Report of Investigation 2025-3

COASTAL FLOOD IMPACT ASSESSMENT FOR DEERING, ALASKA

Jessica E. Christian, Keith C. Horen, and Nora M. Nieminski

Photograph of the Deering, Alaska, shoreline following a November 11–12, 2017, storm. Photo: Alaska Department of Homeland Security & Emergency Management.

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State of Alaska
Department of Natural Resources
Division of Geological & Geophysical Surveys

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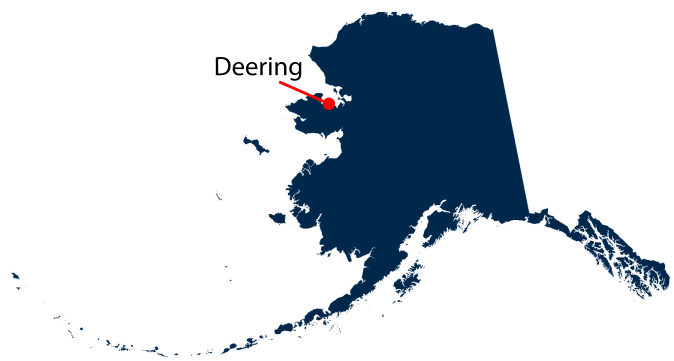
COASTAL FLOOD IMPACT ASSESSMENT FOR DEERING, ALASKA

Jessica E. Christian[1], Keith C. Horen[2], and Nora M. Nieminski[2]

OVERVIEW

This Alaska Division of Geological & Geophysical Surveys (DGGS) report investigates the historical flood record and assesses flood impacts for the community of Deering, Alaska. This community-specific report has three sections: data description, flood impact categorization, and historical flood record. Methods used to evaluate historical floods and delineate flood impact categories (minor, moderate, major), as defined by the National Weather Service (NWS), and are described in detail in Horen and others (2024), an update from the methods described by Buzard and others (2021). Flood and infrastructure heights are relative to the local mean higher high water (MHHW) datum in feet (ft).



SUMMARY

The community of Deering, whose name in Inupiaq is Ipnatchiaq, is located on a flat, sand and gravel spit approximately 300.0 feet (91.44 meters) wide and 0.5 miles (0.80 kilometers) long on the southern coast of Kotzebue Sound at the junction of the Inmachuk River and Smith Creek, roughly 57 miles (92 kilometers) southwest of Kotzebue. The U.S. Army Corps of Engineers (USACE) reports that storm surge and wind-driven waves cause significant flooding once every 40 to 60 years in Deering (USACE, 2007). According to an Interagency Working Group (IAWG) report, Deering faces near-term impacts to wastewater and drinking water infrastructure due to climate change (IAWG, 2010). The Deering Local Hazard Mitigation Plan reports that Deering experiences flood impacts annually, predominately from storm surge and high-water riverine events, but flooding extent and damages are considered "limited" (Architecture, Engineering, Construction, Operations, Management [AECOM], 2019). Additional data collection will improve our understanding of the flooding threat to this community.

Five disaster declarations (1974, 2004, 2005, 2009, and 2022) have been reported for flooding in Deering (Alaska Division of Homeland Security & Emergency Management [DHS&EM], 2016). Based on research done for this report, Deering experienced at least 18 flood events between 1962 and 2024 (16 from storm surges and two from ice jams). We estimated the peak still water heights of 14 of these flood events, categorizing four as minor, seven as moderate, and three as major. The highest flood occurred on November 10, 1974, reaching a still water height of 11.5 ft (3.52 m) MHHW.

DATA

DGGS used geospatial data to assess infrastructure impacts and estimate flood heights from various sources of evidence (e.g., personal accounts, photographs, official reports). We used Esri's ArcGIS Pro version 3.2.0 to map and process these geospatial data.

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Digital Elevation Models and Orthoimagery

Accurate, high-resolution elevation models and orthoimagery are used to measure flood heights in the absence of high water mark (HWM) data. One digital elevation model (DEM; table 1), three aerial images, and three orthoimages (table 2) were used for flood height estimates. Orthoimagery was collected in 1976, 2013, and 2017 for Community Profile Maps (CPM; Alaska Division of Community and Regional Affairs [DCRA], 1976, 2013, 2017) and 2016 by the U.S. Geological Survey. Aerial imagery was collected in 1962, 1975, and 1978. In 2015, USACE collected light detection and ranging (lidar) data, from which a digital terrain model (DTM) was created. Where first-floor elevation data were unavailable (unoccupied buildings, some facility-attached infrastructure, and private property), elevations were extracted from the 2015 DTM. All DEM and orthoimagery will be referenced in this report by the names assigned in tables 1 and 2.

Table 1. Summary of digital elevation models used for Deering, Alaska.

	2015 DSM
Collection date	2015-JUN-01
Elevation type	Lidar Bare Earth
Vertical datum	NAVD88 (GEOID12B)
Ground sample distance	1 ft (0.30 m)
Accuracy	0.2 ft (0.05 m)

Table 2. Summary of orthoimagery used for Deering, Alaska.

	2013 Orthoimagery	2016 Orthoimagery	2017 Orthoimagery
Collection date	2013	2016-AUG	2017
Ground sample distance	0.5 ft (0.15 m)	0.5 ft (0.15 m)	2.0 ft (0.61 m)

First-Floor Elevation Survey

The Alaska Native Tribal Health Consortium completed a field survey of the first-floor elevations of occupied buildings in Deering on January 25, 2023. These data were collected in the North American Vertical Datum 1988 with Geoid 12B applied (NAVD88 [GEOID12B]) in U.S. survey feet (usft) (app. A). The reported vertical accuracy achieved during this survey is ± 0.2 ft (0.06 m). This survey will be referenced within this report as the 2023 first-floor survey. DGGS spatially joined these first-floor elevations to building footprints digitized from the 2016 orthoimagery, identifying 197 as occupied buildings (i.e., residential, public, or commercial structures in which people live or work), 57 of which are residential.

Water Level Sensor

DGGS installed a Stilltek iGage radar water level sensor in Deering in September 2018. The sensor is attached to the south side of the bridge that crosses Smith Creek near the school (figs. 1 and 2). Data collected by this sensor, updated hourly, are available from Alaska Water Level Watch at portal.aoos.org/#metadata/100052/station/data. The vertical accuracy of these data is ± 0.2 ft (0.06 m).

