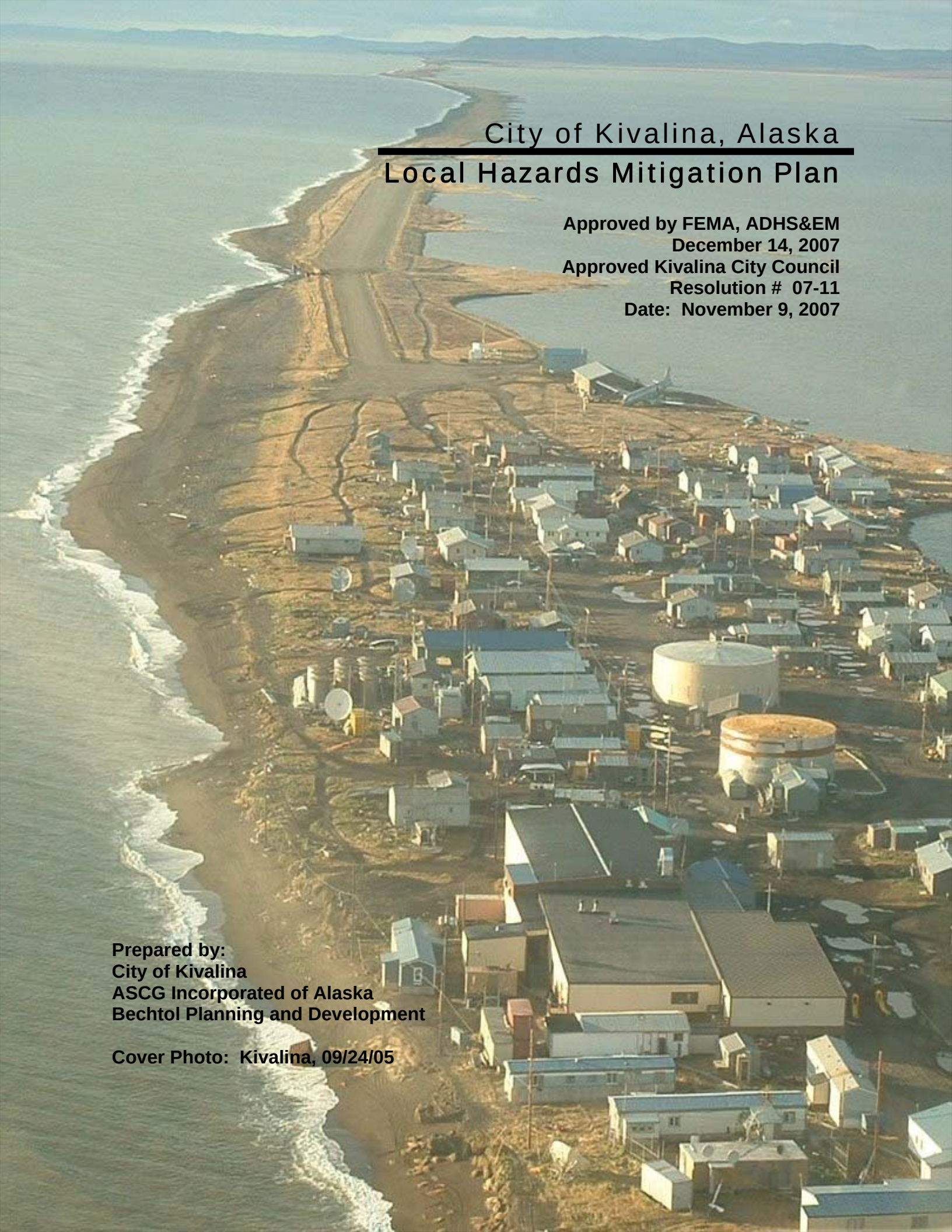

City of Kivalina, Alaska

Local Hazards Mitigation Plan

Approved by FEMA, ADHS&EM
December 14, 2007
Approved Kivalina City Council
Resolution # 07-11
Date: November 9, 2007

Prepared by:
City of Kivalina
ASCG Incorporated of Alaska
Bechtol Planning and Development

Cover Photo: Kivalina, 09/24/05

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Acronyms

AEIS	Alaska Economic Information System
ANCSA	Alaska Native Claims Settlement Act
AVEC	Alaska Village Electric Cooperative
BFE	Base Flood Elevation (100 year flood)
CFR	Code of Federal Regulations
DCCED	(Alaska) Department of Commerce, Community and Economic Development
DEC	(Alaska) Department of Environmental Conservation
DHS&EM	(Alaska) Division of Homeland Security and Emergency Management
DOT&PF	(Alaska) Department of Transportation & Public Facilities
FEMA	Federal Emergency Management Agency
GPM	Gallons per Minute
HMP	Hazard Mitigation Plan
HMPG	Hazard Mitigation Planning Grant
IWC	International Whaling Commission
KRPC	Kivalina Relocation Planning Committee
LHMP	Local Hazard Mitigation Plan
MSL	Mean Sea Level
NFIP	National Flood Insurance Program
NOAA	National Oceanographic and Atmospheric Administration
NVA	Native Village of Kivalina
NWAB	Northwest Arctic Borough
OTZ	Kotzebue
PDMG	Pre Disaster Mitigation Grant
RWST	Raw Water Storage Tank
SF	Square Feet
TWST	Treated Water Storage Tank
USCOE	United States Army Corps of Engineers
WTP	Water Treatment Plant

KIVALINA CITY COUNCIL
P.O. Box 50079
Kivalina, Alaska 99750

RESOLUTION 07-11

ADOPTION OF THE CITY OF KIVALINA LOCAL HAZARDS MITIGATION PLAN!

Whereas, the City of Kivalina recognizes the threat that local natural hazards pose to people and property; and

Whereas, undertaking hazard mitigation projects before disasters occur will reduce the potential for harm to people and property and save taxpayer dollars; and

Whereas, an adopted Local Hazards Mitigation Plan has been sent to the Alaska Division of Homeland Security and Emergency Management and the Federal Emergency Management Agency (FEMA) for their approval;

Now, therefore, be it resolved, that the Kivalina City Council, hereby adopts the City of Kivalina Local Hazards Mitigation Plan as an official plan; and

Be it further resolved, that the City of Kivalina will submit the adopted Local Hazards Mitigation Plan to the Alaska Division of Homeland Security and Emergency Management and the Federal Emergency Management Agency officials for final review and approval.

PASSED AND APPROVED BY THE Kivalina City Council on this 9th day of November, 2007.

IN WITNESS THERETO:

Signature: _____ Title: Mayor
Bert Adams Sr.

Attest: SIGNATURE OF CLERK/SECRETARY

Signature: _____ Title: Secretary
Janet Mitchell

U.S. Department of Homeland Security
Region X
130 228th Street, SW
Bothell, WA 98021-9796

FEMA

December 14, 2007

Mayor Bert Adams, Sr.
Kivalina City Council
P.O. Box 50079
Kivalina, Alaska 99750

Dear Mayor Adams:

The U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) has approved the ***City of Kivalina, Alaska Local Hazards 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 December 14, 2012. The plan also meets the requirements of a Flood Mitigation Assistance (FMA) plan as outlined in 44 CFR Part 78, qualifying the City of Kivalina for FMA project grants.

The plan's approval provides eligibility to apply for hazard mitigation projects through your state. Grant applications will be evaluated individually according to the specific eligibility and other requirements of the particular hazard mitigation grant program. For example, a mitigation project identified in the approved plan may or may not meet the eligibility requirements for Hazard Mitigation Grant Program funding.

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 our state counterpart, Alaska Division of Homeland Security and Emergency Management, who coordinates and administers these efforts for local entities.

Sincerely,

Mark Carey

Mark Carey, Director
Mitigation Division

cc: Mark Roberts, Alaska Division of Homeland Security and Emergency Management

Enclosure

KM:bb

Chapter 1. Planning Process and Methodology

Introduction

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 LHMP includes information to assist the city government, the Tribal government and residents with planning to avoid potential future disaster losses. The plan provides information on natural hazards that affect Kivalina and descriptions of past disasters, and lists projects that may help the community prevent disaster losses. The plan was developed to help the City make decisions regarding natural hazards that affect Kivalina.

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. USCOE Relocation Reports, the most recent dated December 2005, have identified six alternative village sites and costs have been estimated for each of the sites. Chapter 3 of the LHMP discusses the six alternatives; however, the purpose of this plan is to provide mitigation projects for the current village.

Plan Development

Location

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.)

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

Project Staff

The Kivalina City Administrator Janet Mitchell, Mayor Austin Swan, City Council members and IRA Traditional Council members.

ASCG Incorporated and Eileen R. Bechtol of Bechtol Planning & Development were hired to write the plan.

Scott Simmons and Ervin Petty of the Division of Homeland Security & Emergency Management (DHS&EM) and Christy Miller and Taunnie Boothby of the Department of Commerce, Community, and Economic Development (DCCED) provided technical assistance and reviewed the drafts of this plan.

Plan Research

The plan was developed utilizing existing Kivalina plans and studies, as well as outside information and research. A list of sources is included in the bibliography.

Public Involvement

A site visit was conducted on June 8, 2006, the contractor met with:

- Gerald Pickard, McQueen School Principal
- Janet Mitchell, City Administrator
- Austin Swan, Mayor
- Joseph Swan, City Councilmember

Kivalina held a public meeting on September 19, 2006 to gather opinions and ideas for the LHMP. City council members and the IRA Traditional Council attended the meeting. In addition, the community held a meeting on the evening of September 19, 2006 in the New Community Building. Several members of the community attended the meeting.

Comments, revisions, and project information have been incorporated into the final plan. A copy of the LHMP is available for public perusal at City Hall and the IRA Traditional Council offices.

