US Army Corps
of Engineers
Alaska District

Alaska Village Erosion Technical Assistance Program

An Examination of Erosion Issues in the Communities of Bethel, Dillingham, Kaktovik, Kivalina, Newtok, Shishmaref, and Unalakleet.

April 2006

Executive Summary

This report was prepared as a response to legislation that directed the U.S. Army Corps of Engineers (Corps) to investigate issues surrounding erosion at several Alaska Native villages. As part of this effort, the Corps examined erosion rates and control, potential relocation, and impacts to Alaska Native culture and tradition. The Alaska Village Erosion Technical Assistance (AVETA) program is a compilation of efforts in numerous communities funded through the Tribal Partnership Program and subsequent legislation.

Specifically, this report documents the responses to questions raised in the Consolidated Appropriations Resolution, 2003 PL 108-7, Division D - Energy and Water Development Appropriations, 2003, Conference Report (H.R. 108-10, page 807), Senate Report (S.R. 107-220, page 23), and HR 108-357, Section 112, page 10, Conference Report Energy and Water Development Appropriations Bill, 2004 with regards to the communities of Bethel, Dillingham, Kaktovik, Kivalina, Newtok, Shishmaref, and Unalakleet.

The questions asked were: what are the costs of ongoing erosion, what would it cost to relocate a community, and how much time do these communities have left before they are lost to erosion. The following table summarizes the answers to these questions.

Community	Costs of Future Erosion Protection	Cost to Relocate	How Long Does The Community Have*
Bethel	$ 5,000,000	N/A	> 100 years
Dillingham	10,000,000	N/A	> 100 years
Kaktovik	40,000,000	$ 20 – 40 Million	> 100 years
Kivalina	15,000,000	$ 95 – 125 Million	10 – 15 years
Newtok	90,000,000	$ 80 – 130 Million	10 – 15 years
Shishmaref	16,000,000	$100 – 200 Million	10 – 15 years
Unalakleet	30,000,000	N/A	> 100 years

*These numbers assume no future erosion protection, including that listed here, is not implemented

This report documents the wide variety of efforts the Corps is undertaking through Tribal Partnership funding to address ongoing erosion problems in Alaska. Many issues related to erosion protection and community relocation are also discussed in this report. Most importantly, each village has a summary of findings that explores solutions for these most critical villages. This report also describes other Corps efforts such as the Baseline Erosion Assessment, which documents the Corps strategy to address erosion in Alaska both now and in the future.

This technical report has been prepared by the Alaska District, U.S. Army Corps of Engineers in coordination with and with the assistance of multiple agencies, villages, and stakeholders.

1.0 INTRODUCTION

This report was prepared as a response to legislation that directed the U.S. Army Corps of Engineers (Corps) to investigate issues surrounding erosion at several Alaska Native villages. As part of this effort, the Corps examined erosion rates and control, potential relocation, and impacts to Alaska Native culture and tradition. The Alaska Village Erosion Technical Assistance (AVETA) program is a compilation of efforts in numerous communities funded through the Tribal Partnership Program and subsequent legislation.

2.0 STUDY AUTHORITY

The authority for this study is the Consolidated Appropriations Resolution, 2003 PL 108-7, Division D - Energy and Water Development Appropriations, 2003, Conference Report (H.R. 108-10, page 807) and Senate Report (S.R. 107-220, page 23), which reads as follows:

> *"Tribal Partnership Program.—The Committee acknowledges the serious impacts of coastal erosion due to continued climate change and other factors in the following communities in Alaska: Bethel, Dillingham, Shishmaref, Kakatovik, Kivalina, Unalakleet, and Newtok. The Committee directs the Corps to perform an analysis of the costs associated with continued erosion of these communities, potential costs associated with moving the affected communities to new locations (including collocation with existing communities), and to identify the expected time line for a complete failure of the useable land associated with each community. An additional $2,000,000 above the President's request has been provided for this work, of which $1,000,000 is for Shishmaref, AK. Due to rapid erosion occurring at Shishmaref, AK, the Committee directs the Corps to expedite all necessary environmental studies to document the impacts of this severe and continuing erosion."*

Additional authority directing the report to be conducted as a technical study and at full federal cost was provided in HR 108-357, Section 112, page 10, Conference Report Energy and Water Development Appropriations Bill, 2004, which reads as follows:

> *"SEC. 112. The amount of $2,000,000 previously provided under the heading ''Construction, General'' in title I of the Energy and Water Development Appropriations Act, 2003, division D of Public Law 108–7, is to be used to provide technical assistance at full Federal expense, to Alaskan communities to address the serious impacts of coastal erosion."*

3.0 STUDY PURPOSE

Each village had its own study effort, and this report summarizes and compiles the findings for the entire effort. The primary purpose of each study was to respond to the three questions asked by Congress. These questions are stated in Section 2.0 but are repeated here for clarity.

1. What are the costs associated with continued erosion of these communities?
2. What are potential costs associated with moving the affected communities to new locations or an existing community?
3. What is the expected time line for complete failure of the usable land associated with each community?

A secondary purpose of the studies was to provide technical assistance or studies that the particular community would find beneficial. The technical assistance took the form of relocation planning, cultural resource inventories, and investigation of interim erosion protection features.

4.0 STUDY METHODOLOGY

As mentioned in the congressional language, certain issues such as costs of erosion and relocation are subjects of keen interest to many. To answer the questions presented by Congress, certain assumptions were made to ensure consistency of analysis between the various villages. The following is a description of issues we identified, what assumptions were made, and how we analyzed each question

4.1. Relocation Planning Issues and Assumptions

The following is a listing and discussion of a few key issues, how they were resolved through assumptions for this analysis, and what may need to happen to resolve these issues in a more complete manner.

Who selects the new site?
The issue of who does the site selection depends upon jurisdiction and ownership. Whereas the community plays the major role in the selection of an appropriate site, they may not have jurisdiction to choose a site that is in public ownership or has been encumbered through some prior agreement. We have not addressed this issue is this analysis; however, it is a critical item that will need to be addressed as part of relocation planning. The assumption for this analysis is that an adequate site could be identified and acquired through a reasonable process in a reasonable amount of time. It should be noted that the Community of Newtok already has identified and acquired a new location for their community.

What are the criteria used for selecting a new site?
Though specific sites, with the exception of Newtok, have not been identified, certain assumptions have been made regarding criteria for a new location. Most importantly, a new location would not be in a flood or erosion hazard area. It would have enough developable space available to allow room for the existing community to settle plus some room for spreading out or expansion. A new site would also need to be accessible to a water supply,

subsistence, and other resources important to the community. Essentially, the new site should improve the conditions that are causing the community to relocate in the first place.

Does the community move all at once?
The most likely scenario is that the community would not move all at once. Because of the high costs and difficult logistics, a community would realistically move over the course of time. The model that seems most practical is to start at the new site with a few homes and rudimentary infrastructure. Over time, more houses could be moved, with new infrastructure being built at the new site instead of upgrading or replacing facilities at the old. This will spread out the cost and the logistics over time. For a while, it would seem that there are two communities, but eventually, the new site would be the more desirable location for the community to have its permanent residence and the old site would no longer be maintained.

What is to be done with the existing site?
This is a particularly difficult issue especially in regard to any sites of cultural value or areas that may have potential contamination. Our estimates have included some costs for the decommissioning of the old site. Regarding access, it would be expected that the community would still have access to the old site for cultural or subsistence activities. It also may be reasonable to assume that a few families may still maintain a structure or residence at the old site. However, if a relocation effort is to be successful, then groups responsible for the development of housing and infrastructure must stop investing in the old site, and provide resources only to the new. Eventually, the old site could be expected to be utilized as a remote subsistence camp similar to those scattered for miles around the area of the community.

Should the community be moved as-is or should it be upgraded to current standards?
The model we have used is that the relocation effort would move whatever structures can reasonably be moved and replace those that could not. For example, many of the existing houses are quite portable, but other items, such as the bulk fuel tanks, cannot be readily moved. If it would be less expensive to replace than move, then it would be replaced. Funds that would upgrade or replace a system at the old community would be used to build a new system at the new community.

What needs to happen first for relocation?
This issue acknowledges that there are several policies, regulations, and laws that state there must be X number of people in a community before item Y can be provided. The analysis of these regulations is beyond the scope of this study, but will be completed as part of the relocation planning.

What is the timeline for relocation?
Logistics and funding govern this issue. Practically speaking, it will take several years for a community to move. Only so much funding can be provided on an annual basis, and, because of the seasonal weather constraints, there is only so much time that work can be done in any given year. Through our analysis we determined that a timeline of 15 to 20 years for complete relocation is a reasonable expectation.

What costs are directly related to erosion and what are related to other issues?

Erosion issues are not the only reasons why communities want to relocate. Both Kivalina and Shishmaref have expressed that their communities have no room left to expand and that their current location has made it infeasible for them to have running water and sewer hookup. Erosion of land has much to do with why a community has little space to expand, but little to do with ability to have running water and sewer hookups.

What agency will take the lead for erosion and relocation?
The issue of there being no lead agency to administer a statewide erosion program has been mentioned at all levels of government. Indeed, no single agency has all the authorities, much less the funding, to relocate a community. The Corps recognizes this issue and, in the interim, has taken steps to lead the way for a number of discreet elements. For example, the Alaska Baseline Erosion Assessment, an activity to coordinate, plan and prioritize appropriate responses to erosion issues in Alaska, has been using a collaborative planning forum to accomplish project goals. The Corps has assumed a leadership role for coordination and technical analysis, which is being coordinated also through various Federal, State, Federally recognized Tribes, and local agencies. A similar lead agency model may work for addressing the overall issue of erosion in Alaska. In order to execute a program of this magnitude, it is essential that a lead agency be designated through authorization (or some level of empowerment), be provided specific direction, and granted access to a continuous funding stream. Utilizing an assemblage or bundling of agencies would likely hinder accomplishment of implementing a substantial project. Each agency typically has their own program , funding priorities, authorities, and fiscal rules that often are not conducive to multi-agency cooperation efforts. A lead agency is essential to provide commitment, direction and unity of purpose. That lead agency would then be able to tap the skills and abilities of the other agencies to accomplish task within their fields of expertise.

Do existing programs have sufficient funding and authority to initiate a move?
There appears to be sufficient authority throughout several agencies that could build a new community and all its related infrastructure. However, orchestrating the efforts of multiple agencies to implement a well-coordinated relocation would be a significant challenge. Initiating relocation would likely take special authorization and funding to begin the process. The key issues are ensuring funding exists to finance the appropriate programs to assist in the move, and designating the lead agency to lead and coordinate the effort.

Is relocation worth the cost?
Using the Corps typical benefit/cost ratio is probably not appropriate for relocation analysis even though future damages and costs of erosion control and/or relocation are mentioned in this report. There are multiple non-monetary items that have yet to undergo a detailed analysis. These are social and cultural effects as a result of erosion that cannot easily be reflected in dollar damages. Potential negative effects are loss of independence, discrimination, lack of employment opportunities, competition for scarce subsistence resources, and hostile education environment. Adverse life, health, and safety issues include loss of tribal entity, loss of language, increased health risks, and perceived safety in the new location.

What effect does climate change have upon the issue of erosion in Alaska?

For many, climate change seems to be the key issue at the center of Alaska erosion issues. The actual effects are unknown at this time but the issue does appear to have significant influence over erosion issues for coastal communities.