Vertical Datums

Local tidal datums (table 3) for Deering are described by National Oceanic and Atmospheric Administration (NOAA) Center for Operational Oceanographic Products (CO-OPS) tide station 946 9751 available from tidesandcurrents.noaa.gov/stationhome.html?id=9469751. The NAVD88 (GEOID12B) transformation is based on the NOAA Online Positioning User Service (OPUS) shared solution for National Geodetic Survey vertical control monument 946 9751 A (PID: BBCK37) available from ngs.noaa.gov/OPUS/getDatasheet.jsp?PID=BBCK37, identified as the primary tidal benchmark for station 946 9751.

Figure 1. Location of Stilltek iGage radar water level sensor in Deering, Alaska.

Figure 2. Stilltek iGage radar water level sensor installation on the south side of the bridge in Deering, Alaska.

Table 3. Local tidal datums for Deering, Alaska (NOAA CO-OPS tide station 946 9751).

Tidal Datum	Abbreviation	ft MHHW	m MHHW	ft NAVD88 (GEOID12B)	m NAVD88 (GEOID12B)
Mean Higher High Water	MHHW	0.0	0.00	4.8	1.45
Mean High Water	MHW	-0.2	-0.06	4.6	1.39
Mean Sea Level	MSL	-0.9	-0.27	3.9	1.19
Mean Tide Level	MTL	-0.9	-0.27	3.9	1.19
Mean Low Water	MLW	-1.6	-0.47	3.2	0.98
North American Vertical Datum 1988 (GEOID12B)	NAVD88 (GEOID12B)	-4.8	-1.45	0.0	0.00
Mean Lower Low Water	MLLW	-1.8	-0.56	3.0	0.90

FLOOD IMPACT CATEGORIES

Flood impact categories are used by the NWS to define and communicate flood risk to the public. These categories are designated as major, moderate, and minor (NWS, 2016). Definitions for these categories in the NWS guidance specific to Alaska are provided in the form of statements regarding flood impacts, some of which are more qualitative than quantitative (NWS, 2016). To ensure impact assessments are consistent and repeatable, DGGS developed a set of quantitative criteria for each category (Horen and others, 2024). A fourth category, extreme flooding, as defined by DGGS, is included in this report to delineate critical infrastructure situated at heights above the anticipated maximum based on the specifics of the local historical flood record, though flooding is still possible above this height (Horen and others, 2024).

Short definitions for each flood impact category are listed below and are explained in greater detail by Horen and others (2024). Table 4 provides a list of key infrastructure heights and the risk categories they fall within. Additional information about each piece of key infrastructure is detailed in the category blocks that follow table 4. The map series that accompanies this report depicts the potential inundation extents for each flood impact category.

Minor Flooding: "Minimal or no property damage, but possibly some public threat" (NWS, 2016).

Moderate Flooding: "Some inundation of structures and roads… Some evacuations of people and/or transfer of property to higher elevations may be necessary" (NWS, 2016).

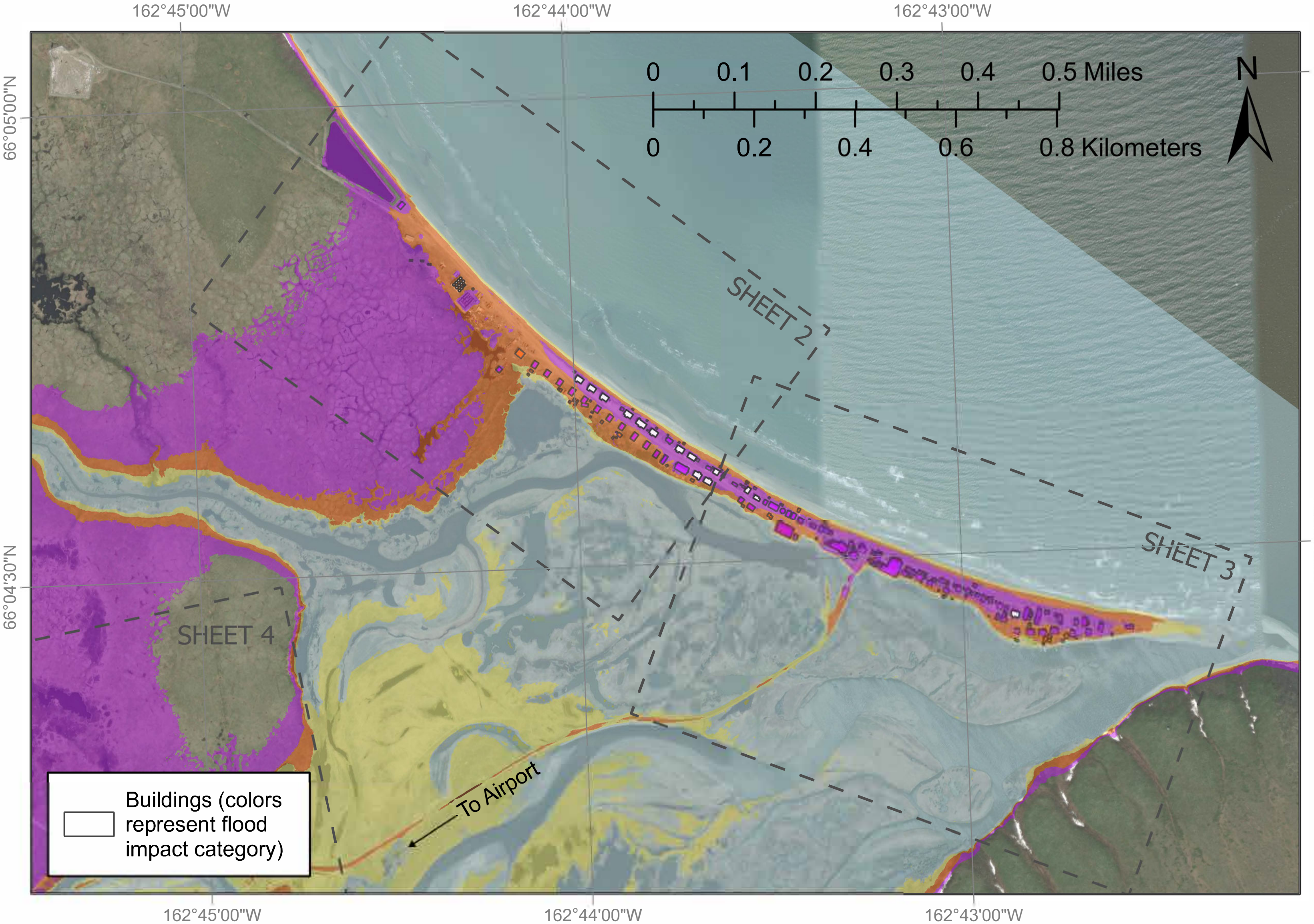
Major Flooding: "Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations are necessary" (NWS, 2016).

