Division of Geological & Geophysical Surveys

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ANNOTATED BIBLIOGRAPHY SERIES IN SUPPORT OF COASTAL COMMUNITY HAZARD PLANNING—NORTHWEST ALASKA

UNALAKLEET, ALASKA

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This annotated bibliography is part of a series created to facilitate access to documents useful for coastal geohazard evaluation and community planning in Northwest Alaska. Below is a comprehensive list of community-specific information sources, each with full bibliographic information and an informative-style annotation that highlights content pertaining to the community of Unalakleet, Alaska. For a detailed description of the preparation and scope of this resource, please refer to this bibliography series' foreword. Any notable errors and/or omissions may be reported to the Coastal Hazards Program manager at the Alaska Division of Geological & Geophysical Surveys (DGGS).

Alaska Department of Commerce, Community & Economic Development (DCCED), accessed 2011, Division of Community & Regional Affairs (DCRA) Community Profiles [website]: State of Alaska Department of Commerce, Community & Economic Development.

http://www.commerce.state.ak.us/dca/profiles/profile-maps.htm

This website provides access to community profile maps for community-based planning. The maps are available in 24" by 36" and 30" by 42" formats. The Unalakleet maps were created in 2004, 1996, and 1980 based on land surveys and/or interpretation of aerial imagery. Subsistence hunting grounds, habitat areas, community buildings and public facilities are delineated. Shoreline position and potential erosion zones are included in the map content. All maps have been sponsored by the Alaska Division of Community & Regional Affairs and contracted to local agencies for production.

Alaska Department of Natural Resources Division of Coastal and Ocean Management (DCOM), accessed February 2011, Alaska Coastal Management program [website]: Alaska Department of Natural Resources Division of Coastal and Ocean Management.

http://alaskacoast.state.ak.us/Explore/Tour.html

This website outlines the Alaska Coastal Management Plans for each coastal district. It provides stewardship plans "to ensure a healthy and vibrant Alaskan coast that efficiently sustains long-term economic and environmental productivity."

Blier, Warren, Stanley Keefe, Wilson A. Shaffer, and Sung C. Kim, December 1997, Storm surges in the region of western Alaska: Monthly Weather Review, vol. 125 p. 3094–3108.

The authors describe the relationship between storm surges in Alaska and extratropical cyclones. They have identified Norton Sound and the Bering Sea as the two regions most vulnerable to cyclone-linked coastal flooding. A statistical storm surge model was developed to provide advanced warning to coastal villages, however, the author highlights that a more accurate model would be necessary to utilize this warning system as a hazard mitigation strategy. The installation of storm-surge gauges would also be required for this warning system to be used successfully.

Bradner, Tim, May 2008, State, federal agencies work to get a handle on coastal erosion [electronic]: Alaska Journal of Commerce, Anchorage, Alaska, 4 p. accession no. 2W62W62903157211

This popular-press article discusses basic actions taken by Newtok in an effort to relocate. They have built three houses and a dock (with federal funds), and are now considering a road from the current location to the new one. Community members of Unalakleet have begun to build houses on high ground, about a half mile from the town's current location. Mike Black, deputy state commerce officer, suggested that priority for state and federal funding be developing evacuation routes, safe houses, and then relocation infrastructure. This article also gives reference to the Immediate Action Workgroup (IAWG) as a further source of information.

Cacchione, David A., and David E. Drake, 1979, Sediment transport in Norton Sound, Alaska: U.S. Geological Survey Open-File Report 79-1555, 88 p.

This report is an investigation of sediment dynamics in Norton Sound and the northern Bering Sea. The major topic of the research was sediment movement and hydrodynamic stresses that occur in the Sound and their relationship to Bering Sea ocean dynamics. Other studies have found sediment accumulation from the Yukon River inconsistent with the rate of supply. The modes of transport for this loss of materials are discussed in the report. This study attempts to provide a description of the bottom transport of sediments, pollutants, nutrients, and other particulate matter, as well as identify hazardous sea floor conditions in Norton Sound.

Chapman, Raymond S., Sung-Chan Kim, and David J. Mark *for* U.S. Army Corps of Engineers, Alaska District, 2009, Storm damage and flooding evaluation, storm-induced water level prediction study for the western coast of Alaska: Vicksburg, MS, U.S. Army Engineer Research and Development Center, Coastal & Hydraulics Laboratory, 92 p.

