can also be found in the tundra. There are no trees on the site, and the scrub willows and alders are located only on the north and west faces.

The site is wet between the tundra grass tussocks and has small tundra ponds at the edges. Walking is difficult. Preliminary investigations show frozen ground at a depth of 3 inches with ice from 1.5 feet to at least 25 feet in depth. The active layer of the site is composed of saturated plastic silts with no sand or gravel.

Drainage of the site is facilitated by little infiltration into the saturated subsoils and micro-channel flow around tussocks to major drainage swales on the west and north sides of the site. These existing channels are shallow and do not extend into the site more than 50 feet from the swale..

The location of the Simiq site, inland from the lagoon, places it far enough away from the Chukchi Sea so that watching for whales from the site will not be possible, in spite of being higher than the surrounding terrain.

3.5.2 Site Development – Simiq

Reference the geotechnical report regarding the depth of gravel recommended to maintain the thermal regime of the site after development. The depth of fill applied to the site is determined by maintenance of the existing frozen thermal regime. Appendix G shows a conceptual layout of infrastructure.

The fill depth should be a minimum of 9 ft, and deeper in those areas called for by grading. Reference Section 3 for a discussion of gravel depth determination criteria.

Grading should maximize the utilization of swales and roadside ditching as much as possible. Where lengths of grade and slopes combine to make swales and ditches too deep, drainage structures such as culverts, manholes, catch basins and subsurface piping shall be employed.

General site grades should be kept to the minimum 2% on undeveloped (soil) surfaces as much as possible, and less than the minimum slopes that promote scour and erosion for the soils used. Pipe grades should be the minimum 1%. Storm drainage

outfalls should be rock-lined to prevent erosion .

3.5.2.1 Construction Considerations – Simiq

Initial geotechnical investigations of Simiq assume that the site is underlain by highly thaw-unstable permafrost. Ongoing follow-up geotechnical investigations may change the assessment.

Based on thaw unstable conditions, construction considerations for the site should consider the presence of thaw-unstable, ice-rich fine-grained materials. Significant settlement should be expected if thawing occurs.

For a site with these conditions, R&M (2000 & 2002) and Shannon and Wilson (2004) suggest the use of pile foundations or a granular fill pad with a post-on-pad foundation to protect from settlement due to thawing of ice-rich soil. Post-on-pad foundations are for areas with little or no massive ice, and require periodic leveling. Another option would be insulated and/or refrigerated shallow foundations; however this method is generally not used for ice-rich conditions and maintenance cost could be very high.

Embankments for roads and runways will also need to be protected from settlement due to permafrost degradation. An estimated embankment thickness of 9 feet should reduce the depth of thaw penetration into the ice-rich soil to nearly zero. Rigid board insulation or allowing for some settlement can reduce embankment thickness. The settlement would occur mostly within the first few years of service. Culverts beneath the embankments are expected to settle due to permafrost degradation, and may need to be re-leveled periodically during the first few years of service. Insulation beneath the culverts may reduce the magnitude of settlement.

Direct bury of settlement-sensitive gravity, pressure, or vacuum sewer systems might be risky due to the settlement potential. Unless the thermal impacts to the permafrost can be minimized by the design, utilities might have to be located above ground.

3.5.3 Infrastructure Development – Simiq

3.5.3.1 Water – Simiq

The closest feasible surface water source to Simiq would be either the Kivalina or Wulik Rivers. TNH visited two ponds adjacent to the west and northeast of the site (in August 2004). The ponds are approximately 11 and 3 acres in size, respectively. Neither appeared to be capable of use as a year-round water supply. Ponds along the southeast side of the Simiq site were not visited, however, they are similar in size to the west and northeast ponds. Ponds in the area typically freeze to the bottom in winter (DOWL 1994).

Simiq is centrally located between the two rivers. Piping distances of 1-1/2 to 2 miles would be required to access either of these sources.

If a surface water source from one of the rivers were used for Simiq, a collection, treatment, and distribution arrangement similar to the existing Kivalina site would be required. Water would be withdrawn through a hose and pipe transmission line placed in the river and pumped to a raw water storage tank (RWST). If the rivers could be tapped with an infiltration gallery year round, the transmission line would have to be heated with a glycol loop to avoid freezing.

Due to the potential for massive ice wedges and unstable thaw conditions, an underground distribution system is likely not feasible at the Simiq site (S&W 2004). If an aboveground distribution system were used,

continuous grade adjustments would be needed.

3.5.3.2 Wastewater – Simiq

Simiq has a slope of less than 5%, and appears to have ice-rich permafrost. The gentle slope of the terrain would allow for a gravity collection system for wastewater disposal. The ice-rich permafrost soils would limit the design to an aboveground arctic pipe system. A pump station located at the base of the slope could collect all the wastewater if needed. A naturally-occurring tundra pond could be used for wastewater disposal.

3.5.3.3 Solid Waste – Simiq

The potential village site is a high point in a swampy area. The land surrounding the site is lower by as much as 50 feet. Based on an August 2004 site visit, there is no location readily suitable for a solid waste site within 2 miles of the potential village site at Simiq. To reach potential solid waste sites to the northeast or east of the site, additional roads of one or more miles would have to be constructed. No nearby gravel source is present, and the very poor soils in the Simiq area would require import of gravel to build roads.

All the land around the site is low enough to be affected by floodwaters of the 100 and 500-year floods. Any solid waste dump located northeast or east of the Simiq site would need to be constructed so that the possibility of flooding is eliminated.

3.5.3.4 Fuel – Simiq

Except for the location of marine headers and fill pipeline routings, the information in 3.2.6 Fuel applies to all potential sites equally.

3.5.3.5 Heating – Simiq

The information in 3.2.7 Heating applies equally to all sites.

3.5.3.6 Electricity – Simiq

The information in 3.2.8 Electricity applies equally to all sites.

3.5.4 Access – Simiq

Road access to the Simiq site from the lagoon may entail construction of a road approximately 3.5 miles long over muskeg type soils from the west side of the lagoon. This road would allow access from the village to boats moored in the lagoon, and from a barge landing on the lagoon to the village.

There is no regular trail access to the Simiq site. Community members questioned about access indicated that a trip from the lagoon to the site takes about a day via four-wheeler due to the poor conditions of the terrain.

Road prism size for an access road from the lagoon to the site would be approximately 5 ft tall at the shoulders with 2:1 side slopes and have a volume of 6.7 cubic yards of material per lineal foot of road length. In addition, a staging pad having an area of approximately one acre may be required at the barge-mooring site. With a gravel depth of 5 ft, this would require an additional 8,800 cubic yards of gravel over geotextile fabric. Regrading of the roads may be required since some thawing of permafrost is anticipated with embankment depths of less than 9 feet.

3.5.4.1 Access for Subsistence Activities – Simiq

The Simiq site has no direct access to the Chukchi Sea. All sea access should be by road to the lagoon and then by boat across the lagoon, out the Singauk Inlet to reach the sea. All equipment needed for marine subsistence activities, all game obtained, and equipment to be stored may need to be hauled across the village access road to the lagoon. The 3.5-mile road distance could make hauling larger items, such as boat

engines and small boats needing repair, difficult with the existing vehicles available in the village.

The location of the site, inland from the lagoon, places it far enough away from the Chukchi Sea so that watching for whales from the site will not be possible, in spite of the elevation being above the surrounding terrain.

The nearest point on a river to the site is a northerly loop of the Wulik River approximately 1.2 miles south of the southern edge of the site. No direct access to any river is planned. Access to all rivers is to be gained from the lagoon.

Beach access may be difficult from the Simiq site. To access beaches north or south of Singauk Inlet, a resident may have to traverse the lagoon access road and take a small boat across the lagoon.

Winter travel by snowmobile should be much easier; as the community members can drive anywhere the ice is thick enough to support the vehicle.

3.5.4.2 Goods & Supplies – Simiq

The main source of goods and supplies for the new village should be by barge. A new barge landing and access road will need to be designed and constructed on the beach on the west side of the lagoon, approximately two miles northwest of the current town site. An access road crossing the lagoon would require culverts placed within the lagoon. Supplies would then need to be transported approximately four miles overland from the barge landing site to the new village site.

Goods and supplies can also be transported to the village via the airstrip, the location of which is discussed in the following section.

3.5.4.3 Air Transportation – Simiq

For the purposes of this study, we have selected a possible airstrip location approximately 5,000 feet southeast of the village. This site would require a road of approximately 6,500 feet, along which the Additional information will be gathered during the Stage II study to determine the best location and design considerations for a new airstrip. For the purposes of this study, we have selected a location approximately 1 mile east of the site on a low ridge. A new airport should be constructed prior to occupancy of the new village site. Refer to Section 3.1 for general recommendations.

3.5.4.4 Roads and Streets within Community – Simiq

The road layout within the community is expected to closely reflect the plan in Appendix G for the Phase I study report. Roads should be designed on a grid system to maximize flow of traffic and access to all portions of the new community.

The thermal regime described in the geotechnical report for the Simiq site may require a gravel pad a minimum of 9 feet thick.

3.5.4.5 Roads Outside the Community – Simiq

The location of the Simiq site and the soil conditions of the surrounding terrain make road construction difficult and expensive. The very poor soils in the area of the Simiq site preclude any specific development of roads outside the village except to access the airstrip and solid waste site. It is anticipated that there should be as few roads as possible outside the village to access the new airstrip, the solid waste facility, and the lagoon boat moorage area. To reduce the amount of road development necessary, two or more of these facilities should be located along the same road.

We have routed two roads connecting the village site to the barge landing and the runway. The barge access road should be 3.5 miles long and extend to the west from

the site. The runway access road should be 1 mile long and extend to the east from the site.

3.5.5 Native Allotments

There are no Native allotments in the vicinity of the Simiq townsite (see Figure 5). However, there are two Native allotments along the Wulik River near a potential airport site. Siting of an airport at this site should be able to avoid the Native allotments.

3.5.6 Relocation Costs – Simiq

Design and construction administration are not included in the following construction cost estimate for relocation to Simiq. The cost estimate to build a new village site at Simiq is **$251.5 million**. Detailed costs are included in Appendix A. A summary is included below:

Site work and Airport Construction	$167,400,000
Erosion Protection	$231,000
Construction Camp	$606,000
Power and Fuel	$5,292,000
Move Buildings	$1,125,000
New Buildings	$52,690,000
Water/Sewer System and Landfill	$21,119,261
Transportation System	$3,056,000
Total Cost	**$251,500,000**

3.5.7 Recommended Plan for Simiq

The Simiq site is located the greatest distance from the Chukchi Sea and the lagoon. This means the Simiq access road will be one of the longest out of the six mainland sites, along with that of the Kuugruaq site. The access road should be around 3.5 miles long over the lagoon and over muskeg that does not provide adequate support for the gravel road prism. Geotextile fabric should be placed in order to support the gravel road base. Even with this addition, the stability of the road may not be good.

The barge landing and should be established on the east side of the Singauk Entrance at the head of the new village access road. Accessing the village road through the existing Singauk Entrance may require the construction of a directional dike to channel the flow of the Wulik River to prevent it from depositing silt in the entrance and requiring intermittent maintenance dredging.

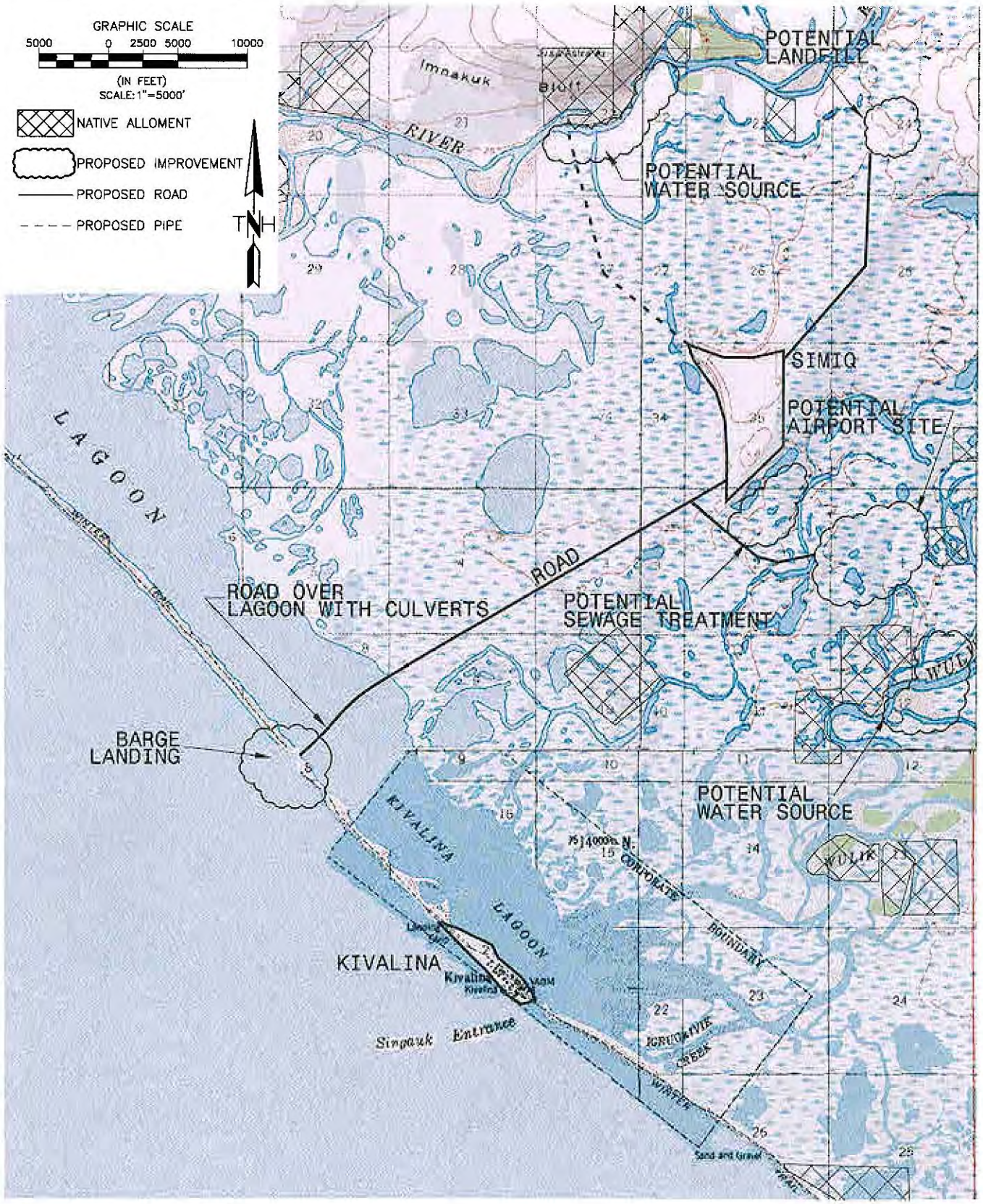
The area to be investigated for the runway to serve the Simiq site is located approximately 1 mile east of the town site along the lower slopes of Klaimigiuktuk Mountain. It is anticipated that this area should provide better subgrade on which to base the 150 ft X 4,000 ft runway. Locating the runway here should provide a better base, but necessitate an additional mile of access road.

Raw water for the Simiq site will most likely come from the Kivalina River approximately 2 miles to the northwest of the new village site. A surface water intake and gravel sump may need to be developed in the river at a depth that will provide year round water and avoid freeze-up during the winter.

Our recommendation for the siting of the landfill for Simiq is close to the village on the west side of the site. This side of the town site is lower than the site itself. A location close to the village should ensure that solid waste makes it to the landfill, and this area should provide some protection from the winds. By placing the landfill on the west side of the town site, access to haul

recyclable materials, batteries, and hazmat to the barge landing for shipping out of the area should be easier. In addition, this location will place the village between the landfill and the runway, and ensure a minimum of 10,000 ft between the landfill and runway.

Siting the sewage lagoon to the northwest of the village site should provide excellent separation between the wastewater treatment unit and raw water intake site. Discharge of the treated effluent into the surrounding muskeg should increase treatment in a 'bioswale' type environment.