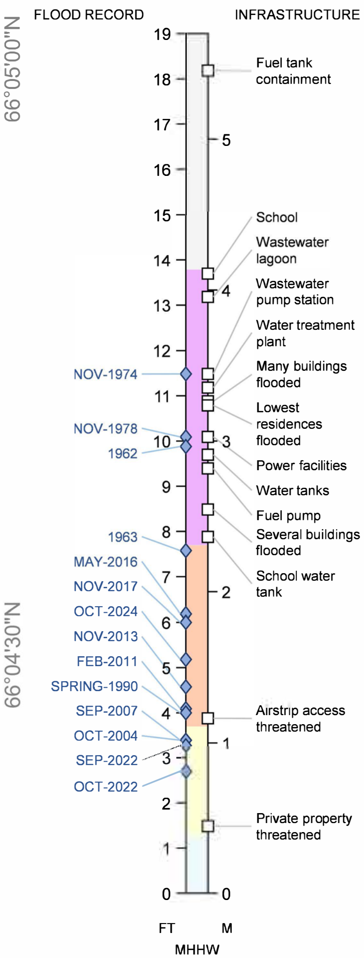
Extreme Flooding: Any flooding that reaches a height above the highest estimated flood height plus the confidence of that estimate (Horen and others, 2024; NWS, 2018).

Table 4. Summary of infrastructure heights and flood categories. Gray = extreme, purple = major, red = moderate, yellow = minor. The extreme category represents infrastructure situated at heights above the highest estimated flood height with confidence included. Categories are based on current infrastructure conditions.

Feature	Height (ft MHHW)	Confidence (ft)	Height (m MHHW)	Confidence (m)
Airstrip inundated	26.1	0.2	7.95	0.05
Fuel tank containment wall	18.2	0.2	5.55	0.07
Extreme	**13.8**		**4.22**	
School	13.7	0.2	4.16	0.07
Wastewater lagoon	13.2	0.2	4.02	0.05
Wastewater pump station	11.5	0.2	3.50	0.07
Water treatment plant	11.2	0.2	3.42	0.07
Many buildings flooded	10.9	0.2	3.33	0.07
Lowest residences flooded	10.8	0.2	3.30	0.07
Power facilities	10.1	0.2	3.09	0.07
Water tanks	9.7	0.2	2.97	0.07
Fuel pump	9.4	0.2	2.86	0.07
Several buildings flooded	8.5	0.2	2.59	0.07
School water tank	7.9	0.2	2.41	0.07
Major	**7.7**		**2.34**	
Airstrip access	3.9	0.2	1.19	0.05
Moderate	**3.7**		**1.14**	
Private property threatened	1.5	0.2	0.44	0.05
Minor	**1.3**		**0.39**	

Flood Impact Map
Deering, Alaska





To calculate height above
NAVD88: add 4.8 ft (1.45 m)
MLLW: add 1.8 ft (0.56 m)

Projection: NAD83 (2011) UTM Zone 3N
Orthoimagery and DTM available from elevation.alaska.gov

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Major Flooding is defined as extensive inundation of structures and roads. Significant evacuation of people and/or transfer of property to higher elevations are necessary.

Moderate Flooding is defined as some inundation of structures and roads at lower elevations. Some evacuation of people and/or transfer of property to higher elevations are necessary.

Minor Flooding is defined as minimal or no property damage. Evacuation of people and/or transfer of property to higher elevations are typically not necessary.

This work was made possible with National Fish and Wildlife Foundation's National Coastal Resilience Funding through a partnership with the Alaska Native Tribal Health Consortium.

Flood Impact Map
Deering, Alaska

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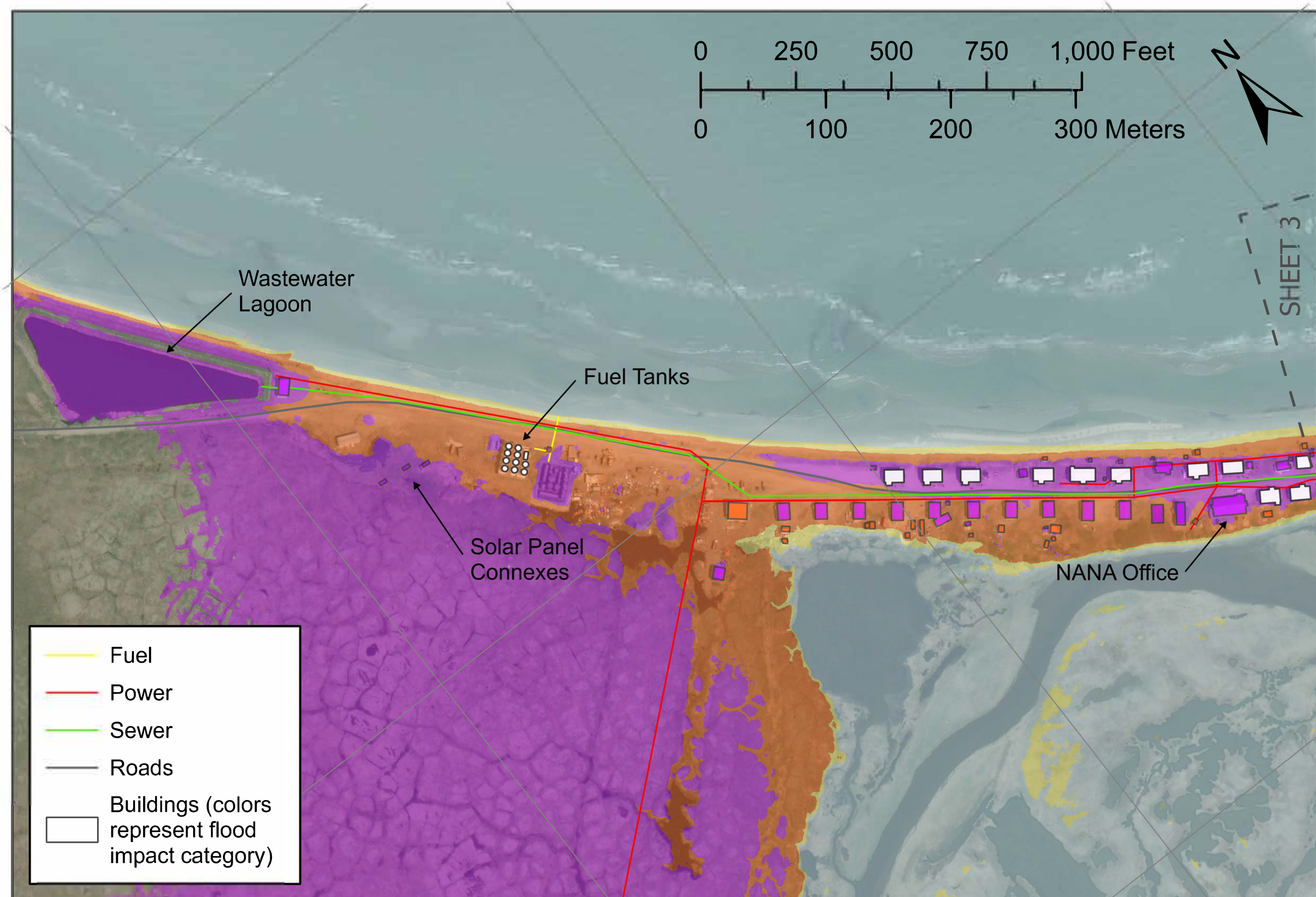
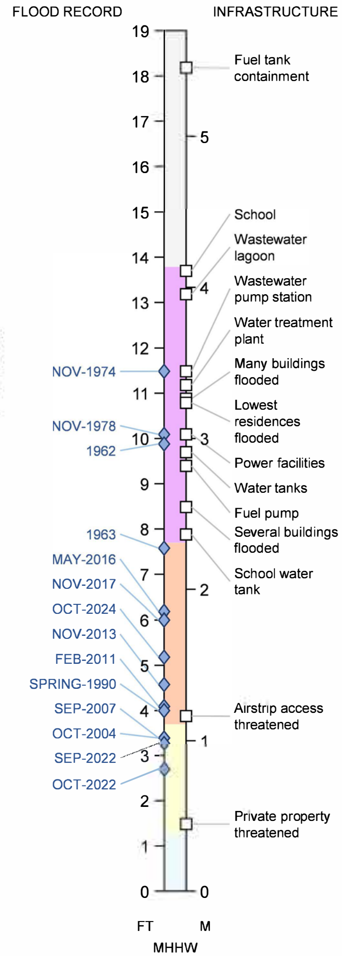
SHEET 2 OF 4





