

Report of Investigation 2021-3 Shishmaref

EROSION EXPOSURE ASSESSMENT—SHISHMAREF

Richard M. Buzard, Mark M. Turner, Katie Y. Miller, Donald C. Antrobus, and Jacquelyn R. Overbeck



Shishmaref, Alaska, in 2012. Shorezone, shorezone.org.



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Contents

Shishmaref Erosion Exposure Assessment.....	1
Acknowledgments	2
References	4

Figures

Figure 1. Replacement cost of all infrastructure in the erosion forecast area	3
Figure 2. Replacement cost of all utilities and transportation infrastructure in the erosion forecast area	3

Tables

Table 1. Quantity of infrastructure with estimated erosion exposure.....	2
Table 2. Replacement cost of infrastructure exposed to erosion.....	2
Table 3. Cost estimate of erosion exposed buildings and tank facilities.....	2

EROSION EXPOSURE ASSESSMENT—SHISHMAREF

Richard M. Buzard¹, Mark M. Turner¹, Katie Y. Miller¹, Donald C. Antrobus², and Jacquelyn R. Overbeck¹

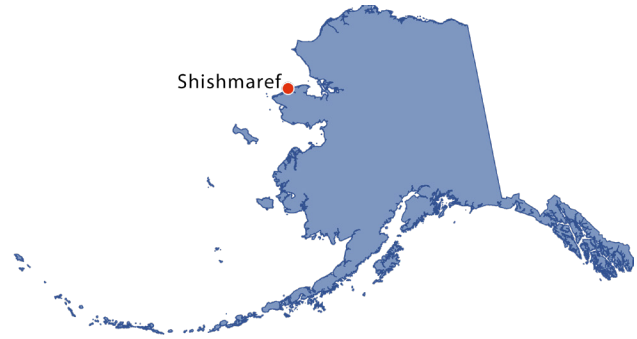
SHISHMAREF EROSION EXPOSURE ASSESSMENT

This is a summary of erosion forecast results near infrastructure at Shishmaref, Alaska. We conduct a shoreline change analysis, forecast 60 years of erosion, and estimate the replacement cost of infrastructure in the forecast area. Buzard and others (2021) describe the method and guidance for interpreting tables and maps.

Source data for this summary include the following:

- Delineated vegetation lines and change assessment by Buzard and others (2021) following the methods of Overbeck and others (2020).
- Infrastructure AutoCAD outlines and metadata from Division of Community & Regional Affairs (2004) Community Profile Map series.
- Added infrastructure such as roads, water and sanitation facilities, and outbuildings, delineated if visible in the most up-to-date high resolution (≤ 0.66 ft [20 cm] ground sample distance) aerial orthoimagery (Alaska Department of Transportation & Public Facilities, personal communication, 2020).
- Computed infrastructure cost from Buzard and others (2021).

Shishmaref is located on Sarichef Island on the northwest coast of the Seward Peninsula. The barrier island is susceptible to erosion caused by wave activity, sea ice gouging, and slumping from thawing permafrost (HDR with RIM First People, 2016). Reduced sea ice can lead to greater erosion during fall and winter storms (U.S. Army Corps of Engineers [USACE], 2009). Overbeck and others



(2020) show erosion rates of the shoreline fronting the Chukchi Sea to range from 3.3 to 7.5 feet per year. The northeast point of Shishmaref is accreting around 12.1 to 1.0 feet per year (Overbeck and others, 2020) due to littoral drift of coastal sediments (USACE, 2009).

The community has varying success with shoreline protection structures (USACE, 2009). Two-hundred feet of rock revetment was installed in 2004, then extended 480 feet in 2005, 600 feet in 2008, and 750 feet in 2009 (USACE, 2009; City of Shishmaref, 2015). The Alaska Department of Transportation & Public Facilities installed more rock revetments along segments of shoreline in front of airport property during the summer of 2019. The existing rock revetments have stabilized the bluff shoreline so we do not forecast erosion in these areas.

We forecast erosion 60 years from the most recent shoreline (2019) at 20-year intervals to identify the exposure of infrastructure to erosion. Infrastructure within the erosion forecast area by 2079 include power lines, a small section of water lines, a road leading the landfill, 7 buildings, and the wastewater lagoon (table 1). No fuel lines are found to be exposed to erosion. The greatest cost is the wastewater lagoon between 2039 and 2059

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(table 1). Although only a portion of the wastewater lagoon is exposed to erosion, failure of a lagoon side wall can result in drainage of the lagoon and failure of the entire facility. The total replacement cost of infrastructure exposed to erosion is \$9.5 million (\pm \$2.8 million) over the next 60 years (table 2 and 3; figs. 1 and 2).