Technical assistance was provided by the U.S. Army Engineer Research and Development Center, Coastal & Hydraulics Laboratory in assessing storm-generated regional water levels and currents at selected sites of ongoing and potential COE projects along the western coast of Alaska. The purpose of this study was to develop frequency-of-occurrence relationships for storm-generated water levels at 17 communities along the western coast of Alaska. Storm wind, pressure, ice, and surge data were generated for each of the areas, and the bathymetry was updated. Fifty-two storm event simulations were performed and a database of water levels versus return period was developed for each site.

City of Unalakleet, WHPacific, Incorporated of Alaska, and Bechtol Planning and Development, June 2008, City of Unalakleet, Alaska, local hazards mitigation plan: City of Unalakleet, Alaska, 70 p.

This plan identifies natural hazards for Unalakleet and includes information to assist the city government and residents with planning to avoid potential disaster losses. The plan is required to be updated every five years by the Department of Homeland Security (DHS) and the Division of Emergency Management (EM). The prioritized list of hazards includes risks due to flooding and erosion in Unalakleet; these hazards arise from changing sea level, offshore ice pack retreats, early melting and late formation of sea ice, storm surge, ice jams, snowmelt, and rainfall. The highest flood on record is the 1965 flood, which reached 18 feet above MSL. The City of Unalakleet is looking to participate in the National Flood Insurance Program (NFIP) to provide flood insurance to homes and businesses, but must first regulate new development and improvement to existing structures.

Denali Commission, March 2011, Road and waterfront project selections, fiscal year 2006–2011: Denali Commission, 9 p.

This report contains an overview of all of the funding dispersed by the Denali Commission Transportation Program from 2006–2011. The document is organized by partner agency/project and includes a description of the project status. Unalakleet was awarded $144,616 and $1,700,000 in FY2006 and FY2007 for street reconstruction projects, which are now complete.

Dorava, Joseph M., Bruce Babbitt, and Gordon P. Eaton, eds., 1995, Overview of environmental and hydrogeologic conditions at Unalakleet, Alaska: U.S. Geological Survey Open-File Report no. 95-347, 8 p.

This report was produced for the Federal Aviation Administration (FAA) to determine if environmentally hazardous materials have been spilled or disposed of in Unalakleet. To complete this study, information about the area's geology and hydrology were collected.

Mean, mean maximum, and mean minimum temperatures are presented from records between 1941 and 1987. The local vegetation is also described. Polygonal ice wedges occur along the coast, however, test bores ranging from 4.6 to 15.2 m resulted in no permafrost within 10 m below the surface. Soils that predominate the area are silt loams developed on alluvium and colluvium. The Unalakleet River drainage basin is about 5,300 km^2 in size with a contribution of 0.26 $m^3/s/km^2$ of water in August, and between 0.0 and 0.003 $m^3/s/km^2$ of water during March. Major flooding events in Unalakleet occurred in 1965, 1968, 1971, and 1974, usually caused by storm-driven waves. Based on regional flood characteristics, estimates of the 2-year and 50-year flood discharges for the Unalakleet River are 600 and 1,240 m^3/s at the mouth. Groundwater may be subject to seasonal intrusion of sea water. Groundwater recharge is mostly confined to areas near the banks of the Unalakleet River, because of the variable permafrost and consolidated earth material. Well logs are provided with formation descriptions based on drill logs from 1962 to 1977.

Drake, D.E., D.A. Cacchione, R.D. Muench, and C.H. Nelson, 1980, Sediment transport in Norton Sound, Alaska: Marine Geology, vol. 36, p. 97–126.

This study examines the suspended sediment and ocean circulation of the northeastern part of the Bering Sea shelf. The authors describe the fate of sediment delivered by the Yukon River to the southwestern corner of Norton Sound and the importance of storm events in Norton Sound associated with erosion and sediment transport. Landsat images were also used to inspect the distribution of sediments and regional circulation in the Sound.