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Projection: NAD83 (2011) UTM Zone 3N
Infrastructure based on DCRA community map
Orthoimagery and DSM available from elevation.alaska.gov

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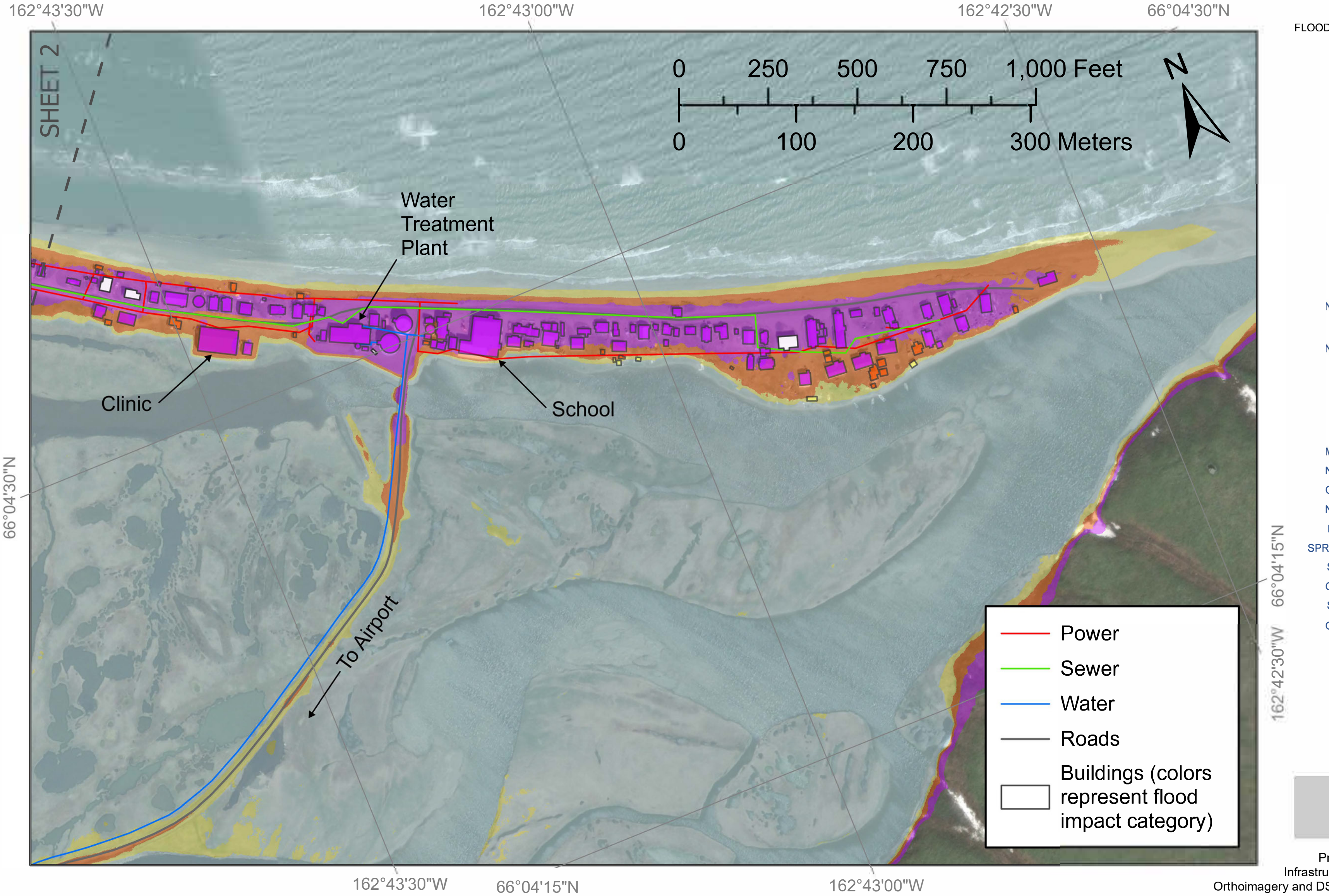
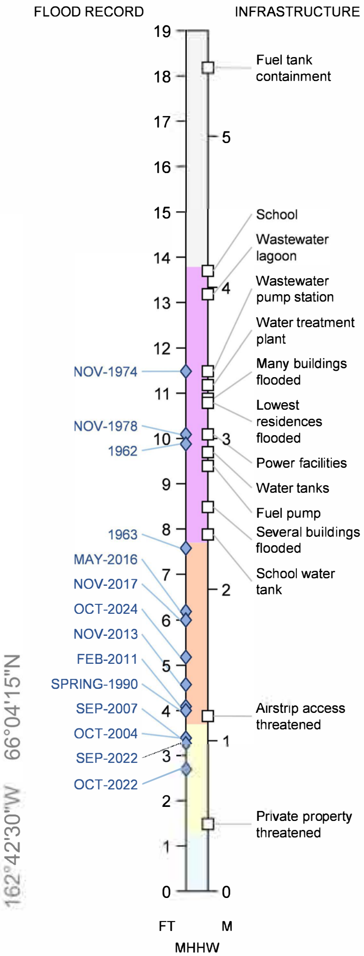
Flood Impact Map