ACKNOWLEDGMENTS

This work was funded by the Denali Commission Village Infrastructure Protection Program through the project “Systematic Approach to Assessing the Vulnerability of Alaska’s Coastal Infrastructure to Erosion.” The community of Shishmaref was not consulted for this report.

Table 1. Quantity of infrastructure with estimated erosion exposure by linear footage (LF) or count (n).

Quantity of Exposed Infrastructure						
Erosion Forecast Date Range	Buildings (n)	Power Lines (LF)	Fuel Lines (LF)	Water Lines (LF)	Roads (LF)	Wastewater Lagoon (SF)
2019 to 2039	3	0	0	7	1,045	0
2039 to 2059	2	0	0	0	522	18
2059 to 2079	2	249	0	0	488	3,935
Combined Total	7	249	0	7	2,055	3,953

Table 2. Replacement cost of infrastructure exposed to erosion per 20-year interval.

Cost to Replace Exposed Infrastructure							
Erosion Forecast Date Range	Buildings	Power Lines	Fuel Lines	Water Lines	Roads	Wastewater Lagoon	Sum
2019 to 2039	\$214,700	\$0	\$0	\$50,000	\$418,000	\$0	\$682,700
2039 to 2059	\$1,097,600	\$0	\$0	\$0	\$208,800	\$6,000,000	\$7,306,400
2059 to 2079	\$1,250,000	\$50,000	\$0	\$0	\$195,200	\$0	\$1,495,200
Combined Total	\$2,562,300	\$50,000	\$0	\$50,000	\$822,000	\$6,000,000	\$9,484,300

Table 3. Cost estimate of erosion exposed buildings and tank facilities by 20-year interval. The count of exposed residential or unspecified buildings is denoted in parentheses. NCA designates buildings with no cost assigned.

Cost to Replace Exposed Buildings and Tank Facilities		
Erosion Forecast Date Range	Building Type	Cost of Replacement
2019 to 2039	Old Tannery Building (1)	NCA
	Residential (2)	\$214,700
2039 to 2059	Old Tannery Building (1)	NCA
	Unspecified (1)	\$1,097,600
2059 to 2079	FAA Conex	NCA
	FAA Maintenance Shelter	\$1,250,000

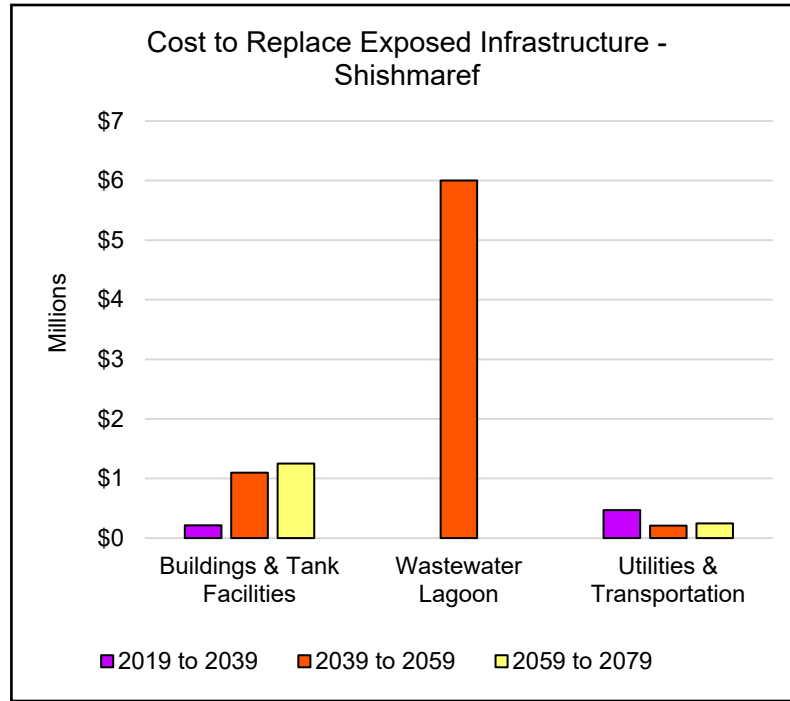


Figure 1. This figure summarizes the replacement cost of all infrastructure in the erosion forecast area. Twenty-year intervals are symbolized by color: purple represents the time interval 2019 to 2039, red represents 2039 to 2059, and yellow represents 2059 to 2079. The bulk of costs is the wastewater lagoon between 2039 and 2059.