A noticeable physical parameter of climate change has been the late forming shore fast ice at locations along the Bering Strait and Chukchi Sea. Sea ice is particularly important during the autumn months when large Artic Ocean storms create waves and storm surge that cause erosion damage to communities typically protected by sea ice. Though the Corps has not investigated the extent of sea ice change, the National Snow and Ice Data Center (NSIDC) has published a trend in reduction of sea ice.

Regarding riverine communities, the effects of climate change and its impacts on erosion have not been investigated by the Corps. A significant factor could be the presence of permafrost in river banks. If permafrost were to become depleted, the river banks could lose stability and become more susceptible to erosion damages.

As the Corps continues to address erosion issues in Alaska, scenario analysis regarding climate trends will become an integral part of the decision making process. In particular, future planning and designs will need to examine various scenarios involving permafrost and sea ice to ensure designs can adapt to the various potential changes.

4.2. Methodologies for Responding to the Three Questions

The following sections detail the specific methodologies we utilized to answer the three questions posed by congress. We attempted to analyze the various communities utilizing the same basis and assumptions, but there always will be differences between each community and how community specific issues are to be addressed. With that in mind, the three questions were answered as follows.

4.2.1. What are the costs associated with continued erosion of these communities?

Question one examines the continued cost of erosion, which can be widely varied depending upon what exactly is being examined. Costs can include damages incurred by erosion, ongoing maintenance of protection structures, what it may cost to install erosion protection, and what are the social and income losses associated with the erosion problem.

For this analysis, the ongoing costs of erosion are broken into three categories:

- *Costs of protective measures installed to date.* This will include any constructed erosion protection project such as revetments, sheet-pile walls, and any emergency erosion protection measures undertaken.

- *Cost of future damages.* The future costs will examine the predicted losses due to future erosion damages. For communities such as Bethel, where much of the shoreline has been protected, this number will be low.

- *Cost of future erosion protection projects.* This category will include expected future construction of new erosion protection projects. Operation and maintenance is also a cost of erosion protection; however, past experience has shown us that operations and maintenance (O&M) is sometimes not actually performed especially if the O&M responsibilities are assigned to a local entity that already has enough financial responsibility as it is. A value for what the costs of future anticipated erosion protection would be, assuming the community either has it planned, requires it for the interim, or would need it if not relocated, has been included in the community specific discussion sections.

Erosion protection efforts to date are somewhat difficult to determine. Information is not always readily available and some erosion expenditures (especially emergency efforts) are undertaken at a local level. Records of those efforts were not available for this study. The following table summarizes data obtained from the Alaska Department of Commerce Community and Economic Development and Corps records for past erosion control efforts in the seven communities that are the subject of this report. Almost $74 million have been expended since 1981 in erosion control efforts for these communities.

Table 1 lists erosion control efforts for the seven listed communities. Table 2 lists other recent erosion control efforts undertaken by the Corps in other Alaskan communities.

Table 1. Summary of Erosion Control Measures Already Implemented

	State of AK Grants	Corps of Engineers	Natural Resources Conservation Service	DOT&PF	Bureau of Indian Affairs
Bethel	$23,493,000	$22,700,000		$4,760,000	
Dillingham		6,100,000			
Kaktovik					
Kivalina	485,000				
Newtok	1,477,000				
Shishmaref	1,715,000	1,500,000		90,000	5,200,000
Unalakleet	1,807,000		1,300,000	180,000	
Total by Funding Source	**$28,977,000**	**$34,300,000**	**1,300,000**	**$5,030,000**	**$5,200,000**

Note: DOT&PF is the State of Alaska Department of Transportation and Public Facilities.

Table 2. Summary of Other Recent Corps Erosion Control Measures

Project Title	Completed	Cost	Description
Deering Streambank Protection	1997	0.7M	Revetment totaling 1,379 lf
Emmonak Streambank Protection	1998	1.2M	Revetment totaling 1,452 lf
Galena Emergency Bank Stabilization	2005	3.9M	Revetment totaling 1,590 lf
Homer Spit Erosion	1998	8.4M	Revetment totaling 4,830 lf
Metlakatla	1995	0.2M	Revetments totaling 1,239 lf

4.2.2. What are potential costs associated with moving the affected communities to new locations or an existing community?

Question two examines the cost difference between moving a village to a new location and co-locating a village with an existing community. As demonstrated previously in the discussion of assumptions, this is an extremely difficult question to answer. Just stating a dollar figure alone does not encapsulate the various costs associated with moving a village. The analysis we performed developed a cost that includes all funds anticipated to be spent by all Federal, State, and local entities to move what can be moved and replace what cannot be moved, in a new location.

To answer the second question, the cost of relocation, three values were investigated:
The first value is the cost of relocating the entire community to a new site, including all the existing facilities, structures, and utilities that can be moved and replacement of those that cannot be moved. We assumed communities would be relocated as is. For example, if a village does not have running water at its existing site, it will not have it at the new location under the assumptions of our analysis. Specific numbers were developed for the three communities most expected to relocate.

The second value is the cost of moving a village to an existing community, typically a regional hub such as Nome, Kotzebue, or Bethel. The co-location would include providing similar amenities to those currently afforded in the hub community. For example, Nome residents have running water; therefore, members of the village being co-located would also have running water. For this analysis, a detailed cost of moving Shishmaref to Nome or Kotzebue was developed. A co-location number for Kivalina was found by scaling the Shishmaref-Kotzebue collocation cost number by the ratio of population in Kivalina to Shishmaref. Similarly, the co-location number for Newtok was found by scaling the Shishmaref-Nome collocation cost by the ratio of the population in Newtok to Shishmaref. This is a rough comparison; however, in our analysis of co-location costs for Shishmaref, the driving factor in the costs was population of individuals being moved into the community of question, thus making the population ratio a reasonable assumption.

We also found that co-locating a community into a neighboring village was almost the same as starting a new community from scratch. Most of the neighboring communities have facilities that are near capacity at best and would require extensive upgrades to make that type of co-location possible.

The third value is an estimate of what it would take to homestead a new community in a new location. This option would have a small group of houses moved or constructed at a mainland site, with no infrastructure support, in similar fashion to the relocation currently being attempted in Newtok, Alaska. More gradually than the phased move, the new community would begin to take root and would eventually qualify for power, schools, runway, etc. Over time, the new community would be allowed to thrive, and the old systematically abandoned.

The values in this document are intended to provide a range or an order of magnitude value from which a comparison of different types of actions can be made.

4.2.3. What is the expected time line for a complete failure of the usable land associated with each community?

The final question was analyzed by using a combination of aerial photography and ground measurements to track the rate of erosion over time, then assuming that rate continues, determines the erosion line be in the future. This methodology has shortfalls. For example, it assumes that the community would do nothing to protect itself, that the soils are basically the same composition as they go farther inland, and that the forces contributing to the erosion would remain constant over the period of future analysis. What this analysis does is show the potential ranges of erosion if left unchecked.

The determination of what is usable land is also subjective. For the sake of this analysis, we assume that if a significant portion of the critical infrastructure in a community (the school, the power plant, the water supply) was left unusable, then the community would have to relocate by default and seek refuge in other communities.

For each community, a recent aerial photograph showing historic shorelines and projected shorelines is included, as well as an estimate of how long the community has left until sufficient infrastructure has been lost to make seeking refuge the only option available.

5.0 COMMUNITY SPECIFIC INFORMATION

The following sections contain information relative to each community regarding answers to the three questions. Section 5.8 contains tables that summarize the information for all the communities. The discussions include information on demographics, employment, infrastructure, school enrollment, and other data that will help the reader develop a feeling for the affected communities. Figure 1 shows the location of each of the seven communities investigated.

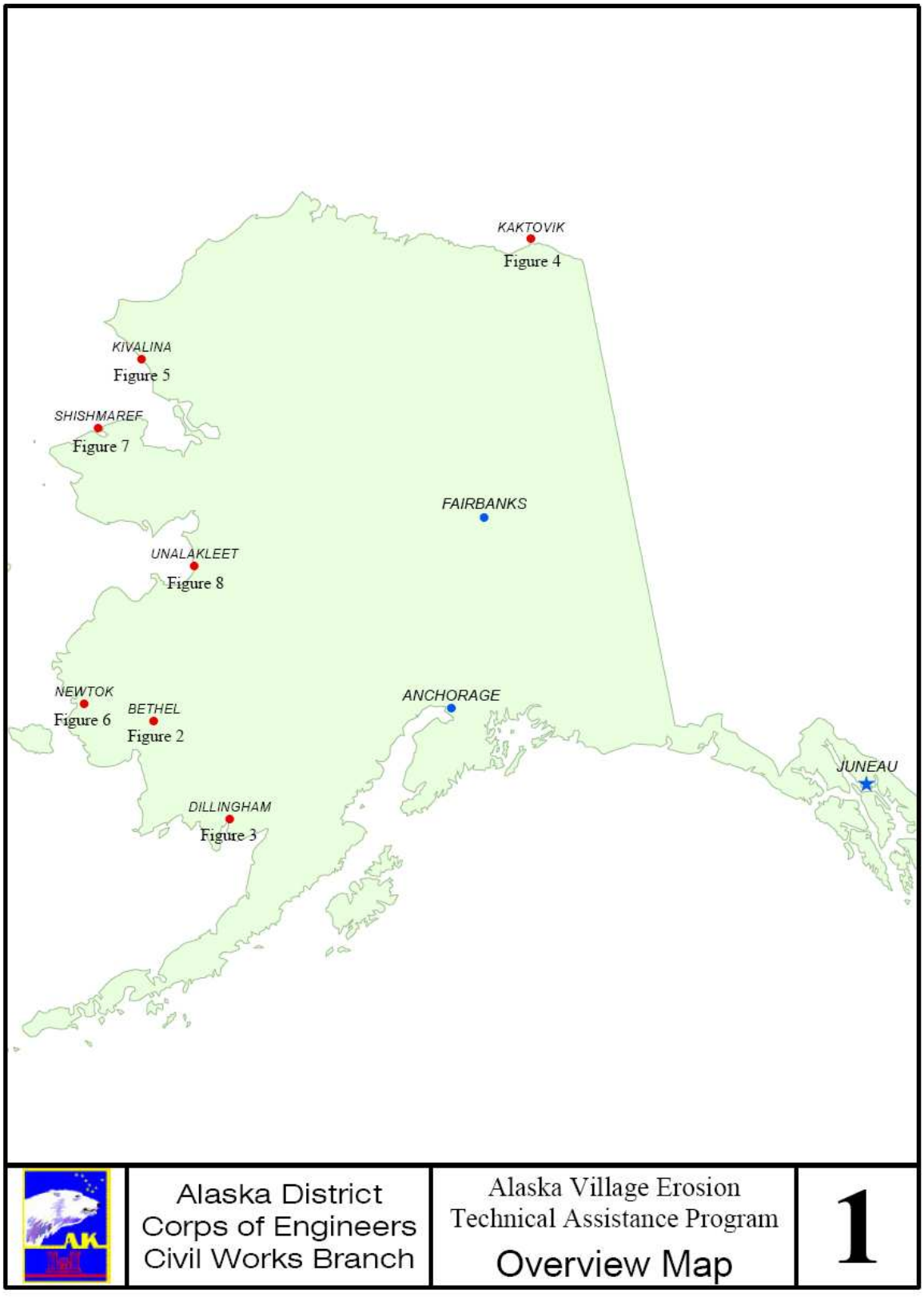


Figure 1 – Community Locations

5.1 Bethel

5.1.1. Community Information

Bethel is located along the Kuskokwim River, 40 miles inland from the Bering Sea. It is in the Yukon Delta National Wildlife Refuge, 400 air miles west of Anchorage. The community is at approximately 60° North Latitude and -161° (West) Longitude (Sec. 09, T008N, R071W, Seward Meridian.) Bethel is in the Bethel Recording District. The area encompasses 43.8 square miles of land and 5.1 square miles of water. Precipitation averages 16 inches a year in this area and snowfall averages 50 inches per year. Summer temperatures range from 42 to 62 degrees Fahrenheit. Winter temperatures range from -2 to 19 degrees Fahrenheit.