Deering, Alaska

REPORT OF INVESTIGATION 2025-3
Christian and others, 2025
SHEET 3 OF 4





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Deering, Alaska

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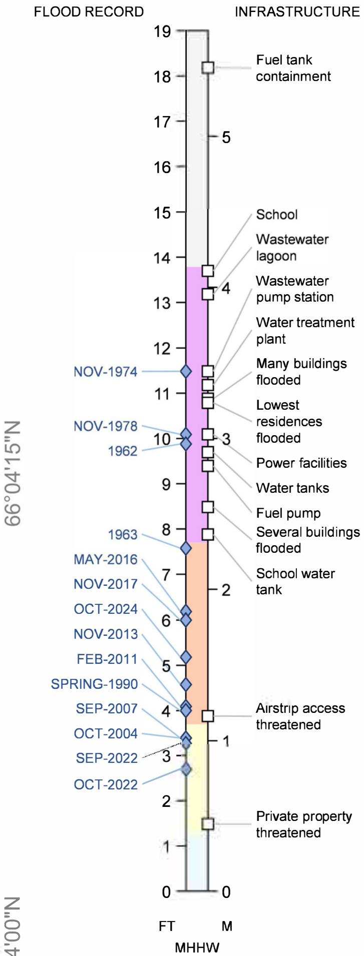
SHEET 4 OF 4



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Extreme Flooding: Greater than 13.8 ft (4.22 m) MHHW

Airstrip: 26.1 ± 0.2 ft (7.95 ± 0.05 m) MHHW

The airstrip is approximately 1.0 mile (1.61 km) inland from the main townsite. Measured from the 2015 DTM, this is the peak elevation of the airstrip.

Fuel tank containment wall: 18.2 ± 0.2 ft (5.55 ± 0.07 m) MHHW

The fuel tank farm is protected by a containment wall that is approximately 4.2 ft (1.28 m) above ground level.

Major Flooding: 7.7 to 13.8 ft (2.34 to 4.22 m) MHHW

School: 13.7 ± 0.2 ft (4.16 ± 0.07 m) MHHW

As the largest public building, with the highest first-floor height, the school has been identified as the most suitable evacuation point.

Wastewater lagoon: 13.2 ± 0.2 ft (4.02 ± 0.05 m) MHHW

The wastewater lagoon, located to the northwest of the townsite, is surrounded by an earthen berm. This is the lowest height atop this berm measured from the 2015 DTM. A breach of this lagoon could introduce sewage contamination into the surrounding environment.

Wastewater pump station: 11.5 ± 0.2 ft (3.50 ± 0.07 m) MHHW

The wastewater pump station is located at the southeast end of the wastewater lagoon.

Water treatment plant: 11.2 ± 0.2 ft (3.42 ± 0.07 m) MHHW

This facility provides treated drinking water for the community.

Many buildings flooded 1.0 ft (0.30 m) or more: 10.9 ± 0.2 ft (3.33 ± 0.07 m) MHHW

We consider "many" buildings to describe more than five occupied buildings. Occupied buildings are residential, public, or commercial structures in which people live or work.

Lowest residences flooded 1.0 ft (0.30 m) or more: 10.8 ± 0.2 ft (3.30 ± 0.07 m) MHHW

This is the height at which the two lowest residential buildings would experience major flooding.

Power facilities: 10.1 ± 0.2 ft (3.09 ± 0.07 m) MHHW

A primary power generation facility was not identified, but three solar panel connexes were included in the 2023 survey. This is the first-floor height of the lowest of these facilities.

Water tanks: 9.7 ± 0.2 ft (2.97 ± 0.07 m) MHHW

The primary water tanks are adjacent to the water treatment plant and contain most of the community's treated water supply. There are two large tanks with heights of 9.7 and 11.5 ft (2.97 and 3.49 m) MHHW and a smaller tank attached to the water treatment plant with a height of 11.0 ft (3.35 m) MHHW.

Fuel pump: 9.4 ± 0.2 ft (2.86 ± 0.07 m) MHHW

The fuel pump provides the sole access to fuel and is located at the northwestern end of the community near the fuel tank farm.

Several buildings flooded less than 1.0 ft (0.30 m): 8.5 ± 0.2 ft (2.59 ± 0.07 m) MHHW

We consider "several" buildings to describe more than one but less than six occupied buildings.

School water tank: 7.9 ± 0.2 ft (2.41 ± 0.07 m) MHHW

The school water tank is the third largest water tank in the community storing treated water. The height of the school water tank forms the basis for the lower limit of the major flooding category.

Moderate Flooding: 3.7 to 7.7 ft (1.14 to 2.34 m) MHHW

Airstrip access: 3.9 ± 0.2 ft (1.03 ± 0.05 m) MHHW

Measured from the 2015 DTM, the ground height of the lowest section of the airstrip access road is 2.9 ft (0.89 m) MHHW. The NWS assumes a depth of 1.0 ft (0.30 m) to be the maximum for reasonably safe travel on flooded roads (NWS, 2023). Adding 1.0 ft (0.30 m) to the height of this portion of the road forms the basis for the lower limit of the moderate flooding category.

Minor Flooding: 1.3 to 3.7 ft (0.39 to 1.14 m) MHHW

Private property threatened: 1.5 ± 0.2 ft (0.44 ± 0.05 m) MHHW

Measured from the 2015 DTM, flood waters would reach the lowest private property at this height. Private property may include storage sheds, boats, fishing equipment, vehicles, and other property at ground level outside of occupied structures. From the 2016 orthoimagery, we identified 80 features meeting this description and extracted the average ground height beneath each from the 2015 DTM. The height of the lowest private property forms the basis for the lower limit of the minor flooding category.