Hartig, Larry, *of* Alaska Department of Environmental Conservation & Governor's Climate Change Sub-Cabinet, October 2010, State of Alaska and State/Federal Executive Roundtable Activities Regarding the Arctic [presentation]: Anchorage, Alaska, Northern Waters Task Force, 53 p.

http://housemajority.org/coms/anw/pdfs/26/NWTF_Powerpoint_Hartig_01Oct10.pdf

This is a powerpoint presentation about the state and federal executive roundtable activities regarding the Arctic. The discussion includes hazards associated with declining Arctic sea ice extent, melting of permafrost, storm surges, and coastal erosion. Thirty-one villages are identified as imminently threatened: Barrow, Kivalina, Selawik, Allakaket, Hughes, Huslia, Shishmaref, Deering, Teller, Koyukuk, Nulato, Golovin, Shaktoolik, Unalakleet, Saint Michael, Kotlik, McGrath, Emmonak, Alakanuk, Chevak, Newtok, Nunapitchuk, Lime Village, Eyak (Cordova), Napakiak, Akiak, Chefornak, Kwigillingok, Dillingham, Clark's Point, and Port Heiden. Specific photos and engineering initiatives for four communitites are discussed, including: Kivalina, Shishmaref, Unalakleet, and Newtok.

Hughes, R., 1974, Unalakleet National Wild River final environmental statement: U.S. Department of the Interior, vol. 19, 386 p.

This document provides descriptions of Unalakleet River water quality and geology. Maximum river flow occurs in late May and early June, with short periods of high water in late July or early August. Winter freeze-up occurs in November or December. The Unalakleet River is a non-glacial river, maintaining its clear character, except the slight turbidity or brownish appearance like similar arctic/boreal areas with acidic soil. The river follows the major trend of the Kaltag fault. The ridges in the north of the drainage area contain Cretaceous mudstone, shale, graywacke, sandstone, and conglomerates. The southern portion contains Cretaceous sediments invaded by a variety of small intrusive bodies of volcanic rock.

Immediate Action Workgroup (IAWG), Michael Black and Patricia Opheen, eds., March 2009, Recommendations to the Governor's Subcabinet on Climate Change: Immediate Action Workgroup, 162 p.

The Immediate Action Workgroup was established to address known threats to Alaskan communities caused by coastal erosion, thawing permafrost, flooding, and fires. This report is a follow-up to the recommendations made in April 2008 and provides recommendations of actions and policies to be implemented in 2009 and 2010. Unalakleet has been identified as one of the communities facing imminent threats such as loss of life, loss of infrastructure, loss of public and private property, or health epidemics.

Community planning for Unalakleet is supported by Kawerak, DOT&PF, and USACE projects. Therefore the workgroup suggests the planning needs are less critical than those of the other five communities being considered. In FY2009, $5 million in state funds was appropriated to Unalakleet to leverage an additional $18.5 million from USACE to build necessary revetment structures. Coordination with DOT&PF has saved on mobilization and demobilization costs by using heavy equipment already in the community. The old high school gym has

been scheduled to be torn down, and could be rebuilt on higher ground to serve as an emergency evacuation building and community center. Unalakleet has requested $1 million for this project, but submitted the request after the deadline.

Immediate Action Workgroup (IAWG), Michael Black and Patricia Opheen, eds., 2008, Recommendations report to the Governor's Subcabinet on Climate Change: Immediate Action Workgroup, 86 p.

This report provides recommendations to the Alaska Governor's Subcabinet on Climate Change by the Immediate Action Workgroup (IAWG). Unalakleet has been identified as susceptible to erosion damages. Another potential threat is the presence of logs from the Yukon River, which can be destructive during storm surges. The recommended $12.8 million erosion mitigation project is a 1,500-foot-long rock revetment, which would be constructed along an existing gabion revetment. Projects to address imminent threats are the development of emergency plans and training/drills, revetment design/construction, and local street rehabilitation projects.

Ivanoff, Herbert; Paul LaBoll, ed., May 2010, Total project snapshot report, Unalakleet—Erosion control: State of Alaska Department of Commerce, Community & Economic Development, total project snapshot report no. 54091v1, 6 p.

This capital budget report describes the state funding necessary for erosion control measures in Unalakleet. The project objectives are completion of a U.S. Army Corps of Engineers funded seawall, development of a Hazard Mitigation Plan, and selection of a site for an emergency evacuation shelter. Unalakleet has requested $4,550,000 to extend the project and ensure timely completion of a rock revetment that extends around the mouth of the river. The state approved $1,741,000 of funding for the start of summer 2011.