Beach landing at Bethel

Example of Bethel shoreline

5.1.2. What are the costs associated with continued erosion?

Three elements are associated with erosion costs: past protection endeavors, the cost of ongoing repair and maintenance, and future damages. These are discussed in more detail in the following paragraphs.

5.1.2.1. Erosion Protection Costs

Bethel is approximately 65 miles upriver from the mouth of the Kuskokwim River and is at the upriver limit of tidal influence from the Bering Sea. Bethel is the major educational, economic, social, and cultural community in the Southwest Alaska Region, serving numerous smaller villages along the Yukon-Kuskokwim River Delta. For the last 40 years the riverbank adjacent to the community has been seriously eroded.

Bethel experiences periodic flooding, mostly because of ice jams during the spring breakup of the Kuskokwim River. The spring ice breakup in 1995 caused such severe erosion that the governor of Alaska declared a state of emergency—scour created a cove 350 feet long and 200 feet inland and endangered several structures. The village's main port is the only one on the western Alaska coast for oceangoing ships and serves as the supply center for villages in the Yukon-Kuskokwim Delta. In response to the 1995 emergency, the Corps placed rock along 600 linear feet of the riverbank and dock.

Riverbank Protection at Bethel

Looking other direction

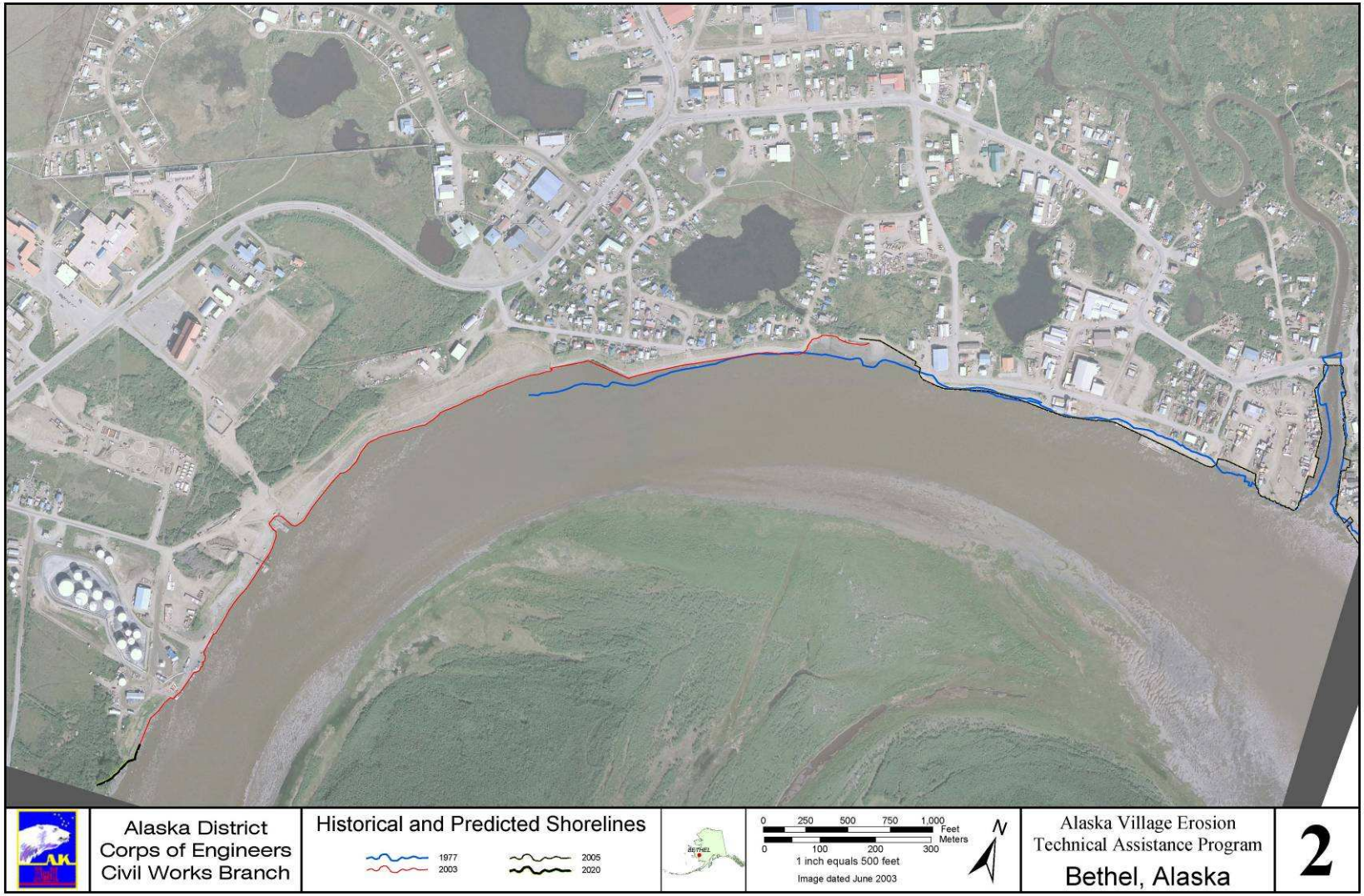
This was the beginning of a Corps 8,000-foot bank stabilization seawall project that cost $24 million and was completed in 1997. This project included stabilization of the riverbank from the existing petroleum dock at the downstream end to the Bethel city dock at the upstream end.

Although Bethel is not in imminent danger, it has experienced serious erosion and has undertaken various infrastructure-specific activities to resolve this problem. The Corps has a project underway to repair the seawall by placing more rock, by replacing a steel tieback system, and placing steel wale on the inland side of the pipe piles. The project will reinforce the seawall 1,200 feet so that it protects the entrance to Bethel's small boat harbor. The initial cost estimate for this project in 2001 was over $4.7 million. The project should be completed in 2006. Because of these measures, there are no plans for Bethel to relocate or collocate to another site.


Pile wall of current concern at Bethel.

Obvious outward bowing of wall.

Erosion control efforts by the State of Alaska legislative grants and Department of Transportation and Planning Formulation (DOT&PF) funds, Corps, and Federal Aviation Association (FAA) to date total more than $57 million.


Alaska District
Corps of Engineers
Civil Works Branch
Historical and Predicted Shorelines
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BETHEL
0 250 500 750 1,000 Feet
0 100 200 300 Meters
1 inch equals 500 feet
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Alaska Village Erosion
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5.1.2.2. Future Damages

Future erosion damages are expected to be minimal because of the existing 8,000-foot bank stabilization seawall, which is undergoing repairs that will extend the life of the project.

5.1.3. What are potential costs associated with moving to a new location or an existing community?

There is no reasonable need for Bethel to relocate. With the exception of a few small segments, the erosion at Bethel has been contained. The rest of the erosion is currently being addressed through other means. In addition, the community and state have not expressed interest in relocating Bethel; therefore, numbers for relocation were not developed.

5.1.4. What is the expected time line for a complete failure of the usable land?

With proper maintenance, the existing and planned projects should provide adequate erosion protection well into the future. No time line is provided because complete failure of the usable land is highly unlikely in the short or long term.

Table 3 - Summarized Information for Bethel

Community	Costs of Future Erosion Protection	Cost to Relocate	How Long Does The Community Have*
Bethel	$ 5,000,000	N/A	> 100 years

*These numbers assume no future erosion protection, including that listed here, is not implemented

5.2. Dillingham

5.2.1. Community Information

Dillingham is at the extreme northern end of Nushagak Bay in northern Bristol Bay at the confluence of the Wood and Nushagak rivers. It is 327 miles southwest of Anchorage and is a 6-hour flight from Seattle. The community is at approximately 59° North Latitude and -158° (West) Longitude (Sec. 21, T013S, R055W, Seward Meridian.). Dillingham is in the Bristol Bay Recording District. The area encompasses 33.6 square miles of land and 2.1 square miles of water. The primary climatic influence is maritime; however, the arctic climate of the Interior also affects the Bristol Bay coast. Average summer temperatures range from 37 to 66 degrees Fahrenheit. Average winter temperatures range from 4 to 30 degrees Fahrenheit. Annual precipitation is 26 inches, and annual snowfall is 65 inches. Heavy fog is common in July and August. Winds of up to 60 to 70 mph may occur between December and March. The Nushagak River is ice-free from June through November.

View of downtown Dillingham

Corps shore protection at Snag Point

5.2.2. What are the costs associated with continued erosion?

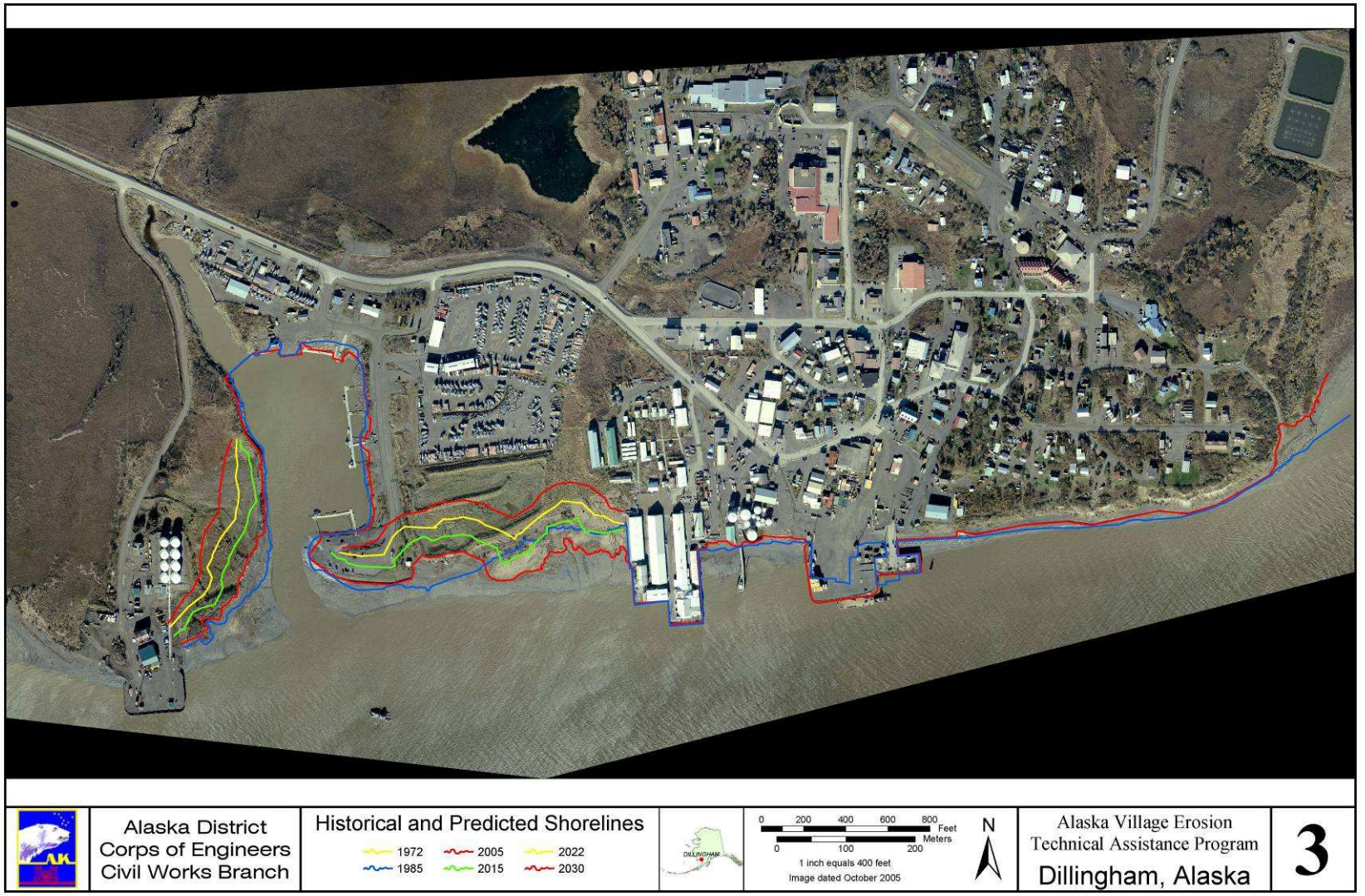
There are three elements related to costs associated with erosion: past protection endeavors, the cost of ongoing repair and maintenance, and future damages. These are discussed in more detail in the following paragraphs.