HISTORICAL FLOOD RECORD

The historical flood record for Deering is listed in chronological order below, with estimated floods identified by impact category. This record was compiled from information available to the public through open sources or upon request. Additional undocumented flood events may have impacted the community. Historical information was used in conjunction with the best available, temporally relevant geospatial data to estimate flood heights where possible.

All estimates and confidences were calculated following the methods developed by Horen and others (2024). As described by Horen and others (2024), each estimate is accompanied by two confidence metrics, an estimate confidence based on the combined known potential errors and a time-based confidence based on the temporal relevance of the data used to estimate a given event. Temporal confidence values are noted with an asterisk (*) where the data used to estimate the flood event height were collected 20 years or more before or after the event: in these cases, the large temporal discontinuity may result in a value that could potentially exceed what the confidence model predicts (Horen and others, 2024).

For each flood event, a list and summarization of sources is included, as well as an explanation of the data used and steps performed during estimation, where relevant. Each flood height estimate is classified into a single flood impact category, but estimate confidences may span more than one category. Table 5 provides a complete list of the flood events found during our research, with estimated floods categorized and listed in order from highest to lowest, and floods not estimated listed in chronological order. Figure 3 provides a timeline of the estimated flood events and a visual representation of the flood height estimates and confidences.

Table 5. Summary of historical floods in Deering, Alaska. Flood categories are included for reference: purple = major, red = moderate, yellow = minor.

Estimated Floods

Category	Flood Date	Type	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)
Major	1974-NOV-10	Storm Surge	11.5	± 1.3	± 1.0*	3.52	± 0.40	± 0.30*
Major	1978-NOV-08	Storm Surge	10.1	± 1.0	± 1.0*	3.06	± 0.30	± 0.30*
Major	1962	Storm Surge	9.9	± 0.2	± 1.0*	3.02	± 0.05	± 0.30*
Moderate	1963	Storm Surge	7.6	± 0.2	± 1.0*	2.33	± 0.05	± 0.30*
Moderate	2016-MAY-13	Ice Jam	6.2	± 0.3	± 0.2	1.88	± 0.09	± 0.06
Moderate	2017-NOV-12	Storm Surge	6.0	± 1.2	± 0.1	1.82	± 0.38	± 0.03
Moderate	2024-OCT-22	Storm Surge	5.2	± 0.2	± 0.0	1.59	± 0.06	± 0.00
Moderate	2013-NOV-10	Storm Surge	4.6	± 0.2	± 0.1	1.40	± 0.06	± 0.03
Moderate	2011-FEB-25	Storm Surge	4.1	± 1.2	± 0.2	1.25	± 0.36	± 0.06
Moderate	1990-SPRING	Ice Jam	4.0	± 0.2	± 1.0*	1.22	± 0.05	± 0.30*
Minor	2004-OCT-18	Storm Surge	3.4	± 0.5	± 0.6	1.04	± 0.16	± 0.18
Minor	2007-SEP-18	Storm Surge	3.4	± 0.5	± 0.4	1.04	± 0.16	± 0.13
Minor	2022-SEP-18	Storm Surge	3.3	± 0.2	± 0.0	0.99	± 0.06	± 0.00
Minor	2022-OCT-08	Storm Surge	2.7	± 0.2	± 0.0	0.84	± 0.06	± 0.00

Floods Not Estimated

Date	Type
1973-NOV-10	Storm Surge
2001	Storm Surge
2006	Storm Surge
2011-NOV-09	Storm Surge