Ivanoff, Steve, *of* The Village of Unalakleet, October 2007, The state and federal response to storm damage and erosion in Alaska's coastal villages [testimony]: Committee on Homeland Security and Governmental Affairs (CHSGA) Ad Hoc Subcommittee on Disaster Recovery, 6 p.

This is the testimony of Steve Ivanoff before the Committee on Homeland Security and Governmental Affairs, discussing the history of storm damage and possible consequences of inaction in Unalakleet. The community is described as a hub of education and medical services to the 15 villages in Norton Sound. Flooding from storm surges has become more frequent, with disaster declarations in 2003–2005. The resulting erosion is concentrated at the mouth of the river and along the ocean beach. Gabion walls were constructed in 2000, but have been marginally damaged, requiring repair work before the next storm season. The Army Corps of Engineers is in the final planning process for the construction of a riprap wall. Alaska Department of Transportation & Public Facilities (DOT&PF) is in the process of designing a riprap wall to protect the beach along the airport, as well as elevating the evacuation road. The community water source is threatened by erosion of the piping that runs 5 miles north along the side of the roads and beach.

Mr. Ivanoff describes how many residents are now seeking to build homes in the nearby hills because of long-term safety, but access roads are necessary to speed up this process and encourage development. He points out that funding is currently available for reactive measures, but not proactive measures.

Johnson, Walter R., and Zygmunt Kowalik, April 1986, Modeling of storm surges in the Bering Sea and Norton Sound: Journal of Geophysical Research, vol. 91, no. C4, p. 5119–5128.

Based on the results of a numerical model used to examine sea level, currents, and ice distribution during Bering Sea storm events, the authors suggest that the presence of land-fast ice in Norton Sound has a measurable effect on the size and onshore arrival time of storm-surge events. Both land-fast and pack ice are included as parameters in the model runs. The model is validated using observations and measurements from the February 1982, March 1982, and November 1974 storm events and reproduces observations of sea ice redistribution during these storm events.

Klein, Joe, Mike Scott, and Bunny B.G. Sterin, May 2000, Unalakleet National Wild River, Alaska—Resource values and in-stream flow assessment: Anchorage, Alaska, U.S. Bureau of Land Management, 37 p.

The primary objective of the work summarized in this report was to determine the quality and amount of habitat available to Unalakleet River salmon. This report contains synthetic monthly stream discharge data, developed using varying gauges information to simulate flow in the Unalakleet River between 1976 and 1994. Sediment characteristics are reported indirectly as habitat indications.

Lau, David, July 2010, Regional integration team spearheads development of guidance critical to Alaska coastal erosion program: Fort Shafter, Hawaii, U.S. Army Corps of Engineers, Pacific Ocean Division, news release no. 10-05, 2 p.

This release announces that the Secretary of the Army has been authorized to carry out structural and non-structural projects for storm damage prevention and reduction, coastal erosion, and ice and glacial damage in Alaska under the Energy and Water Development Appropriations Act of 2010. This allows for the continuation of projects in Unalakleet, Kivalina, Shishmaref, and Newtok.

Mason, Owen K., and James W. Jordan, 2002, Minimal late Holocene sea level rise in the Chukchi Sea—Arctic insensitivity to global change?: Global and Planetary Changes, vol. 32, p. 13–23.

In this article, Mason and Jordan outline the apparent disconnect between late Holocene global sea-level rise and the moderate sea-level rise observed in Northwest Alaska. Radiocarbon ages taken from peat and storm deposits in Seward Peninsula lagoons allowed for the reconstruction of a sea-level curve spanning the last 6,000 years. The results indicate that sea level in Northwest Alaska has risen an average 0.3 mm per year compared to the global average of 1–2 mm per year. The authors suggest several hypotheses for these differing rates, including cold sea-surface temperatures (limited steric expansion), geoid variation, and/or the development of permafrost. Although observed rates of sea-level rise are moderate for the Chukchi Sea, the article cautions that the response of northern Alaska's coasts to future global climate change remains uncertain and requires continued investigation.

Natural Resource Conservation Service, April 2003, Flood plain management study for the city and Native village of Unalakleet, Alaska: Natural Resources Conservation Service, U.S. Department of Agriculture, 75 p.