5.2.2.1. Erosion Protection Costs

Previous efforts to control riverbank erosion near the small boat harbor consisted of timber plank and pile bulkheads built in 1983 by the City of Dillingham at Snag Point, about ¾ mile east of the small boat harbor; 1,600 feet of sheet-pile bulkhead built by the Corps at Snag Point between 1995 and 1998 (COE 1995, 1997); and about 600 feet of sheet-pile bulkhead built by the Corps immediately east of the harbor entrance in 1999 (COE 1998). In addition, Bristol Alliance Fuels has installed a sheet-pile wall to protect their mooring facilities. Erosion control efforts by the Corps to date total more than $6 million.

Storm waves entering Dillingham Harbor

Corps protection on harbor east bank


Alaska District
Corps of Engineers
Civil Works Branch
Historical and Predicted Shorelines
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A project to protect Dillingham Harbor and the surrounding facilities is nearing completion of the planning phase and the beginning of the design phase. Typical annual storms are causing land to erode along the west bank of Dillingham Harbor. As seen in the photos above, the waves enter the harbor and continually erode the west bank. The east bank has already been protected by a Corps project. Erosion at the west side of the harbor entrance is also fueled by wave action in conjunction with high tides. Currently, the west bank of Dillingham Harbor is eroding at an average rate of 11 feet per year. If left unchecked, the continued erosion would lead to a significant decrease of harbor protection. In addition to reduced bank protection for the harbor, floats, and commercial fishing fleet, land as well as the majority of the fuel supply for the area would be lost. Construction of this project is scheduled for 2007.

5.2.2.2. Future Damages

It is expected that future erosion damages are expected to be minimal because of the existing bank stabilization seawall and the proposed erosion protection project at the east and west bank of the harbor.

5.2.3. What are potential costs associated with moving to a new location or an existing community?

There is no reasonable need for Dillingham to relocate. With the exception of a few small segments, the erosion at Dillingham has been contained. The rest of the erosion is currently being addressed through other means. In addition, the community and State have not expressed interest in relocating Dillingham; therefore, numbers for relocation were not developed.

5.2.4. What is the expected time line for a complete failure of the usable land?

Complete failure of the Dillingham property is not expected in the foreseeable future. Some erosion control measures are already in place, removal and reburial of grave sites is already occurring, and other measures are underway.

Table 4 - Summarized Information for Dillingham

Community	Costs of Future Erosion Protection	Cost to Relocate	How Long Does The Community Have*
Dillingham	$ 10,000,000	N/A	> 100 years

*These numbers assume no future erosion protection, including that listed here, is not implemented

5.3. Kaktovik

5.3.1. Community Information

Kaktovik is on the north shore of Barter Island between the Okpilak and Jago Rivers on the Beaufort Sea coast. It is the only community within the boundaries of the Arctic National Wildlife Refuge, which is 19.6 million acres and an occasional calving ground for the Porcupine caribou herd. The community is at approximately 70° North Latitude and -143° (West) Longitude (Sec. 13, T009N, R033E, Umiat Meridian). Kaktovik is in the Barrow Recording District. The area encompasses 0.8 square mile of land and 0.2 square mile of water. The climate of Kaktovik is arctic. Temperatures range from -56 to 78 degrees Fahrenheit. Precipitation is light, at 5 inches, with snowfall averaging 20 inches.

The Village of Kaktovik

Shoreline Erosion

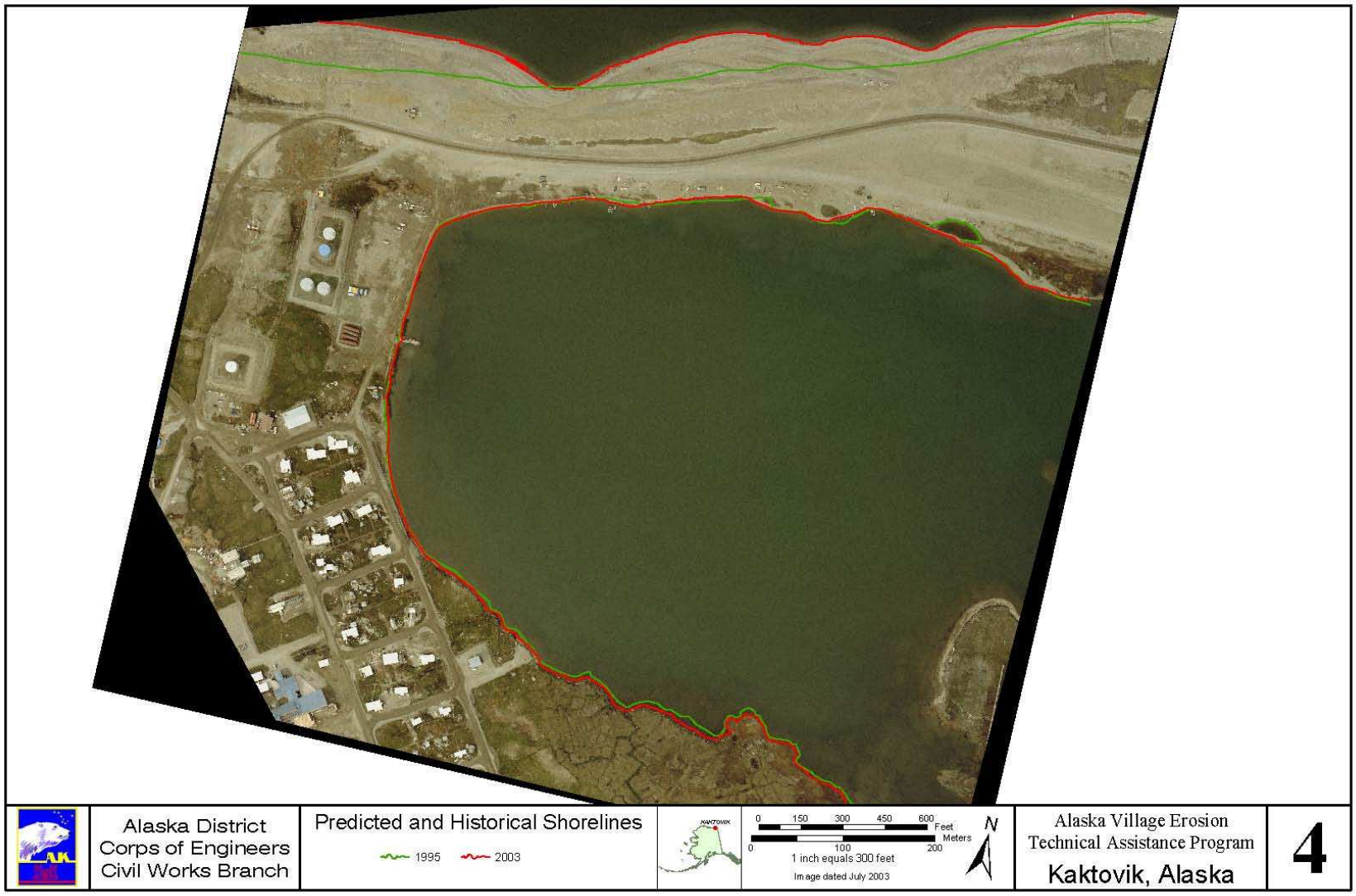
5.3.2. What are the costs associated with continued erosion?

There are three elements related to costs associated with erosion: past protection endeavors, the cost of ongoing repair and maintenance, and future damages. These are discussed in more detail in the following paragraphs.

5.3.2.1. Erosion Protection Costs

Shoreline Erosion

The only notable erosion that has had a direct effect on the community is along the frontage within the lagoon (Pipsuk Bight). Protection of this area was provided in the 1990's by construction of a timber crib wall. This structure has performed well and has essentially stabilized the area such that erosion is not a problem for the community along this portion of the lagoon.


Alaska District
Corps of Engineers
Civil Works Branch
Predicted and Historical Shorelines
1995
2003
0 150 300 450 600
Feet
Meters
0 100 200
1 inch equals 300 feet
Image dated July 2003
N
Alaska Village Erosion
Technical Assistance Program
Kaktovik, Alaska
4

The existing airstrip is on the low elevation sand spit immediately north of the community. Erosion protection measures have been constructed in the past along the seaward edge of the airstrip. Recent surveys and aerial photography indicate that the airstrip is stable. Flooding due to storm surge increases in water surface elevation is an ongoing problem during open water storm season.

The U.S. Air Force Long Range Radar Site (LRRS) is immediately west of the community of Kaktovik. Numerous buildings, fuel tanks, a sewage lagoon, and an old landfill are located there. The northern limits of this site are directly exposed to the wave action in the Beaufort Sea. A gravel bag revetment was designed by the Corps and constructed in 1999 along with a groin field to build a beach in front of the revetment to reduce the amount of wave energy at this site.

Corps Gravel Bag Revetment in1999

Revetment in 2003

Four sites in the vicinity of Kaktovik eligible for listing on the National Register of Historic Places are affected by erosion. Artifacts eroded from these areas are being lost. Local government agencies and members of the community are concerned about the loss of artifacts and history associated with this area. Without the protection of the sites or documentation and preservation of the artifacts, valuable information will be lost, which will reduce our understanding of the history of the culture along the coastal community in the Arctic National Wildlife Refuge (ANWR).

5.3.2.2. Future Damages

With the exception of the airport and cultural resources, the community of Kaktovik is not experiencing significant damages such as erosion, wave attack, or flooding from coastal storms. There have been no reports of damaged or destroyed infrastructure or buildings from coastal storms with the exception of a snow fence west of the community. Minor erosion in Kaktovik Lagoon was reported, but would not pose any threat for at least 100 years.

Airport

If a new airport is constructed, this would eliminate the erosion and flood damages the current airport is experiencing. Protection for the existing runway is estimated to cost approximately $40 million.

Cultural Sites

For centuries, as the name implies, trade has been conducted at Barter Island between people along the Beaufort Sea coast from Barrow to central Canada. The people of Kaktovik trace their roots to many areas of northern Alaska and Canada. The *Archaeological Evaluation of Cultural Resources* Near Kaktovik, Barter Island, Alaska prepared in October 2004 recommended the site Qaaktugvik be examined for the National Register of Historic Places as a traditional cultural property. This parcel is in danger of being lost to erosion. Because of its significance, the Corps is undertaking a study to more closely examine and catalog the area.