Plan Implementation

The City Council of Kivalina will be responsible for adopting the Kivalina LHMP and all future updates or changes. This governing body has the authority to promote sound public policy regarding hazards. The LHMP will be assimilated into other Kivalina plans and documents as they come up for review according to each plans' review schedule.

Table 1. Kivalina Plans

Document	Completed	Next Review
Kivalina Relocation Community Layout Plan	2001	N/A
USCOE Community Improvement Feasibility Report	1998	N/A
USCOE Relocation Planning Project	2003	N/A
USCOE Relocation Planning Project	2005	N/A

Continuing Review Process

The City Administrator of Kivalina will evaluate the Kivalina LHMP on an annual basis to determine the effectiveness of programs and to reflect changes in land development, status, or other situations that make changes to the plan necessary. The City Administrator and her staff will review the mitigation project items to determine their relevance to changing situations in the city, 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 analysis information to determine if this information should be updated and/or modified, and give any new available data or changes in status.

Continued Plan Development

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.

The plan will be updated every fives years, as funding becomes available, or after a Federally Declared Disaster if there is direction from ADHS&EM or FEMA to update the plan.

Updating and maintaining the plan will be administered by the City Administrator. This will include adding additional hazards and completing vulnerability assessments for existing hazard chapters.

The following table lists the schedule for completion of these tasks, provided that funds are available to do so:

Table 2. Continued Plan Development

Hazard	Status	Hazard Identification Completion Date	Vulnerability Assessment Completion Date
Floods	Completed	2006	2006
Erosion	Completed	2006	2006
Severe Weather	Completed	2006	2006
Earthquake	Completed	2006	2006
Economic	Future Addition	2009	2011
Technological	Future Addition	2009	2011
Public Health Crisis	Future Addition	2009	2011

Continued Public Involvement

The Kivalina LHMP will be kept at the City and IRA Traditional Council offices. Possible continued public involvement include reviewing the plan during village relocation meetings and on a City or IRA website.

The plan will also be available through the DHS&EM Planning Mitigation.Com software program.

The plan will also be available and discussed during spring break-up or when flooding and/or significant erosion occurs.

Risk Assessment Methodology

The goal of mitigation is to reduce the future impacts of a hazard including loss of life, property damage, and disruption to local and regional economies, environmental damage and disruption, and the amount of public and private funds spent to assist with recovery.

Mitigation efforts begin with a comprehensive risk assessment. A risk assessment measures the potential loss from a disaster event caused by an existing hazard by evaluating the vulnerability of buildings, infrastructure, and people. It identifies the characteristics and potential consequences of hazards and their impact on community assets.

A risk assessment typically consists of three components; hazards identification, vulnerability assessment and risk analysis.

1. *Hazards Identification* – The first step in conducting a risk assessment is to identify and profile hazards and their possible effects on the jurisdiction. This information can be found in Chapter 3: Hazards.

2. *Vulnerability Assessment* – Step two is to identify the jurisdiction's vulnerability; the people and property that are likely to be affected. It includes everyone who enters the jurisdiction including employees, commuters, shoppers, tourists, and others.

Populations with special needs such as children, the elderly, and the disabled should be considered; as should facilities such as the health clinic because of their additional vulnerability to hazards.

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. 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.

3. *Risk Analysis* – The next step is to calculate the potential losses to determine which hazard will have the greatest impact on the jurisdiction. Hazards should be considered in terms of their frequency of occurrence and potential impact on the jurisdiction. For instance, a possible hazard may pose a devastating impact on a community but have an extremely low likelihood of occurrence; such a hazard must take lower priority than a hazard with only moderate impact but a very high likelihood of occurrence.

Additionally, the risk analysis must utilize a multi-hazard approach to mitigation. One such approach might be through a composite loss map showing areas that are

vulnerable to multiple hazards. For example, there might be several schools exposed to one hazard but one school may be exposed to four different hazards. A multi-hazard approach will identify such high-risk areas and indicate where mitigation efforts should be concentrated.

Currently there are insufficient funds and data with which to conduct an accurate risk analysis for all the hazards affecting Kivalina. However, risk analysis information will be added as it is completed.

Vulnerability Assessment Methodology

The purpose of a vulnerability assessment is to identify the assets of a community that are susceptible to damage should a hazard incident occur.

Critical facilities are described in the Community Profiles Section of this hazard plan. A vulnerability matrix table of critical facilities as affected by each hazard is provided in Chapter 3 of this document.

Facilities were designated as critical if they are: (1) vulnerable due to the type of occupant (children or elderly, for example); (2) critical to the community's ability to function (roads, power generation facilities, water treatment facilities, etc.); (3) have a historic value to the community (cemetery); or (4) critical to the community in the event of a hazard occurring (emergency shelter, etc.).

Based on a pilot program FEMA and the Alaska Division of Homeland Security and Emergency Management (DHS&EM) has initiated to inventory critical facilities in Alaska, it should be taken into consideration that Alaska critical facilities vary fundamentally from other states. A local post office in a rural community in Alaska may also be the location of the police station, emergency operations center, hospital, and only store within 100 miles.

This hazard plan includes an inventory of all facilities from the Kivalina City records and land use map.

Federal Requirement for Risk Assessment

Recent federal regulations for hazard mitigation plans outlined in 44 CFR Part 201.6 (c) (2) include a requirement for a risk assessment. This risk assessment requirement is intended to provide information that will help the community identify and prioritize mitigation activities that will prevent or reduce losses from the identified hazards. The federal criteria for risk assessments and information on how the Kivalina LHMP meets those criteria are outlined below:

Table 3. Federal Requirements

Section 322 Requirement	Location in Plan
Identifying Hazards	Kivalina past plans and land use map and community members identified natural hazards.
Profiling Hazard Events	The hazard-specific sections of the Kivalina LHMP provide documentation for all of the large-scale natural hazards that may affect the City. Where information was available, the LHMP lists relevant historical hazard events.
Assessing Vulnerability: Identifying Assets and Estimating Potential Losses	Vulnerability assessments for floods, erosion, severe weather, and earthquakes have been completed and are contained within the hazard chapter. Additional vulnerability assessments will be added as they are funded and completed.
Assessing Vulnerability: Analyzing Development Trends	The Community Profile Section and Chapter 3 include a description of development in Kivalina and the land use maps lists all structures and utilities in the community.

Economic Analysis

FEMA uses two approaches to economic analysis of mitigation projects: benefit/cost analysis and cost-effectiveness analysis. Conducting a benefit/cost analysis for a mitigation activity can assist communities in determining which projects are financially worth undertaking to avoid disaster losses in the future. Cost-effectiveness analysis evaluates how to best spend a given amount of money to achieve a specific goal.

Determining the economic feasibility of mitigating natural hazards can provide decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

The village will use a FEMA-approved benefit/cost analysis approach to analyze and prioritize mitigation project ideas. The community will develop a list of mitigation projects to be undertaken and will periodically evaluate the effectiveness of these projects.

Only mitigation options with essentially no cost can be accurately assessed at this time. The data necessary to conduct an accurate cost-benefit analysis of mitigation options that require significant investments is not currently available, but will be added as resources allow further study.

Chapter 4, Mitigation Strategy, outlines the overall strategy to reduce vulnerability to the effects of the hazards studied. Currently the planning effort is limited to the hazards determined to be of the most concern; flooding, erosion, severe weather and earthquake; however, the mitigation strategy will be regularly updated as additional hazard information is added and new information becomes available.

The City of Kivalina will use the following factors to prioritize mitigation project items should funding become available.

1. Extent the project reduces risk to life.

2. Extent to which benefits are maximized when compared to the costs of the project.

3. Project protects critical facilities or critical city functionality.
   A. Hazard probability.
   B. Hazard severity.

Please see specific projects in Chapter 4.

Chapter 2: Community Profile

Kivalina Community Overview

Government

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.

Table 4. Community Information

Community Information	Contact Information and Type
Current Population:	385 (2005 State Demographer certified population)
Pronunciation:	kiv-uh-LEE-nuh
Incorporation Type:	2nd Class City City of Kivalina Austin Swan, Mayor Janet Mitchell, City Administrator P.O. Box 50079 Kivalina, AK 99750 Phone 907-645-2137 Fax 907-645-2175 E-mail kivalinacity@yahoo.com
Borough Located In:	Northwest Arctic Borough Thomas Bolen, Public Services Director P.O. Box 1110 Kotzebue, AK 99752 Phone 907-442-2500 Fax 907-442-2930 E-mail tbolen@nwabor.org Web http://www.nwabor.org
Native Tribe:	Native Village of Kivalina (IRA) President: Jerry Norton Tribal Administrator: Colleen Swan P.O. Box 50051 Kivalina, AK 99750 Phone 907-645-2153 Fax 907-645-2193 E-mail kivalina@aitc.org colleen.swan@kivaliniq.org.

Community Information	Contact Information and Type
Regional Native Corporation:	NANA Regional Corporation P.O. Box 49 Kotzebue, AK 99752 Phone 907-442-3301 Fax 907-442-2866 E-mail marie.greene@nana.com Web http://www.nana.com
Regional Non-Profit	Maniilaq Association President/CEO: Helen Bolen P.O. Box 256 Kotzebue, Alaska 99752 Phone: 1-800-478-3312 E-mail: hbolen@maniilaq.org
Census Area:	Northwest Arctic Census Area
Regional Development:	NW Arctic Economic Dev. Comm. P.O. Box 1110 Kotzebue, AK 99752 Phone 907-442-2500 Fax 907-442-3740 E-mail lstoops@northwestarcticborough.org Web http://www.nwabor.org/edc/

Location

Kivalina is located in northwestern Alaska, within the Northwest Arctic Borough. It is approximately 80 miles northwest of Kotzebue, 520 miles northwest of Fairbanks, 360 miles southwest of Barrow, and 83 miles north of the Arctic Circle. The village is situated on the southeast tip of a 5.5-mile long barrier island located between the Chukchi Sea (Arctic Ocean) and Kivalina Lagoon.