XREF's/IMAGES USED FOR THIS DWG:

PLOTTED: 06/16/06 TIME: 4:15 pm

LAYER MGR: *.lay CTB FILE: *.ctb

DRAWING NAME: village site infrastructure maps.dwg

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Figure 7

SIMIQ CONCEPTUAL LAYOUT

DESIGN BY: MEW	DATE: 6/16/06
DRAWN BY: JT	PROJECT No: 03003.007
SCALE: 1" = 5000'	REV. –
CAD DWG FILE:	
FIELD BOOK: –	SHEET 1 OF 1
GRID: –	

Imnakuk Bluff, Photo 1

View S showing stream channel emptying into River

Imnakuk Bluff, Photo 2

View N showing pond in stream channel

Imnakuk Bluff, Photo 3

View downstream from Imnakuk Bluff at landing site, note shallow water depth

Imnakuk Bluff, Photo 4

Limestone gravel at face at stream channel

Imnakuk Bluff, Photo 5

View N on Imnakuk Bluff

Imnakuk Bluff, Photo 6

Aerial view of Imnakuk Bluff area

KIVALINA VILLAGE
RELOCATION PROJECT

FIGURE 8 IMNAKUK BLUFF

PHOTOS BY TRYCK NYMAN HAYES, INC., AUGUST 25, 2004
KIVALINA, ALASKA

SHEET 1 of 1

FILE NAME KIVALINA_IMNAKUK_BLUFF.DWG

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FIELD BOOKS	
DESIGN	
STAKING	
AS-BUILT	

DESIGNED	OFC
DRAWN	OFC
CHECKED	MEW
DATE	10/10/05
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JOB NO.	03003.007

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3.6 IMNAKUK BLUFF

3.6.1 Location and Site Description – Imnakuk Bluff

The Imnakuk Bluff site lies on the north side of the Kivalina River, approximately 1.5 miles east of the river's mouth. The west end of the site is 2.6 miles northeast of the Chukchi Sea and the southeast corner of the site is situated about 5.5 miles north-northeast of the existing village. It is a parcel of land 1.5 miles long by ½ mile wide, with its long axis lying parallel to the river, and its south boundary at the river.

A steep, 50 ft high bluff face that drops off to the river below characterizes the site. From the shoulder of the bluff, the site slopes upward to the north between 5-8% grade along a distance over a mile.

The soils near the shoulder of the bluff are more dry and stable than those 200+ ft north of the slope where wet, muskeg soils begin and extend beyond the north limits of the site. Reference the Geotechnical Report for a more in-depth description of the site soils.

Muskeg plants and other low arctic flora such as arctic cotton; moss, sedges, berries and grasses make up the bulk of the ground cover to within 200+ ft of the bluff. From the bluff to the north, the drier, more gravelly soils support a sparser growth of ground cover of predominantly Arctic Willow. Few scrub alder and willow bushes grow in protected depressions in the terrain.

The USACE (1998) report indicates that local residents knowledgeable about the Imnakuk Bluff site indicate winter winds can be a severe constraint to community comfort.

A stream cuts through the site, flowing north-south, about 1/3 the distance from the east boundary. This stream may provide an outlet for sewage provided it can be treated sufficiently to meet ADEC discharge standards and a permit can be obtained.

One characteristic of Imnakuk Bluff that raises safety concerns are the bluffs dropping off to the Kivalina River on the south side of the site. This presents a hazard to both vehicle and pedestrian traffic. Any design for a village at this site should require safety fencing along the top of the bluffs.

3.6.2 Site Development – Imnakuk Bluff

Reference the geotechnical report regarding the depth of gravel recommended for maintaining the thermal regime of the site after development. The depth of fill applied to the site is determined by maintenance of the existing frozen thermal regime.

The fill depth over this site will vary depending on the type of subgrade soil it is placed on. Test holes showed permafrost at the surface at this site, therefore we anticipate that fill will be a minimum of 9 ft.

Grading should maximize the utilization of swales and roadside ditching as much as possible. Where lengths of grade and slopes combine to make swales and ditches too deep, drainage structures such as culverts, manholes, catch basins and subsurface piping shall be employed.

General site grades should be kept to the minimum of 2% on undeveloped (soil) surfaces as much as practicable, and less than the minimum slopes that promote scour and erosion for the soils used. Pipe grades should be a minimum of 1%. Storm drainage outfalls should be rock lined to prevent erosion and heated to maintain open flows during the colder spring nights.

Imnakuk Bluffs has native allotments on the site. The presence of native allotments presents site control issues that must be resolved prior to selection of development of this site.

3.6.2.1 Construction Considerations – Imnakuk Bluff

S&W (2005) states that soils consist of ice-rich permafrost. Residential structures could be founded on post-and-pad or pile foundations.

3.6.3 Infrastructure Development – Imnakuk Bluff

3.6.3.1 Water – Imnakuk Bluff

Based upon the water resource study (Appendix H), a surface water source is proposed for Imnakuk Bluff. For the purposes of this study, the Kivalina River is assumed to be the water source. Geotechnical investigations in 2005 (S&W 2005) showed that Imnakuk is underlain by ice lenses and has ice rich permafrost. Only above ground water and sewer systems can be considered for Imnakuk. Circulation in series among homes and buildings should be considered as a means of applying building heat to keep the system thawed in winter.

3.6.3.2 Wastewater – Imnakuk Bluff

Imnakuk Bluff has a slope between 3% to 7%, and ice-rich permafrost. A gravity collection system and aboveground utilidor would work best at this site.

A sewage lagoon system, located ½ miles south, is proposed for this site. See Section 3.2.4.2.1 on page 43 for details of a 3 cell lagoon system.

S&W (2005) states that sewer utilities would likely be above grade, as the existing solid conditions do not support buried utilities. The sewer mains would need to be constructed with arctic pipe.

Instability related to lagoon construction is an issue. On-site wastewater disposal with a leach field would not be appropriate due to shallow bedrock and frozen ground (S&W, 2004).

3.6.3.3 Solid Waste – Imnakuk Bluff

The site is situated at an elevation approximately 50 ft above the Kivalina River. At this elevation, it is not in any floodplain and the potential for surface water to enter the solid waste site does not appear to be a concern. Any solid waste site located north or east of the village site would be at a higher elevation than the village, and therefore be less susceptible to flooding. The river itself appears to be a flood plain.

Based on the September 2005 site visit, a possible solid waste disposal site could be located 1 to 1 ½ miles east of the site in the land on top of the bluff. The site appears to be high enough in elevation to avoid any flooding and may have natural soils that can be used to build a berm around the site. Additional fill may be required but could likely be obtained from the islands between the braids of the Kivalina River. Permitting of the solid waste site may be difficult as disturbance of anadromous fish habitat may occur during landfill construction and operation (August 2004 site visit).

3.6.3.4 Fuel – Imnakuk Bluff

Except for the location of marine headers and fill pipeline routings, the information in 3.2.6 Fuel applies to all potential sites equally.

3.6.3.5 Heating – Imnakuk Bluff

The information in 3.2.7 Heating applies equally to all sites.

3.6.3.6 Electricity – Imnakuk Bluff

The information in 3.2.8 Electricity applies equally to all sites. However, due to the site's exposure to high winds, it may be possible to utilize wind power generation.

3.6.4 Access – Imnakuk Bluff

Road access from the Imnakuk Bluff site to the lagoon may have to extend about 1.8 miles west of the site and cross Imnakuk Creek to access an area where a landing can

be constructed. This road should terminate at the east side of the lagoon, making it necessary for a boat trip across the lagoon in order to reach the barrier spit. If a road were to be constructed to the Chukchi Sea beach, it would have to extend approximately 1 more mile across the lagoon.

Access to the Bluffs site by boat may be difficult. During the August site visit, we traveled to the site via a small boat piloted by Joe Swan. Finding a channel to reach the Kivalina River was difficult, and the boat grounded on a sand bar before we were able to locate a landing point. The nearest landing point was about a ½ mile upstream of the portion of the site cut by a small stream.

No barge access up the Kivalina River will be possible without dredging. The high bluffs at the river make landing and unloading a barge nearly impossible. Grades of an access road from the West are also a concern. The slope rises quickly from the lagoon to the top of the site. Road grades should have to be kept to a reasonable slope to ensure winter use is not dangerous. Slopes should be kept to less than 12%.

3.6.4.1 Access for Subsistence Activities – Imnakuk Bluff

Access to the Chukchi Sea for hunting sea mammals and fishing should be through the lagoon or from the Chukchi Sea beach.

The location of the Bluff site, inland from the lagoon, places it far enough away from the Chukchi Sea so that watching for whales from the site will not be possible, in spite of the elevation above the surrounding terrain.

The site provides direct access to the Kivalina River via a couple of foot trails from the site. Access to the village from the Kivalina River may be difficult for most of the length of the site. The high, steep bluffs make moving any game from the river to the new village site complicated. The best river access may be from the village to the lagoon, and from the lagoon to the river via boat.

The Wulik River is at the southern end of the lagoon. Access to this river should be by boat from the boat-staging pad at the end of the road from the new village to the lagoon.

Beach access from the Imnakuk Bluff site should be by boat or road across the lagoon.

Gravel roads from the new village site at Imnakuk Bluffs may be expensive to construct and maintain. The terrain to the west and east is muskeg, wet, ice-rich and poor support for roads. The terrain to the South, across the braided channels of the Kivalina River, is made up of good gravels, but the river channels impose barriers to pedestrian and four-wheeler traffic.

There are two proposed access roads from the village. One is routed 0.7 miles to the northwest to access the proposed runway, the other access road runs East to the proposed barge landing north of the Imnakuk Creek.

3.6.4.2 Goods & Supplies – Imnakuk Bluff

At the barge access site, a 1 acre staging area should be constructed for loading and unloading the barge. This staging area should allow the community to stage the materials and ferry them to the new village.

The exact location for the airstrip is unknown at this time. Additional information will be gathered during the Stage II study to determine the best location and design considerations for a new airstrip. For the purposes of this report and the cost estimate, we have shown the airstrip runway located 0.7 miles northwest of the site as described in the USACE (1998) report.

3.6.4.3 Air Transportation – Imnakuk Bluff

The USACE (1998) report indicates that a 4,000 ft runway could be constructed approximately 0.7 miles west of the proposed community and connected to the new village by a gravel road.

The December 1997 letter from ADOT&PF indicates that ADOT&PF feels that the Imnakuk Bluff site, as described in the 1997 Corps Draft Feasibility Study, would be a good site for a new runway. ADOT&PF several available locations, good elevation and foundation condition options, no flood hazard, reduced potential for foundation degradation and upland and alluvial options for foundation material.

Additional information will be gathered during the Stage II study to determine the best location and design considerations for a new airstrip. Refer to Section 2.1 for general recommendations.

3.6.4.4 Roads & Streets within Community – Imnakuk Bluff

The road layout within the community is expected to closely reflect the plan in Appendix G for the Phase I study report. Roads should be designed on a grid system to maximize flow of traffic and access to all portions of the new community.

The soil conditions of the Imnakuk Bluff site require road prism to be a minimum of 9 feet thick.

It is important to note that the bluff poses a hazard. For the safety of the community, a protective fence along the top of the bluff on the south side of the new village is recommended.

3.6.4.5 Roads Outside the Community – Imnakuk Bluff

The location of the Imnakuk Bluff site and the soil conditions of the surrounding terrain make road construction difficult and expensive. It is anticipated that there will be as few roads as possible outside the village to access the new airstrip, the solid waste facility, sewage lagoons and the lagoon boat moorage area. To reduce the amount of road development necessary, two or more of these facilities should be located along the same road.

3.6.5 Native Allotments

There are two Native allotments in the immediate vicinity of the Imnakuk Bluffs site that constrain the layout of a new townsite (see Figure 9). These townsites are located along the eastern half of the proposed townsite. Relocation at this site would likely require resolution of the use of these Native allotments and are a potential constraint to use of this site for relocation. In addition, two additional Native allotments are located to the east of the potential landfill site. These sites can probably be avoided, however if native allotments pose site constraints, the village location could be shifted west to avoid site control issues.

3.6.6 Relocation Costs – Imnakuk Bluff

Design and construction administration are not included in the construction cost estimate below. The cost estimate to build a new village site at Imnakuk Bluffs is **$248.7 million.** Detailed costs are included in Appendix A. A summary is included below:

Site Work and Airport Construction	$165,900,000
Erosion Protection	$231,000
Construction Camp	$606,000
Power and Fuel	$5,292,000
Move Buildings	$1,125,000
New Buildings	$52,690,000

Water/Sewer System and Landfill	$19,844,807
Transportation System	$3,056,000
Total Cost	**$248,700,000**

3.6.7 Recommended Plan for Imnakuk Bluff

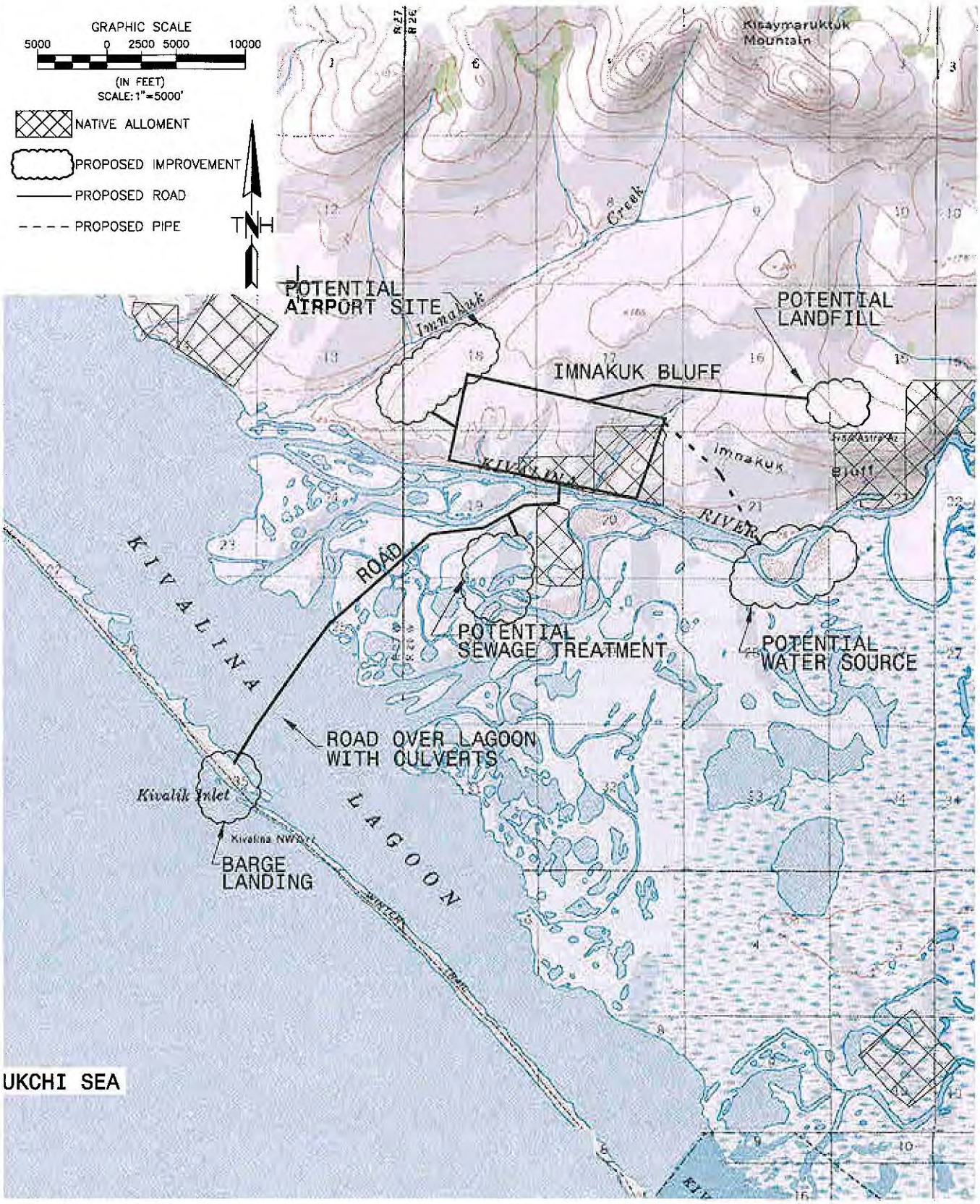
The Imnakuk Bluffs Site is situated approximately 6.3 miles north-northeast of the existing town site on the north side of the Kivalina River.

The area to be investigated for the runway to serve the Imnakuk Bluffs Site is located approximately 2/3 miles northwest of the town site at the lower slopes of the hills north of the site. It is anticipated that this area should provide a better subgrade on which to base the 150 ft X 4,000 ft runway. The landfill should be sited east of the site to maintain the required 10,000 feet from the runway.