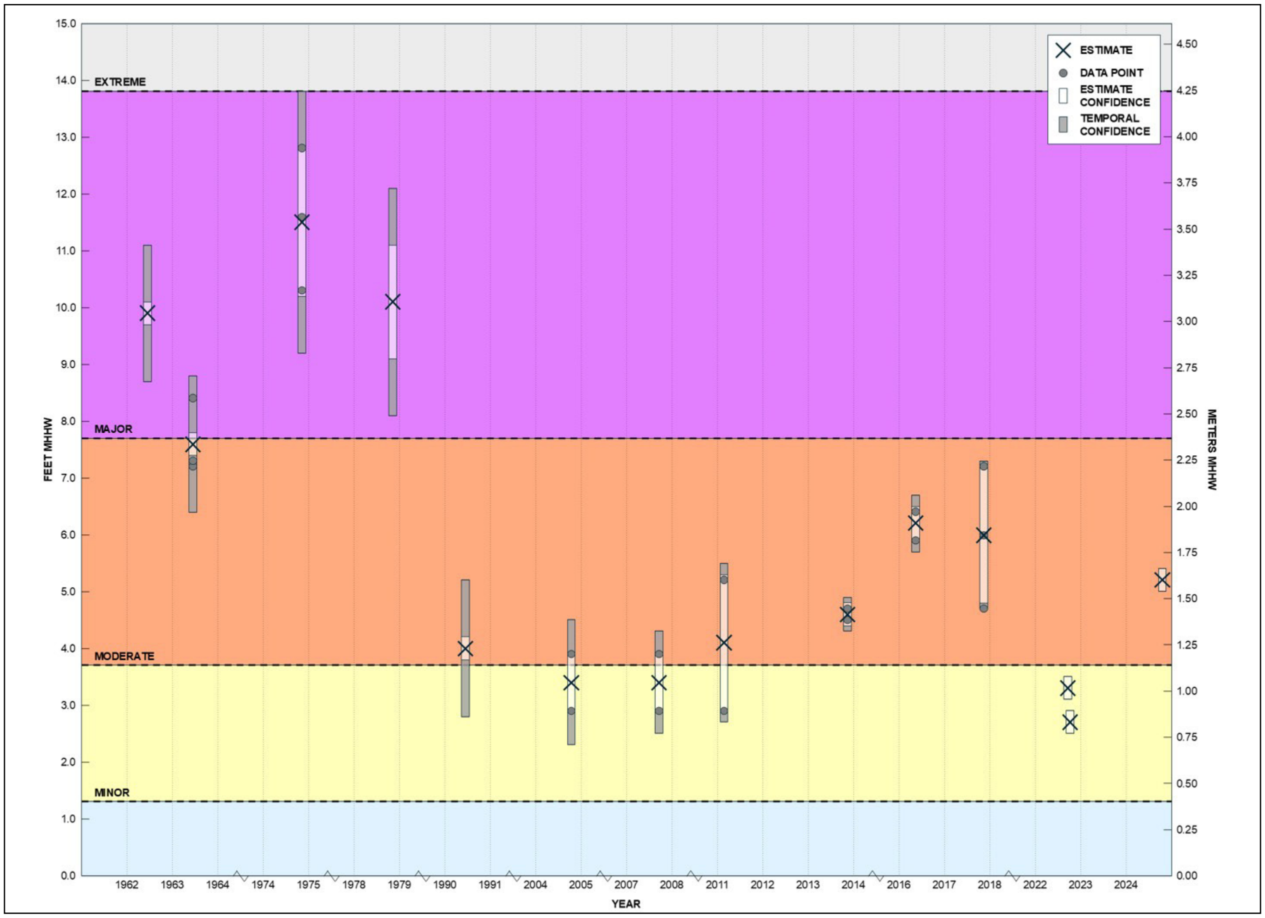

Figure 3. Timeline of estimated flood events and visual representation of flood height estimates and confidences for Deering, Alaska. Flood height estimates were calculated following the methods developed by Horen and others (2024). Estimates are denoted by black X symbols. Data points used during estimation are represented by dark-gray dots. Estimate confidences are displayed as vertical, light-gray boxes. Temporal confidences are displayed as vertical, dark-gray boxes. Each flood height estimate may only be classified into a single flood impact category, but total estimate confidences may exceed the upper and lower bounds of the data used during estimation and may span more than one flood impact category.

FLOOD EVENT SUMMARIES

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
1962	9.9	± 0.2	± 1.0*	3.02	± 0.05	± 0.30*	Major

The USACE Floodplain Notes for Deering mention a potential storm event in 1962 (USACE, 2017). This report notes that "waves came over the road and there was water and storm debris on the west end of the runway during a coastal storm thought to be in 1962. Floodwater also came over the road between the school and the PHS water storage tank. This was prior to the installation of the barrel revetment at this location" (USACE, 2017). The barrel revetment can be seen in aerial imagery that was collected on August 17, 1962, indicating this storm event must have happened before the date the aerial imagery was collected.

To estimate this flood, we located the stretch of Front Street between the school and the water storage tanks within the 1962 aerial imagery and overlaid this with a simple bathtub model applied to the 2015 DTM to approximate the minimum water height at which water would reach the south side of the road (fig. 4).

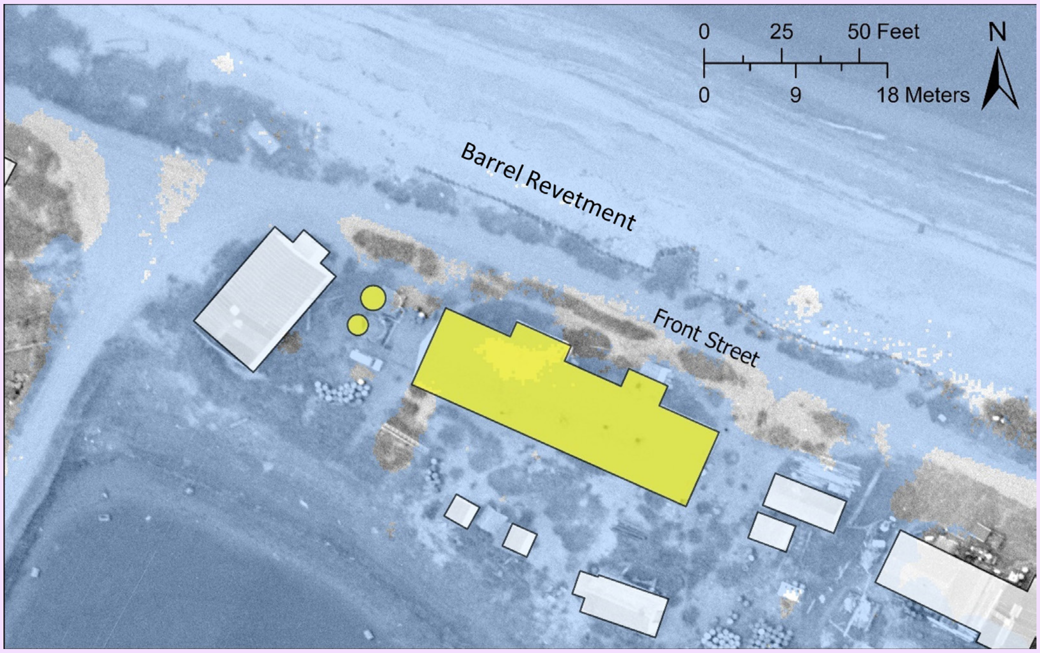

Figure 4. Location of school and water storage tanks (yellow) within 1962 aerial imagery with simple bathtub model applied to the 2015 DTM. Barrel revetment is visible north of Front Street.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
1963	7.6	± 0.2	± 1.0*	2.33	± 0.05	± 0.30*	Moderate

The USACE Floodplain Notes for Deering mention that "a coastal storm surge in 1963 inundated the low-lying end of the spit to a maximum depth of 2 ft" (USACE, 2017). Wise and others (1981) provide a listing of historical storm events, including a 1963 event impacting Kotzebue Sound, specifically Deering, where "20% of village flooded at a maximum depth 2 ft. The village is 15 ft above sea level with maximum surge reported at 17 ft above sea level" (Wise and others, 1981).

NOAA CO-OPS tide station 946 9751 does not provide a local datum for tidal epoch 1960–1978 and no datum is specified in DGGS's compilation of events from Wise and others (1981), meaning the heights provided cannot be adjusted to any current datums. Both sources agree regarding the water depth, with USACE (2017) indicating a general area of flooding and Wise and others (1981) specifying a percentage of coverage, though it is not clear if this is a quantification of the area or number of affected structures.

To estimate this flood, we evaluated the 2.0 ft (0.61 m) maximum depth and 20 percent inundation descriptions. First, we delineated the extent of the village from the 1962 aerial imagery and determined the lowest height within these extents from the 2015 DTM, adding 2.0 ft (0.61 m) to get an unreasonably low estimate of 0.1 ft (0.05 m) MHHW (fig. 5A). We then used the 1962 village extents to generate volumetric calculations from the 2015 DTM to determine the height at which 20 percent of that area would be inundated, resulting in a more reasonable estimate of 7.2 ft (2.20 m) MHHW (fig. 5B). Next, from the 2015 DTM we extracted the ground height beneath building footprints digitized from the 1962 aerial imagery and added 2.0 ft (0.61 m) to the lowest height, resulting in an estimate of 7.3 ft (2.22 m) MHHW. These results would only reach the ground height beneath seven percent of the buildings in 1962, so we calculated the upper limit of the lowest 20 percent of ground heights beneath buildings, resulting in an estimate of 8.4 ft (2.57 m) MHHW, which would exceed the 2.0 ft (0.30 m) maximum depth described. An average of the three more reasonable heights was calculated to estimate a flood height of 7.6 ft (2.33 m) MHHW.