Access into and out of Kivalina is primarily by plane and barge. A 3,000-foot long, gravel airstrip, located just to the northwest of the village, accommodates regular scheduled and charter air service from Kotzebue. Crowley Marine Services barges goods from Kotzebue during July and August.

There are no roads to Kivalina. However, in the winter there are marked snow machine trails connecting to other villages and Kotzebue. There are also numerous subsistence trails within the area. Depending on the season, small boats, snow machines, all-terrain vehicles (ATVs) and/or full-sized vehicles are used for local transportation.

Climate

Kivalina lies in the transitional climate zone, which is characterized by long, cold winters and cool summers. The average low temperature during January is -15° Fahrenheit; the average high during July is 57°. Temperature extremes have been measured from -54° to 85°. Snowfall averages 57 inches, with 8.6 inches of precipitation per year. The Chukchi Sea is ice-free and open to boat traffic from mid-June to the first of November.

Population and Economy

At the time of the 2000 U.S. Census, the population of Kivalina was 377. Alaska Natives represented 96.6% of the population. The 2000 Census also revealed that the average household had approximately 4.83 persons in it. Between 1970 and 2000, Kivalina's population increased from 188 to 377, which is an annual increase of 2.3%. If this trend continues, Kivalina would have a population of 600 in the 2020.

The people of Kivalina primarily depend on traditional subsistence practices, combined with a modern wage economy. Employment opportunities are limited, but there is some employment through the City, Village Council, school, Maniilaq Association, and local stores. The Red Dog Mine (a zinc mine located approximately 53 miles northeast of the village) also offers some employment. Six residents hold commercial fishing permits. Native carvings and jewelry are produced from ivory and whale bone.

Subsistence hunting is the village's primary source of meat. Subsistence foods harvested include seal, walrus, whale, salmon, whitefish and caribou. Kivalina is one of ten whaling communities in the Alaska Eskimo Whaling Commission. In accordance with International Whaling Commission (IWC) rules, Alaska Native whalers can legally hunt an allocated number of bowhead whales each year for food, oil, and Native craft materials.

At the time of the 2000 Census, the median household income was $30,833. The official unemployment rate was 25.5% and there were an estimated 164 jobs in the community.

History and Culture

Kivalina has long been a stopping-off place for seasonal travelers between arctic coastal areas and Kotzebue Sound communities. It is the only village in the region where people hunt the bowhead whale. At one time, the village was located at the north end of the Kivalina Lagoon. It was reported as "Kivualinagmut" in 1847 by Lt. Zagoskin of the Russian Navy. Lt. G.M. Stoney of the U.S. Navy reported the village as

"Kuveleek" in 1885. A post office was established in 1940. An airstrip was built in 1960. Kivalina incorporated as a City in 1969. During the 1970s, new houses, a new school and an electric system were constructed in the village. Before 1976, high school students from Noatak would attend school in Kivalina, and board with local families.

Public Facilities

Wells have proven unsuccessful in Kivalina. Water is drawn from the Wulik River via a 3-mile surface transmission line, and is stored in a 700,000-gallon raw water tank. It is then treated and stored in a 500,000-gallon steel tank. Water is hauled by residents from this tank. One-third of residents have tanks, which provide running water for the kitchen, but homes are not fully plumbed.

The school and clinic have individual water and sewer systems. Residents haul their own honey buckets to bunkers. A new landfill and honey bucket disposal site were recently completed. A Master Plan is underway to examine sanitation alternatives at the new community site. Electricity is provided by the Alaska Village Electric Cooperation (AVEC).

There is one school located in the community, attended by 127 students. Local hospitals or health clinics include Kivalina Clinic. Kivalina is classified as an isolated village in EMS Region 4A in the Maniilaq Association Region. Emergency Services have coastal and air access. Emergency service is provided by volunteers and a health aide

Community Assets

This section outlines the resources, facilities and infrastructure that, if damaged, could significantly affect public safety, economic conditions, and environmental integrity of Kivalina.

Community Map

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 Facilities: Those facilities and infrastructure necessary for emergency response efforts.

- Kivalina Airport
- Kivalina Clinic

Essential Facilities: Those facilities and infrastructure that supplement response efforts.

- Kivalina Native Store

- Native Store Warehouse
- Old Tank Farm
- Water Tank
- Community Hall
- Alaska Village Electric
- AVEC Tank Farm
- City Hall/IRA Office
- Public Safety/City Jail
- DOT Hanger
- Native Storage Tank Farm
- School Tank Farm

Critical Infrastructure: Infrastructure that provides services to Kivalina.

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

Vulnerable Populations: Locations serving population that have special needs or require special consideration.

- McQueen School
- Churches

Cultural and Historical Assets: Those facilities that augment or help define community character, and, if lost, would represent a significant loss for the community.

- Kivalina Community Hall

Community Resources

This section outlines the resources available to Kivalina for mitigation and mitigation-related funding and training.

Federal Resources

The federal government requires local governments to have a hazard mitigation plan in place to be eligible for funding opportunities through FEMA such as the Pre-Disaster Mitigation Assistance Program and the Hazard Mitigation Grant Program. 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 below:

- **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 mirror the four major phases of hazard mitigation planning used in the development of the Kivalina Hazard Mitigation Plan. 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 Disaster Mitigation Act (DMA) 2000 requirements (http://www.fema.gov/fima/planhowto.shtm).

- **Post-Disaster Hazard Mitigation Planning Guidance for State and Local Governments.** FEMA DAP-12, September 1990. This handbook explains the basic concepts of hazard mitigation and shows state and local governments how they can develop and achieve mitigation goals within the context of FEMA's post-disaster hazard mitigation planning requirements. The handbook focuses on approaches to mitigation, with an emphasis on multi-objective planning.

- **Mitigation Resources for Success CD.** FEMA 372, September 2001. This CD contains a wealth of information about mitigation and is useful for state and local government planners and other stakeholders in the mitigation process. It provides mitigation case studies, success stories, information about Federal mitigation programs, suggestions for mitigation measures to homes and businesses, appropriate relevant mitigation publications, and contact information.

- **A Guide to Federal Aid in Disasters.** FEMA 262, April 1995. When disasters exceed the capabilities of state and local governments, the President's disaster assistance program (administered by FEMA) is the primary source of federal assistance. This handbook discusses the procedures and process for obtaining this assistance, and provides a brief overview of each program.

- **The Emergency Management Guide for Business and Industry.** FEMA 141, October 1993. This guide provides a step-by-step approach to emergency management planning, response, and recovery. It also details a planning process that businesses can follow to better prepare for a wide range of hazards and emergency events. This effort can enhance a business's ability to recover from financial losses,

loss of market share, damages to equipment, and product or business interruptions. This guide could be of great assistance to Kivalina businesses.

Other federal resources include:

- **Department of Agriculture.** Assistance provided includes: Emergency Conservation Program, Non-Insured Assistance, Emergency Watershed Protection, Rural Housing Service, Rural Utilities Service, and Rural Business and Cooperative Service.

- **Department of Energy, Office of Energy Efficiency and Renewable Energy, Weatherization Assistance Program.** This program minimizes the adverse effects of high energy costs on low-income, elderly, and handicapped citizens through client education activities and weatherization services such as an all-around safety check of major energy systems, including heating system modifications and insulation checks.

- **Department of Housing and Urban Development, Office of Homes and Communities, Section 108 Loan Guarantee Programs.** This program provides loan guarantees as security for federal loans for acquisition, rehabilitation, relocation, clearance, site preparation, special economic development activities, and construction of certain public facilities and housing.

- **Department of Housing and Urban Development, Community Development Block Grants.** Administered by DCCED, Division of Community Advocacy. Provides grant assistance and technical assistance to aid communities in planning activities that address issues detrimental to the health and safety of local residents, such as housing rehabilitation, public services, community facilities, and infrastructure improvements that would primarily benefit low- and moderate-income persons.

- **Department of Labor, Employment and Training Administration, Disaster Unemployment Assistance.** Provides weekly unemployment subsistence grants for those who become unemployed because of a major disaster or emergency. Applicants must have exhausted all benefits for which they would normally be eligible

- **Federal Financial Institutions.** . Member banks of FDIC, FRS or FHLBB may be permitted to waive early withdrawal penalties for Certificates of Deposit and Individual Retirement Accounts

- **Internal Revenue Service, Tax Relief.** Provides extensions to current year's tax return, allows deductions for disaster losses, and allows amendment of previous tax returns to reflect loss back to three years.

- **United States Small Business Administration.** May provide low-interest disaster loans to individuals and businesses that have suffered a loss due to a disaster. Requests for SBA loan assistance should be submitted to the Alaska Division of Homeland Security and Emergency Management.

Other resources: The following are Websites that provide focused access to valuable planning resources for communities interested in sustainable development activities.

- **Federal Emergency Management Agency,** http://www.fema.gov – includes links to information, resources, and grants that communities can use in planning and implementation of sustainable measures.

- **American Planning Association,** 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,** http://ibhs.org – an initiative of the insurance industry to reduce deaths, injuries, property damage, economic losses, and human suffering caused by natural disasters. Online resources provide information on natural hazards, community land use, and ways citizens can protect their property from damage.

State Resources

DHS&EM is responsible for coordinating all aspects of emergency management for the State of Alaska. Public education is one of its identified main categories for mitigation efforts.

Improving hazard mitigation technical assistance for local governments is another high priority list item for the State of Alaska. Providing hazard mitigation training, current hazard information, and the facilitation of communication with other agencies would encourage local hazard mitigation efforts. DHS&EM provides resources for mitigation planning on their Website at http://www.ak-prepared.com.