The raw water source for the Imnakuk Bluffs Site has not yet been determined. Two possible raw water sources for this village option are the Kivalina River and Imnakuk Creek. Both of these potential sources are being investigated in the current water resource investigation project (2006-2007).

The landfill should be located along the access road from the barge landing to facilitate ease of transporting recyclable materials and the barge landing for shipping.

The sewage lagoon should be located below the town site on the south side, along the road to Kivalina Lagoon.



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TIME: 4:30 pm
XREF's/IMAGES USED FOR THIS DWG:

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TRYCK NYMAN HAYES, INC.
911 W. 8TH AVENUE, SUITE 300
ANCHORAGE, AK 99501-3497
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FIGURE 9

IMNAKUK BLUFF CONCEPTUAL LAYOUT

DESIGN BY: MEW	DATE: 6/16/06
DRAWN BY: JT	PROJECT No: 03003.007
SCALE: 1" = 5000'	REV. –
CAD DWG FILE:	
FIELD BOOK: –	SHEET 1 OF 1
GRID: –	

Tatchim Isua, Photo 1

View N from W edge of Tatchim Isua site

Tatchim Isua, Photo 2

View W from W edge of Tatchim Isua site

Tatchim Isua, Photo 3

Gravel patch at Tatchim Isua site

Tatchim Isua, Photo 4

View E from W edge of Tatchim Isua site

Tatchim Isua, Photo 5

View S from W edge of Tatchim Isua site

Tatchim Isua, Photo 6

Aerial view of Tatchim Isua site

KIVALINA VILLAGE
RELOCATION PROJECT

FIGURE 10 TATCHIM ISUA

PHOTOS BY TRYCK NYMAN HAYES, INC., AUGUST 24, 2004
KIVALINA, ALASKA

SHEET 1 of 1

FILE NAME KIVALINA_TATCHIM_ISUA.DWG

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PLOT SCALE: 1:1

3.7 TATCHIM ISUA

3.7.1 Location and Site Description – Tatchim Isua

The Tatchim Isua site is situated approximately 0.2 miles north of the lagoon and 9 miles north of the existing village. The site is on a bluff about 1.7 miles east of the Chukchi Sea and approximately 40 ft above the small Asikpak Lagoon located near the toe of the western slope.

The site is treeless and has little vegetative coverage. The ground within 400 ft of the bluff is dry and solid to walk on. The surface shows gravel through a thin covering of Arctic Willow.

The Tatchim Isua site is comprised of a maximum of 40 acres of the solid, dry gravelly material, which tapers out to wetter tundra on the north and west. The east and southern edges of the site are characterized by bluff faces rising gently off the lagoon below for a hundred yards, and then becoming steeper within a hundred feet of the shoulder of the site. The immediate bluff slopes rise at about a 45-degree angle for the last 35 ft.

The surface of the site slopes to the South and West over a distance of about a ½ mile. The tundra slope above the gravel site is extensive. Slopes are in the 5%-8% range with lower grades to the southeast and northwest for distances of up to 800 yards to drainage courses flowing south and west.

The faces of the bluffs on the western and southern sides are sparsely covered with scrub willow.

Reference Appendix B for geotechnical borings at the site. Eight borings were drilled in 2005. The results showed that ice rich silt was encountered 20 feet down on one of the borings, and a layer of massive ice was located on the lower bench (Shannon & Wilson, 2005).

3.7.2 Site Development – Tatchim Isua

Reference the geotechnical report regarding the depth of gravel recommended in maintaining the thermal regime of the site after development. The depth of fill applied to the site will be determined by two criteria: adequate fill to facilitate buried utilities where feasible, and the required grading to promote adequate drainage throughout the site.

The fill depth over this site will vary depending on the type of subgrade soil it is placed on. We anticipate that fill should be 3 ft, deeper in those areas of poor soils, and no fill required in the more dry, more stable subgrade soils.

Grading should maximize the utilization of swales and roadside ditching. Where lengths of grade and slopes combine to make swales and ditches too deep, drainage structures such as culverts, manholes, catch basins and subsurface piping shall be employed.

A benefit of developing this site is that it is landlocked and does not require protective armor rock to ensure against erosion; however the barge landing will require erosion protection.

3.7.2.1 Construction Considerations – Tatchim Isua

If bedrock is relatively shallow and overlain by a thin layer of soil, larger structures could be founded on conventional foundation systems, and residential structures could be founded post-and–pad or conventional shallow systems (S&W, 2004).

General site preparation for structures might involve building a level pad, and then replacing the surficial frost-susceptible or thaw-unstable soils with stable nonfrost susceptible fill (S&W, 2004).

3.7.3 Infrastructure Development – Tatchim Isua

3.7.3.1 Water – Tatchim Isua

The most probable water source for Tatchim Isua is the Asikpak River (see Appendix H). Another small creek flows through the site, but it is not known if it flows year-round.

A belowground distribution system would be feasible at the Tatchim Isua site. S&W (2005) indicates that water utilities could be directly buried in the weathered rock and soil, or in a thin pad at the site.

3.7.3.2 Wastewater – Tatchim Isua

Tatchim Isua has a slope of less than 3% and large gravel pads. In the upper bench of land, and the area above the upper bench, the subsurface conditions show relatively shallow, weathered bedrock. Sewer utilities could be directly buried in the weathered rock and soil, or in a thin pad. The buried utilities would not be impacted by large differential movements due to permafrost thawing (SW 2005). If facilities are installed in the upper bench of land, a vacuum collection system and an underground arctic pipe system should be recommended. The available space allows for a sewage lagoon at this site.

Instability concerns with lagoon construction are expected to be minimal. Lakes at the base of the hill might be considered for wastewater treatment and disposal. On-site wastewater disposal with a leach field would not be appropriate due to shallow bedrock and frozen ground.

3.7.3.3 Solid Waste – Tatchim Isua

The Tatchim Isua site and its respective potential solid waste sites are well above the flood plain at an elevation of approximately 75 feet. The nearest flood plain is at the foot of the western bluff. There is minimal potential for surface water to enter the site.

A potential solid waste site is located on gently rolling hills about 0.5 to 2 miles southeast of the site. This area appears to have the capacity to support a solid waste site, but may have shallow ice. Fill soil would be needed to develop this site (TNH 2004). Drainage of the existing soil was poor during the 2004 site visit, and a visual inspection indicated silty and wet ground. Borrow material for covering landfill debris would have to be brought in from other locations.

3.7.3.4 Fuel – Tatchim Isua

Except for the location of marine headers and fill pipeline routings, the information in 3.2.6 Fuel applies to all potential sites equally.

3.7.3.5 Heating – Tatchim Isua

The information in 3.2.7 Heating applies equally to all sites.

3.7.3.6 Electricity – Tatchim Isua

The information in 3.2.8 Electricity applies equally to all sites.

3.7.4 Access – Tatchim Isua

Road access to the Tatchim Isua site is required to allow for barge landing and transfer of materials to the site. Figure 9 shows a proposed 1.5 mile long road from a barge landing area on the Chukchi Sea to the town site. The road would be gravel, with 5 feet of fill and 2:1 side slope shoulders. Geotextile fabric would be placed at the base of the road between the gravel fill section and the tundra.

3.7.4.1 Access for Subsistence Activities – Tatchim Isua

Access to the Chukchi Sea and its beaches for hunting sea mammals and fishing should be across a half mile of the 1.5 mile long barge landing road. All harvested game and equipment needed for subsistence activities

may need to be hauled across the village access road to the barge landing area.

Access to the Kivalina and Wulik Rivers would be from the Kivalina Lagoon. The Kivalina Lagoon is reported to be very shallow in the vicinity of Tatchim Isua. To access the deeper areas of the lagoon, boat traffic would have to follow the coast from the barge landing area to one of the inlets to the lagoon, then travel up the Wulik or Kivalina Rivers.

This site is sufficiently elevated and close enough to the sea that the community can easily watch for whales that pass close by the shoreline. With a good spotting scope, several miles of coastline are visible from the western edges of the site.

The north bank of the Kivalina River should also be accessible by foot from the Tatchim Isua site by walking southeast along the west side of the lagoon and crossing Imnakuk Creek.

Constructed gravel roads from the new village site at Tatchim Isua may be expensive to construct. This high cost prohibits many roads from being built around the village. We anticipate that in addition to the Chukchi Sea access road west from the village site, that there may be one additional road of similar structural section to the east from the village to access the solid waste dumpsite. Due to lack of specific information regarding the location of these sites, no exact length for this road can be determined. However, a length in excess of 10,000 ft is anticipated because of the requirement to site any solid waste dump at least that distance from any runway accessed by turbojet aircraft. Figure 9 shows the proposed road.

3.7.4.2 Goods & Supplies – Tatchim Isua

The main source of goods and supplies for the new village should be by barge. A new barge landing and access road to the village should be designed and constructed west of the village site on the Chukchi Sea.

A barge landing on the sea may expose a moored barge to the strong wind and wave action developed over the long westerly fetch existing at the outer side of the barrier spit. This may mean that the barge may have to wait to moor and unload during bad weather.

The location of an airstrip is unknown at this time. Additional information will be gathered during the Stage II study to determine the best location and design considerations for a new airstrip. Until a suitable location is found, the community should use the existing airstrip and ferry goods across the lagoon to utilize the new village access road.

For the purposes of this study and the cost estimate, we have assumed the runway should be located approximately half a mile west of the site.

3.7.4.3 Air Transportation – Tatchim Isua

Air transportation for the new village should be through the existing airstrip until a new airstrip is located, designed and constructed. Access to the existing airstrip requires boat travel along the beach. This may make emergency medical evacuation difficult, and in some instances necessitate the use of a helicopter to airlift injured people from the village itself.

Any future airport built specifically to serve the village should be sited considering soil conditions and required depth of gravel, distance from the new village, distance from the solid waste dump, wind conditions and flight path safety. Figure 11 shows a potential location for the new airport, but further investigation into this site will be needed.

3.7.4.4 Roads & Streets - Tatchim Isua

The road layout within the community is expected to closely reflect the plan in Appendix G for the Phase I study report. Roads should be designed on a grid system to maximize flow of traffic and access to all portions of the new community.

The soil conditions of the Tatchim Isua site vary with the distance east from the bluff side of the site. For approximately 400 ft, a dryer soil consisting of limestone fragments in a silt matrix provides good support for both buildings and roads. From a distance of 400 ft east of the bluffs to the east, the site gradually rises and the soils are composed of wet, clayey silt with frozen ground encountered at approximately 3 ft. These two different soil conditions may dictate two different depths of gravel for the road/building prisms. The regions near the shoulder of the bluff are underlain by more gravelly soils and are more easily utilized for installation of utilities in the roadbed than are areas underlain by silty, ice-rich soils.

The location of the Tatchim Isua site and its soil conditions make road construction difficult and expensive. It is anticipated that there should be as few roads as possible outside the village to access the new airstrip, solid waste facility and lagoon boat moorage area. Preferably, two or more of these facilities should be located along the same road, to reduce the amount of road development necessary.

3.7.5 Native Allotments

There are seven Native allotments along the northeast end of Kivalina Lagoon (see Figure 11). One of these allotments impinges slightly on the south corner of the Tatchim Isua townsite. Potential barge landing, landfill and sewage treatment sites abut against two of the Native allotments.

3.7.6 Relocation Costs – Tatchim Isua

Design and construction administration are not included in the construction cost estimate below. The cost estimate to build a new village site at Tatchim Isua is **$154.9 million.** Detailed costs are included in Appendix A. A summary is included below:

Site work and Airport Construction	$70,400,000
Erosion Protection	$231,000
Construction Camp	$606,000
Power and Fuel	$5,292,000
Move Buildings	$1,125,000
New Buildings	$52,690,000
Water/Sewer System and Landfill	$21,521,638
Transportation System	$3,056,000
Total Cost	**$154,900,000**

3.7.7 Recommended Plan for Tatchim Isua

The Tatchim Isua area is located about 9 miles north of the existing village site, approximately ¼ mile north of the extreme north end of the Kivalina Lagoon. During investigation in August 2004, the site showed some good gravel areas on the south slopes above the shoulder of the bluff.

Figure 11 shows the recommended configuration of infrastructure for Tatchim Isua. Access to the site would be from a road and barge landing area located on the Chukchi Sea. The sewage lagoons would be located along this road. The airport facility would be located west of the townsite.

However, if wind studies show that the location is not appropriate, then an alternative locations would have to be considered. The alternative location would most likely be the same airport location as described for Imnakuk Bluff (approximately 2 miles east of Tatchim Isua, on the lower slopes of the hills north of the site). It is anticipated that this area should provide a better subgrade on which to base the 150 ft X 4,000 ft runway. An additional 10,500 lf of access road from the site may be needed. The landfill could be sited along the airport access road, and still maintain the 10,000 lf of separation between runway and landfill.

The raw water source for the Tatchim Isua Site has not yet been determined. However, the water resource report (Appendix A) recommends the Asikpak River as a source . Cost estimates will be based on this assumption.

The proposed landfill is located 1.4 miles east of the site.

The sewage lagoon should be located to the west of the townsite, along the small stream that drains into the wetlands below the site. The stream can be used as a surface discharge stream for the treated lagoon effluent. This may create a shorter length of sewage pump line than some other sites and access the best discharge route in the area, for this site.

GRAPHIC SCALE
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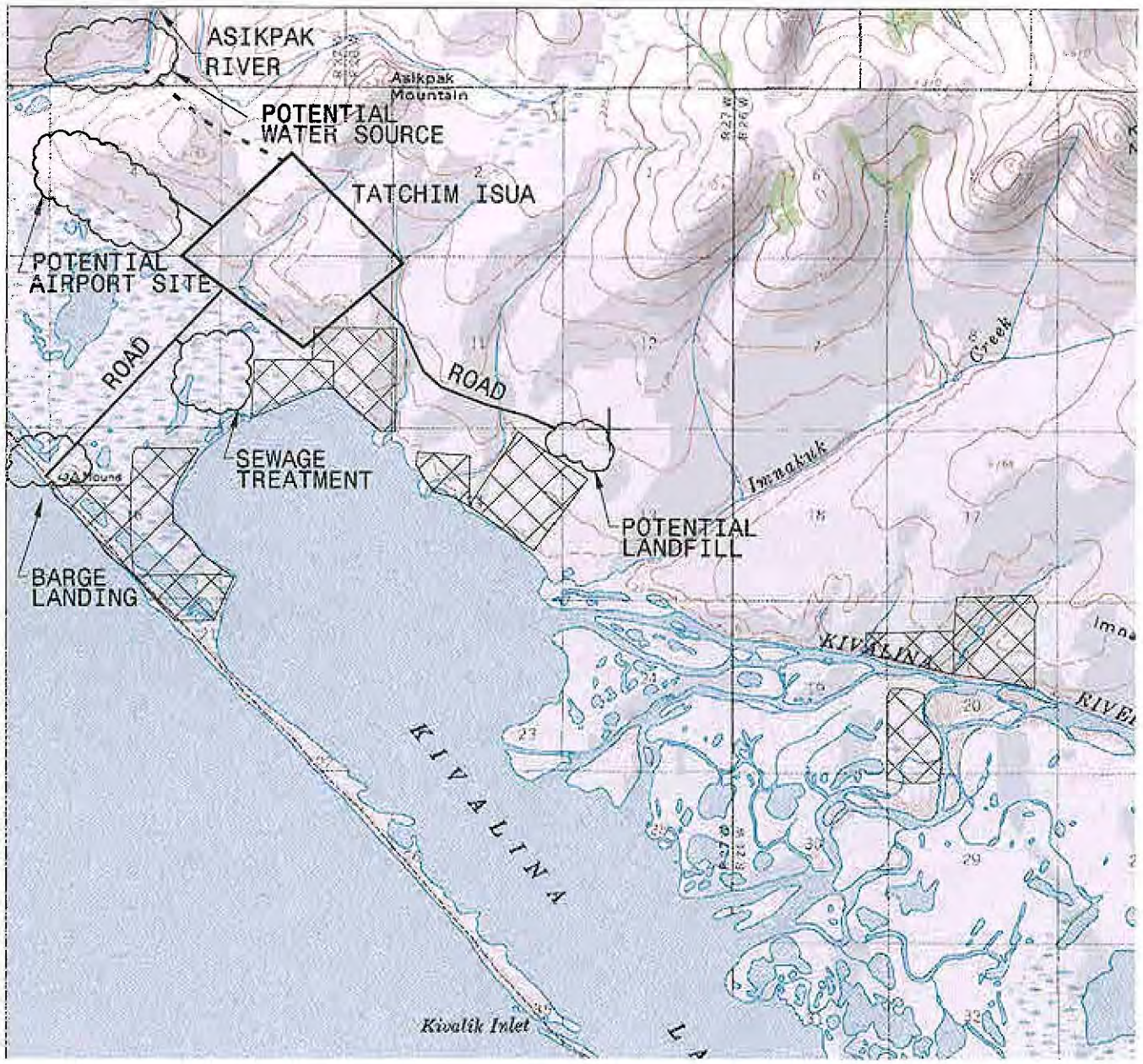
(IN FEET)
SCALE: 1"=5000'