Summary of Erosion Costs

Protection of the airport would be approximately $40 million. Because of the unknown quantity and quality of artifacts, and the inherent difficulties in assigning a monetary value to an item of cultural significance, the costs of damages to the cultural sites has not been determined.

5.3.3. What are potential costs associated with moving to a new location or an existing community?

There is no reasonable need for Kaktovik to relocate. With the exception of the airport and a few small segments, the erosion at Kaktovik has been contained. In addition, the community and State have not expressed interest in relocating Kaktovik; therefore, numbers for relocation were not developed. The cost to relocate the airport at Kaktovik is estimated at $20 to $40 million

5.3.4. What is the expected time line for a complete failure of the usable land?

Though there are some localized areas of concern (the airport and cultural sites) erosion is not expected to cause failure of the community within the foreseeable future (hundreds of years).

Table 5 - Summarized Information for Kaktovik

Community	Costs of Future Erosion Protection	Cost to Relocate	How Long Does The Community Have
Kaktovik	$ 40,000,000 *	$20 – 40 million *	> 100 years

*This is for the airport, the only area of erosion concern.

5.4. Kivalina

5.4.1. Community Information

Kivalina is at the tip of an 8-mile barrier reef located between the Chukchi Sea and Kivalina River. It is 80 air miles northwest of Kotzebue. The community is at approximately 67° North Latitude and -164° (West) Longitude, (Sec. 21, T027N, R026W, Kateel River Meridian.). Kivalina is in the Kotzebue Recording District. The area encompasses 1.9 square miles of land and 2.0 square miles of water. The community is in the transitional climate zone, which is characterized by long, cold winters and cool summers. The average low temperature during January is -15 degrees Fahrenheit, and the average high during July is 57 degrees Fahrenheit. Temperature extremes have been measured from -54 degrees Fahrenheit to 85 degrees Fahrenheit. 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.

Kivilana shoreline with skiffs

Typical structures in Kivalina

Undermined building on Kivalina

Emergency shoreline protection - 2005


Alaska District
Corps of Engineers
Civil Works Branch
Predicted and Historical Shorelines
1975
1990
1997
2000
2010
2020
2030
0 150 300 450 600
Feet
Meters
0 100 200
1 inch equals 300 feet
Image dated August 2000
Alaska Village Erosion
Technical Assistance Program
Kivalina, Alaska
5

What are the costs associated with continued erosion?
There are three elements related to costs associated with erosion: past protection endeavors, the cost of ongoing repair and maintenance, and future damages. These are discussed in more detail in the following paragraphs.

5.4.1.1. Erosion Protection Costs

Kivalina has not historically seen significant erosion. The Kivalina spit has seen cyclic erosion and accretion, with modest accretion on the Chukchi Sea side more prevalent during the 30-year period of 1970 to 2000. The higher energy storms that could result in significant erosion occur during the winter months when the Chukchi Sea is frozen. This has resulted in natural erosion protection in the past. However, with global climate change the period of open water is increasing and the Chukchi Sea is less likely to be frozen when damaging winter storms occur. Winter storms occurring in October and November of 2004 and 2005 have resulted in significant erosion that is now threatening both the school and the Alaska Village Electric Cooperative (AVEC) tank farm. This erosion has resulted in the loss of some teacher housing and the school and community washateria drain fields. Erosion control efforts by the state from 1985 to 2002 totaled $477,000, and during the last two years emergency erosion control efforts have cost approximately $850,000.

5.4.1.2. Cost of New Shoreline Protection

Due to the significant erosion of the last 2 years, emergency erosion protection is being pursued by both the State and Federal governments. The Northwest Arctic Borough (NWAB) is seeking $2.93 million to construct an erosion control structure at Kivalina to protect the tank farms. The NWAB hopes to construct this emergency protection during the summer of 2006. The Corps is currently investigating interim erosion protection for the community of Kivalina, recognizing that there will likely be a significant timeline associated with moving a community. Though detailed designs have not been developed, based on recent experience in other communities, e.g. Shishmaref, an 800-foot-long erosion protection structure to protect the school and AVEC tank farms is estimated to cost $8 million, while a more significant interim erosion protection structure to protect the full community is estimated to cost about $15 million.

5.4.1.3. Future Damages

The approach used to determine potential erosion damages at Kivalina is based on several assumptions as they pertain to the damage categories of residential, commercial, public infrastructure, and land values. In addition, damages are based on an assumed rate of erosion. These damages are those that would occur should the erosion protection not be installed or the community not relocate.

Residential Structures Assumptions

Oceanfront properties are assumed to fail in the 10-year project horizon and the rest of the village is assumed to fail in the 20-year project horizon. It is assumed that as erosion approaches individual homes, homeowners will take steps to salvage their personal property. With nowhere to move the structures, once the erosion reaches them, they will be a complete loss.

Commercial and Public Buildings Assumptions

The Kivalina Native Store and warehouse are the primary commercial structures in the community. While the store and warehouses are moveable, the lack of available land precludes relocation.

Infrastructure Assumptions

Roads, utility lines, the sewage lagoon, and solid waste site construction are based on the recent Shishmaref study with a discount for the smaller Kivalina population.

5.4.1.4. Summary of Future Damages

If no bank protection structures were to be installed, the combined residential, commercial, and public buildings and infrastructure costs due to erosion at Kivalina total more than $105 million for the 20-year project horizon, although the community will become uninhabited long before complete loss occurs.

5.4.2. What are potential costs associated with moving to a new location or an existing community?

The community has long assumed that the island would succumb to natural forces, and that they would have to move. To this end, residents have pursued relocation for the last 20 years. Their efforts have been stymied by difficulties in choosing a new village site, funding the relocation effort, and social problems within the village stemming from overcrowding, poverty, and other difficult living conditions.

Kivalina has yet to determine if they are going to relocate and where they would relocate to, which makes it difficult to estimate what the relocation costs would be. In addition, some of the sites selected by some in the community would require a significant amount of fill to be brought in, which would costs hundreds of millions of dollars, making those sites infeasible. The following, however, are preliminary estimates based upon finding a site requiring little or no fill to raise it above flood levels.

A relocation of the community to a new location would cost an estimated $123.4 million, which would include a minimal level of housing, water, and sanitation facilities.

A co-location to Kotzebue, the nearest hub community, would cost an estimated $95 million. This information is based upon a 2004 preliminary cost of alternatives for co-locating Shishmaref to Kotzebue, scaled to reflect the difference in population for Shishmaref and .

5.4.3. What is the expected time line for a complete failure of the usable land?

The winter storms of 2004 and 2005 eroded 70 to 80 feet of uplands behind the school. The bank line is now within 25 feet of the main school structure. Erosion in the vicinity of the

AVEC tank farm is similar, with only 5 feet of uplands remaining between the nearest tanks and the bank line. Without the construction of emergency erosion control structures, the school and tank farm will begin to fail within the next year if erosion continues at the same rate as it has during recent months,. Even if erosion slows, these critical structures are in imminent danger and are unlikely to survive for any extended period of time. Due to the physical lack of open land in the Kivalina community, these structures can not be relocated, and their failure would render the community uninhabitable.

Table 6 - Summarized Information for Kivalina

Community	Costs of Future Erosion Protection	Cost to Relocate	How Long Does The Community Have*
Kivalina	$ 15,000,000	$95 – 125 Million	10 – 15 years

*These numbers assume no future erosion protection, including that listed here, is not implemented

5.5. Newtok

Newtok is on the Ninglick River north of Nelson Island in the Yukon-Kuskokwim Delta Region. It is 94 miles northwest of Bethel. The community is at approximately 60° North Latitude and -164° (West) Longitude (Sec. 24, T010N, R087W, Seward Meridian). Newtok is in the Bethel Recording District. The area encompasses 1.0 square mile of land and 0.1 square mile of water. Newtok has a marine climate. Average precipitation is 17 inches, with annual snowfall of 22 inches. Summer temperatures range from 42 to 59 degrees Fahrenheit; winter temperatures are 2 to 19 degrees Fahrenheit.

Typical Newtok Erosion

The Village of Newtok

5.5.1. What are the costs associated with continued erosion?

There are three elements related to costs associated with erosion: past protection endeavors, the cost of ongoing repair and maintenance, and future damages. These are discussed in more detail in the following paragraphs.

5.5.1.1. Erosion Protection Costs

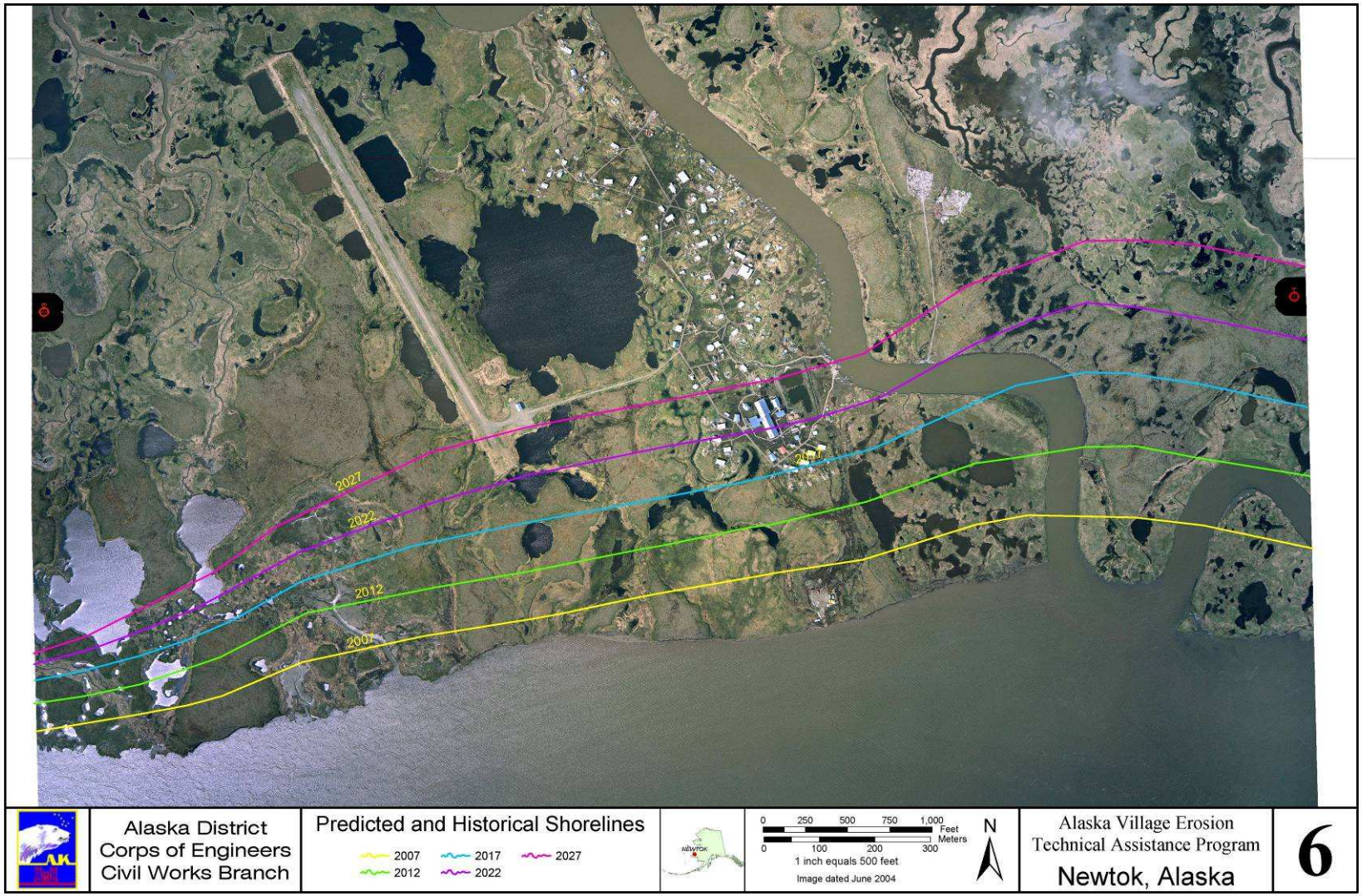
The Ninglick River has been eroding and moving in the direction of Newtok for decades. There are no geologic or channel geometry limitations evident that will slow down or stop the erosion before it reaches Newtok. Erosion control efforts by the state from 1983 to 1989 totaled almost $1.5 million.