DCCED, Division of Community Advocacy: Provides training and technical assistance on all aspects of the National Flood Insurance Program and flood mitigation.

Other state resources include:

- **Division of Senior Services:** Provides special outreach services for seniors, including food, shelter and clothing.

- **Division of Insurance:** Provides assistance in obtaining copies of policies and provides information regarding filing claims.

- **Department of Military and Veteran's Affairs:** Provides damage appraisals and settlements for VA-insured homes, and assists with filing of survivor benefits.

Other Funding Sources and Resources

- **Real Estate Business.** Real estate disclosure is required by state law for properties within flood plains.

- **American Red Cross.** Provides for the critical needs of individuals such as food, clothing, shelter, and supplemental medical needs. Provides recovery needs such as furniture, home repair, home purchasing, essential tools, and some bill payment may be provided.

- **Crisis Counseling Program.** Provides grants to State and Borough mental health departments, which in turn provide training for screening, diagnosing and counseling techniques. Also provides funds for counseling, outreach, and consultation for those affected by disaster.

Local Resources

Kivalina has a very limited 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 City, and are summarized in the following tables.

Table 5. Legal and Technical Capability

Regulatory Tools (ordinances, codes, plans)	Local Authority (Y/N)	Comments (Year of most recent update; problems administering it, etc)
Building code	N	
Zoning ordinance	N	
Subdivision ordinance or regulations	N	
Special purpose ordinances (floodplain management, stormwater management, hillside or steep slope ordinances, wildfire ordinances, hazard setback requirements)	Y	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.
Growth management ordinances (also called "smart growth" or anti-sprawl programs)	N	
Site plan review requirements	N	
Comprehensive plan	N	
A capital improvements plan	N	
An economic development plan	N	
An emergency response plan	N	
A post-disaster recovery plan	N	
A post-disaster recovery ordinance	N	
Real estate disclosure requirements	N	

Table 6. Administrative and Technical Capability

Staff/Personnel Resources	Y/N	Department/Agency and Position
City Administrator	Y	City Administrator
City Clerk	Y	
Public Works Director	N	
Librarian	N	
Firefighters	Y	Volunteer Fire Chief
Planner(s) or engineer(s) with knowledge of land development and land management practices	N	
Engineer(s) or professional(s) trained in construction practices related to buildings and/or infrastructure	N	
Planners or Engineer(s) with an understanding of natural and/or human-caused hazards	N	
Floodplain manager	N	
Surveyors	N	
Staff with education or expertise to assess the community's vulnerability to hazards	N	
Personnel skilled in GIS and/or HAZUS	N	
Scientists familiar with the hazards of the community	Y	Elders with extensive knowledge of hazards affecting the community
Emergency manager	Y	Mayor
Grant writers	Y	City Administrator
Environmental Advisory Council	N	

Table 7. Fiscal Capability

Financial Resources	Accessible or Eligible to Use (Yes or No)
Community Development Block Grants (CDBG)	Y
Capital improvements project funding	Y
Authority to levy taxes for specific purposes	Y
Fees for sewer	N
Impact fees for homebuyers or developers for new developments/homes	N
Incur debt through general obligation bonds	N
Incur debt through special tax and revenue bonds	N
Incur debt through private activity bonds	N
Withhold spending in hazard-prone areas	N

Chapter 3: Hazards

Hazard Matrix – City of Kivalina

Table 8. Hazard Matrix

Hazard Matrix – City of Kivalina
(Northwest Arctic Borough, State of Alaska Hazard Matrix)

Flood	Wildland Fire	Earthquake	Volcano	Avalanche	Tsunami & Seiche
Y - H	N	Y - L	N	N	N
Severe Weather	**Landslides**	**Erosion**	**Drought**	**Technological**	**Economic**
Y - H	N	Y - H	N	Y	Y

Hazard Identification:

Y: N: U:	Hazard is present in jurisdiction but probability unknown Hazard is not present Unknown if the hazard occurs in the jurisdiction
Risk: L : M : H:	 Hazard is present with a low probability of occurrence Hazard is present with a moderate probability of occurrence Hazard is present with a high probability of occurrence

Source: Alaska State All-Hazards Plan, 2004

Hazard Vulnerability Assessment Matrix

Identification of Assets

Because Kivalina is a small community of 385 residents, every structure is essential to the sustainability and survivability of Kivalina residents. The Hazard Vulnerability Matrix below includes a list of facilities, utilities and businesses and their vulnerability to natural hazards.

- Essential facilities, which are necessary for the health and welfare of an area and are essential during the response and recovery phase of a disaster such as: city facilities, health clinic and schools.

- Transportation systems such as: airport and roads.

- Lifeline utility systems such as: potable water and wastewater treatment plant, fuel farms, electrical generation facilities and power grid and communications systems.

- Businesses that provides services or commodities.

The following table is from Map 1 Kivalina Land Use Map, 1999. The table demonstrates how the entire village is at risk for all the identified hazards.

Table 9. Kivalina Hazard Vulnerability Matrix

Facility	Flood	Erosion	Severe Weather	Earthquake
State Airport Hanger	X	X	X	X
Native Storage Tank Farm	X	X	X	X
School Tank Farm	X	X	X	X
School Rental Unit	X	X	X	X
McQueen School	X	X	X	X
Kivalina Native Store	X	X	X	X
Native Store Warehouse	X	X	X	X
Old Tank Farm	X	X	X	X
Native Store Storage	X	X	X	X
Friends Church Storage	X	X	X	X
Native Pump House	X	X	X	X
Friends Church	X	X	X	X
Washeteria	X	X	X	X
Water Tank	X	X	X	X

Facility	Flood	Erosion	Severe Weather	Earthquake
Alaska Army National Guard	X	X	X	X
Water Tank	X	X	X	X
Clinic	X	X	X	X
OTZ Telephone Co-op	X	X	X	X
City Bingo Hall	X	X	X	X
Community Hall	X	X	X	X
Alaska Village Electric	X	X	X	X
AVEC Tank Farm	X	X	X	X
Epiphany Church	X	X	X	X
Post Office	X	X	X	X
City Hall/IRA Office	X	X	X	X
City Storage	X	X	X	X
GCI Phone Mobile	X	X	X	X
Friends Church Cabin	X	X	X	X
IRA Council Storage	X	X	X	X
Heavy Equipment Storage	X	X	X	X
DOT Hangar	X	X	X	X

Kivalina's Vulnerability to Identified Hazards:

All of the facilities in the village are vulnerable to the natural hazards listed above. The following facilities provide services and are critical to the safety of the community.

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

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 community presently has a National Guard facility. The National Guard is a popular organization in many communities in rural Alaska. The residents would like to keep the presence of the Guard, and would like a facility at the new 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.

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.

Kivalina's primary water source is a point 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/June. Although the Wulik River is ice free in May/June, water is normally not pumped until July due to the high silt content of the river water after break up. Water is also pumped in October, prior to the freeze up of the Wulik River.

When the tide is low, 14,000 feet of 4-inch diameter fire hose is temporarily installed between the 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 until the tank is filled, over approximately five to six days.

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 gpm.

Treated water is pumped from the plant into a 500,000-gallon Treated Water Storage Tank (TWST). Treatment of the raw water involves the use of a 54-inch pressure sand filter and a *Giardia* barrier microfilter. 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.

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

Sanitary facilities for the clinic are simple. The clinic contains two sinks, but no flush toilets. All wastewater effluent from the clinic to its lift station is graywater. Human waste is collected in honey buckets, as is typical in the village.

Residents obtain treated water from the watering point at the washeteria. They collect water in containers, such as 30-gallon garbage cans, and self-haul to their homes. Water is pumped into personal containers at a rate of $0.50 for 30 gallons through a pay box located on the east side of the washeteria. The individual collecting the water must keep a flow switch depressed until the 30 gallons has been pumped. Water is transported to homes by the individual 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.

The storage tank is filled manually and feeds the plumbing by gravity. Attempts to install a piped water distribution system are evident in Kivalina. An arctic pipe water system was installed in the village around 1988. Looped arctic pipes, remnants of this old distribution system, are still attached to some houses.

The only facilities served by on-site wastewater disposal systems are the school buildings and washeteria/clinic. Residents dispose of non-septic wastewater and graywater 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 the community of Kivalina. 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.

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 landfill bunker. Bags deposited at the hatch of the already full wood bunkers in the village and along the way to the landfill bunker are potential sites of pathogen transfer to the community.

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 drainfield located on the western beach. The washeteria/clinic drainfield measured about 93 feet long by 18 feet wide before it was destroyed by erosion during an October 2004 storm. The drainfield was not rebuilt after the storm because of feasibility issues.

The McQueen School wastewater treatment system was installed in 1992. It consists of a gravity fed sump and duplex pump lift station, aeration tank, settling tank, chlorine contact tank, and a slow sand filter. Wastewater travels through an aeration chamber, clarifying tank, sand filters, and a chlorine contact chamber. A mound drainfield 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, erosion, severe weather and earthquake could potentially impact any part of Kivalina.

All Kivalina residents, even those with properties unaffected directly, will suffer in flooding events due to difficulties in getting around the community by 4-wheeler (the primary method of motorized travel), impacts to public safety (access and response capabilities), limited availability of perishable commodities, and isolation.

A severe weather event would create an area-wide impact and could damage structures and potentially isolate Kivalina from the rest of the state.

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

Section 1. Floods and Erosion

Hazard Description and Characterization

Types of Flooding and Erosion Events in Kivalina

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 the flow of the Kivalina River.

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 shorefast 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.

Shorefast 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. 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.

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. Villagers have expended great effort to protect against erosion as demonstrated with this picture.

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.