NATIVE ALLOMENT
PROPOSED IMPROVEMENT
PROPOSED ROAD
PROPOSED PIPE

TNH



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TNH
ENGINEERING/SURVEYING & LANDSCAPE ARCHITECTURE
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FIGURE 11

TATCHIM ISUA CONCEPTUAL LAYOUT

DESIGN BY: MEW	DATE: 6/16/06
DRAWN BY: JT	PROJECT No: 03003.007
SCALE: 1" = 5000'	REV. --
CAD DWG FILE:	
FIELD BOOK: --	SHEET 1 OF 1
GRID: --	

Kiniktuuraq, Photo 1

View of gully near beach at Kiniktuuraq

Kiniktuuraq, Photo 2

Trash on Kiniktuuraq site

Kiniktuuraq, Photo 3

View of cold storage dens at Kiniktuuraq site looking NE, Kivalina in background

Kiniktuuraq, Photo 4

Beach at W side of Kiniktuuraq looking N

Kiniktuuraq, Photo 5

View N from near landing site showing cold storage den

Kiniktuuraq, Photo 6

Aerial view of Kiniktuuraq site

PLOT SCALE: 1:1

SHEET 1 of 1

FILE NAME KIVALINA_KINIKTUURAQ.DWG

KIVALINA VILLAGE RELOCATION PROJECT

FIG 12 KINIKTUURAQ

PHOTOS BY TRYCK NYMAN HAYES, INC., AUGUST 24, 2004
KIVALINA, ALASKA

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3.8 KINIKTUURAQ

3.8.1 Location and Site Description – Kiniktuuraq

Kiniktuuraq was selected as the preferred site in 2000, prior to TNH's 2004 on-site investigation of the area. Located at the south end of the lagoon near the mouth of the Wulik River, the Kiniktuuraq site is approximately a mile southeast of the existing village. The site fronts the Chukchi Sea on its southwest side, and is separated from the lagoon by Kiniktuuraq Creek, a tributary of the Wulik River, and a small island.

This site shares many of the same characteristics of Kuugruaq and Igrugaivik. It is wet to the point of being swampy, underlain by unstable, ice-rich, fine-grained soils, and subject to destruction of the existing thermal regime without the addition of a minimum of 9 ft of gravel over the site.

This site is relatively flat, with the exception of two distinct elevations separated by a sharp incline between them. Reference the geotechnical report for discussion of these areas.

The site is essentially devoid of trees and brush. The major forms of flora are arctic plants that flourish in wet environments, such as arctic moss, sedges, arctic cotton and grasses.

3.8.2 Site Development – Kiniktuuraq

Kiniktuuraq was observed in the fall of 2004 to be flooded by storm driven tides. The site is at an elevation of 10 feet and would need to be raised above the projected storm surge elevation of 13.5 feet to facilitate development as a town site. In addition to protecting from storm surge, the site must be developed to protect the thaw unstable permafrost.

To protect against permafrost degradation, a gravel pad would have to be constructed a minimum of 9 feet thick. Reference the geotechnical report for more information about gravel requirements for the site.

Grading should maximize the utilization of swales and roadside ditching as much as possible. Where lengths of grade and slopes combine to make swales and ditches too deep, drainage structures such as culverts, manholes, catch basins and subsurface piping shall be employed.

Because the Kiniktuuraq site is fronted by water on two sides, the Chukchi Sea to the west and a channel of the Wulik River on the north, the site is vulnerable to erosion and must be armored using armor rock and riprap on those sides.

3.8.2.1 Construction Considerations – Kiniktuuraq

Construction considerations for the Kiniktuuraq site can be referenced from R&M (2000) and R&M (2002). Test Borings were drilled during 1999 to investigate potential borrow material along the beach. Test Borings were also drilled in 2002 to investigate potential borrow material underlying the Kivalina Lagoon.

R&M (2000 and 2002) states that foundation soils encountered were thaw-unstable, ice-rich, fine-grained materials. Significant settlement should be expected if thawing occurs. However, very little thaw settlement should be expected along the beach areas. Permafrost was encountered within all test borings except for those drilled along the beach and those drilled under the lagoon.

In 2000 and 2002, R&M observed massive ice in test borings drilled within the upper terrace (upland) area. Many other borings encountered considerable visible ice as stratified or distinctly oriented formations. Saline groundwater was encountered as far upstream along the Wulik River as the northwest portion of Igrugaivik.

R&M (2000 and 2002) suggests use of pile foundations or a granular fill pad with a post-on-pad foundation to protect from settlement due to thawing of ice-rich soil. Insulated post-on-pad foundations can be used in this situation, but require periodic leveling due to settling. Another option would be insulated and/or refrigerated shallow foundations (thermosyphons). This method is generally used for large heavy loads such as water storage tanks and not used for light-load conditions.

R&M (2000 and 2002) states that embankments for roads and runways should be protected from settlement due to permafrost degradation. An estimated embankment thickness of 9 feet should reduce the depth of thaw penetration into the ice-rich soil to nearly zero. Rigid board insulation or allowing for some settlement can reduce embankment thickness. The settlement would occur mostly within the first few years of service. Culverts beneath the embankments are expected to settle due to permafrost degradation, and may need to be re-leveled periodically during the first few years of service. Insulation beneath the culverts may reduce the magnitude of settlement.

S&W (2004) states there is a potential for an increase in soil salinity and soil temperature due to the proximity of the site to the ocean. Increased soil salinity and soil temperatures would reduce the unit capacity of pile foundation systems in ice-rich soils. Pile foundation systems at this site could be deeper and refrigeration requirements greater than at the Igrugaivik site.

S&W (2004) also states that although the thermal integrity of the permafrost could be maintained by insulating the land surface with a thick fill, maintaining the integrity of ice-rich permafrost exposed at the coast would be more difficult. Both thermal degradation and mechanical erosion of these soils along the coast could undermine site fills unless adequately protected. In addition to mechanical stabilization, ice-rich soil along the coast would require thermal protection and protection from saline seawater.

3.8.3 Infrastructure Development – Kiniktuuraq

3.8.3.1 Water – Kiniktuuraq

No test wells have been drilled at the Kiniktuuraq site. A test well drilled about 1 mile inland at the Igrugaivik site in May 2002 produced saline water from a thaw bulb along the Wulik River (R&M 2002). Based on this finding, a well placed in similar deposits at the Kiniktuuraq site will likely produce salt water.

The Kiniktuuraq site is covered by a number of small tundra ponds a few hundred square feet in area, none of which appear large enough to provide a sustainable raw water source (TNH 2004).

Due to the lack of nearby freshwater from either surface or groundwater sources, a collection, treatment, and distribution arrangement similar to the existing Kivalina site would be required. Water would be withdrawn through a hose and pipe transmission line placed in the Wulik River and pumped to a raw water storage tank. If the Wulik River could be tapped with an infiltration gallery year round, the transmission line would have to be heated with a glycol loop to avoid freezing.

An underground distribution system is infeasible at this site due to massive ice wedges and unstable thaw conditions (R&M 2000, 2002; S&W 2004). If an aboveground distribution system were used, continuous grade adjustments would be needed.

3.8.3.2 Wastewater – Kiniktuuraq

The unstable thaw conditions at the Kiniktuuraq site present a large problem for

a sewage collection system. The Kiniktuuraq site is situated on low elevation and flat terrain. Soils consist of ice-rich permafrost and large ice wedges. A vacuum collection system and an above ground utilidor are recommended for development of this site. DOWL (1994) stated a sewage lagoon could be built on this site but would require special considerations.

R&M (2000 and 2002) states that degradation of permafrost is expected beneath and around any proposed sewage lagoon placed on the perennially frozen fine-grained soils. This may result in significant thaw settlements, particularly under the lagoon dikes. The lagoon dikes should be constructed sufficiently high to account for settlement, or periodically evaluated in order to maintain the required lagoon capacity.

3.8.3.3 Solid Waste – Kiniktuuraq

No developable possible solid waste site was identified during the August 2004 fly-over. Assuming a potential site existed near the village site, great amounts of gravel fill would be required to raise the area above the flood plain. A minimum of 9 ft of gravel would be required to preserve the thermal regime under the proposed town site. Small quantities of sand and gravel could potentially be mined from the beach and along the edges of the Wulik River for small projects, as sand and gravel quantities are limited to volumes of 1,000 to 3,000 cubic yards per deposit pocked (DOWL/BBFM, 1998). Permitting a gravel mining operation in the river may be difficult. Transporting the gravel/sand cover soil to the potential landfill site would be very difficult.

Kiniktuuraq is the location of the old dumpsite, presenting permitting issues.

3.8.3.4 Fuel – Kiniktuuraq

Except for the location of marine headers and fill pipeline routings, the information in 3.2.6 Fuel applies equally to all potential sites.

3.8.3.5 Heating – Kiniktuuraq

The information in 3.2.7 Heating applies equally to all sites.

3.8.3.6 Electricity – Kiniktuuraq

The information in 3.2.8 Electricity applies equally to all sites.

3.8.4 Access – Kiniktuuraq

Since it is bordered on two sides by water, site access would be primarily by boat. The landward side of this site to the west and south abuts terrain that is a continuation of the wet conditions of the subject site.

3.8.4.1 Access for Subsistence Activities – Kiniktuuraq

Access to the lagoon and to the Chukchi Sea for hunting sea mammals and fishing should be direct as the site fronts the sea and abuts the lagoon. Safe boat moorage would be on the lagoon side of the site or along Kiniktuuraq Creek. The sea can be reached in less than 5 minutes from any point along the lagoon side of the parcel.

The mouth of the Wulik River is located less than a mile northeast of the north side of the site. Access to this river should be by boat from the boat-staging pad at the north side of the property, or from Kiniktuuraq Creek to the Northeast.

The Kivalina River near the north end of the lagoon can be accessed by boat from the lagoon.

Beach access from the Kiniktuuraq site is immediate along the southwest face of the site. This site affords miles of beach to the south that can be accessed by foot for beachcombing, wood gathering, hunting or more easily accessing areas inland of the beach. Beach access to the north side of Singauk Inlet should be by boat across the lagoon.

Subsistence activities such as gathering berries and greens and small game can be easily performed from the site by foot or on four-wheeler. The wet, unstable nature of the terrain should make travel by four-wheeler slow.

3.8.4.2 Goods & Supplies – Kiniktuuraq

Barge access to the Chukchi Sea can be direct from the southwest side of the site. The barge landing for this site would be a beach landing next to the village site, which would not require construction of an access road.

An airstrip could be located approximately 3.5 miles to the northeast of the village site and connected to the village via a road.

3.8.4.3 Air Transportation – Kiniktuuraq

Because the new airstrip must be located 10,000 feet from the landfill, we recommend that the airstrip should instead be located approximately 3.5 miles northeast of the village to accommodate distance requirements.

A new airport should be constructed prior to occupancy of the new village site. Refer to Section 3.1 for general recommendations.

3.8.4.4 Roads & Streets within Community – Kiniktuuraq

The road layout within the community is expected to closely reflect the plan in Appendix G for the Phase I study report. Roads should be designed on a grid system to maximize flow of traffic and access to all portions of the new community.

3.8.4.5 Roads Outside the Community – Kiniktuuraq

The location of the Kiniktuuraq site and the soil conditions of the terrain surrounding it make road construction difficult and expensive. There should be as few roads as possible outside the village; therefore we have recommended that the airstrip, landfill, and sewage treatment plant all be located along the same road. A 0.3 mile road to the barge landing may be necessary to facilitate loading and offloading of supplies.

3.8.5 Native Allotments

There are no Native allotments in the vicinity of the Kiniktuuraq townsite (see Figure 13). Use of this site and associated facilities are not constrained by Native allotments.

3.8.6 Relocation Costs – Kiniktuuraq

Design and construction administration are not included in the construction cost estimate. The cost estimate to build a new village site at Kiniktuuraq is **$248.2 million**. Detailed costs are included in Appendix A. A summary is included below:

Site work and Airport Construction	$163,700,000
Erosion Protection	$2,613,600
Construction Camp	$606,000
Power and Fuel	$5,292,000
Move Buildings	$1,125,000
New Buildings	$52,690,000
Water/Sewer System and Landfill	$22,125,007
Transportation System	N/A
Total Cost	**$248,200,000**

3.8.7 Recommended Plan for Kiniktuuraq

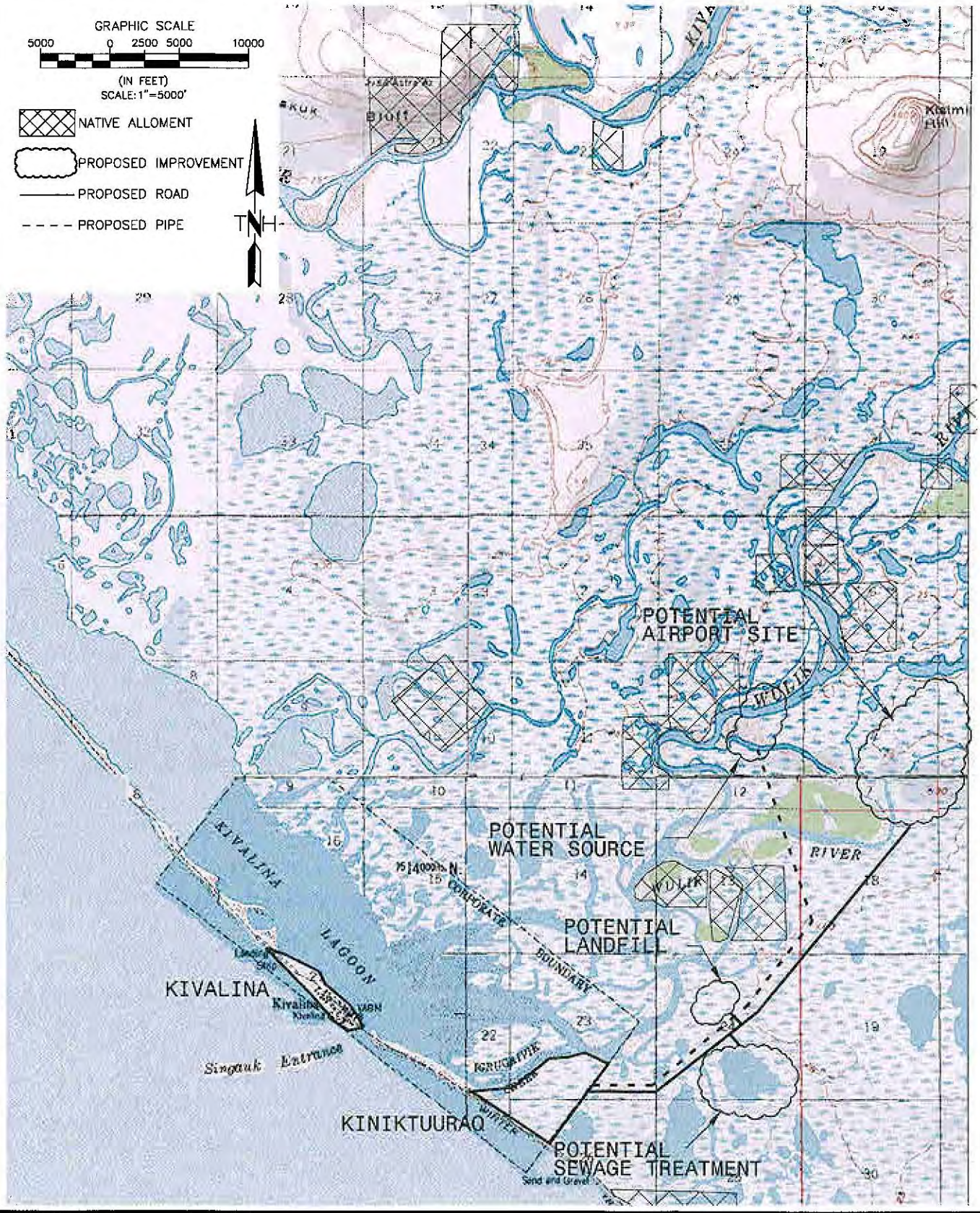
The barge access landing and boat storage pad should be sited on the west side of the spit, on the north edge of the proposed

village site. This should provide the storage and staging areas with relatively level areas, and facilitate ease of loading and unloading the barge. The road from the barge landing to the village should be less than 300 ft long.