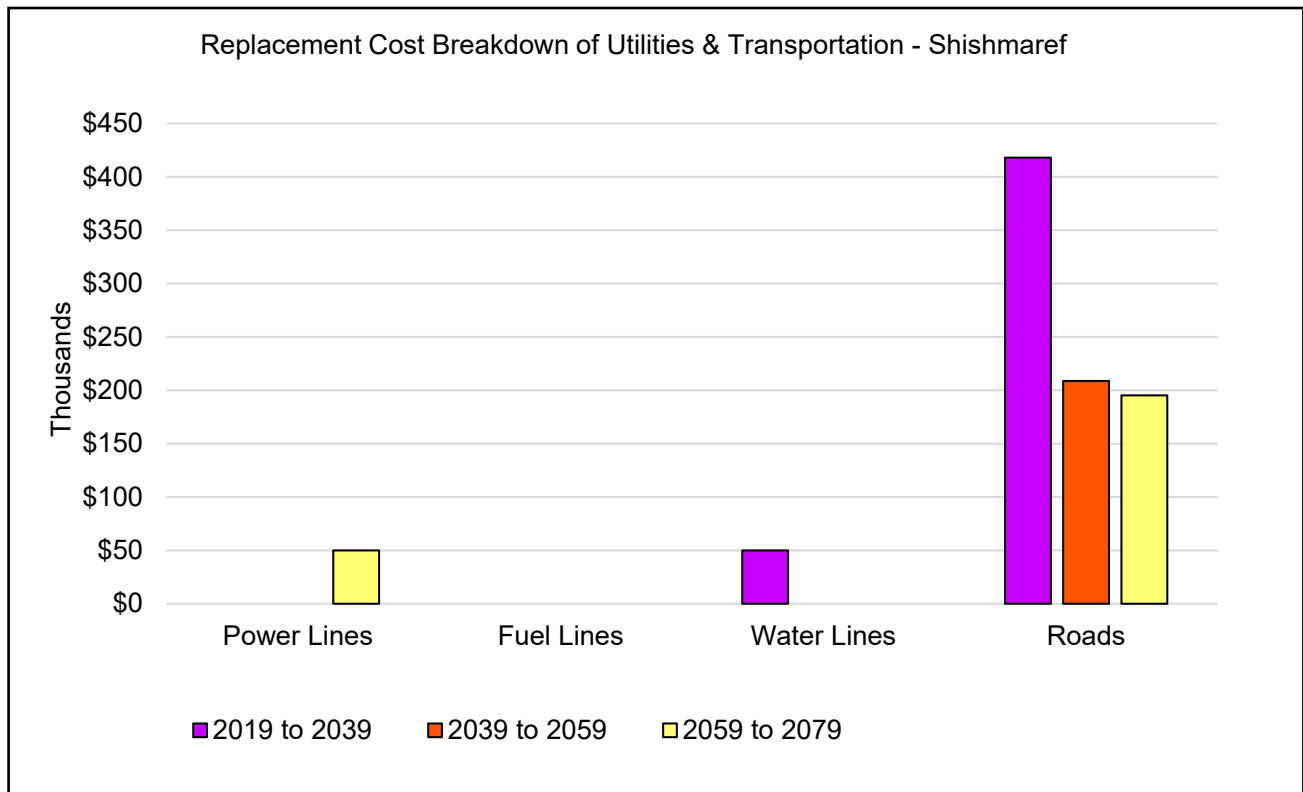


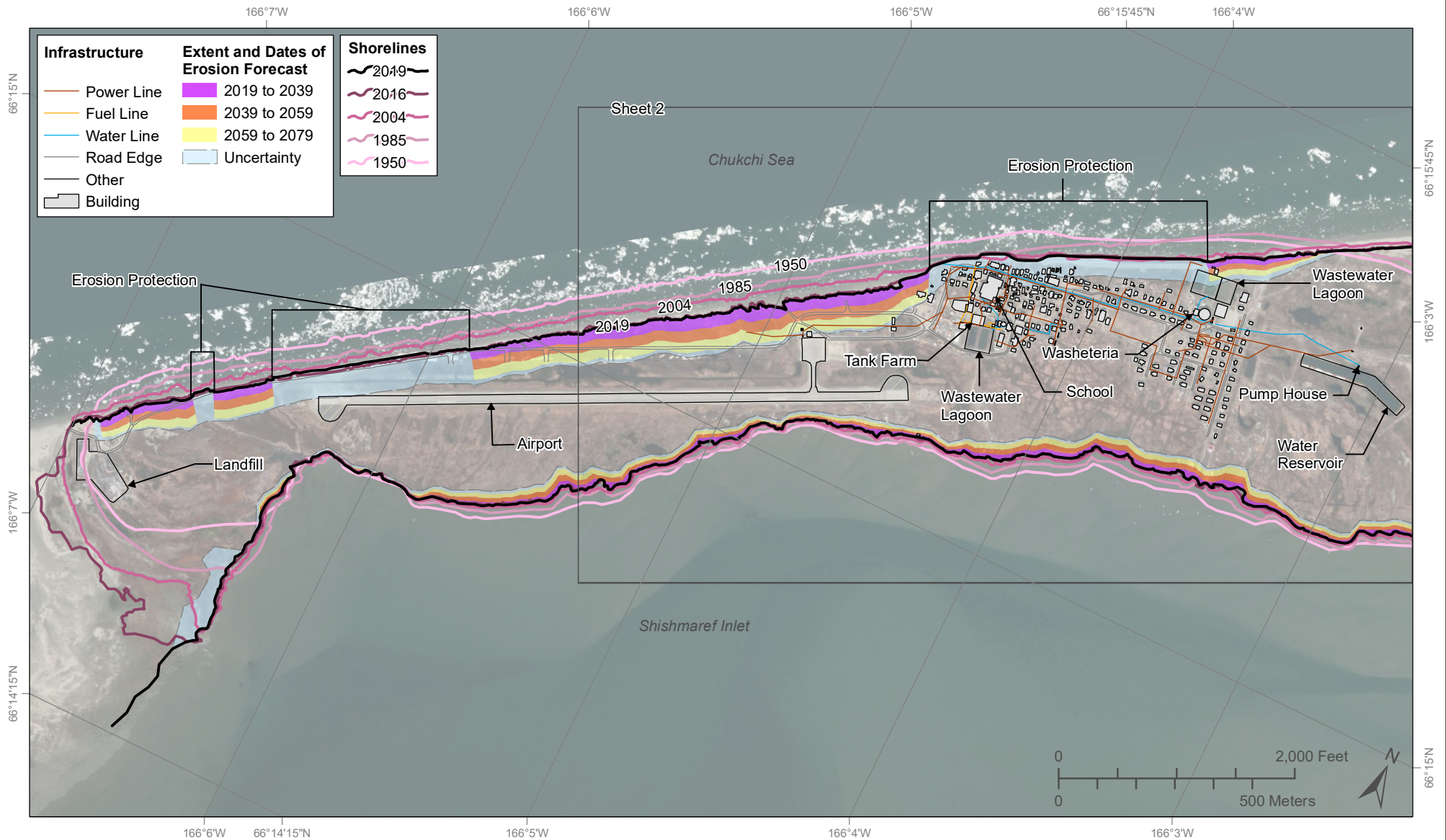
Figure 2. This figure breaks down the replacement cost of all utilities and transportation infrastructure in the erosion forecast area.

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Erosion Forecast Shishmaref, Alaska