Implications of the former would include rejection of low-lying sites, even though they are considered to be a "safe" distance from the coast. While the amount of sea level rise that will be seen in Alaska is not yet determinable, it is projected to be as much as 1-2 feet over the next 100 years in more temperate locations.

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 USCOE to be 15 to 20 years away.

(Source of above section: *Kivalina Relocation Planning Project Draft Project, December 2005. USCOE)*

Flood and Erosion Hazards

Deposition
Deposition is the accumulation of soil, silt, and other particles on a river bottom or delta. Deposition leads to the destruction of fish habitat and presents a challenge for navigational purposes. Deposition also reduces channel capacity, resulting in increased flooding or bank erosion.

Erosion
Erosion is a process that involves the wearing away, transportation, and movement of land. Erosion rates can vary significantly as erosion can occur quite quickly as the result of a flash flood, coastal storm or other event. It can also occur slowly as the result of long-term environmental changes. Erosion is a natural process but its effects can be exacerbated by human activity.

Stream bank erosion involves the removal of material from the stream bank. When bank erosion is excessive, it becomes a concern because it results in loss of streamside vegetation, loss of fish habitat, and loss of land and property.

Contaminated water
Floodwaters pose a health hazard by picking up contaminants and disease as they travel. Outhouses, school sewer, septic bunkers, and dog yards are all potential sources of disease transported by floodwaters and erosion. Lack of a water source is a significant concern for flood victims, especially if the flood has been extensive enough to contaminate the public water tanks. In such a case, outside bottled water is at times the only source of clean water.

Previous Occurrences of Flooding and Erosion Events

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 Chuckchi 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.

2004 Bering Strait Sea Storm declared October 28, 2004 by Governor Murkowski; 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 in the Northwest Artic Borough, including Kivalina, Kotzebue.

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.

It is possible that observed trends related to delays in formation of shorefast 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.

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.

During the 2005 storm season, two stormed caused considerable erosion damage to the community. One more similarly-sized storm could undermine bulk fuel tanks, damage the runway, and/or wash away structures. Already, numerous power poles and a sanitary leachfield have been destroyed.

The storm on September 22-24, 2005, which caused significant erosion and loss of land, was estimated to have a storm surge height of 8.5 feet above mean sea level (MSL). The average elevation of the village is between 9 and 10 feet above MSL. The 100-year storm surge has been calculated by the USCOE to be 16.3 feet above MSL.

2005 West Coast Storm declared October 24, 2005 by Governor Murkowski; 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.

Local Flood and Erosion Hazard Identification

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 longshore 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 Waulik and Kivalina Rivers converge. Erosion has been occurring steadily for over two decades, with signs of acceleration in recent years.

Land Uses, Buildings and Facilities Susceptible to Damage from the 100-year Flood

Table 10. Land Use Types in Kivalina

Land Use Type	Number of Uses
Residential	71
Commercial	5
Public	27

Please see Table 8 earlier in this chapter, which lists facilities and utilities in areas susceptible to flooding.

Housing in Kivalina is crowded and inadequate. According to the 1990 U.S. Census, Kivalina had 71 single-family residences. There is no multi-family housing in Kivalina. The residences have one to three bedrooms and house as many as five to 15 occupants. The 1990 average number of people per household in Kivalina was 4.70, which is nearly 50 percent higher than the United States average and about 40 percent higher than the state average. A state survey summarized several characteristics of homes in the Northwest Arctic Borough. The houses are among the smallest of all regions in the state, averaging just 731 square feet.

Housing conditions vary from older dwellings to new housing, with the newer homes being built by the Northwest Inupiat Housing Authority. The lack of utilities supplying water and sewer, the lack of flooding and erosion control, and the lack of available real estate for expansion have hindered development of new housing.

The NANA Corporation, State of Alaska, and individuals with native allotments own the land in the vicinity of Kivalina. The State of Alaska owns a portion of land at the site of the airstrip that extends from the edge of the community. Because of its dedication to transportation needs, it is unavailable for community expansion. In addition, the state owns the land under the Kivalina Lagoon, which is a potential source of gravel. The City of Kivalina is entitled to select up to 1,280 acres of land for municipal purposes under Section 14 c (3) of ANCSA, although they have yet to make a selection. The Bureau of Indian Affairs acts as trustee for Native Allotments and their approval is needed prior to lease or sale of allotments.

Community Participation in the NFIP

The City of Kivalina is part of the National Flood Insurance Program (NFIP) because the village is included in the Northwest Arctic Borough. However, as a practical matter, without building permits or site review flood regulations are not implemented in the community.

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 mapping areas of flood risk, and requiring local implementation to reduce flood damage primarily through requiring the elevation of structures above the base (100-year) flood elevations. At this time, due to lack of public services and the inevitable relocation of the village, implementing flood regulations in the village is unlikely.

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.

Flood and Erosion Mitigation Goals, Objectives and Projects

Goals and Objectives

Goal 1. Reduce flood damage.

Objective 1.1: Support continued construction and maintenance of a seawall and elevation and flood proofing of structures in the community.

Goal 2. Prevent future flood damage.

Objective 2.1: Consider the benefits and costs of joining the National Flood Insurance Program.

Goal 3: Increase public awareness

Objective 3.1 Increase public knowledgeable about mitigation opportunities, floodplain functions, emergency service procedures, and potential hazards.

Flood and Projects

There have been several detailed studies regarding relocating the village to another site. The most recent study, *USCOE Relocation Planning Project, December 2005* lists the following alternatives:

Improve the current site, or

Move the village to a new site at:

- Imnakuk Bluffs,
- Simiq,
- Tatchim Isua,
- Kiniktuuraq,
- Igrugaivik, or
- Kuugruaq.

The report further states: “Kivalina residents have voted several times to choose the new village town site from the list of alternative sites. However, not only does a significant portion of the community disagree with the elected site, but the site chosen (Kiniqtuuraq) has proven to be geotechnically inappropriate and strategically

problematic with respect to the ongoing erosion of the northern Alaska coastline. Site selection and availability of funding are major obstacles to the progress of the project."

Relocating the community is inevitable, however, mitigating flooding and erosion hazards in the current community is necessary to protect the residents and infrastructure until a relocation effort is accomplished.

Potential Projects:

Evacuation Road

The Northwest Arctic Borough hired ASCG to prepare *Kivalina Evacuation Relocation Road Feasibility Study, December 2005.* The report made the following recommendation.

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. 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.

Seawall Construction and Maintenance

A seawall was constructed in 2005 to protect the community. The cost of the seawall was $3,000,000; continued maintenance of the seawall is necessary to protect the village until relocation of the village can be accomplished.

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.

Kivalina Maps

Accurate flood maps should be prepared that delineate areas of flooding and upland areas.

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.

Section 2. Severe Weather

Hazard Description and Characterization

Weather is the result of four main features: the sun, the planet's atmosphere, moisture, and the structure of the planet. Certain combinations can result in severe weather events that have the potential to become a disaster.

In Alaska, there is great potential for weather disasters. High winds can combine with loose snow to produce a blinding blizzard and wind chill temperatures to 75°F below zero. Extreme cold (-40°F to -60°F) and ice fog may last a week at a time. Heavy snow can impact the interior and is common along the southern coast. A quick thaw means certain flooding.

Winter Storms

Winter storms originate as mid-latitude depressions or cyclonic weather systems. High winds, heavy snow, and cold temperatures usually accompany them. To develop, they require:

• Cold air - Subfreezing temperatures (below 32ºF, 0ºC) in the clouds and/or near the ground to make snow and/or ice.

• Moisture - The air must contain moisture in order to form clouds and precipitation.

• Lift - A mechanism to raise the moist air to form the clouds and cause precipitation. Lift may be provided by any or all of the following:

• The flow of air up a mountainside.

• Fronts, where warm air collides with cold air and rises over the dome of cold air.

• Upper-level low-pressure troughs.

Heavy Snow

Heavy snow, generally more than 12 inches of accumulation in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, airports and major 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 accidents. Casualties also occur due to overexertion while shoveling snow and hypothermia caused by overexposure to the cold weather.

Extreme cold

What is considered an excessively cold temperature varies according to the normal climate of a region. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." In Alaska, extreme cold usually involves temperatures below –40 degrees Fahrenheit. Excessive cold may accompany winter storms, be left in their wake, or can occur without storm activity.

Extreme cold can bring transportation to a halt across interior Alaska for days or sometimes weeks at a time. Aircraft may be grounded due to extreme cold and ice fog conditions, cutting off access as well as the flow of supplies to northern villages.

Extreme cold also interferes with a community's infrastructure. It causes fuel to congeal in storage tanks and supply lines, stopping electric generation. Without electricity, heaters 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.

Ice Storms

The term "ice storm" is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. They 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 from the accumulation of freezing rain, which is rain that becomes super cooled and freezes upon impact with cold surfaces. Freezing rain most commonly occurs in a narrow band within a winter storm that is also producing heavy amounts of snow and sleet in other locations.

Freezing rain develops as falling snow encounters a layer of warm air in the atmosphere deep enough for the snow to completely melt and become rain. As the rain continues to fall, it passes through a thin layer of cold air just above the earth's surface and cools to a temperature below freezing. The drops themselves do not freeze, but rather they become super cooled. When these super cooled drops strike the frozen ground, power lines, tree branches, etc., they instantly freeze.