The new runway for the village site at Kiniktuuraq should be located about 3.5 miles northeast of the site. The landfill would be located along the access road to the airport, about 7,500 feet northeast of the village and over 10,000 feet from the airport.

The most likely raw water source for the Kiniktuuraq Site is the Wulik River. Potential sources of raw water may be investigated in the water study that is currently pending publication. There are no other known sources of water in the Kiniktuuraq Site area.

The sewage lagoon may be located east of the town site between the gravel pad for the new village and the new runway (approximately 7,500 feet from the village site). A surface discharge should be established to dispose of the treated lagoon effluent onto the surrounding wetlands.



XREF's/IMAGES USED FOR THIS DWG:

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FIGURE 13

KINIKTUURAQ CONCEPTUAL LAYOUT

DESIGN BY: MEW	DATE: 6/16/06
DRAWN BY: JT	PROJECT No: 03003.007
SCALE: 1" = 5000'	REV. –
CAD DWG FILE:	
FIELD BOOK: –	SHEET 1 OF 1
GRID: –	

3.9 IGRUGAIVIK

3.9.1 Location and Site Description – Igrugaivik

This site is situated adjacent to the Kiniktuuraq site, lying inland about half a mile from the northwest edge of the Kiniktuuraq. It is located approximately 2 miles east of the existing Kivalina site. The site is bounded on the west by the main channel of the Wulik River, and by sloughs or ponds on the south and north sides.

The site is essentially flat in two abutting areas with a surface differential of about 3 ft. Reference the geotechnical report for a complete description of the site.

This site is very similar to the Kiniktuuraq site, dominated by low, arctic flora such as mosses, sedges and grass. The site does not have any trees or shrubs. Any site relief is marginal and strictly local. This site appears to be basically flat. The site features small tundra ponds scattered about its area, with a large pond located on the southeast corner and an elongated pond abutting the northwest side.

No ground truthing site visit was conducted under this contract. The material presented here is a compilation of data gathered from existing literature dating back to 1994.

3.9.2 Site Development – Igrugaivik

The fill depth over this site will vary depending on the type of subgrade soil it is placed on. We anticipate that gravel fill should be a minimum of 9 ft.

Grading should maximize the utilization of swales and roadside ditching as much as possible. Where lengths of grade and slopes combine to make swales and ditches too deep, drainage structures such as culverts, manholes, catch basins and subsurface piping shall be employed.

Because the Wulik River flows past the north edge of the site, the face of the site fronting the river may have to be protected with armor rock to resist erosion from river flow.

Construction considerations for the Igrugaivik site can be referenced from R&M (2000 and 2002). Test borings were drilled in 1999 to investigate potential borrow material along the beach. Test borings were also drilled in 2002 to investigate potential borrow material underlying the Kivalina Lagoon.

R&M (2000 and 2002) states that foundation soils encountered were thaw-unstable, ice-rich fine-grained materials. Significant settlement should be expected if thawing occurs. Permafrost was encountered within all test borings. Many borings encountered considerable visible ice as stratified or distinctly oriented formations. Saline groundwater was encountered as far upstream along the Wulik River as the northwest portion of Igrugaivik.

R&M (2000 and 2002) suggests the use of pile foundations or a granular fill pad with a post-on-pad foundation to protect from settlement due to thawing of ice-rich soil. Post on pad foundation are for areas with little or no massive ice, and require periodic leveling. Another option would be insulated and/or refrigerated shallow foundations. This method is generally not used for ice-rich conditions and maintenance cost could be very high.

Roads within the site are recommended to have a 9 foot gravel thickness, while access roads may be 5 feet thick. R&M (2000 and 2002) states that embankments for roads and runways may also need to be protected from settlement due to permafrost degradation. An estimated embankment thickness of 9 feet may reduce the depth of thaw penetration into the ice-rich soil to nearly zero. Rigid board insulation or allowing for some settlement can reduce embankment thickness. The settlement would occur

mostly within the first few years of service. Culverts beneath the embankments are expected to settle due to permafrost degradation, and may need to be re-leveled periodically during the first few years of service. Insulation beneath the culverts may reduce the magnitude of settlement.

3.9.3 Infrastructure Development – Igrugaivik

3.9.3.1 Water – Igrugaivik

Based on the results of a geophysical survey conducted at the Igrugaivik site, Golder Associates (1997) found indications that a thaw bulb in floodplain and river terrace deposits near the bank of the Wulik River might provide an adequate year-round source of readily treatable groundwater. USACE (1998) proposed that a water supply system at this site consist of a well, pump house, water treatment building, relocation of an existing water storage tank from Kivalina, and an aboveground distribution system with forced circulation.

A test well drilled at the Igrugaivik site in May 2002, however, produced only saline groundwater. The saltwater was encountered in sand and gravel deposits at depths of 30 to 41 feet, which lay beneath a surficial permafrost layer (R&M 2002). R&M suggested the salts might be concentrating along the line of freezing/bonding at the edge of the permafrost. The source of the salt could be from a subsurface saltwater wedge effect, or from infiltration along the river during high tides or storm surges. Storm surge modeling indicates that maximum surge events can reach about 11 feet in elevation (1 foot above the highest elevation of the site) at Kivalina (USACE 1998). Further sampling of the river in various locations should be conducted to determine the extent of salt water intrusion. Additional test wells targeting potential thaw bulbs further up the river would need to be drilled in order to identify a non-saline supply of groundwater, with corresponding added costs for a longer piping distance. The location of any additional wells should take into account the inland reach of tides and storm surge.

The Igrugaivik site vicinity is covered by a number of small tundra ponds, none of which appear large enough to provide a sustainable surface water source. If a surface water source from the Wulik River were used for Igrugaivik, a collection, treatment, and distribution arrangement similar to the existing Kivalina site would be required. Water would be withdrawn through a hose and pipe transmission line placed in the river and pumped to a raw water storage tank. If the Wulik River could be tapped with an infiltration gallery year round, the transmission line would have to be heated with a glycol loop to avoid freezing.

If a year-round groundwater source is identified for Igrugaivik, R&M (2000 & 2002) and S&W (2004) suggest aboveground water utilities for the site, due to the potential for large differential settlement. The aboveground construction would thermally decouple the utilities from the subgrade and allow grade adjustments if necessary.

3.9.3.2 Wastewater – Igrugaivik

The unstable thaw conditions at the Kiniktuuraq site present a large problem for a sewage collection system.

Because of the flat terrain and permafrost at Igrugaivik, a vacuum collection system and above ground arctic pipe is recommended. USACE (1998) discusses that wastewater treatment could be accomplished by the development of a settlement lagoon at the 6 acre tundra pond near the proposed beach access road. Discharge of effluent after settlement of sludge could be directed to a

minor channel of the Wulik River by the pond.

Aboveground sewer utilities are suggested by R&M (2002) due to the potential for large differential settlement. Direct burial of settlement-sensitive gravity, pressure, or vacuum sewer systems might be risky due to the settlement potential.

R&M (2000 and 2002) mentions that massive ice wedges and large differential settlement would affect sewage lagoons. High lagoon dikes need to be constructed to account for settlement or periodically regraded as necessary to avoid causing a membrane liner to rupture. In an unlined lagoon, a piping type of failure could occur along lenses or wedges of massive ice. A sewage lagoon constructed with earthen dikes should be sited in an area without massive ice if possible, or a tundra pond could be used. Septic tanks and a package treatment plant would also eliminate some of the potential problems with a constructed lagoon.

USACE (1998) proposed a sludge disposal site by the road near the proposed sewage treatment lagoon.

3.9.3.3 Solid Waste – Igrugaivik

S&W (2004) assumed that the site is underlain by potentially highly thaw-unstable soils based on its 2004 site investigation. Since at least 9 feet of gravel would be required to preserve the thermal regime under the proposed town site, construction of a solid waste landfill would be difficult and expensive.

3.9.3.4 Fuel – Igrugaivik

Except for the location of marine headers and fill pipeline routings, the information in 3.2.6 Fuel applies to all potential sites equally.

3.9.3.5 Heating – Igrugaivik

The information in 3.2.7 Heating applies equally to all sites.

3.9.3.6 Electricity – Igrugaivik

The information in 3.2.8 Electricity applies equally to all sites.

3.9.4 Access – Igrugaivik

The Igrugaivik site, like the Simiq site, provides only one direct avenue of access. This site is surrounded by muskeg type soils that are saturated, thermally unstable and provide poor structural support for vehicles, including four-wheelers. Access from the main channel is the most direct access to the site.

A road will need to be constructed to provide year-round access to this site. The best route appears to be to the southwest along the Wulik River, across the Kiniktuuraq site to the sand spit on the south side of the Singauk Inlet near the river's mouth. While this one mile long route presents additional design problems over a straight route to the Chukchi Sea along a southwest course, it benefits from accessing the south end of the lagoon, where a protected barge landing can be constructed. Bridges would have to be constructed and culverts installed to cross channels and streams along the route. This is the same route as described in the USACE (1998) study. A total of 1.3 miles of road (west to the Singauk Entrance and east to a potential runway location) is required.

It is important to note that to stabilize the sand spit comprising the south side of the Singauk Inlet, the spit may have to be armored against wave and storm erosion on all sides.

We have not been able to discover any existing data regarding the depth of the south end of the lagoon. The action of the flow of the Wulik River in conjunction with the tidal influences on the Singauk Inlet

make the entrance to the lagoon and flow channels at the south end difficult to determine. To understand what engineering considerations are necessary at the south end of the lagoon, a study specific to the river and tide actions may have to be conducted if this site is selected as the preferred new village location.

It is possible for boats to navigate up the channel of the Wulik River to access the west side of the Igrugaivik site. This would provide an additional boat tie-up point near the village.

3.9.4.1 Access for Subsistence Activities – Igrugaivik

Access to the lagoon, rivers, and the Chukchi Sea for hunting sea mammals and fishing should be at the proposed barge landing site. The location of the site, inland from the lagoon, places it far enough away from the Chukchi Sea so that watching for whales from the site will not be possible.

The 1 mile road from the northwest end of the site to the lagoon may allow foot and vehicle traffic to easily access the barge and boat staging pads and the lagoon.

Beach access from the Igrugaivik site may be either by foot or four-wheeler over the muskeg to the southwest of the site or by the road from the village pad to the south end of the lagoon, and then west to the south side of the Singauk Inlet. Access to the beach on the north side of the inlet may be by boat from the lagoon only.

Subsistence activities such as gathering berries and greens and small game hunting can be easily performed from the site by foot or on four-wheeler. The wet, unstable nature of the terrain may make travel by four-wheeler slow. The very high cost of constructing roads across the muskeg may require that roads from the village be limited to an access to the airstrip and solid waste dump facility and barge landing. It is anticipated that this road may be at least 1.3 miles long.

3.9.4.2 Goods & Supplies – Igrugaivik

A road to the beach is the most likely access to the barge landing. At the barge landing site, a one acre staging area should be constructed to enable loading and unloading of the barge. This staging area should allow the community to stage the materials and ferry them to the new village.

The location of an airstrip is unknown at this time. Additional information should be gathered during the Stage II study to determine the best location and design considerations for a new airstrip. Until a suitable location is found, the community should use the existing airstrip and ferry goods across the lagoon to utilize the new village access road.

The USACE (1998) study describes a 4,000 ft long runway site northwest of the site. No distance is given, but for the purposes of a cost estimate for this study we have located it about 1 mile east of the east end of the site. If the solid waste dumpsite is located along the gravel road to the barge landing, it should easily be outside the 10,000 ft runway exclusion zone (see Figure 12).

3.9.4.3 Air Transportation – Igrugaivik

The December, 1997 letter from ADOT&PF to Dr. Orson Smith, USACE Project Manager regarding location and logistics for a new runway indicates that ADOT&PF feels the Igrugaivik site has moderate ability to support a new airstrip. The letter cites ice-rich soils, potential foundation degradation, possible river erosion and heavy reliance on river resources for foundation material.

Additional information will be gathered during the Stage II study to determine the best location and design considerations for a new airstrip. For the purposes of this study,

we have selected a location approximately 1 mile east of the site on a low ridge. A new airport should be constructed prior to occupancy of the new village site. Refer to Section 3.1 for general recommendations.

3.9.4.4 Roads & Streets within Community – Igrugaivik

The road layout within the community is expected to closely reflect the plan in Appendix G for the Phase I study report. Roads should be designed on a grid system to maximize flow of traffic and access to all portions of the new community.

The poor soil conditions and unstable thermal regime of the Igrugaivik site may necessitate the construction of a thick gravel pad to protect the existing conditions. This pad should also serve to raise the new village above the level of the anticipated storm surge.

3.9.4.5 Roads Outside the Community – Igrugaivik

The location of the Igrugaivik site and the soil conditions of the terrain surrounding it make road construction difficult and expensive. It is anticipated that there should be as few roads as possible outside the village to access the new airstrip, solid waste facility and lagoon boat moorage area. Preferably, two or more of these facilities should be located along the same road, to reduce the amount of road development necessary. A total of 2.3 miles of road outside the village proper is assumed for this site.

3.9.5 Native Allotments

There are no Native allotments in the immediate vicinity of the Igrugaivik townsite (see Figure 14). However, there is a Native allotment to the south of a potential sewage treatment plant.

3.9.6 Relocation Costs – Igrugaivik

Design and construction administration are not included in the construction cost estimate. The cost estimate to build a new village site at Igrugaivik is **$246.1 million**. Detailed costs are included in Appendix A. A summary is included below:

Site work and Airport Construction	$164,800,000
Erosion Protection	$1,045,440
Construction Camp	$606,000
Power and Fuel	$5,292,000
Move Buildings	$1,125,000
New Buildings	$52,690,000
Water/Sewer System and Landfill	$20,521,057
Transportation System	N/A
Total Cost	**$246,100,000**

3.9.7 Recommended Plan for Igrugaivik

The Igrugaivik Site is the southernmost of the three village sites on the south side of the Singauk Entrance. It is located south of the Kiniktuuraq site and is accessible to the Wulik River by a side slough.

The new runway for the village site at Igrugaivik may be located about at the same location as described for the Kiniktuuraq Site. It is about 1 mile west of the proposed Igrugaivik Site. It is anticipated that this area may provide a poor subgrade on which to base the 150 ft X 4,000 ft runway, and a geofabric base may be required to provide support and separation for the muskeg

below. The short length of village to runway road and the close routing of the barge landing to village road mean that siting the landfill along either may be difficult.

Siting the landfill at the same location proposed for the Kiniktuuraq Site, on the base of the gravel spit, adjacent to the dredged channel should provide the required separation from the new runway, as well as a close location to the village for ease of use and to the barge landing for transport of recyclable materials, batteries and hazmat for shipping.

The most likely raw water source for the Igrugaivik Site is the Wulik River. Potential sources of raw water will be investigated in the water study that is currently pending publication. There are no other known sources of water in the Igrugaivik Site area. It is anticipated that a raw water intake structure should be constructed in a thaw bulb, to furnish a year round water supply.

The sewage lagoon should be located south of the town site to allow surface discharge to flow southward, away from the proposed village pad. A surface discharge should be established to dispose of the treated lagoon effluent onto the surrounding wetlands.