5.5.1.2. Cost of New Shoreline Protection

To protect Newtok from further erosion would require a 5,280-foot-long erosion revetment. Construction costs are estimated at $90 million.

5.5.1.3. Future Damages

The approach used to determine potential erosion damages at Newtok is based on several assumptions as they pertain to the damage categories of residential, commercial, public infrastructure, and land values. In addition, damages are based on an assumed rate of erosion. These damages are those that would occur should the erosion protection not be installed or the community not relocate.


2027
2022
2012
2007
Alaska District
Corps of Engineers
Civil Works Branch
Predicted and Historical Shorelines
2007
2012
2017
2022
2027
NEWTOK
0 250 500 750 1,000 Feet
0 100 200 300 Meters
1 inch equals 500 feet
Image dated June 2004
N
Alaska Village Erosion
Technical Assistance Program
Newtok, Alaska
6

Residential Structures Assumptions

Some residential structures are expected to be lost in about 10 to 15 years with major loss in about 20 years. It is assumed that as erosion approaches individual homes, homeowners will take steps to salvage their personal property.

Commercial and Public Buildings Assumptions

Public buildings in Newtok include a health clinic, school, armory, church, the Traditional Council Office, Post Office, and Community Hall. Some of these may be able to move to a different location in town before being lost to erosion, but the majority of these would be reached by the erosion in 10 to 15 years.

Infrastructure Assumptions

Estimates were made concerning the boardwalks, electric lines, and water pipeline that would be lost as a result of erosion in the years prior to the lost over the next twenty years. Public utilities are considered a total loss in about twenty to twenty five years.

5.5.1.4. Summary of Future Damages

The combined residential, commercial, and public buildings and infrastructure costs due to erosion at Newtok are estimated to be more than $119 million for the 50-year project horizon.

5.5.2. What are potential costs associated with moving to a new location or an existing community?

In 1994, the Newtok Traditional Council started a relocation planning process in response to the erosion problem. The Council analyzed six potential village relocation sites, and a community vote in August 2003 overwhelmingly selected a site on the north end of Nelson Island, approximately 9 miles southeast of Newtok. This site is known locally as Takikchak. In January 2004 the Newtok Traditional Council provided a report prepared by the engineering firm ASCG, Inc, which documented the Council's relocation planning process and site selection. This report included a geotechnical overview of the Takikchak site conducted by the Corps under the Planning Assistance to States (PAS) program.

Congress approved a land exchange between the Newtok Village Corporation and the U.S. Fish and Wildlife Service in 2003, under the Alaskan Native Village and the Interior Department Land Exchange Act of November 17, 2003, Public Law 108-129, 117 Stat. 1358. The Department of Interior conveyed 10,943 acres at the Takikchak site to the Newtok Village Corporation on April 28, 2004.

The community is actively working to establish a seed community in this new location by getting a few new Department of Housing and Urban Development (HUD) houses constructed at the new site.

To relocate Newtok "as-is" to the Nelson Island site would cost an estimated $125 million.

To collocate Newtok "as-is" with one of the nearby Nelson Island communities would cost an estimated $76 million.

5.5.3. What is the expected time line for a complete failure of the usable land?

According to work done by Woodward-Clyde Consultants, the erosion appears to be caused mainly by wave action and thermal degradation of the ice rich riverbank. The average long-term erosion rate in the Newtok area from 1957 to 2003 was estimated to be 71 feet per year. The minimum erosion rate for this period, which occurred from 1974 to 1977 and from 1999 to 2003, was 42 feet per year. The maximum erosion rate for this period, which occurred between 1977 and 1983, was 113 feet per year.

Based upon the erosion rates and the location of major utilities and infrastructure, the community will be a complete loss in 10 to 15 years.

Table 7 - Summarized Information for Newtok

Community	Costs of Future Erosion Protection	Cost to Relocate	How Long Does The Community Have*
Newtok	$ 90,000,000	$80 – 130 Million	10 -15 years

*These numbers assume no future erosion protection, including that listed here, is not implemented

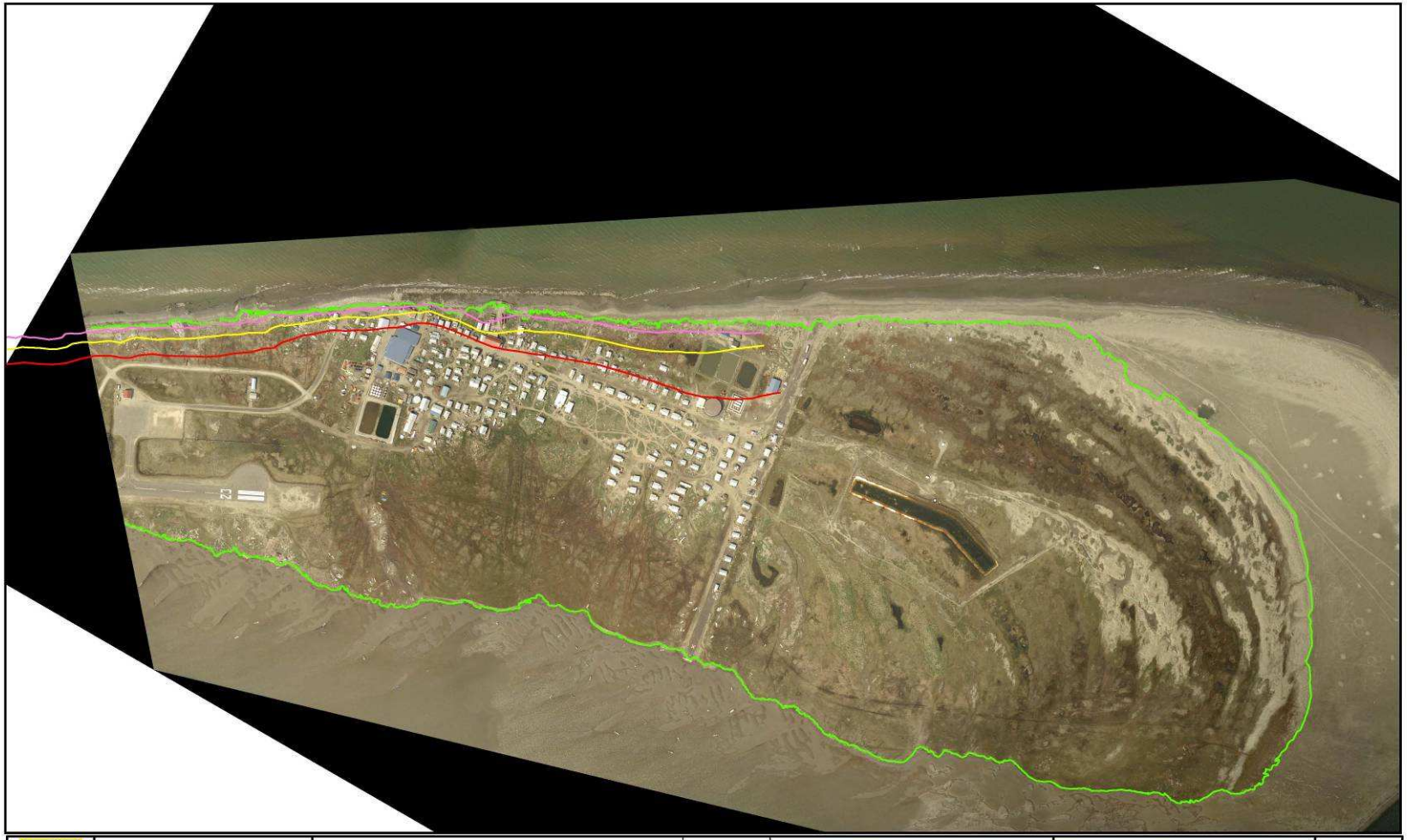
5.6. Shishmaref

5.6.1. Community Information

Shishmaref is on Sarichef Island in the Chukchi Sea, just north of Bering Strait. Shishmaref is 5 miles from the mainland, 126 miles north of Nome, and 100 miles southwest of Kotzebue. The village is surrounded by the 2.6 million-acre Bering Land Bridge National Reserve. It is part of the Beringian National Heritage Park, endorsed by Presidents Bush and Gorbachev in 1990. The community is at approximately 66° North Latitude and -166° (West) Longitude, (Sec. 23, T010N, R035W, Kateel River Meridian). Shishmaref is in the Cape Nome Recording District. The area encompasses 2.8 square miles of land and 4.5 square miles of water. The area experiences a transitional climate between the frozen arctic and the continental Interior. Summers can be foggy, with average temperatures ranging from 47 to 54 degrees Fahrenheit; winter temperatures average -12 to 2 degrees Fahrenheit. Average annual precipitation is about 8 inches, including 33 inches of snow. The Chukchi Sea is typically frozen from mid-November through mid-June, although in recent years freeze up has occurred later and thaw earlier.

The community of Shishmaref

Old articulated concrete mat project


Alaska District
Corps of Engineers
Civil Works Branch
Predicted and Historical Shorelines
2053
2013
2028
2004
SHISHMAREF
0 250 500 750 1,000 Feet
0 100 200 300 Meters
1 inch equals 500 feet
Image dated June 2004
Alaska Village Erosion
Technical Assistance Program
Shishmaref, Alaska
7

5.6.2. What are the costs associated with continued erosion?

Three elements are associated with erosion costs: past protection endeavors, the cost of ongoing repair and maintenance, and future damages. These are discussed in more detail in the following paragraphs.

5.6.2.1. Historical Erosion Protection Costs

The community of Shishmaref is being affected by high rates of erosion along the shoreline. Climatic conditions have led to icepack development occurring later and later each year. Without the icepack in place, the island is more susceptible to fall and early winter storms that have increased erosion and littoral drift. Erosion and littoral drift are shifting the island footprint northeastward and southwestward, subjecting the developed areas to massive wave scour and erosion of the fine materials that make up the island. Erosion is undermining buildings and infrastructure, causing several structures to collapse and fall into the sea. All efforts to arrest the erosion have been unsuccessful for other than short periods of time.

Past protection attempts in 2003.

BIA protection in foreground in 2003.

Recently the Bureau of Indian Affairs (BIA), the City of Shishmaref, and the Corps have invested in shoreline protection along the community of Shishmaref. In 2004, the BIA installed 200 feet of shoreline protection along the shoreline near the Native store. In 2005, the Corps installed 230 feet of protection, connecting to the BIA project, extending to the east to protect the Shishmaref School. Also in 2005, the community of Shishmaref installed about 250 feet of protection extending to the east from the Corps project.

Post Fall 2004 Storm

Corps Project Under Construction in 2005

Post Construction – Corps Project to Right / City Project to Left in 2005

Erosion control efforts by the state (including legislative grants and Department of Transportation funding), Corps, and BIA to date total more than $9.5 million.