Local Severe Weather Hazard Identification

Table 11. Kivalina Weather Statistics

CAPE LISBURNE, ALASKA
Period of Record General Climate Summary - Temperature

	Monthly Averages			Daily Extremes				Monthly Extremes			
	Max.	Min.	Mean	High	Date	Low	Date	Highest Mean	Year	Lowest Mean	Year
	F	F	F	F		F		F	-	F	-
Annual	21.9	13.1	17.5	74	8/6/1968	-47	2/19/1955	21.5	1967	13.2	1955
Winter	1.0	-9.2	-4.1	47	12/21/1983	-47	2/19/1955	4.2	1982	-13.9	1955
Spring	13.5	3.6	8.6	54	5/20/1969	-39	3/5/1955	17.8	1967	0.6	1984
Summer	46.9	38.4	42.7	74	8/6/1968	20	6/3/1974	46.3	1977	39.0	1975
Fall	26.3	19.7	23.0	64	9/5/1974	-23	11/26197	26.9	1973	18.2	1975

Table updated on Aug 1, 2006
Source: Western Regional Climate Center, wrcc@dri.edu

Previous Occurrences of Severe Weather

Please see Table 11 above for previous occurrences of severe weather.

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.

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 shorefast as the temperature drops. Areas of open water may occur during the winter depending on changes in wind, currents, and temperature.

Severe Weather Hazard Vulnerability

Please see Hazard Vulnerability Assessment Matrix and description at the beginning of this chapter.

Severe Weather Mitigation Goals and Projects

Severe Weather Goals and Projects

Goal 1: Mitigate the effects of extreme weather by instituting programs that provide early warning and preparation.

Goal 2: Educate people about the dangers of extreme weather and how to prepare.

Goal 3: Develop practical measures to warn in the event of a severe weather event.

Potential Projects:

Research and consider instituting the National Weather Service program of *"Storm Ready".*

Storm Ready is a nationwide community preparedness program that uses a grassroots approach to help communities develop plans to handle all types of severe weather—from tornadoes to tsunamis. The program encourages communities to take a new, proactive approach to improving local hazardous weather operations by providing emergency managers with clear-cut guidelines on how to improve their hazardous weather operations.

To be officially Storm Ready, a community must:

1. Establish a 24-hour warning point and emergency operations center.
2. Have more than one way to receive severe weather forecasts and warnings and to alert the public.
3. Create a system that monitors local weather conditions.
4. Promote the importance of public readiness through community seminars.
5. Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises.
6. Demonstrate a capability to disseminate warnings.

Specific Storm Ready guidelines, examples, and applications also may be found on the Internet at: www.nws.noaa.gov/stormready

Conduct special awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc.

Expand public awareness about NOAA Weather Radio for continuous weather broadcasts and warning tone alert capability.

Encourage weather-resistant building, construction materials, and practices.

Install a siren to warn people of a severe weather event or disaster event.

Install automated weather sensors. Automated weather sensors are the chief method by which the National Weather Service detects the occurrence of incoming severe weather.

Section 3. Earthquake

Hazard Description and Characterization

Approximately 11% of the world's earthquakes occur in Alaska, making it one of the most seismically active regions in the world. Three of the ten largest quakes in the world since 1900 have occurred here. Earthquakes of magnitude 7 or greater occur in Alaska on average of about once a year; magnitude 8 earthquakes average about 14 years between events.

Most large earthquakes are caused by a sudden release of accumulated stresses between crustal plates that move against each other on the earth's surface. Some earthquakes occur along faults that lie within these plates. The dangers associated with earthquakes include ground shaking, surface faulting, ground failures, snow avalanches, seiches and tsunamis. The extent of damage is dependent on the magnitude of the quake, the geology of the area, distance from the epicenter and structure design and construction. A main goal of an earthquake hazard reduction

program is to preserve lives through economical rehabilitation of existing structures and constructing safe new structures.

Ground shaking is due to the three main classes of seismic waves generated by an earthquake. Primary waves are the first ones felt, often as a sharp jolt. Shear or secondary waves are slower and usually have a side-to-side movement. They can be very damaging because structures are more vulnerable to horizontal than vertical motion.

Surface waves are the slowest, although they can carry the bulk of the energy in a large earthquake. The damage to buildings depends on how the specific characteristics of each incoming wave interact with the buildings' height, shape, and construction materials.

Earthquakes are usually measured in terms of their magnitude and intensity. Magnitude is related to the amount of energy released during an event while intensity refers to the effects on people and structures at a particular place. Earthquake magnitude is usually reported according to the standard Richter scale for small to moderate earthquakes.

Large earthquakes, like those that commonly occur in Alaska are reported according to the moment-magnitude scale because the standard Richter scale does not adequately represent the energy released by these large events.

Intensity is usually reported using the Modified Mercalli Intensity Scale. This scale has 12 categories ranging from not felt to total destruction. Different values can be recorded at different locations for the same event depending on local circumstances such as distance from the epicenter or building construction practices. Soil conditions are a major factor in determining an earthquake's intensity, as unconsolidated fill areas will have more damage than an area with shallow bedrock. Surface faulting is the differential movement of the two sides of a fault. There are three general types of faulting.

Strike-slip faults are where each side of the fault moves horizontally. Normal faults have one side dropping down relative to the other side. Thrust (reverse) faults have one side moving up and over the fault relative to the other side.

Earthquake-induced ground failure is often the result of liquefaction, which occurs when soil (usually sand and course silt with high water content) loses strength as a result of the shaking and acts like a viscous fluid.

Liquefaction causes three types of ground failures: lateral spreads, flow failures, and loss of bearing strength. In the 1964 earthquake, over 200 bridges were destroyed or damaged due to lateral spreads. Flow failures damaged the port facilities in Seward, Valdez and Whittier.

Similar ground failures can result from loss of strength in saturated clay soils, as occurred in several major landslides that were responsible for most of the earthquake damage in Anchorage in 1964. Other types of earthquake-induced ground failures include slumps and debris slides on steep slopes.

Local Earthquake Hazard Identification

Earthquakes with the magnitude of 6.0 or greater have occurred four times in both the Chukchi Sea and Western Alaska. The largest earthquake on record for this region occurred in 1958, approximately 210 miles southeast of Kivalina near Huslia with a magnitude of 7.3, followed by two M6.0 aftershocks. During this earthquake, extensive failure in unconsolidated surface soils within an elongated northeast zone were observed. The Kaltag Fault System passes south of Huslia, but no significant seismic activity has been associated with this fault.

An earthquake of 6.0 occurred on the Seward Peninsula in 1950; however, there is little information available about this earthquake. In 1928, a M6.9 earthquake and three M6.0 aftershocks occurred in the western Chukchi Sea approximately 155 miles west of Kivalina an earthquake. The Kobuk Fault, east-west trending fault that displaces Quaternary deposits, triggered a series of moderate M4.6 earthquakes approximately 225 miles west of Kotzebue.

A geologic map of the area prepared by the Geological Society of America, (Neotectonic Map of Alaska, Plafker, Gilpin, and Lahr 1993), does not show faults or linements with evidence of Holocene (0 to 11,000 years) or Quaternary (11,000 to 500,000 years) displacement within approximately 140 miles of the Kivalina site. Earthquake-induced geologic hazards that may affect the site include landslides, fault rupture, settlement, liquefaction, and associated effects (loss of shear strength, bearing capacity failures, loss of lateral support, ground oscillation, lateral spreading, etc.). Liquefaction occurs when excess pore pressures develop during untrained cyclic loading of uncohesive soils, causing a reduction in effective stress and strength. 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.

The following tables were obtained from the University of Alaska, Fairbanks, and Alaska Earthquake Information Center website at: http://www.giseis.alaska.edu/Seis/

The tables and other information at the website list the Kivalina area as having a low probability of an earthquake. However, since all of Alaska is at risk for an earthquake event Kivalina could be at risk for an earthquake or have secondary impact from an earthquake in the region.

The City of Kivalina staff and elders have stated that to their knowledge an earthquake has or has not caused any damage in the Kivalina area, however, the danger always exists in Alaska.

Figure 1. AEIS Earthquake Active Faults

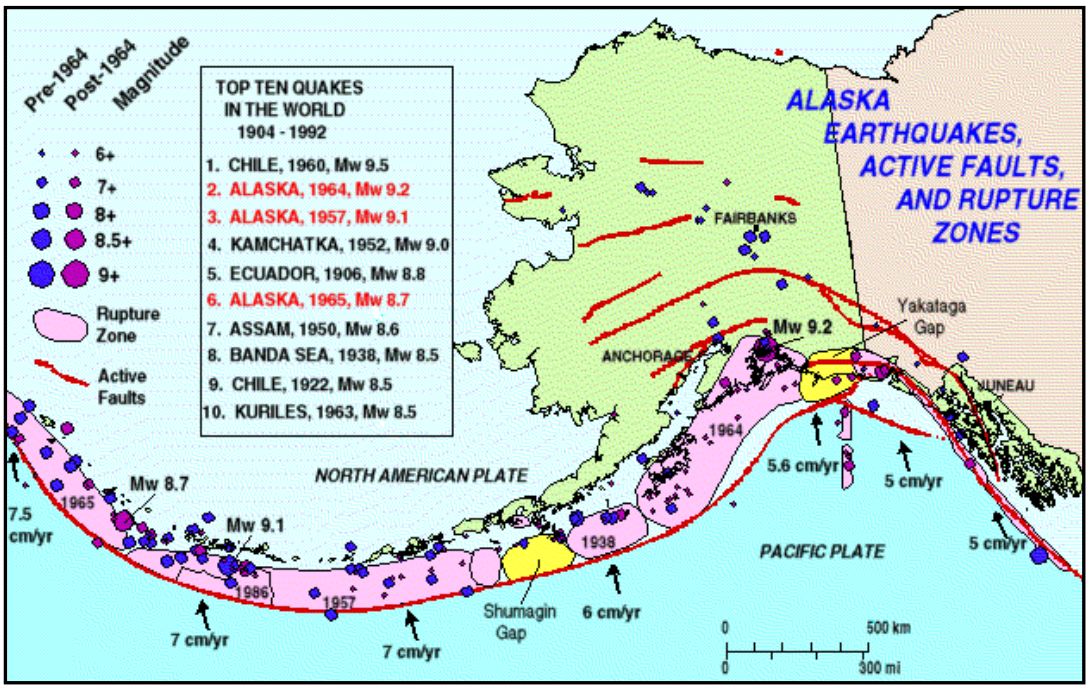
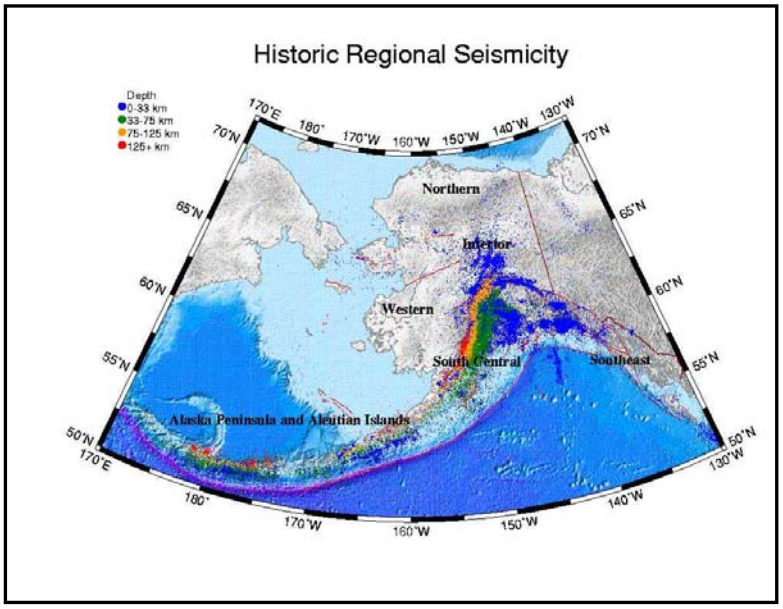