This report was carried out through the Watershed Protection and Flood Prevention Act per request of the Native Village of Unalakleet. Included are detailed hyrdrographic conditions based on the USGS gage on the Unalakleet River and application of UNET, a U.S. Army Corps of Engineers hydraulic model. The historical gage data were used to create discharge and surface elevation return intervals of flooding up to 100 years. Flood hydrographs are available for multiple locations along the river, as well as projected flood cross sections. Although a thorough analysis was not undertaken, coastal flooding was identified as the most probable cause of flooding damages below 1 foot and above 3 feet of elevation.

Rodney P. Kinney Associates, Inc., and Kawerak Transportation Program, March 2007, Unalakleet long-range transportation plan: Eagle River, Alaska, Indian Reservation Roads Program, E04509-UNALAKLEET, 81 p.

This plan describes transportation priorities for Unalakleet including funding priorities of the Bureau of Indian Affairs (BIA) Indian Reservation Roads (IRR) Program. When this plan was written, the IRR program included 28.5 miles of road with about 193.2 miles of road planned to be submitted. The plan prioritized six projects:

1. *Upgrade community streets ($9 million)*
2. *Elevate beachfront roads and construct community streets with pavement and proper drainage ($2 million)*
3. *Construct subsistence and economic routes ($754 million)*
4. *Replace North River bridge and provide erosion protection ($2 million)*
5. *Construction and upgrades to marine facilities ($14 million)*
6. *Provide route stakings, navigational upgrades, and signs to improve winter travel safety ($100,000/mile)*

This list represents the community's needs over the next 20 years for better economic growth and access to resources. The current road inventory can be viewed in table 4.1.

Russell Cox, Sally *of* Alaska Division of Community & Regional Affairs (DCRA), 2011, Alaska climate change impact mitigation program [powerpoint]: Anchorage, Alaska Division of Community & Regional Affairs, 28 p.

This is a powerpoint presentation about the Alaska Climate Change Impact Mitigation Program (ACCIMP) presented by Sally Cox, a planner with the Alaska Department of Commerce, Community & Economic Development. Communities that have been identified for community planning grants under this program are Kivalina, Shishmaref, Koyukuk, Unalakleet, Shaktoolik, and Newtok.

Sallenger, Asbury H., Jr., 1983, Measurements of debris-line elevations and beach profiles following a major storm: Northern Bering Sea coast of Alaska: U.S. Geological Survey Open-File Report 83-394, 12 p.

From introduction: "During November 1974, a severe storm occurred in the Bering Sea; winds gusted to greater than 100 km/hr and barometric pressure dropped 34 mb. Combined storm surge and wave run-up reached as high as 5 m along the northern Bering Sea coast of Alaska. Shortly after the storm, the northern Bering Sea froze. Following breakup in 1975 and during the ice-free season of 1976, we surveyed beach profiles and elevations of debris lines at stations around the northern Bering Sea coast of Alaska. In this open-file report, these data are used to show the approximate magnitude of combined storm surge and wave run-up in the study area."

Sallenger, Asbury H., Jr., and John R. Dingler, September 1978, Coastal processes and morphology of the Bering Sea coast of Alaska: Menlo Park, California, U.S. Geological Survey, Research Unit No. 431, 66 p.

The purpose of the research outlined in this paper was to characterize the regional physical environment of the Bering Sea coast of Alaska to prepare for potential oil and gas development and subsequent hazards to infrastructure and environment. The net direction of longshore transport, coastal morphology, and reconnaissance-based beach morphology and sediment characteristics were used as indicators. Measurements were taken along the Bering Sea coast of debris-line elevations that were reached during the 1974 Bering Sea storm. Coastal change was measured near Nome using near-shore coastal profiling and aerial photography from 1976 and 1977. Wave characteristics and sea level variations were also measured to check the validity of the wave model used. The specific objective of the research was to develop a coastal setback line beyond which petroleum development would not occur.

Scott, Michael, September 2000, Aerial photography assessment of riparian areas in the Unalakleet drainage, Alaska: Anchorage, Alaska, U.S. Bureau of Land Management, Open File Report no. 81, 23 p.