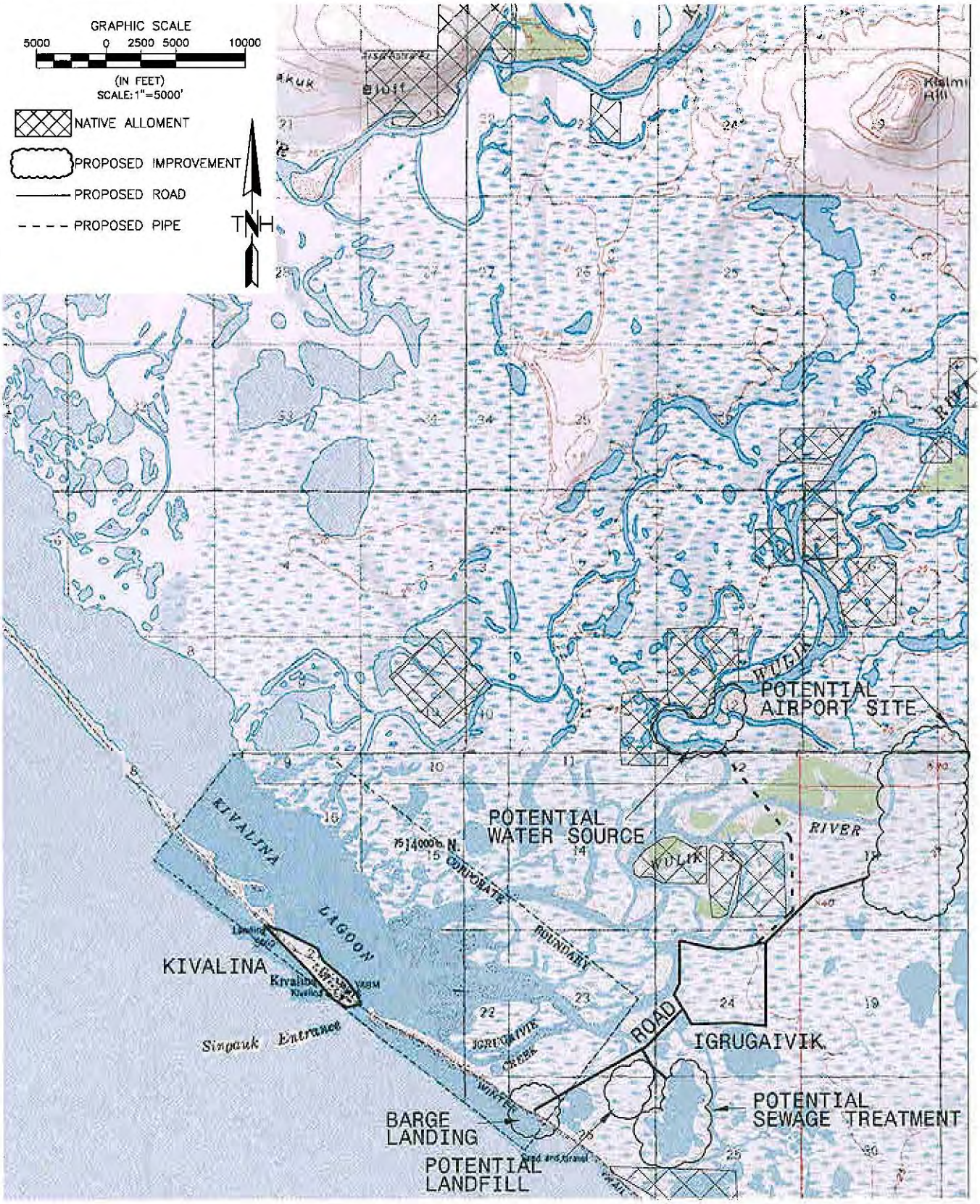

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FIGURE 14

IGRUGAIVIK CONCEPTUAL LAYOUT

DESIGN BY: MEW	DATE: 6/16/06
DRAWN BY: JT	PROJECT No: 03003.007
SCALE: 1" = 5000'	REV. –
CAD DWG FILE:	
FIELD BOOK: –	SHEET 1 OF 1
GRID: –	

3.10 KUUGRUAQ

3.10.1 Location and Site Description – Kuugruaq

The Kuugruaq site is several hundred yards directly north of the Igrugaivik site and about 2 miles east of the existing Kivalina town site. From the air, the three sites on the south side of the Wulik River, including Kuugruaq, all appear to have the same characteristics: low, wet, ice-rich soils with numerous tundra ponds, sloughs and channels in and around the indicated areas.

No ground truthing site visit was conducted under this contract. The material presented here is a compilation of data gathered from existing literature dating back to 1994. From geotechnical reports, and from aerial photos, the site has both thaw stable soils with gravel and sand, plus ice rich permafrost soils. The Wulik River has undercut the permafrost areas leaving part of the village site thawed with gravel benches and willows. The undisturbed parts of the site have classical polygonal ground indicated ice rich permafrost.

When the Wulik River was at flood stage in 1993, approximately half the Kuugruaq site was inundated with floodwater (DOWL, 1994). Approximately 100 acres of site land was left above the 1993 flood level. Further investigations of flood levels should be conducted for this site before it is chosen.

Any consideration of this site as the new village site should take this information into account when laying out the new site.

3.10.2 Site Development – Kuugruaq

The fill depth over this site can vary depending upon the use of insulation placed below the fill to reduce the thickness of gravel. We anticipate that fill may be a minimum of 9 feet.

Grading should maximize the utilization of swales and roadside ditching as much as possible. Where lengths of grade and slopes combine to make swales and ditches too deep, drainage structures such as culverts, manholes, catch basins and subsurface piping shall be employed.

The full length of the north and west sides of the site may have to be protected with armor rock to protect against erosion from the Wulik River. Approximately 9,000 lf of erosion protection may be required.

3.10.2.1 Construction Considerations – Kuugruaq

Golder (1997) reports the active and abandoned floodplain portions of the site may be underlain by relatively thaw-stable soils. A thaw-stable subgrade would greatly simplify and reduce construction cost of structures and infrastructure. Commercial, municipal, and community structures could be founded on conventional foundations or pile foundations, and residential structures could be founded post-and-pad or on more conventional foundation systems. Road sections in town could be thinner. General site preparation for structures might involve replacing surficial frost-susceptible soils and raising the site grade above flood level with a nonfrost-susceptible fill. The area of potentially thaw-unstable soils for development is limited, and some facilities such as runway and access roads would have to be constructed over ice-rich, thaw unstable ground.

3.10.3 Infrastructure Development – Kuugruaq

3.10.3.1 Water – Kuugruaq

Based on the results of a geophysical survey conducted at the Kuugraaq site, Golder Associates (1997) found indications that a thaw bulb in abandoned floodplain deposits near the Wulik River bank might provide an adequate year-round source of readily treatable groundwater. A test well drilled in 2002 at the nearby Igrugaivik site produced

only saline groundwater (R&M 2002). The recommended Kuugraaq test well is located about ¼ mile further inland from the coastline than the Igrugaivik well. If the Kuugraaq well also proves to be saline, additional test wells targeting similar deposits and thaw bulbs further upstream along the river would be needed to identify a non-saline supply of groundwater, with corresponding added costs for a longer piping distance. The location of any additional wells should take into account the inland reach of tides and storm surge as a possible source of saline groundwater.

The Kuugruaq site is covered by a number of small tundra ponds, none of which appear large enough to provide a sustainable surface water source. If a surface water source from the Wulik River were used for Kuugruaq, a collection, treatment, and distribution arrangement similar to the existing Kivalina site would be required. Water would be withdrawn through a hose and pipe transmission line placed in the river and pumped to a raw water storage tank. If the Wulik River could be tapped with an infiltration gallery year round, the transmission line would have to be heated with a glycol loop to avoid freezing.

If a groundwater source is proved up for the Kuugruaq site, the proposed water supply system would likely consist of a well, pump house, water treatment building, relocation of an existing water storage tank from Kivalina, and an aboveground distribution system with forced circulation. S&W (2004) suggests that aboveground water and sewer utilities would be required for the eastern portion of the Kuugruaq site, due to the potential for differential settlement in old terrace deposits. Utilities could be directly buried in the western portion of the site, which is covered by floodplain deposits and relatively thaw-stable soils.

3.10.3.2 Wastewater – Kuugruaq

Because of the flat terrain and permafrost at Kuugruaq, a vacuum collection system and above ground arctic pipe system is recommended. DOWL (1994) stated the land area and construction materials are available to construct a sewage disposal system.

As stated above, S&W (2004) suggests that aboveground sewer utilities would be required for the eastern portion of the Kuugruaq site. For the western portion of the site, sewer utilities could likely be directly buried, and instability concerns with lagoon construction could be minimal. A leach field could be considered for wastewater disposal (S&W, 2004).

3.10.3.3 Solid Waste – Kuugruaq

There is a limited potential area of thaw-unstable soil available for development. Some facilities would have to be constructed over fine-grained, ice-rich, and highly thaw-unstable soil (S&W 2004). The area appears to represent an unstable thermal regime with very poor soils. Construction of a solid waste landfill would be difficult and expensive.

3.10.3.4 Fuel – Kuugruaq

Except for the location of marine headers and fill pipeline routings, the information in 3.2.6 Fuel applies to all potential sites equally.

3.10.3.5 Heating – Kuugruaq

The information in 3.2.7 Heating applies equally to all sites.

3.10.3.6 Electricity – Kuugruaq

The information in 3.2.8 Electricity applies equally to all sites.

3.10.4 Access – Kuugruaq

The Kuugruaq site can be made accessible using the same road design for Igrugaivik

shown in the USACE (1998) report. The 1998 report has a road design consisting of a 3 feet of fill, with 2 to 1 side slopes. The road width is 20 feet wide. The close proximity of the Kuugruaq site to the Igrugaivik site would necessitate only a short road extension to access the Kuugruaq site.

The proposed barge access road shown in Figure 15 would provide access to the Chukchi Sea for residents of a new community developed at Kuugruaq. The road should provide community access to both the sea and the lagoon.

The location of the site, inland from the lagoon, places it far enough away from the Chukchi Sea so that watching for whales from the site will not be possible.

The Wulik River makes up the west boundary of the Kuugruaq site. Access to the river can be direct from the site. If a gravel boat staging pad is not constructed at the barge landing at the Singauk Inlet, it could be built at the site to provide a more protected moorage for the community's boats.

Beach access from this site could be by foot or four-wheeler over the proposed gravel road to the Singauk Entrance, or by boat from the Wulik River, downstream to the entrance.

Constructed gravel roads from the new village site at Kuugruaq may be expensive to construct and maintain. A 1.47mile long Singauk Entrance access road cost is required. Additional road length may be required to reach the new runway and the Kuugruaq village site.

Road access to subsistence sites from the Kuugruaq site may be limited to the corridor between the Singauk Entrance barge landing and the new runway north of the Igrugaivik site, a maximum of approximately 3 miles. Access to areas to harvest greens, berries and hunt small game along the river or coastal beach is good. Traveling inland to the east or south from this site may be difficult over the soft soils and wet ground cover.

3.10.4.1 Goods & Supplies – Kuugruaq

A barge landing could be located on the beach southwest of the Kuugruaq site. Access to the barge landing to offload goods and supplies may be via a 1.75 mile long access road.

At the barge access site a 1 acre staging area should be constructed to enable loading and unloading of the barge. This staging area should allow the community to stage the materials and ferry them to the new village.

Goods and supplies can also be delivered via air. The location of the new airstrip is discussed in the following section.

3.10.4.2 Air Transportation – Kuugruaq

The location of the new airstrip would be at the same site as the Kiniktuuraq airstrip; approximately 7,500 feet northeast of the Kuugruaq village site. The relatively close proximity of the airstrip to the village would make it convenient for residents to access. Access to the airstrip would be over an approximately 1.75 mile long access road. A new airport should be constructed prior to occupancy of the new village site. Refer to Section 3.1 for general recommendations.

3.10.4.3 Roads & Streets within Community – Kuugruaq

The road layout within the community is expected to closely reflect the plan in Appendix G for the Phase I study report. Roads should be designed on a grid system to maximize flow of traffic and access to all portions of the new community.

The road system would be constructed on top of the gravel pad installed to protect the thermal regime of the underlying soils. An

estimated minimum of 9 feet of gravel may be required for a structural roadbed for community streets.

3.10.4.4 Roads Outside the Community – Kuugruaq

The location of the Kuugruaq site and the soil conditions of the terrain surrounding it make road construction difficult and expensive. It is anticipated that there should be as few roads as possible outside the village, accessing the new airstrip, solid waste facility and lagoon boat moorage area.

The USACE (1998) report describes a total of approximately 2 miles of road for the Igrugaivik site with the airstrip located at the Northeast end of the road, the barge landing at the West end of the road and the solid waste dump site situated between the new village and the barge site, a minimum of 10,000 ft from the runway. Because of new setback requirements for the airstrip, we recommend approximately 3 miles of road to reach all the facilities and still allow for proper distance between the landfill and the airstrip.

3.10.5 Native Allotments

There are two Native allotments in the immediate vicinity of the Kuugruaq site that constrain the layout of a new townsite (see Figure 13). These townsites are located along the northern half of the proposed townsite. Relocation at this site would likely require resolution of the use of these Native allotments and are a potential constraint to use of this site for relocation.

3.10.6 Relocation Costs – Kuugruaq

A construction cost estimate to relocate to this site has been prepared. Design and construction administration are not included in the costs. The cost estimate to build a new village site at Kuugruaq is $245.6 million. Detailed costs are included in Appendix A. A summary is included below:

Site work and Airport Construction	$164,800,000
Erosion Protection	$2,961,750
Construction Camp	$606,000
Power and Fuel	$5,292,000
Move Buildings	$1,125,000
New Buildings	$52,690,000
Water/Sewer System and Landfill	$18,146,638
Transportation System	N/A
Total Cost	**$245,600,000**

3.10.7 Recommended Plan for Kuugruaq

The Kuugruaq Site is the easternmost of the three village sites on the south side of the Singauk Entrance. It is located north and west of the Igrugaivik Site and abuts the Wulik River along its northern edge.

Access to this site should be from the beach barge landing near the Kiniktuuraq site.

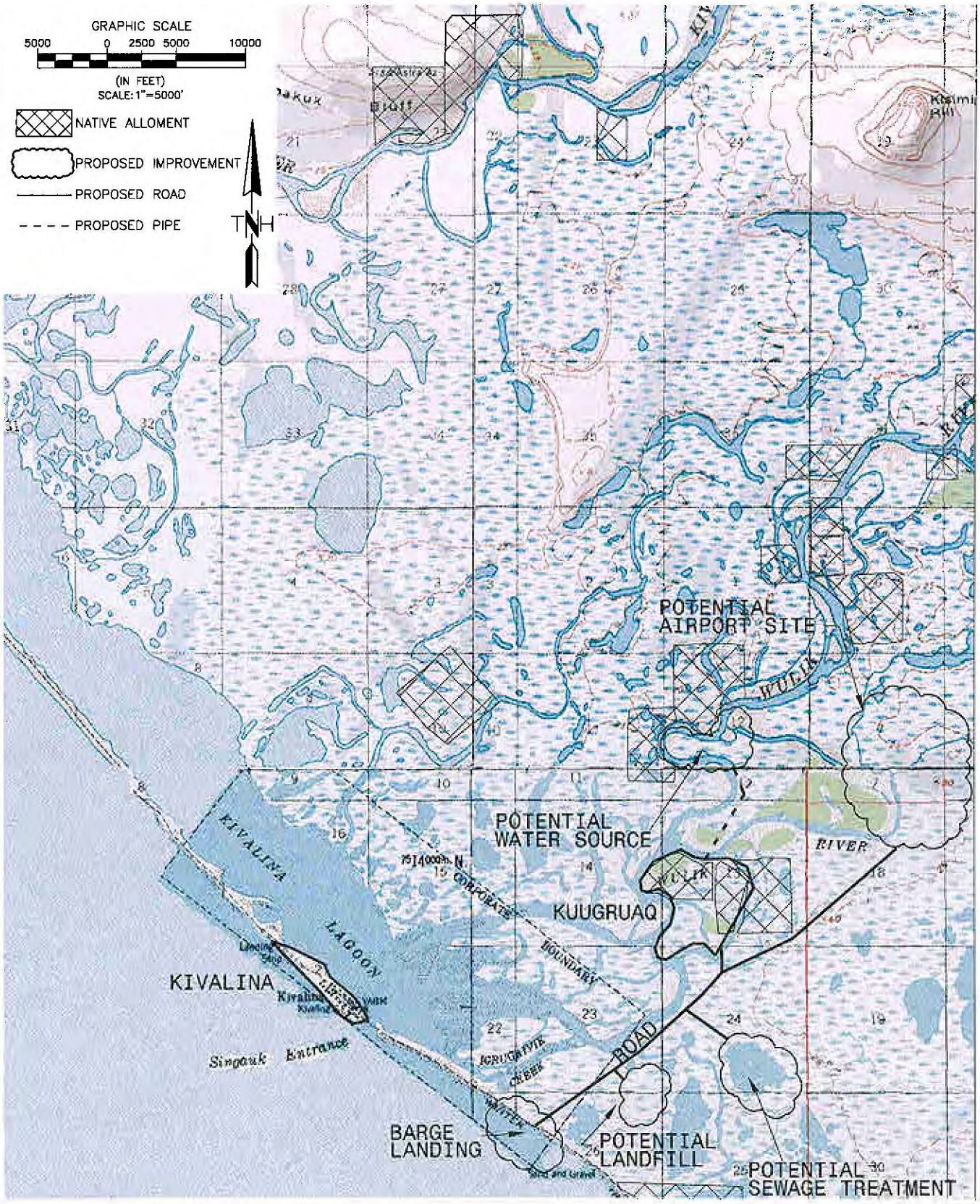
The new runway for the village site at Kuugruaq may be located about 1.75 miles northeast of the site. It is anticipated that this area may provide a poor subgrade on which to base the 150 ft X 4,000 ft runway, and a geofabric base may be required to provide support and separation for the muskeg below.