Figure 2. AEIS Historic Regional Seismicity



The State of Alaska State Hazard Plan designates Kivalina as in a Zone 1, Low Risk of potential earthquake danger (on a scale of 0 being the lowest).

Previous Occurrences of Earthquakes

There have been no previous occurrences of earthquakes in Kivalina.

Earthquake Hazard Vulnerability

Please see Hazard Vulnerability Assessment Matrix and description at the beginning of this chapter.

Earthquake Mitigation Goals and Projects

Earthquake Goals and Projects

Goal 1: Obtain funding to protect existing critical infrastructure from earthquake damage.

Potential Projects:

If funding is available, perform an engineering assessment of the earthquake vulnerability of each identified critical infrastructure owned by the City of Kivalina.

Identify buildings and facilities that must be able to remain operable during and following an earthquake event.

Contract a structural engineering firm to assess the identified buildings and facilities to determine their structural integrity and strategy to improve their earthquake resistance.

Section 4. Description of Hazards Not Present in Kivalina

Avalanche, Landslides and Volcanoes

Kivalina is located on a flat floodplain with a gentle topographic relief in the city estimated to be 10 – 12 feet. There is no danger from avalanches, landslides or volcanoes because there are no mountains or steep slopes in the city.

Tsunamis and Seiches

There is no danger of tsunamis and seiches since the topography of the Bering Sea and Kivalina does not allow for a tsunami to build up and threaten the community.

Fault rupture on the seafloor can produce tsunamis, a hazard in coastal areas. There were no reported tsunamis associated with the 1928 submarine earthquakes in the Chukchi Sea. The closest recorded submarine earthquake that produced a tsunami occurred in 1991 in the Bearing Sea southwest of St. Matthew Island, (West Coast &

Alaska Tsunami Warning databases). This M6.1 earthquake occurred near the edge of the continental shelf.

Wildland Fire

There are no trees or grasslands in Kivalina. Therefore, there is no fuel to produce a wildland fire. A structure fire is possible, but the scope of this plan is limited to natural hazards. The following paragraphs outline the topography and soils in Kivalina.

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 quaternary 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 deep 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*).

Chapter 4: Mitigation Strategy

Mitigation Strategy Development

This chapter of the plan outlines Kivalina's overall strategy to reduce its vulnerability to the effects of the hazards studied. Currently the planning effort is limited to the hazards determined to be of the most concern; flooding, severe weather and earthquake; however, the mitigation strategy will be regularly updated as additional hazard information is added and new information becomes available.

The following projects or plans are not prioritized, they are numbered simply for ease of identification.

The City of Kivalina will use the following factors to prioritize mitigation project items should funding become available. Due to the dollar value associated with both life-safety and critical facilities the prioritization strategy represents a special emphasis on benefit-cost analysis because the factors of life-safety and critical facilities will steer the prioritization towards projects with likely good benefit-cost ratios.

1. Extent to which benefits are maximized when compared to the costs of the project.

2. Extent the project reduces risk to life-safety.

3. Project protects critical facilities or critical city functionality.

    A. Hazard probability.

    B. Hazard severity.

Mitigation Project Plan

Table 12. Mitigation Project Plan

Mitigation Projects	Responsible Agency	Cost	Funding Sources Possible	Estimated Timeframe
Project 1. Relocate Sewage Treatment Plant	NWAB	$3,500,000	NWAB FEMA	>1 year
Project 2. Relocate fuel lines to school	NWAB	>$150,000	NWAB FEMA	>1 year
Project 3. Remove exposed sewage bunkers on shoreline	FEMA DEC City	>$150,000	Federal and State Grants	Ongoing
Project 4. Relocate homes threatened by erosion	FEMA State Agencies City	>$10,000	Federal and State Grants	Ongoing
Project 5. Repair wind and ice damaged public water tank skins	FEMA DEC	To be determined	Federal and State Grants	>1 year
Project 6. Repair exposed underground water lines from lagoon to community	FEMA City State Agencies	To be determined	Federal and State Grants	>1 year
Project 7. Kivalina Lagoon erosion control project	USCOE	To be determined	Federal Project	>10 years

Mitigation Projects	Responsible Agency	Cost	Funding Sources Possible	Estimated Timeframe
Project 8. Evacuation/Relocation Road	USCOE FEMA DHS&EM City	$21,000,000	USCOE FEMA DHS&EM	>1 year
Project 9. Seawall Construction and Maintenance	USCOE FEMA DHS&EM City	$3,000,000	USCOE FEMA DHS&EM	Ongoing
Project 10. Structure Elevation and Floodproofing, and continued participation in the NFIP	City DCCED FEMA	To be Determined	DHS&EM FEMA	Ongoing
Project 11. Kivalina Maps	FEMA USCOE	>$10,000	DCCED USCOE	<1 year
Project 12. Public Education	City DCCED	Staff Time	DCCED	Ongoing
Project 13: Research and consider instituting the National Weather Service program of *"Storm Ready"*.	City	Staff Time	DCCED	<1 year

Mitigation Projects	Responsible Agency	Cost	Funding Sources Possible	Estimated Timeframe
Project 14: Conduct special a awareness activities, such as Winter Weather Awareness Week, Flood Awareness Week, etc.	City DCCED DHS&EM	Staff Time	DCCED DHS&EM	<1 year
Project 15: Expand public awareness about NOAA Weather Radio for continuous weather broadcasts and warning tone alert capability.	City	Staff Time	NOAA	Ongoing
Project 16: Encourage weather resistant building construction materials and practices.	City	Staff Time	City	<1 year
Project 17: Install a siren to warn people of a severe weather or disaster event.	City DCCED DHS&EM	>$5,000	DCCED DHS&EM	<1 year
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.	DHS&EM	>$20,000	PDGM	>1 year
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.	City DHS&EM DCCED	Staff Time	State Grants	<1 year

Mitigation Projects	Responsible Agency	Cost	Funding Sources Possible	Estimated Timeframe
Project 20: Identify buildings and facilities that must be able to remain operable during and following an earthquake event.	City DHS&EM	Combine with Project 14	PDMG	>5 years
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.	City DHS&EM	Combine with Project 14	PDMG	>5 years
Project 22: Develop a contract with DHS&EM that would go into effect after a major disaster to facilitate funds being funneled into the Village	City DHS&EM	To be determined	PDMG DHS&EM	<1 year

Glossary of Terms

A-Zones A-Zones are found on all Flood Hazard Boundary Maps (FHBMs), Flood Insurance Rate Maps (FIRMs), and Flood Boundary and Floodway Maps (FBFMs).

Acquisition Local governments can acquire lands in high hazard areas through conservation easements, purchase of development rights, or outright purchase of property.

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

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

Asset Any manmade or natural feature that has value, including, but not limited to people; buildings; infrastructure like bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks.

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

Base Flood A term used in the National Flood Insurance Program to indicate the minimum size of a flood. This information is used by a community as a basis for its floodplain management regulations. It is the level of a flood that has a one-percent chance of occurring in any given year. Also known as a 100-year flood elevation or one-percent chance flood.

Base Flood Elevation (BFE) The elevation for which there is a one-percent chance in any given year that flood water levels will equal or exceed it. The BFE is determined by statistical analysis for each local area and designated on the Flood Insurance Rate Maps. It is also known as 100-year flood elevation.

Base Floodplain The area that has a one percent chance of flooding (being inundated by flood waters) in any given year.

Building A structure that is walled and roofed, principally above ground and permanently affixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.

Building Code The regulations adopted by a local governing body setting forth standards for the construction, addition, modification, and repair of buildings and other structures for the purpose of protecting the health, safety, and general welfare of the public.

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

Community Rating System (CRS) The Community Rating System is a voluntary program that each municipality or county government can choose to participate in. The activities that are undertaken through CRS are awarded points. A community's points can earn people in their community a discount on their flood insurance premiums.

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

Designated Floodway The channel of a stream and that portion of the adjoining floodplain designated by a regulatory agency to be kept free of further development to provide for unobstructed passage of flood flows.