5.6.2.2. Cost of New Shore Protection

The Corps is also developing a project that will protect the remaining portions of shoreline as well as upgrade all the existing projects to the same standard of protection. The project is currently estimated to cost $16,000,000. This project will provide for consistent protection stretching along the entire community waterfront, not including the airport. The recently installed projects will provide some protection against the ongoing erosion problem. The city project could use an additional layer of armor stone and both the BIA and city project may need to be elevated, but both should provide adequate protection until the remainder of the Corps project can be built. Protecting the airport may require additional effort.

5.6.2.3. Future Damages

The approach used to determine potential erosion damages at Shishmaref is based on several assumptions as they pertain to the damage categories of residential, commercial, public infrastructure, and land values. In addition, damages are based on two different rates of erosion. An examination of the erosion rates based on aerial photos from 1973 to 2003 show a somewhat subdued rate of erosion, while actual erosion rates from 2001 to 2003 are much

more dramatic. These damages would occur if the proposed project was not installed or the community did not relocate.

Residential Structure Assumptions

Several existing residences are within a 5 to 10 year range of the erosion line. It is assumed that as erosion approaches individual homes, homeowners will take steps to salvage their personal property. However, since there is limited available land in the community, it would be difficult to relocate buildings, so they are considered a total loss. It is estimated that much of the community's residential structures would be lost in the next 10 to 15 years.

Commercial and Public Buildings Assumptions

According to the Alaska Department of Commerce, Community, and Economic Development, there are 16 active business licenses in Shishmaref. These include city offices, the washeteria, arts and crafts stores, school, community center, and a variety of other public buildings. Under both erosion scenarios, these buildings will be lost within the 50 year planning horizon, with critical infrastructure being lost within 10 to 15 years.

Infrastructure Assumptions

Infrastructure includes power, communications, bulk fuel facilities, sewage lagoon, airport, and some water supply tanks. The airport and sewage lagoon have the greatest vulnerability. The power plant and bulk fuel facilities would likely be lost after the school.

5.6.2.4. Summary of Future Damages

The value of the combined land lost, residential and commercial buildings, public buildings and infrastructure lost, and the costs fuel tank decommissioning, and closure due to erosion at Shishmaref range from more than $47 million to more than $130 million for the 50-year project horizon.

5.6.3. What are potential costs associated with moving to a new location or an existing community?

Shishmaref has formed a Relocation Coalition consisting of city officials, Native village elders, and other community leaders that has identified an area on the western shores of Shishmaref Lagoon near Tin Creek where the community could relocate. Relocating Shishmaref and providing similar services currently afforded to Shishmaref residents would cost approximately $180 million.

A collocation of the community would be to Nome or Kotzebue. Nome has more room for a collocation and has a lesser cost of the two at $93 million.

5.6.4. What is the expected time line for a complete failure of the usable land?

The Shishmaref erosion rates are subject to many factors including weather, when sea ice is formed, amount of permafrost exposed, types of bank protection, and quantities of bank protection installed. Estimating future erosion for Shishmaref was done utilizing two erosion

rates. The current profile shows extreme rates of erosion that would all but eliminate the community's viability in about 10 years. The longer period record shows a slower rate of about 25 years until the community is no longer viable. Loss of viability in this example means a significant decrease in the ability of the community to provide basic services for its residents (e.g. power, water, education). These rates are highly subjective and can accelerate or decelerate based upon types of bank protection, magnitude and frequency of storms, and differences in soil conditions. Choosing a reasonable midpoint range yields a 10 to 15-year timeline before enough of the critical infrastructure is lost to force an evacuation.

Table 8 - Summarized Information for Shishmaref

Community	Costs of Future Erosion Protection	Cost to Relocate	How Long Does The Community Have*
Shishmaref	$ 16,000,000	$100 – 200 Million	10 -15 years

*These numbers assume no future erosion protection, including that listed here, is not implemented

5.7. Unalakleet

5.7.1. Community Information

Unalakleet is on Norton Sound at the mouth of the Unalakleet River, 148 miles southeast of Nome and 395 miles northwest of Anchorage. The community is at approximately 63° North Latitude and -160° (West) Longitude, (Sec. 03, T019S, R011W, Kateel River Meridian). Unalakleet is in the Cape Nome Recording District. The area encompasses 2.9 square miles of land and 2.3 square miles of water. Unalakleet has a subarctic climate with considerable maritime influences when Norton Sound is ice-free, usually from May to October. Winters are cold and dry. Average summer temperatures range from 47 to 62 degrees Fahrenheit; winter temperatures average -4 to 11 degrees Fahrenheit. Extremes have been measured from -50 to 87 degrees Fahrenheit. Precipitation averages 14 inches annually, with 41 inches of snow.

The Unalakleet shoreline.

Typical rock filled gabion bank protection

5.7.2. What are the costs associated with continued erosion?

Three elements associated with erosion costs are: past protection endeavors, the cost of ongoing repair and maintenance, and future damages. These are discussed in more detail in the following paragraphs.

5.7.2.1. Historical Erosion Protection Costs

In 2000 the Natural Resource Conservation Service (NRCS) constructed 1,400 feet of gabions (wire baskets filled with rock) beginning at the upstream end of the fish processing plant on the Unalakleet River and extending around the end of the spit approximately 1,000 feet with a cost of about $1.3 million. A late November storm in 2003 caused severe damage to the gabions. The State of Alaska signed a disaster declaration for this area and the community is applying for funding to repair the gabions. The estimated remaining life of the gabions ranges between 2 and 10 years. Failure would cause site specific damage to structures and facilities, but complete loss of the community is not expected.

Sagging Gabion Wall

Typical Gabion Cell Rupture

Erosion control efforts by the state from 1983 to 2004 totaled almost $2 million.

5.7.2.2. Cost of New Shoreline Protection

The existing bank protection at Unalakleet is in need of major repair or replacement. The gabion structure has been ruptured in places, spilling the rock core out where it can easily be washed away even during good weather conditions. The Corps is developing a project to remedy the erosion in this location through the construction of a riprap revetment with an estimated cost of about $30,000,000.

5.7.2.3. Future Damages

Residential Structures Assumptions

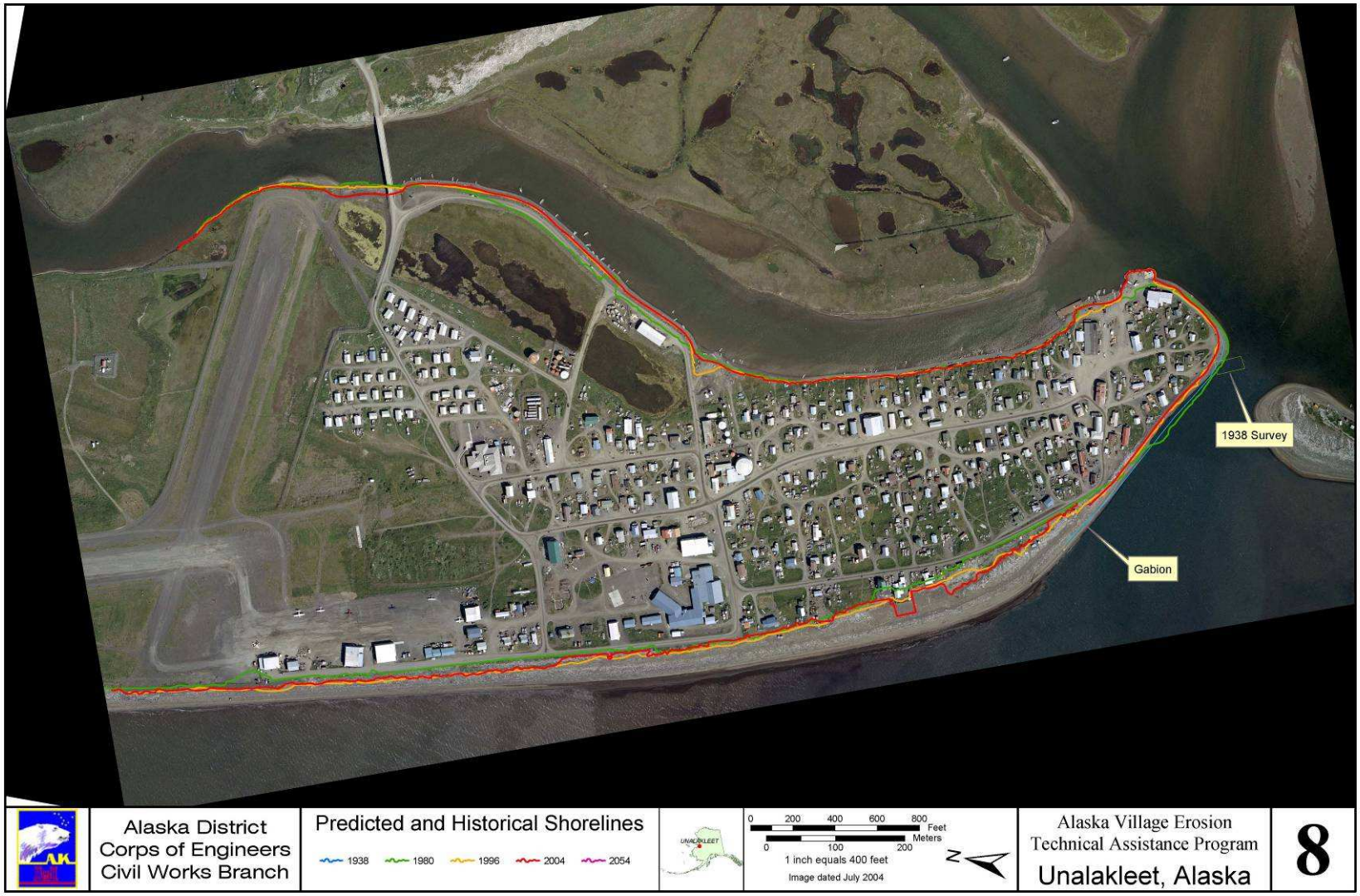
Some housing is be expected to be lost if the bank protection is not be repaired or replaced. These losses would be limited in nature to areas directly adjacent to gabion wall failure.

Commercial and Public Buildings Assumptions

The Unalakleet Fisheries processing plant is subject to erosion loss within the 50-year planning horizon. Due to the specialized nature of fish processing and the generally large pieces of equipment, it is assumed that moving the building and equipment out of harm's way is not an option.

Infrastructure Assumptions

Various site specific roads, electric and telephone lines, and water and sewer lines in the community are subject to loss, though the infrastructure as a whole is not be expected to be destroyed.


1938 Survey
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Corps of Engineers
Civil Works Branch
Predicted and Historical Shorelines
1938
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UNALAKLEET
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0 100 200 Meters
1 inch equals 400 feet
Image dated July 2004
N
Alaska Village Erosion
Technical Assistance Program
Unalakleet, Alaska
8

5.7.2.4. Summary of Future Damages

The combined residential, commercial and public buildings, and infrastructure costs due to erosion are more than $105 million for the 50-year project horizon if the existing protection is not repaired or no further erosion protection is installed.

5.7.3. What are potential costs associated with moving to a new location or an existing community?

There is no reasonable need for Unalakleet to relocate. With the exception of a few small segments, the erosion at Unalakleet has been contained. The rest of the erosion is currently being addressed though other means. In addition, the community and state have not expressed interest in relocating Unalakleet; therefore, costs for relocation were not developed.