Siting the landfill is more difficult for this site than most of the others because the best location, which is the same as for Kiniktuuraq and Igrugaivik puts it too far

away from the proposed village site to ensure it will be properly utilized year round. Locating the landfill on the west side of the new village gravel pad may provide the required 10,000 lf of separation from the new runway, as well as make access to it by the community convenient. This location will place the landfill farther away from the barge landing, but transportation of recyclable materials, batteries and hazmat to the barge landing for shipping can be accomplished by 4-wheeler and trailer or snow machine and sled.

The most likely raw water source for the Kuugruaq Site is the Wulik River. Potential sources of raw water will be investigated in the water study that is currently pending. There are no other known sources of water in the Kuugruaq area. It is anticipated that a raw water intake structure wick be constructed in a thaw bulb, to furnish a year round water supply.

The sewage lagoon may be located east of the town site on the east side of the road to the new airstrip. A surface discharge may be established to dispose of the treated lagoon effluent onto the surrounding wetlands.



XREF's/IMAGES USED FOR THIS DWG:

PLOTTED: 06/16/06 TIME: 4:31 pm

LAYER MGR: *.lay CTB FILE: *.ctb

DRAWING NAME: village site infrastructure maps.dwg

TNH
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FIGURE 15

KUUGRUAQ CONCEPTUAL LAYOUT

DESIGN BY: MEW	DATE: 6/16/06
DRAWN BY: JT	PROJECT No: 03003.007
SCALE: 1" = 5000'	REV. –
CAD DWG FILE:	
FIELD BOOK: –	SHEET 1 OF 1
GRID: –	

3.11 COMPARISON OF ALTERNATIVE SITES

The planning team developed a site comparison matrix to help the community of Kivalina compare the strengths and weakness of the seven sites. The site comparison matrix is qualitative in nature and shows the relative strengths and weaknesses of each site. The 31 siting criteria that are being suggested for site comparison include physical environment factors, construction and utilities factors, social and access factors, and cost implications. These siting criteria are summarized in Section 1.5. These factors are included in a site comparison matrix shown in Appendix D. These factors have been presented to the community for initial consideration on the December 7, 2004 meeting, and were updated with their input from meetings on September 15, 2005 .

3.11.1 Criteria Values and Weighting

The planning team has assigned values to the siting criteria for each site. With the exception of estimated costs, it is not possible to assign a quantitative value to each criterion at this time. For each factor, under the four criteria factor, a qualitative value of 1 to 5 has been assigned. These values have been assigned given the relative strengths and weaknesses of each site; 5 as the highest value showing the greatest benefit/least risk and 1 having the least benefit greatest risk. A value of 3 is considered neutral.

Depending on the perspective of the public and agency stakeholder, not all criteria are of equal importance in selecting a relocation site. For example, subsistence access may not be as crucial to an agency responsible for public utilities as vulnerability to storm surges or erosion hazards. Local residents may feel that the impact of site location on everyday life, such as access to subsistence, cost of travel, and comfort with a site is equally as important as relocation costs.

In the case of some siting criteria, design measures and extra funding can mitigate potential concerns. Of the 31 siting criteria, 8 fall into this category:

- Soils and ice content,
- Sewage disposal availability
- Ease of water storage and distribution
- Solid waste disposal availability
- Gravel requirements to develop the site
- Site for an airport with a crosswind runway
- Site preparation costs
- Access road development costs

Six criteria have been identified as critical to site suitability, and may not be easily mitigated by design and funding. These criteria include:

- Storm surge vulnerability
- Shoreline erosion vulnerability
- Water supply source and quality
- Community expansion potential
- Land status
- Operation and maintenance costs

Finally, the importance of social and access factors to local residents should not be underestimated. Sites that result in higher transportation and utility costs can create economic hardships.

3.11.2 Siting Criteria

A summary of the 31 siting criteria are presented below:

3.11.2.1 Physical Environment

Storm Surge Vulnerability – whether the site is vulnerable to storm surge and flooding, based on the site location, site

elevation, and historic observations of flooding. This affects the safety of the site and site preparation/structural design costs.

River Flooding Vulnerability – whether the site is vulnerable to spring breakup and fall flooding, based on the site location, site elevation, and historic observations of flooding. This affects the safety of the site and site preparation/structural design costs.

Shoreline Erosion Vulnerability – whether the site is vulnerable to coastal or riverine erosion, based on the site location, site elevation, soil characteristics (fine grained, ice-rich), aerial photograph analysis, and historic observations of erosion. This affects the safety of the site and site preparation/structural design costs.

Site drainage and wetlands – whether the site has standing water when temperatures are above freezing, has particular drainage issues or problems, and whether the site has jurisdictional wetlands, based on aerial photograph analysis and historic observations of erosion. This affects the site preparation/structural design costs and permitting relocation.

Soils/Ice content – whether the site has soil characteristics such ice-rich, high organic, or water content, which affects the stability of the site given climate change. This affects the amount of gravel needed for site preparations and can affect the site preparation/ structural design costs.

Vulnerability to High Winds – whether the site has exposure to high winds, which can affect snow drifts around buildings and roads, and affect heating bills

Water Supply Source and Quality – location, quantity available, and quality of water supply. This affects the viability of a good town site, and costs involved in pumping, storing, and treating water.

3.11.2.2 Construction and Utilities Factors

Sewage Disposal Availability – whether the site has a pond or other suitable area for sewage disposal and treatment, and other factors such as soil and drainage conditions. This affects the site preparation/structural design costs, permitting, and health considerations

Ease of Water Storage and Distribution – whether site topography and soils lend themselves to water storage and distribution systems. This affects the site preparation/structural design costs.

Solid waste disposal availability – whether the site has a suitable area for landfill, and other factors such as soil, drainage conditions, and separation from an airport site. This affects the site preparation/structural design costs, permitting, wildlife nuisance, and health considerations

Gravel Requirements to Develop the Site – how much gravel the site requires for community development, including soil conditions and need to insulate permafrost, and elevation needs to get out of flood areas. This is one of the primary cost factors in site preparation/structural design costs.

Barge Access Distance to the Site – whether the site has good barge access for unloading construction material, fuel, and freight, and whether an access road to deep water along the coast is required**.** This affects site preparation costs and operation and maintenance costs for a community.

Site for an Airport with Crosswind Runway – whether the site has a suitable location for an airport with a crosswind runway, including orientation to prevailing winds and adequate separation from a community landfill. This affects overall site relocation costs.

Community Expansion Potential – whether the community has an adequate and suitable area for community growth and expansion. Lack of adequate space for community expansion may not solve many of the problems that the community is currently facing.

Ease of Maintaining Two sites during Construction/relocation – whether a site can be easy accessed during construction and for moving facilities between the existing and new town site. This affects relocation costs and schedule.

Permitting Obstacles – whether a site has issues affecting obtaining state and federal permits, including wetlands and sensitive fish and wildlife species. This affects relocation costs and schedule.

3.11.2.3 Social and Access Factors

Distance from Current Village Site – The distance between the community and a subsistence harvest site is both an economic and safety factor. An increase in distance increases fuel cost for ATV, snowmachine, and boat access. An increase in distance also increases travel time, which can be a safety issue in bad weather.

Access to the Ocean – Kivalina residents utilize the ocean for hunting marine mammals and access to traditional use areas. Proximity is a factor in people's comfort with a new town site, and has implications for fuel costs and safety

Access to the Wulik River – the Wulik River is an important area for subsistence fishing, access, and traditional camps. Proximity is a factor in people's comfort with a new town site, and has implications for fuel costs and safety.

Access to the Kivalina River – the Kivalina River is an important area for subsistence access, and traditional camps. Several families have Native Allotments and traditional camp sites along the Kivalina River, and use them for subsistence and cultural purposes.

Proximity is a factor in people's comfort with a new town site, and has implications for fuel costs and safety.

Access to Kivalina Lagoon – the Kivalina Lagoon provides protected boat access for subsistence activities. Proximity is a factor in people's comfort with a new town site.

Access to Subsistence Camps and Traditional Use Areas – whether a site has easy and safe access to subsistence camps and traditional use areas, and has implications for fuel costs and safety**.**

Location of Boat and Gear Storage – whether a site has nearby, adequate, and safe storage areas for boats and subsistence gear. Proximity is a factor in people's comfort with a new town site.

Potential for Ice Cellar Construction – Ice cellars have traditionally been used for food storage. The ability to use existing or construct new ice cellars is a factor in people's comfort with a new town site.

General Comfort with Site – whether the site is one where people would be comfortable living. A site where people are uncomfortable may not make a successful relocation site.

Land Status – whether the site has appropriate ownership availability of land for relocation. A site with native allotments of other potential encumbrances may complicate relocation and add to cost.

3.11.2.4 Cost Implications

Site Preparation – site preparation is potentially the highest cost associated with relocation. A site that requires a substantial amount of gravel may be extremely costly for relocation.

Access Road Development Costs – a site may need access roads to airports, boat access areas, landfills, and to a barge landing. The length of access roads required for a new community site are a factor in construction and O&M costs

O&M Costs – Operations and maintenance costs can affect the viability of a relocation site. Typical costs are associated with roads, utilities and public facilities.

Fuel Costs – Fuel costs can affect the viability of a relocation site. Higher fuel costs are associated with access roads, and increased power generation and space heating needs due to climate.

3.11.3 Preliminary Site Ranking

Of the seven alternative sites, Tatchim Isua receives the highest overall point value, and highest value in all four categories except for Physical Environment (primarily due to uncertainty regarding water supply). Imnakuk Bluff scores relatively high in second place, with resolution of land status being the primary outstanding issue. Simiq scores in the middle range, but there are many unknowns regarding the site, and the community has not previously considered it. The four southern sites, and particularly the two coastal sites (Kiniktuuraq and Existing) receive lower values primarily due to continued long-term vulnerability to flooding and erosion, construction and utility factors. However, these sites score much higher with regard to social and access factors.

Figure 16 **Master Relocation Matrix** **Matrix Criteria**

site has generally positive attributes associated with this specific criteria

site has mixed positive and negative attributes with specific criteria; or criteria is neutral

site has generally negative attributes associated with this specific criteria

	Site						
	Tatchim Isua	Imnakuk Bluff	Simiq	Kuuruaq	Igrugaivik	Kiniktuuraq	Existing Site
PHYSICAL ENVIRONMENT							
Storm surge vulnerability	5	5	5	3	3	1	1
River flooding vulnerability	5	5	5	2	2	3	3
Shoreline erosion vulnerability	5	5	5	2	2	1	1
Site drainage and wetlands	4	3	2	3	1	1	5
Soils - ice content	3	3	2	3	1	1	5
Vulnerability to high winds	1	1	3	3	3	3	3
Water supply - source and quality	4	5	2	2	2	1	1
Subtotal Physical Environment	27	27	24	18	14	11	19
CONSTRUCTION & UTILITIES FACTORS							
Sewage disposal availability	5	3	5	3	2	2	1
Ease of water storage and distribution	4	4	2	3	2	1	1
Solid waste disposal availability	5	5	3	1	1	1	1
Gravel requirements to develop site	3	3	2	2	2	1	2
Barge access/distance to site	3	2	1	2	2	5	5
Site for an airport with crosswind runway	4	3	4	3	3	3	2
Community expansion potential	5	5	4	2	2	2	1
Ease of maintaining two sites during construction	1	1	1	3	3	4	3
Permitting Obstacles	4	4	3	2	2	2	3
Subtotal Construction and Utilities	34	30	25	21	19	21	19
SOCIAL AND ACCESS FACTORS							
Distance from current village site	1	2	3	4	4	5	5
Access to the ocean	3	2	1	4	4	5	5
Access to the Wulik River	1	1	1	5	5	5	4
Access to the Kivalina River	3	5	1	2	2	2	2
Access to the Kivalina Lagoon	4	3	1	4	4	5	5
Access to subsistence camps and traditional use areas	2	2	1	4	4	5	5
Location of boat/gear storage	2	2	1	5	5	5	5
Potential for ice cellar construction	3	3	5	5	5	5	2
General comfort with site	2	3	2	3	3	3	3
Land Status	5	2	5	1	5	5	3
Subtotal Social and Access	*26*	*25*	*21*	*37*	*41*	*45*	*39*
COST IMPLICATIONS							
1 Site preparation costs	5	1	1	1	2	1	3
Access road development costs	4	2	2	3	3	4	5
2 O&M costs	4	4	3	2	2	1	1
3 Cost of living (heat, power)	2	2	2	3	3	3	3
Fuel costs for access to subsistence areas, airport, dock	1	2	2	3	3	4	4
Subtotal Cost Implications	16	11	10	12	13	13	16
COMPARATIVE TOTAL	103	93	80	88	87	90	93
RANK	1	2	7	5	6	4	3

1 Site preparation cost estimates range from $155 to 252 million

2 O&M costs reflect differences in costs per village, mostly for maintaining errosion and flood barriers

3 Costs for heat and power are assumed to be higher in areas where terrain is subject to higher winds (hillside sites)

4 PUBLIC INVOLVEMENT

4.1 PUBLIC INVOLVEMENT OVERVIEW

Public involvement for the project includes public, KRPC, and agency meetings, and the collection of public opinion and comment. Public meetings will be held in the village of Kivalina and may involve a combination of presentations and open house format. Residents of the village will be given the opportunity to comment on the project through other means as well.

4.2 PUBLIC INVOLVEMENT PURPOSE AND NEED

It is crucial to receive public input to successfully complete this project in part because of the need for community acceptance of a new town site and the controversial nature of the project itself. The task of site selection ultimately falls to the residents of the village, who must consider issues such as physical environment, social factors, construction and utilities, cost factors, and access to subsistence areas while making their decisions. Public meetings for this project are particularly important not only because of the project's significance, but because of its time frame and the potentially contentious nature of the site selection process.

Public involvement is an important part of the site selection process. It includes meetings with the KRPC, public meetings, house-to-house visits, discussions with community leaders and facility operators, and meetings with classes at the McQueen School.

4.3 PUBLIC INVOLVEMENT ACTIVITIES

4.3.1 Public Meetings

Village suggestions on site comparison factors and characteristics were solicited during three meetings: a public meeting in December 2004, an Elders Council meeting in September 2005, and a public meeting in December 2005. Given the amount of information presented at the December meeting, it was difficult to obtain comments on the strengths and weaknesses of specific sites. Consultation with the Native Village of Kivalina resulted in the suggestion to use the Kivalina Elders Council to provide their knowledge and experience with regard to the alternative relocation sites.

An Elders Council Meeting was held on September 15 at 6 pm. Approximately 25 elders were present. The intent of the meeting was learning from the elders any traditional knowledge they have about the six proposed sites for village relocation, specifically with regards to the physical environment and subsistence activities.

Elders were asked to help answer a series of questions for each of the relocation sites under consideration. Information learned on each of the sites is summarized in "Strengths" and "Weaknesses" table below.