Report of Investigation 2021-3
Buzard and others, 2021
Shishmaref, Sheet 1 of 2



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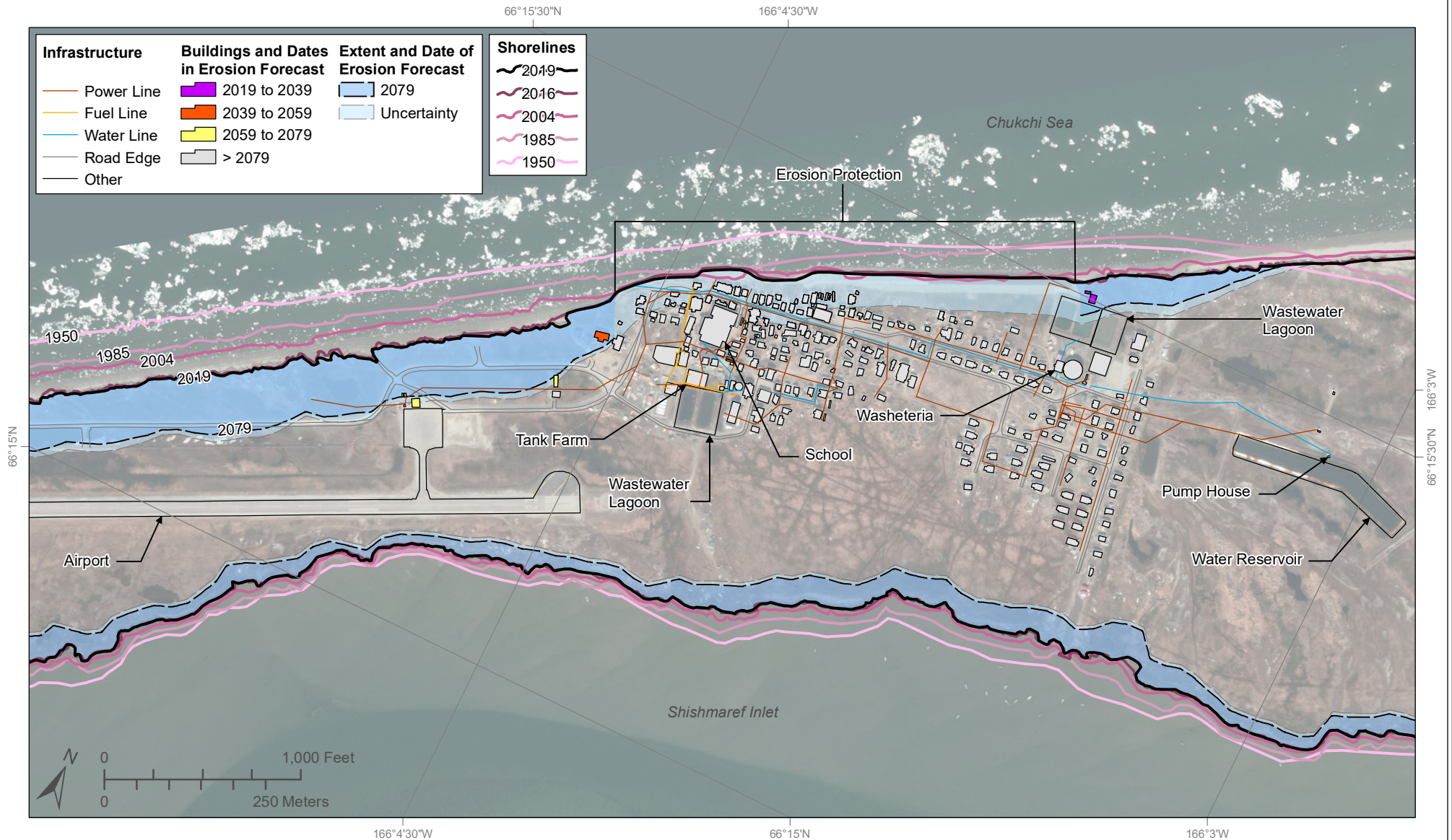
Erosion and accretion of coasts and rivers result in shoreline change. These rates of shoreline change at Alaska communities are calculated from historical and modern shorelines (shorelines shown as lines in pink scale and labeled by year). The long-term (1950 to 2019) shoreline change rate is used to forecast where erosion could impact community infrastructure. Erosion is forecast to reach the colored areas by specified time intervals: 2019 to 2039 (purple), 2039 to 2059 (orange), and 2059 to 2079 (yellow). The area of uncertainty of the 2079 shoreline at a 90 percent confidence interval is light blue. Areas that are not colored by time interval are not forecast to erode by 2079 based on the historical shoreline change rate. For more detailed information about the impacts to infrastructure from erosion at Shishmaref, refer to the Shishmaref erosion exposure assessment report.

This work is part of the Coastal Infrastructure Erosion Vulnerability Assessment project funded by the Denali Commission Environmentally Threatened Communities Grant Program. Components of this map were prepared by the Alaska Department of Commerce, Community, and Economic Development (DCCED) using funding from multiple municipal, state, federal, and tribal partners. The original AutoCAD drawing of the infrastructure data layers was converted to ArcGIS.



Erosion Exposure Shishmaref, Alaska

Report of Investigation 2021-3
Buzard and others, 2021
Shishmaref, Sheet 2 of 2



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Erosion and accretion of coasts and rivers result in shoreline change. These rates of shoreline change at Alaska communities are calculated from historical and modern shorelines (shorelines shown as lines in pink/scale and labeled by year). The long-term (1950 to 2019) shoreline change rate is used to forecast where erosion could impact community infrastructure. Erosion is forecast to year 2079 (dark blue) with a 90 percent confidence interval area of uncertainty (light blue). Buildings forecast to be impacted by erosion are colored by the range of years when the impact is forecast to occur: 2019 to 2039 (purple), 2039 to 2059 (orange), 2059 to 2079 (yellow), and no impacts expected by 2079 (gray). For more detailed information about the impacts to infrastructure from erosion at Shishmaref, refer to the Shishmaref erosion exposure assessment report.

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