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

Digitize To convert electronically points, lines, and area boundaries shown on maps into x, y coordinates (e.g., latitude and longitude, universal transverse Mercator (UTM), or table coordinates) for use in computer

Disaster Mitigation Act DMA 2000 (public Law 106-390) is the latest legislation of 2000 (DMA 2000) to improve the planning process. It was signed into law on October 10, 2000. This new legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur.

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

Elevation The raising of a structure to place it above flood waters on an extended support structure.

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

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

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

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

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

Flood Disaster Assistance Flood disaster assistance includes development of comprehensive preparedness and recovery plans, program capabilities, and organization of Federal agencies and of State and local governments to mitigate the adverse effects of disastrous floods. It may include maximum hazard reduction, avoidance, and mitigation measures, as well policies, procedures, and eligibility criteria for Federal grant or loan assistance to State and local governments, private organizations, or individuals as the result of the major disaster.

Flood Elevation Elevation of the water surface above an establish datum (reference mark), e.g. National Geodetic Vertical Datum of 1929, North American Datum of 1988, or Mean Sea Level.

Flood Hazard Flood Hazard is the potential for inundation and involves the risk of life, health, property, and natural value. Two-reference base are commonly used: (1) For most situations, the Base Flood is that flood which has a one-percent chance of being exceeded in any given year (also known as the 100-year flood); (2) for critical actions, an activity for which a one-percent chance of flooding would be too great, at a minimum the base flood is that flood which has a 0.2 percent chance of being exceeded in any given year (also known as the 500-year flood).

Flood Insurance Rate Map Flood Insurance Rate Map (FIRM) means an official map of a community, on which the Administrator has delineated both the special hazard areas and the risk premium zones applicable to the community.

Flood Insurance Study Flood Insurance Study or Flood Elevation Study means an examination, evaluation and determination of flood hazards and, if appropriate, corresponding water surface elevations, or an examination, evaluations and determination of mudslide (i.e., mudflow) and/or flood-related' erosion hazards.

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

Governing Body The legislative body of a municipality that is the assembly of a borough or the council of a city.

Hazard A source of potential danger or adverse condition. Hazards in the context of this plan will include naturally occurring events such as floods, earthquakes, tsunami, coastal storms, landslides, and wildfires that strike populated areas. A natural event is a hazard when it has the potential to harm people or property.

Hazard Event A specific occurrence of a particular type of hazard.

Hazard Identification The process of identifying hazards that threaten an area.

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

Hazard Mitigation Grant Program The program authorized under section 404 of the Stafford Act, which may provide funding for mitigation measures identified through the evaluation of natural hazards conducted under §322 of the Disaster Mitigation Act 2000.

Hazard Profile A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.

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

Mitigate To cause something to become less harsh or hostile, to make less severe or painful.

Mitigation Plan A systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in the State and includes a description of actions to minimize future vulnerability to hazards.

National Flood Insurance The Federal program, created by an act of Congress in Program (NFIP) 1968 that makes flood insurance available in communities that enact satisfactory floodplain management regulations.

One Hundred (100)-Year The flood elevation that has a one-percent chance of occurring in any given year. It is also known as the Base Flood.

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

Repetitive Loss Property A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1000 each have been paid within any 10-year period since 1978.

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

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

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

Runoff That portion of precipitation that is not intercepted by vegetation, absorbed by land surface, or evaporated, and thus flows overland into a depression, stream, lake, or ocean (runoff, called immediate subsurface runoff, also takes place in the upper layers of soil).

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

Seismicity Describes the likelihood of an area being subject to earthquakes.

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

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

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

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

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

Vulnerability Assessment The extent of injury and damage that may result from hazard event of a given intensity in a given area. The vulnerability assessment should address impacts of hazard events on the existing and future built environment.

Watercourse A natural or artificial channel in which a flow of water occurs either continually or intermittently.

Watershed An area that drains to a single point. In a natural basin, this is the area contributing flow to a given place or stream.

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5. Kivalina Relocation Community Layout Plan, December 2001. Prepared for USCOE, Kivalina Relocation Planning Committee by Tryck Nyman Hayes, URS Corporation.

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Appendix A

Kivalina Leaderships' Proposal

Attachment A

Kivalina Leaderships' Proposal

NATIVE VILLAGE OF KIVALINA
KIVALINA CITY COUNCIL
PRESENTATION TO
SENATOR LISA MURKOWSKI
Barrow, Ak

July 10-13, 2006

Inuit Circumpolar Conference

Still talking about relocation since 1963, in the meantime…..

- Delay is causing money to be spent on things that could have been avoided and is now also endangering peoples' lives.
- People are fearing for their lives (peoples' comments).
- Homes on the southeast side of Kivalina are in danger of falling into the lagoon.
- 60 ft of land has eroded since 2004 on the southwest beach side.
- Storm surges have threatened the airport

No communication between Kivalina Leadership and the Borough, giving no voice to the people of Kivalina.

- Northwest Arctic Borough is making plans without input from Kivalina, i.e. evacuation road to nowhere, erosion control project. The proposed evacuation road will require more studies, which translates to a longer wait because of the flood plain and wetland status of most of the lands inland of Kivalina.
- Senator Stevens said that he would make Northwest Arctic Borough the point of contact for his office regarding Kivalina but the borough has not passed on any information.
- During the first years of our Memorandum of Agreement between the Northwest Arctic Borough, Kivalina City Council and the Native Village of Kivalina, the Borough made little effort to attend the Relocation project meetings called for by the Kivalina leadership to discuss the project, which resulted in division and disharmony in the village.

Site Selection was voted on in the late '90's by the people of Kivalina, which is being ignored.

- The people have already voted twice and were given the impression that Kivalina was making a final selection, per Army Corps of Engineers..
- Because of the final vote, the Department of Transportation and Public Facilities began their study process to site the airport in 2000 at Kiŋiktuuraq, and conducted wind data collection
- As a result of the vote, BIA also allocated funding for a survey of the new site, which expired in February of 2006. Now we may have problems getting that money reallocated.
- The Northwest Arctic Borough selected Tatchim Isua as a relocation site, which was suggested to the Army Corps of Engineers as a possible gravel site only, after the election of the new site.

The NWAB is manipulating the process until the objective of the Borough is realized for whatever their motives are.

- The Northwest Arctic Borough politically monopolized the relocation project by cutting off communication between the Kivalina Leadership and the Army Corps of Engineers which caused a loss of 1 ½ yrs. of the PAS agreement which lead to an extension of another 2 years to the 5 year plan, for which Kivalina provides a 50/50 match.
- Against the wishes of the village leadership, the Army Corps of Engineers, under pressure brought to bear, were told to use the storm surge study for the Delong Mountain Transportation System Port Site expansion project for the Kivalina Relocation Project.

No plans to improve living conditions in existing site using the Kivalina Relocation Project as an excuse.

- Lack of water and sewer, which causes health risks.
- Army Corps of Engineers existing schedule is a detriment to our chances for an improved and safer living condition.
- Any capital improvement project is either stymied or cancelled because of the possibility of relocation.

This relocation project has been labeled "model project" with "everything new", which unnecessarily escalated the estimated project cost, which in turn, makes the move next to impossible

- We can't afford to be the "model village" for future relocation projects for the Army Corps of Engineers because recent fall storm surges that happened in 2004-2005 have accelerated the erosion process.

Behind schedule-original master schedule lists 2006 as beginning of construction.

- Back to square one for the fourth time, according to the Army Corps of Engineers stage 1 master plan, which projects another wait for 7-10 years, years we don't have due to recurrences of extreme fall storm surges.
- All studies that needed to be done for relocation are already finalized, we are ready to move.
- Study done by the Army Corps of Egineers in 2000, which is still in draft form, determined that Kivalina is in imminent danger of flooding. It predicts that Kivalina will be inundated with approximately 4.5 to 6ft of ocean water.

Using estimated project cost to defer the peoples' decision to relocate Kivalina to Kiŋiktuuraq.

- Cost of moving Kivalina to Kiŋiktuuraq is highly over estimated, per Kivalina leadership, e.i., gravel cost alone would cost $200-250 million.
- This estimated cost is based on Kivalina being a "model village" for future Army Corps of Engineers' projects, which consists of all new homes, public facilities & community infrastructure.
- The people have been told many times, at every opportunity by the Army Corps of Engineers and the Northwest Arctic Borough that it is not likely that Congress will fund the project unless we move away from the coast because of the amount of gravel our village pad would need that would cost too much.

Kivalina Leaderships' Proposal

(Our proposal goes against what is being planned for us by outside entities such as the Army Corps of Engineers and the Northwest Arctic Borough)

- Kivalina is willing to compromise by moving any existing infrastructure that is movable with minimum damage as opposed to getting everything all new.
- Any public infrastructure such as school, clinic, utility plant, and airport will be taken care of by their respective agencies.
- Individuals homes that are movable will be moved.
- Let us move to Kiŋiktuuraq because it's what the majority of the people voted for.
- The Northwest Arctic Borough's proposed evacuation road can go from Kiŋiktuuraq to Kisimigiuqtuq as opposed to the proposed road going from Kivalina, our existing site, to the same, which is an excellent source of gravel.

BENEFITS OF THIS PROPOSAL

- We can only hope that the village is moved before it is flooded and lives are saved as a result.
- Village move is more immediate than what the Corps proposes.
- Cost of project is brought down considerably.
- Economic Development is possible closer to shore.
- Cost of living is kept at a minimum in order for the village to support itself.
- Due to accessibility by barge, fuel cost are kept at a minimum.
- The Northwest Arctic Borough's proposed evacuation road is still useful for it's intended purpose.
- Access to subsistence resources provided by the ocean is preserved, which is important because according to a study conducted by the Department of Fish and Wildlife, 79% of our people's diet consists of marine mammals.