5.7.4. What is the expected time line for a complete failure of the usable land?

Catastrophic failure of the sand spit is not expected; however, the community will continue to suffer property damage and loss from erosion. Unalakleet suffers from erosion on both the ocean side (Norton Sound) and from the Unalakleet River. The erosion rate on the Norton Sound side averages 1 foot per year and occurs when storm surge attacks the spit, washing away beach material. The rate of erosion from the Unalakleet River is more severe and averages 2 feet per year.

At current erosion rates the fish processing plant and some residences at the mouth of the Unalakleet River could be lost within 2 to 10 years. The community's water line running along Norton Sound could also be lost, as well as some parts of the airport. Over time, erosion will continue to capture some residences, roads, and utilities but the community as a whole will not be destroyed.

Table 9 - Summarized Information for Unalakleet

Community	Costs of Future Erosion Protection	Cost to Relocate	How Long Does The Community Have*
Unalakleet	$ 30,000,000	N/A	> 100 Years

*These numbers assume no future erosion protection, including that listed here, is not implemented

5.8. Summation of Community Information

It is very clear that there are many issues that need both immediate and continued attention. In addition, there is no clear cut way to rank communities in terms of need. The concern of ranking raises several questions. Is it best to use criteria that aids the most people, avoids the most damages, or has the earliest time horizon for failure? How do financial considerations (at the local, state, and national level) play into ranking the communities? If funds are limited and insufficient to help the community with the greatest need, would it be better to aid two other communities with smaller protection requirements? Would other social, environmental, or regional effects change our thinking in terms of the community with the greatest need?

Many other communities in the state also have erosion problems. This report examines only seven. The following tables summarize the information provided in this report for decision-makers and planners concerning these seven communities and erosion protection needs.

Table 10 – Summarized Community Information

Community	Costs of Future Erosion Protection	Cost to Relocate	How Long Does The Community Have*
Bethel	$ 5,000,000	N/A	> 100 years
Dillingham	10,000,000	N/A	> 100 years
Kaktovik	40,000,000	$ 20 – 40 Million	> 100 years
Kivalina	15,000,000	$ 95 – 125 Million	10 – 15 years
Newtok	90,000,000	$ 80 – 130 Million	10 – 15 years
Shishmaref	16,000,000	$100 – 200 Million	10 – 15 years
Unalakleet	30,000,000	N/A	> 100 years

*These numbers assume no future erosion protection, including that listed here, is not implemented.

6.0 ONGOING CORPS EFFORTS

Additional planning work and funding were identified in the Consolidated Appropriations Act of 2005, PL 108-447, Division C - Energy and Water Development Appropriations Act, 2005.

> *"Tribal Partnership Program.—The conferees acknowledge the serious impacts of coastal erosion and flooding due to continued climate change in Alaska. The conference expects the Corps to continue its work in this area and has included a total of $4,000,000, of which $2,000,000 is to combat erosion in Alaska. A field hearing was held in Anchorage, Alaska, on June 29 and 30, 2004, on the impacts of severe erosion and flooding on Alaska Native villages. There is no Federal or State agency to coordinate and assist these communities in the relocation or in the interim provide preventative measures to slow the effects of the erosion and flooding. The conference finds there is a need for an Alaska erosion baseline study to coordinate and plan the appropriate responses and assistance for Alaska villages in the most need and to provide an overall assessment on the*

priority of which villages should receive assistance. Therefore, the conference has provided the $2,000,000 for this study."

This legislation was implemented to provide additional funding through the Tribal Partnership program for technical activities for the seven named communities. Work continued in Kaktovik, Kivalina, Newtok, and Shishmaref to assist with studies and technical reports addressing various aspects of the erosion issue. No work was continued in Bethel, Dillingham, or Unalakleet because their activities were funded through other appropriations. The Alaska Baseline Erosion Assessment was initiated to identify, plan, and prioritize appropriate responses to ongoing erosion issues in Alaska communities.

In addition to more study authority and funding, in 2005 and 2006 a new authority was added for construction of projects at full Federal expense: Consolidated Appropriations Act of 2005, PL 108-447, Division C - Energy and Water Development Appropriations Act, 2005, which states as follows:

"SEC. 117. Notwithstanding any other provision of law, the Secretary of the Army is authorized to carry out, at full Federal expense, structural and non-structural projects for storm damage prevention and reduction, coastal erosion, and ice and glacial damage in Alaska, including relocation of affected communities and construction of replacement facilities."

Energy and Water Appropriations Bill, 2006, Senate Report 109-84, Page 41 states:

"The Committee has provided $2,400,000 for Alaska Coastal Erosion. The following communities are eligible recipients of these funds: Kivalina, Newtok, Shishmaref, Koyukuk, Barrow, Kaktovik, Point Hope, Unalakleet, and Bethel. Section 117 of Public Law 108-447 will apply to this project."

With the limited amount of funds identified for construction activities, a decision was made to focus efforts upon constructing additional shoreline protection for Shishmaref.

The authority and Congressional funding provided under Section 117 has allowed the Corps to focus on implementation of much needed coastal erosion projects through efficient planning, expedited design, and creative contracting methods.

6.1. Bethel

Bethel appears to have sufficient protection in place to protect it from the majority of erosion damages. A project is ready for construction to protect the remaining sections of stream bank once the non Federal sponsor provides the necessary real estate.

This bank stabilization project was authorized under Public Law (P.L.) 99-190, Section 116, Stat. 1318. The project provides for the extension of the existing Bethel Bank Stabilization Project. The project's Congressional Direction Source is the Energy and Water Development Appropriations Act of 2001, as enacted by Section 1(a) (2) of P.L. 106-377, Conference Report 106-988, page 211, and the Water Resources Development Act of 1986, Section 601, P.L. 99-662. It authorizes and directs the Corps to extend the existing project an additional 1,200 linear feet upstream.

Bethel was named in the 2006 Energy and Water Appropriation as a recipient of Section 117 funding; a letter report will be prepared in 2006 that will assess implementing the project under Section 117 at full Federal expense.

6.2. Dillingham

Similar to Bethel, Dillingham appears to have sufficient protection from erosion with the distinct exception of areas adjacent to the Dillingham small boat harbor. A project is being developed to address this erosion issue that consists of a breakwater and revetments to provide protection to the Dillingham small boat harbor, the regional fuel depot, and other facilities.

6.3. Kaktovik

Although no structures are expected to be impacted by erosion, there are significant cultural resources sites that are being exposed by erosion and may potentially be lost. The local community has expressed a strong desire for analysis of the archeological site and a determination of its magnitude, significance, and options for the future. Because of this a study is underway using Fiscal Year (FY) 2005 funding to catalog the resources being impacted.

Kaktovik was named in the 2006 Energy and Water Appropriation as a recipient of Section 117 funding, a letter report will be prepared in 2006 to assess needs for a Section 117 project.

6.4. Kivalina

The Corps is continuing a community planning effort to identify a cost effective relocation site that would be acceptable to the Kivalina community and to refine the costs, design requirements, and timeline for relocation. This work will include the development of an Environmental Impact Statement EIS to document the environmental and cultural impacts of ongoing erosion and potential relocation. Kivalina currently requires assistance to address an ongoing erosion problem that was recently worsened by fall storms. Kivalina was named in the 2006 Energy and Water Appropriation as a recipient of Section 117 funding. A letter report will be prepared in 2006 to assess implementing an interim erosion protection project under Section 117, followed by plans and specifications for the proposed project.

6.5. Newtok

The Corps is continuing to assist the community with developing a plan for relocation by refining costs, design requirements, and a timeline for relocation. This work will include the development of an EIS to document the environmental and cultural impacts of the ongoing erosion and potential relocation. Newtok was named in the 2006 Energy and Water Appropriation as a recipient of Section 117 funding. A letter report will be prepared in 2006 to assess implementing a project under Section 117.

6.6. Shishmaref

The Corps is completing documentation that discusses the environmental, social, and cultural impacts related to a relocation or co-location. Shishmaref currently requires assistance to address an ongoing erosion problem that could destroy the community before it could relocate. Several other documents were prepared in support of the environmental document. A report, Preliminary Cost of Alternatives, was prepared to document the costs of the community staying on Sarichef Island, moving to a new location, or co-locating with Nome or Kotzebue. The report, "We're always going back and forth", Kigiqtaamiut Subsistence Land Use and Occupancy For the Community of Shishmaref, was prepared to document the importance of subsistence activities for the community of Shishmaref, and the report Co Location Cultural Impact Assessment, documented the various impacts the community of Shishmaref would have if it were to relocate to a hub community such as Nome or Kotzebue.

Shishmaref was named in the 2006 Energy and Water Appropriation as a recipient of Section 117 funding. A letter report will be prepared in 2006 to assess implementing an interim erosion protection project under Section 117, followed by preparation of plans and specifications, and award of a construction contract for the proposed project in the latter part of FY 2006.

6.7. Unalakleet

Unalakleet appears to have preliminarily addressed their erosion issues through the construction of a gabion revetment; however, more work will need to be done to provide more permanent protection. Unalakleet was named in the 2006 Energy and Water Appropriation as a recipient of Section 117 funding. A letter report will be prepared in 2006 to assess implementing a more permanent erosion protection project under Section 117, followed by preparation of plans and specifications for the proposed project.

6.8. Other Communities

In the FY 2006 Energy and Water Appropriations Bill, Point Hope, Koyukuk, and Barrow were identified as other communities eligible for funding under Section 117. Barrow has a feasibility study underway to address its ongoing beach erosion and coastal flooding problem. A letter report will be prepared in 2006 to assess implementing a project under Section 117. The Corps has investigated conditions at Point Hope and Koyukuk under different programs with various degrees of Federal interest being found. A letter report that will assess implementing projects under Section 117 will be prepared for each community in 2006.

6.9. Other Studies

As mentioned previously, FY 2005 funding identified the need for an Alaska Baseline Erosion Assessment. The assessment is being prepared by coordinating with other agencies, planning appropriate responses to erosion problems, and prioritizing communities that need some sort of response. In FY 2005 a list of villages was identified as needing some assessment of their erosion problem. In FY 2006 and 2007, the villages' erosions problems and needs will be assessed and the reports will be made available as they are completed. About 165 communities in the state were identified to have specific erosion problems. Approximately 60 communities will be able to be addressed with the current appropriation.

The Corps has also used Tribal Partnership funding to perform Coastal Hydraulic Modeling. The purpose of this effort was to develop frequency-of-occurrence relationships of storm generated water levels and currents for selected village locations ranging from the Aleutian Islands to the south near the Canadian border to the north and east. The development of the storm-induced water levels and currents was accomplished by performing Advanced Circulation (ADCIRC) numerical model simulations for the Alaska coast along the Bering, Chukchi, and Beaufort seas. This effort will allow for a better understanding of the frequency and magnitude of storms, thus leading to better planning and design in the project development process.

7.0 CONCLUSION

This report has documented the wide variety of efforts the U.S. Army Corps of Engineers has undertaken using Tribal Partnership funding to address the ongoing erosion problems in Alaska. As stated in this report, our analysis uncovered many issues related to erosion protection and community relocation. Through the planning effort of the Tribal Partnership program, the Corps is addressing these issues and exploring solutions for some of the most critical villages. With the ongoing efforts of the Baseline Erosion Assessment and other programs, the Corps is working a strategy for now and the future to address erosion in Alaska. Ongoing work at all levels of the organization is seeking ways to streamline the Corps processes and to expedite implementation of common sense projects. Through continued support at all levels of government, the Corps can and will help lead the way towards success.

This technical report has been prepared by the Alaska District, U.S. Army Corps of Engineers in coordination with and with the assistance of multiple agencies, villages, and stakeholders. It is hereby respectfully submitted for your information.

/s/

Timothy J. Gallagher
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District Commander