The BLM Riparian-Wetland Initiative for the 1990s outlines policy, regulations, and guidance for the identification, protection, restoration, and maintenance of riparian-wetland areas for BLM lands. Alaska has been identified as a "special situation" in that only a small proportion of wetlands have been disturbed. Because of the magnitude and remoteness of riverine riparian areas, a landscape-scale approach using aerial photography was used to evaluate wetland health.

The most current statewide aerial photography was flown in the 1980s at 1:60,000 and 1:40,000 scales. In this study, interpreters used a portable light table in the field to help them review reaches before and after field verification. Although most aerial photography in Alaska is old, this method was found to be 95% accurate for assessing proper functioning conditions of riparian-wetland areas in the Unalakleet Basin by the Natural Resource Conservation Service.

Simpson, J.J., January 1984, Final report, task force on erosion control: Alaska Department of Transportation & Public Facilities, project no. R-30023, 101 p.

The Erosion Control Task Force was appointed to investigate and inventory potential erosion problems on a statewide basis, to prioritize the erosion problem sites by severity and need, and to provide preliminary design plans where immediate remedial action is required. Sites were rated based on public safety, public property, private property, time of projected loss, ability to move, approximate replacement value, and economic value. Projected costs of erosion protection measures were analyzed, and totaled $16,802,300 for all projects. This report outlines specific engineering projects to reduce the effects of coastal and riverine erosion for communities throughout Alaska.

Unalakleet was identified as having a persistent erosion problem at the end of the sand spit, making buildings in town vulnerable to flooding and erosion damage. This report recommends that Unalakleet build a rock revetment at the very southern tip of the spit with rock materials non-native to the area.

Sloan, Charles E., Donald R Kernodle, and Ronald Huntsinger, 1986, Hydrologic reconnaissance of the Unalakleet River basin, Alaska, 1982–83: U.S. Geological Survey *with* U.S. Bureau of Land Management, Water-Resources Investigations Report no. 86-4089, 18 p.

This report includes a record of average monthly snowfall and precipitation from 1941–1979, landcover distribution for the Unalakleet basin, streamflow and runoff values, mineral concentration in water, and previous flood and fluvial erosion information.

Thorsteinson, Lyman K., Paul R. Becker, and David A. Hale, 1989, The Yukon Delta—A synthesis of information: Anchorage, Alaska, National Oceanic and Atmospheric Administration (NOAA), OCS study no. MMS 89-0081, 89 p.

This document contains a synthesis of physical and ecological information about the Yukon–Kuskokwim River Delta. "[Since 1974], the Outer Continental Shelf Environmental Assessment Program has administered oceanographic research to characterize the environmental components and processes of the Alaskan Outer Continental Shelf." This research, once primarily based on oil and gas exploration, has provoked interest about the importance of the physical and biological habitats of the delta.

The physical environment is described in terms of geomorphology, hydrology, bathymetry, sedimentology, coastal circulation, hydrography, and environmental sensitivity mapping. The biological environment is described in terms of primary productivity, invertebrates, fisheries, avifauna, and mammals.

Areas of research highlighted as in need of further exploration are ice-edge effects, prevailing sea-ice movements to the southwest, and subsurface northwesterly transport of Norton Sound water masses. If oil and gas exploration develops, more work must be conducted to determine the effects that this activity would have on the estuarine habitat.

Mean monthly wind statistics from Unalakleet were used to illustrate the large-scale wind field affecting the Yukon Delta. This included the average wind speed and direction during specific seasons.

Unalakleet Planning Organizations and Kawerak's Community Planning and Development Program, Kathy Johnson and Janice Dickens, eds., *for* The Community of Unalakleet and The Bering Strait Development Council, June 2009, Unalakleet local economic development plan, 2009–2013: Kawerak Incorporated, 83 p.

AS 29.40.030 requires that Unalakleet adopt a comprehensive plan to "define policy statements, goals, and standards for the physical, social, and economic development of the community." This plan is a part of the "ongoing effort to improve community conditions and well-being of its members." The plan outlines ten economic development priorities for Unalakleet. These include priorities related to coastal hazards such as erosion control, development of a hazard mitigation plan, building/designing an emergency shelter, and protecting water transmission lines along the coast.

Other priorities include new waterline construction and a new water tank/source, building an elder assisted-living facility, energy-waste heat installation/connection for community buildings, new housing, a new public safety building/jail, fixing/building snow fences, fixing/installing street lights, building a new maintenance shop, creating more local job training, and supplying satellite internet for community buildings.