Site	Strengths	Weaknesses
Kivalina (no action)	Good subsistence access.	Extreme erosion taking place – has become a public safety issue.
Imnakuk Bluff	No flooding around this site.	Rocky shoreline along the river that is hard on boats.
	No known erosion problems.	Water has potential to be salty below the bluff due to tidal influences.
		Wind is much stronger at this site.
		Subsistence access is a problem due to the shallow lagoon and preferences to use the Wulik River over the Kivalina River.
		Barge access would be a problem; a road would have to be built from the site.
		Higher cost of living due to increased transportation (gas) needs.
Kuugruaq	Gravel is in the area, but is on a Native allotment.	Area floods during spring breakup.
	Existing water source is near Kuugruaq	
Tatchim Isua	Above flood levels.	Water supply would have to be pumped from further up the Kivalina River or a different creek.
	No known erosion problems.	Wind and snowfall is stronger than at Kivalina.
		Area would not be good for subsistence due to difficulty of transport through the shallow lagoon.
		Higher cost of living due to increased transportation (gas) needs.
Kiniktuuraq	Water supply would be similar to Kivalina (pumping from a source upriver).	Site is sinking – would have to add gravel every year.
	Original relocation site chosen by the people.	Lots of erosion along the coast.
	Would result in the least amount of cultural change for the community.	Soils are just mud and ice – very swampy; Deep drainage ditches on site

Site	Strengths	Weaknesses
		Not as much water access for subsistence.
Kiniktuuraq		Area was flooded during recent storms Gravel pad would have to be put in place to raise the site above flood level.
Igrugaivik	Doesn't flood that often.	Soils are a mixture of silt/ice or gravel/ice. Higher areas are mostly ice.
	Not a lot of erosion – primarily during the high waters in the spring.	
	Subsistence access is good.	
Simiq		No community support for this site.

The strengths and weaknesses of the existing Kivalina site were not discussed in any detail. Most community members in attendance felt that the Kiniktuuraq site was very similar to the current Kivalina village site. They were concerned with the potential for the same levels of erosion and flooding, however felt that Kiniktuuraq would get much calmer weather. The subsistence access from Kiniktuuraq was felt not to be quite as good as from around Kivalina.

August 2004 Community Visit and Public Meeting: Members of the planning teams from COE, URS, and TNH took part in a community visit and public meeting on August 23, 2004. The purpose of the visit was to hold the public meeting, conduct an agency meeting, and conduct site visits to the potential town sites.

Members of the planning team attended a joint meeting (the KRPC, the City of Kivalina, NVK, and NWAB) held at the city hall offices on August 23, 2004. Attendees discussed the current status of the project. Issues involving project progress and community concerns were also discussed.

The community public meeting was held at 7pm at McQueen School. The meeting presented the scope of work, introduced representatives from involved agencies, and presented plan objectives to the community. The meeting also included discussion of planning efforts and tasks for the current phase of planning.

December 2004 Community Visit and Public Meeting: The second meeting was held on December 7th, 2004 and was comprised of a review of the October 28th agency meeting in Anchorage, review of steps in the relocation process and schedule, a site comparison workshop, and a discussion of the next steps in relocation. A KRPC meeting was held at City offices prior to the public meeting. A National Environmental Policy Act training workshop was held the morning following the public meeting.

December 2005 Community Visit and Public Meeting

On December 12, 2005, a community meeting was held at 7 pm at McQueen School. The meeting presented the draft report and recommendations.

4.3.2 Agency Meetings

October 2004 Agency Meeting: On October 28, 2004, the USACE, TNH, and URS held

an agency meeting on the Kivalina Relocation Plan studies. Attendance generally included representatives of various state and federal agencies that would likely have a role in relocating the community of Kivalina, and included representatives of the Kivalina IRA, the City of Kivalina, the KRPC, and the Northwest Arctic Borough (NWAB) (see attached sign-in sheets).

The intent of the meeting was to provide a briefing on the progress of studies associated with the relocation of Kivalina, specifically initial considerations regarding the phasing and schedule for relocation. Given the potential funding resources, program jurisdictions and requirements, and expertise of the agency participants, it was felt that they could provide important review and feedback regarding the information being presented. There were four items that were listed as agenda items:

- Overview of Project and Current Scope of Work
- Review of Phasing and Funding Considerations for Master Schedule Development Items
- Presentation of Draft Master Relocation Schedule for Discussion
- Suggestions and Revisions for Draft Master Relocation Schedule

4.4 SUMMARY OF COMMENTS

4.4.1 Public Comments

Among the most significant concerns brought forth by the people of Kivalina are the following:

4.4.1.1 Gravel

The residents of Kivalina are concerned about the amount of gravel necessary to construct a new town site. During past public involvement activities, residents were advised that the gravel requirements for a new town site make the move barely feasible. The need for large amounts of gravel has led to significant community distress.

4.4.1.2 Costs

The costs of the project are daunting. Availability of funding is questionable, and residents are concerned that if there is no funding, they may not be able to move their village regardless of the problems they have with the current site.

4.4.1.3 Time frame

Some residents have worked on the relocation project for over ten years. The current schedule shows that completion is not possible within the next seven years. Lack of progress on the project is an enormous concern for residents.

4.4.1.4 Sanitation, Health, Water and Sewer

Currently the village of Kivalina has no water and sewer. Sanitation and health are difficult for residents to maintain while using honey buckets and dumpsites. Residents have expressed their strong desire for more efficient sanitation for the village

5 CONCLUSIONS

Steady erosion has threatened the Village of Kivalina for nearly two decades. The potential loss of the town site to the encroaching sea is a dire concern for the community. Storms in the winter of 2004 caused the erosion of the beach near the school and fuel farm. One occupied house was undercut by erosion and had to be evacuated. In 2005, storms have threatened the airport runway, school housing, and the fuel farm, and the season for fall storms is not yet over. With each new storm, the threat of erosion continues.

The existing town site is already limited in land, as it is surrounded by water on all sides. Sanitation is insufficient and presents a serious health issue for residents. Recent projects to upgrade sanitation have been cancelled because the funding agencies will not fund projects that are threatened by erosion. Funding agencies are also reluctant to fund improvements to the existing town site, since the community may have to be relocated. Ongoing housing shortages, a general lack of community sanitation systems, and a pressing situation with ongoing erosion have led the community to pursue relocation of the village.

5.1 Challenges With All Sites Currently Under Consideration

Any of the sites under consideration for Kivalina relocation that are analyzed in this report can be technically constructed. However, the analysis conducted for this report, including siting criteria and site evaluations, indicate that none of the sites currently under consideration are ideal for relocation. Previous and recent geotechnical investigations indicated that soils are ice-rich under all the sites being considered except the current Kivalina site and Tatchim Isua. No potential town sites rank high in all four of the major site evaluation criteria categories: physical environment, construction and utilities factors, social and access factors, and cost implications. This is best illustrated by a comparison of Kiniktuuraq and Tatchim Isua.

Kiniktuuraq was chosen by referendum as the community's preferred site for relocation in 2000. It is favorable in terms of location near the existing site and location for subsistence access. The site requires minimal access roads and has good barge access. It also ranks high in terms of subsistence-related and O&M costs, and many in the community are comfortable with the site. However, Kiniktuuraq is subject to coastal erosion and flooding, and is underlain by permafrost. Site preparation may require a substantial amount of gravel (a minimum of 9 feet) to elevate it above flood levels and insulate the permafrost. Given current trends in climate change, this and all other low-lying coastal sites are likely to prove infeasible.

Tatchim Isua is not particularly good for access to subsistence resources. Its general location makes access to subsistence resources problematic, and shallow water depth at the end of the Kivalina Lagoon limits boat access. For this and other cultural reasons, the community does not appear to be comfortable with the site. The site may also require access roads to both barge landings and boat launch areas, and the location of water supply has yet to be identified. However, the site is above any coastal or riverine flood elevations, and has the best soils of any of the sites under consideration. The site may likely require the least amount of gravel of any of the sites under consideration.

As shown above, Kiniktuuraq, selected by the community as the preferred site, and Tatchim Isua, the best site from a construction standpoint, both present difficulties. The other sites under

consideration are even more problematic. Coastal sites are the most susceptible to erosion and flooding. Some coastal and riverine sites are also underlain by permafrost. Gravel pad and other site preparation requirements would be extensive, and could still be subject to erosion, flooding, and other storm damage over time. Low lying sites are likely to experience problems with sewage disposal, landfills, and water supply. Sites that are located above areas prone to flooding and erosion are less likely to have good coastal and river access for subsistence activities or barges that supply fuel and freight. They may require longer access roads to areas that provide boat and barge access. There is less community comfort with these sites compared to coastal and river sites, and they may entail increased costs associated with subsistence activities due to longer travel times.

The comparison of those two sites also shows that even sites with good coastal and riverine access for subsistence and traditional use purposes may be insufficient to support the new village immediately. Both the new site and the existing town site must be maintained during relocation.

5.2 Rapidly Changing Environmental Conditions

There is ample evidence that environmental conditions in the Arctic, including the Kivalina area, have been changing rapidly. These changes may be linked to long-term climate change, and include:

- **More severe fall storms** – fall storms on the Chukchi Sea are more severe and can occur later in the fall/winter season.
- **More severe erosion and flooding** – the severity of fall storms, coupled with delays in ice formation on the Bering Sea, have increased the frequency and severity of erosion and flooding events at Kivalina.
- **Accelerated permafrost melting** – communities throughout the Alaskan arctic are seeing an increase in permafrost melting and subsequent ground settlement.

These changes have significant ramifications in selecting a relocation site that will be safe and can be maintained over the long term. They also have significant implications for construction design and costs of sites that are subject to these climate change-related events. Even if designed properly, long-term trends make it difficult to maintain integrity and could entail continual O&M costs. Based on the increasing threats to low-lying sites along the coast and rivers, and to ice-rich sites in general, further consideration of the existing Kivalina site, Kiniktuuraq, Kuugruaq, Igrugaivik, and Simiq are not recommended for further consideration. Only Imnakuk Bluffs and Tatchim Isua should remain under consideration.

Due to the challenges with existing sites, it may be appropriate to consider additional sites. Any consideration of additional sites should include consideration of long-term climate changes. Potential sites include a higher rocky area behind the Simiq site, and a location that could access both the Wulik River and the Red Dog road system. It cannot be over-emphasized that any sites for future consideration should be subject to geotechnical investigation to determine the presence and nature of ice in the soil.

5.3 Cost Considerations

Appendix A indicates that while there is a wide range in the total relocation costs between the sites, given the assumptions identified for this study, the least expensive site is over $150 million (Tatchim Isua), and the most expensive site is nearly $252

million (Simiq). Site preparation and construction is by far the major cost element of relocation, ranging from approximately one-third to over two-thirds of total relocation costs, and gravel for site pads and roads is the most significant component of site preparations. Because of the need to elevate sites above flooding levels and/or insulating ice-rich soils, cost estimates included an assumption of a gravel pad at least 9 feet thick due to the substantial amount of gravel required to prevent melting the permafrost. Part of the high cost was an assumed need to import the volume of gravel required.

New approaches to the volume and source of gravel are needed. Alternative design assumptions such as aboveground utilities, flush and haul systems, boardwalks, pile building foundations, and use of gravel capped pads could reduce the amount of gravel required. Local sources of gravel, such as Tatchim Isua and the mountain behind Simiq could also reduce gravel costs, if the volume and characteristics of the gravel on those sites are suitable for construction purposes.

Costs associated with site and facility operations and maintenance, access to airports and ports, and additional travel time for subsistence and other traditional activities are vital considerations. Longer distances to airports, ports and subsistence areas can substantially increase fuel costs and raise safety concerns.

Sites with continued exposure to flooding, erosion, and permafrost melting may have ongoing and potentially costly maintenance requirements.

Finally, initiating and sustaining Kivalina relocation activities will require a large infusion of funding. Such an amount is beyond the normal program capacity of state and federal agencies, and would likely require a combination of specific funding actions by Congress and the Alaska State Legislature.

5.4 Schedule Considerations

Appendix C addresses the master schedule for relocation. Given the number of agencies involved, necessary approvals, facility requirements, and complexity of Kivalina relocation in addition to design, permitting, NEPA compliance requirements, and construction timeframes would result in a schedule of at least 10 years. Relocation of Kivalina cannot wait 10 years, given current conditions and threats to safety and property. A streamlined emergency response approach needs to applied to shortening the schedule, with a single agency involved as overall lead for relocation. All participating agencies must recognize the severity of the risk to Kivalina, and work together to shorten program and regulatory requirements. This type of approach could shorten the schedule for relocation to three to five years. In the meantime, some form of effective emergency erosion and flood protection needs to be installed at Kivalina to protect lives and property.

5.5 The Community Situation Is Dire

As indicated throughout the report and in preceding sections of the conclusions, the current situation in Kivalina is dire. Fall storms are increasing in severity and frequency, and a significant amount of shoreline has been lost in the last two years alone. Erosion is threatening to damage the airport runway, school and associated housing, and the fuel farm. Should this occur, it could become difficult to maintain a functioning community. While an emergency evacuation plan has been completed, plans for an emergency evacuation road are under way, and some limited local erosion protection has been put in place, more immediate and coordinated action is needed. Without action, Kivalina does not have even five years for relocation.

5.6 New Relocation Solutions Are Needed

More work is needed prior to taking the next step of design or construction, and this involves some new thinking. Ongoing water source studies and geotechnical investigations may confirm the suitability of certain sites for construction. Site control for the selected relocation site may have to be obtained. Native allotments overlap or border Tatchim Isua, Imnakuk Bluff and Kuugruaq.

Relocation Schedule. Based on uninterrupted steady progression of funding, design, and construction, it would take 10 years to completely move the village to a new site. Maintaining a 10-year schedule is optimistic under current regulations. A key feature of maintaining schedule is to obtain funding for the master planning stages; detailed feasibility studies; environmental studies; and seed money to start construction of major components such as airports, roads, harbors, and site grading/pad. The community of Kivalina, Northwest Arctic Borough, and participating state and federal agencies need to develop an accelerated schedule that protects the public interest in environment and expenditure funds while expediting response to an emergency situation.

Relocation Costs. In 2005 dollars, construction cost estimates to move the village range from $123 million to $249 million. Costs need to be adjusted during progression of the project to account for inflation and to add engineering and construction management costs. New approaches and assumptions for gravel requirements and source, site design, and facility design can reduce relocation costs, as potentially can the consideration of a limited number of new sites. These items need to be investigated immediately

Agency Coordination. In order to move Kivalina, agency coordination is critical. Currently, the Corps of Engineers is assisting with the initial planning stages. However, it does not have funds and specific authority to lead the project past the planning stages. Other agencies such as ANTHC have a strong role in the community, but they do not have the authority or technical expertise to lead a village relocation project. A strong "lead" agency may be needed to keep the project moving, coordinate with other funding agencies, and to assist the community through the process.

Emergency Erosion Protection. Immediate action is needed to design and construct emergency erosion protection to protect critical community facilities. A system must be funded, designed, and constructed prior to next fall's storm season(2006).

Finally, while this study has a relocation matrix that shows factors for selecting a site, the initial rankings for a village site may need to be reviewed and updated during public involvement steps between the 95% and 100% reports. At that stage, a recommendation and conclusions can be made about selecting a village relocation site. This final report incorporates the views of the community and other interested agencies, and provides objective information for the community to consider while deciding which alternative plan is most appropriate, affordable, and sustainable.

5.7 Next Steps

The next steps in the relocation process involve three sets of activities.

<u>Pursue Temporary Erosion Protection Measures.</u> Temporary measures are needed to protect the school and fuel facilities from erosion. The community of Kivalina, working with the Northwest Arctic Borough,

Alaska District Corps of Engineers, and other entities such as the Denali Commission should work cooperatively to obtain funding, design and construct suitable erosion protection structures.

Confirm Community Selection for Relocation Site. The community needs to carefully review this report and the advantages and disadvantages associated with each sites, including relative risk and likelihood of receiving addition funding. The choice of a site for relocation should then be confirmed in a formal referendum.

Initiate Next Steps in Implementing Community Relocation. The Master Relocation Schedule in Appendix C lays out the estimated phases and specific steps to proceed from site confirmation to completion of relocation. The next steps in Phase Three, Planning, are as follows:

- Obtain funding for selected site planning and design activities
- Initiate comprehensive master planning for the selected site
- Complete specific infrastructure and utility feasibility studies and initiate grant applications for design and construction
- Identify agency to lead future funding, design and construction efforts associated with relocation
- Acquire design and permitting phase funding

Completion of these steps will lead to initiation of project design phase (Phase 4).

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