U.S. Army Corps of Engineers, accessed 2011, Civil works floodplain management services [website]: U.S. Army Corps of Engineers, Alaska District.

http://www.poa.usace.army.mil/en/cw/fld_haz/floodplain_index.htm

This website provides flood-hazard data for communities throughout Alaska. A link is provided to a flood-hazard-specific bibliography, maintained by the U.S. Army Corps of Engineers. The highest reported flood event in Unalakleet was 18 ft above MSL in 1965; a recommended minimum building elevation is set 19.0 ft above MSL.

U.S. Army Corps of Engineers, 2009, AVETA report summary—Unalakleet, Alaska: Alaska Baseline Erosion Assessment, U.S. Army Corps of Engineers, Alaska District, 4 p.

This report is a brief overview of projected costs due to erosion-driven infrastructure loss and the projected costs of necessary erosion control measures in Unalakleet, Alaska. The report includes historic and predicted shoreline position maps for Unalakleet, dependent on erosion rates determined to be 1 foot per year on the side of Norton Sound, and 2 feet per year on the portion of the sand spit in contact with the Unalakleet River.

U.S. Army Corps of Engineers, March 2009, Study findings and technical report—Alaska baseline erosion assessment: Elmendorf Air Force Base, Alaska, U.S. Army Corps of Engineers, Alaska District, 68 p.

http://www.poa.usace.army.mil/AKE/Home.html

This statewide assessment was conducted by the U.S. Army Corps of Engineers to coordinate, plan, and prioritize responses to erosion throughout Alaska. The report designated Unalakleet, along with 25 other

communities, as priority action communities. Section 117 of the 2005 Energy and Water Development Appropriations Act has initiated construction projects at Kivalina, Newtok, Shishmaref, and Unalakleet.

There have been two erosion projects completed since 2004 in Unalakleet. These projects, totaling $1.8 million, involved protecting roadways from erosion damage. At the time of this report, Unalakleet was in the preliminary stage of a $5 million erosion protection project funded by a legislative grant.

The Corps has proposed a revetment for a large portion of the frontage, but residential structures are still threatened and this report estimates that damage is expected to occur within 10 years. The designed revetment is a 1,500-foot rock structure to be emplaced over the existing gabion seawall and is projected to cost $28 million. With the repeal of Section 117, the funding for this project is uncertain.

U.S. Army Corps of Engineers, November 2008, Request for proposals, coastal erosion control, Unalakleet, Alaska: U.S. Army Corps of Engineers, Alaska District, Elmendorf Air Force Base, Alaska, inv. no. W911KB-09-R0004 UNK134508A, 12 p.

This document contains site plans and survey control for the coastal erosion control project in Unalakleet, including revetment section schematics.

U.S. Army Corps of Engineers, Timothy J. Gallagher, ed., April 2006, Alaska village erosion technical assistance program—An examination of erosion issues in the communities of Bethel, Dillingham, Kaktovik, Kivalina, Newtok, Shishmaref, and Unalakleet: U.S. Army Corps of Engineers, Alaska District, 44 p.

This report documents an investigation of issues surrounding erosion at several Alaska Native villages. It contains an examination of erosion rates and control, potential relocation sites, and impacts to Alaska Native culture and tradition. Unalakleet is identified as requiring $30 million for future erosion protection, and was not identified as in need of immediate relocation efforts because the community location is described as stable on a 100-year timescale. The project to mitigate erosion is the construction of a riprap revetment. The loss of residential, commercial, and public buildings and infrastructure due to erosion is more than $105 million for the 50-year project horizon if no action is taken.

U.S. Army Corps of Engineers, Patricia S. Opheen and Carl E. Borash, eds., August 2008, Invitation for bid, coastal erosion control, Unalakleet, Alaska: U.S. Army Corps of Engineers, Alaska District, Elmendorf Air Force Base, Alaska, inv. no. W911KB-08-B0008 UNK134508, 229 p.

This document contains the contractual agreement between the U.S. Army Corp of Engineers and associated agencies for a coastal erosion control project in Unalakleet. The project will require the development of a rock source for a total of 49,000 cubic yards of three types of rock units required for the revetment. The total projected cost, including meeting all required land reclamation standards, is $31 million.

U.S. Government Accountability Office (GAO), June 2009, Report to congressional requestors—Alaska Native villages, limited progress has been made on relocating villages threatened by flooding and erosion: U.S. General Accountability Office Report GAO-040895T, 53 p.

http://www.gao.gov/products/GAO-09-551

This report is a follow-up to the 2003 GAO report on flooding and erosion in Alaska Native villages, and was completed to identify concerns due to climate change that have increased the urgency of federal and state efforts. The GAO developed recommendations for Congress that include:

1. *A flooding assessment to augment the erosion assessment completed by the Army Corps of Engineers.*
2. *An amendment to federal legislation so that 64 more villages may be eligible for grants.*
3. *Designating a federal entity to oversee and coordinate village relocation efforts.*

The report identified 31 villages as facing imminent flooding and erosion threats, including Unalakleet. The village was declared a state flood disaster area in 2003 and 2005. "Villagers told the GAO that the 2005 storm was the most damaging, causing severe erosion to the protective seawall and flooding in the village." The Corps is in the construction stages of shoreline protection at Kivalina, Shishmaref, and Unalakleet. State contractors are helping villages to produce hazard assessments and mitigation plans, allowing them to qualify for FEMA hazard relief funds. These plans, training, and drills are scheduled for completion by the end of 2009.

Unalakleet has rights to land on a nearby hillside and access via an evacuation road. An estimated $8.8 million would be required to develop a subdivision in this region that would accommodate 300 homes. The funding, however, is not in place and without infrastructure there is little incentive for people to relocate. "The Corps, ADOT&PF, and Kawerak are each planning projects to reinforce an existing seawall and provide new protection to vulnerable areas of shoreline."

U.S. Government Accounting Office (GAO), 2003 [2004], Alaska Native villages—Most are affected by flooding and erosion, but few qualify for federal assistance: U.S. General Accounting Office Report GAO-04-142, 82 p.

http://www.gao.gov/products/GAO-04-142

This study was conducted to provide recommendations to Congress that would improve how state and federal agencies respond to flooding and erosion in Alaska. This was done by:

1. *Determining the extent to which these villages were affected.*
2. *Identifying federal and state flooding and erosion programs.*
3. *Determining the current status of efforts to respond to flooding and erosion in nine villages.*
4. *Identifying alternatives that Congress may wish to consider when providing assistance for flooding and erosion (see "Highlights" section).*

The recommendations provide alternatives to current actions taken during flooding and erosion responses by including federal agencies and the Denali Commission. The adoption of policies by the Denali Commission would guide investments in infrastructure for Alaska Native villages affected by flooding and erosion. Unalakleet was one of the nine villages thoroughly reviewed.

Unalakleet is identified as having a long history of flooding, dating back to the 1940s. The seawall that is in place at Unalakleet was funded fully by Natural Resources Conservation Service (NRCS) because local and state funding could not be procured. $400,000 from Norton Sound Economic Development Corporation and $400,000 from the Alaska Department of Transportation & Public Facilities was raised by Unalakleet to cost-share a feasibility study through the Army Corps of Engineers. The feasibility study addresses a navigational access problem at the harbor caused by accretion of eroded material at the harbor entrance in the form of six sandbars. Unalakleet was mentioned to be a leader in negotiating with federal agencies about cost-share requirements.

Wise, James L., Albert L. Comiskey, and Richard Becker, 1981, Storm surge climatology and forecasting in Alaska: Anchorage, Alaska, Arctic Environmental Information and Data Center, University of Alaska, 26 p.

The objective of this study was to improve the quality of life and the security of property in coastal areas susceptible to flooding by enhancing the decision-making process for human activities and development. This study compiles historical climatological data to develop a surge forecast regression equation.

The Seward Peninsula, Norton Sound, and Lower Yukon areas are identified as having the greatest frequency of reported coastal storms in Alaska. Norton Sound exhibits shallow waters offshore, combined with the open waters of the Bering Sea, allowing for a long fetch for storm-wave development. The range of wind directions for the development of storm surges is limited to west–southwest to west; however, flooding is experienced due to rising water levels throughout the Sound.

Nine of the ten storm-surge cases described in detail for Unalakleet occurred in the fall, the other in July. A storm in October 1963 was responsible for $100,000 in damages.