Though this flood estimate is categorized as moderate based on the average, the upper extent of the confidence range could also potentially place this flood event within the major category.

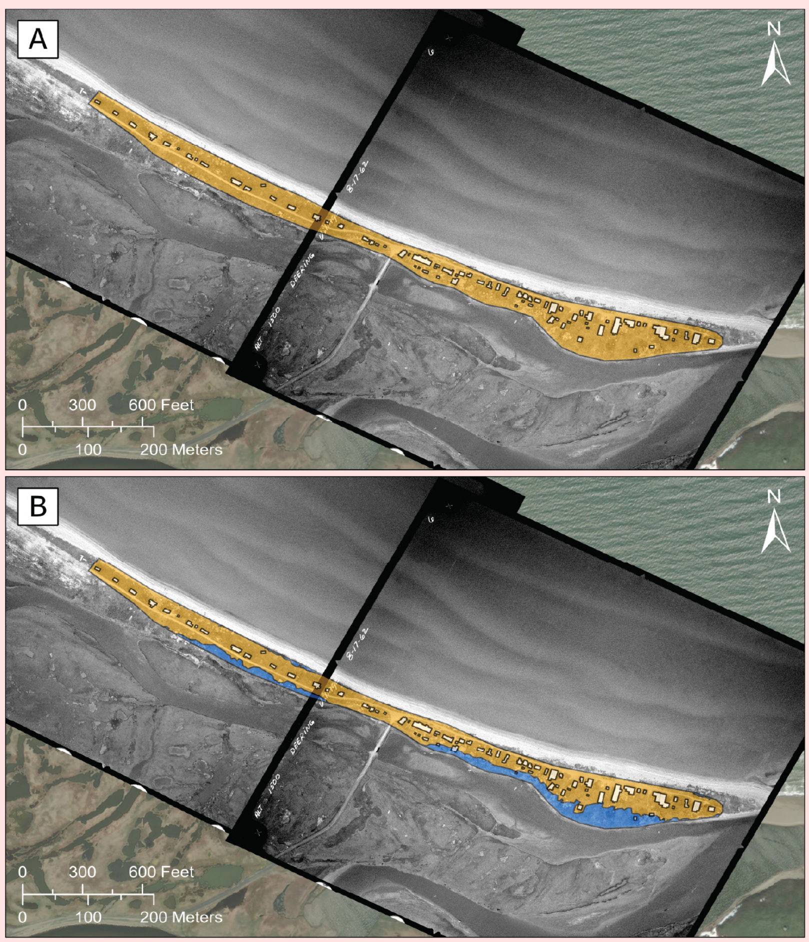

Figure 5. A. 1962 village extents (orange) and building footprints (white). **B.** 1962 village extents (orange), simple bathtub model inundation at 20 percent by area (blue), and building footprints (white).

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
1973-NOV-10	-	-	-	-	-	-	Major

The USACE Erosion Information Paper on Deering stated that "a major flood in 1973 caused extensive damage to many homes and a number of residents were temporarily evacuated to a mining camp 22 miles upriver" (USACE, 2007). The USACE Floodplain Notes stated "run up from waves slightly topped a 27-inch board set in the entrance door of the Alfred Karmun house during the coastal storm of November 10, 1973" but make no mention of still water levels (USACE, 2017). The NOAA Storm Data report from June 1974 details a Bering Sea storm that impacted Teller, Deering, Shishmaref, Kotzebue, and Unalakleet on November 15, 1973, stating "storm with gusting winds to 50 knots creating sea waves to 14 feet… at Deering 17 dwellings were lost. Some communication outages" (NOAA, 1974a). Wise and others (1981) list a storm event on November 10 and 11, 1973, noting "Deering dwellings flooded, roads and airstrip damaged… 15 ft seas in Norton Sound, Chuckchi Sea, and Kotzebue Sound, ice covered, water 6-8 ft deep on top of shore fast ice."

The loss of "17 dwellings" (NOAA, 1974a) clearly made this a major flood event at the time based on DGGS's categorization criteria, though there is not enough specific information or temporally relevant data to form an estimate of the flood height.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
1974-NOV-11	11.5	± 1.3	± 1.0*	3.52	± 0.40	± 0.30*	Major

The 1992 USACE Community Information Form for Deering reports community members mentioned the worst flood occurred in the fall of 1974, with the "retail store floor under 2 ft. of water" and "10+" homes flooded along with the "post office" and "school" (USACE, 1992). Photographs included with the USACE form show a flood staff incremented in hundredths of feet and two signs attached to a power pole located near the front of the retail store with one sign reading "RECOMMENDED BUILDING HEIGHT" and the other, located approximately 1.2 ft (0.35 m) below the first, reading "HIGH WATER ELEVATION" (fig. 6). The entryway of the store in the photograph appears to be level with the ground. The NOAA Storm Data report from November 1974 details a "Winds and Tidalwave" event that impacted the "northwest coastal region of Alaska" on November 11. "The area was declared a disaster area under Public Law 93-888 by President Ford," with "women and children evacuated during the storm… minor water damage in the village," and "approximately eight claims for unmet losses" (NOAA, 1974b).

A building labeled "store" can be seen on the 1976 Alaska DCRA CPM of Deering (DCRA, 1976) and was present in both the 1962 and 1975 aerial imagery (fig. 7), as well as the 2016 orthoimagery (fig. 6). The 2023 first-floor survey indicated this building was still being used as a store and provided a first-floor height of 10.8 ft (3.28 m) MHHW, as well as the height of a point labeled "FF RECOMMENDED BLDG ELEV" at 11.4 ft (3.48 m) MHHW, collected in approximately the same location as the 1992 photographs (fig. 6). The average ground height beneath the store, 9.6 ft (2.93 m), was extracted from the 2015 DTM using a building footprint digitized from the 1975 aerial imagery.

The first-floor height of the store is 0.7 ft (0.20 m) below the height of the "recommended building elevation" point, which, if the same as the sign as it existed in 1992, would place the "high water elevation" sign 0.4 ft (0.12 m) below the first-floor height of the store and 0.6 ft (0.35 m) above the average ground height beneath the store. Though these elevations seem to contradict the USACE reporting, there are no clear indications for or against the possibility that any of the elevations in question may have changed between 1974, 1992, and 2023 (e.g., telephone pole being replaced, sinking, or rising due to settling or frost heave; "recommended building elevation" sign being moved; first-floor of store being raised; etc.). The 1992 report and photographs do not specify the year of the event associated with the "high water elevation" sign, though, from the context of the report it is

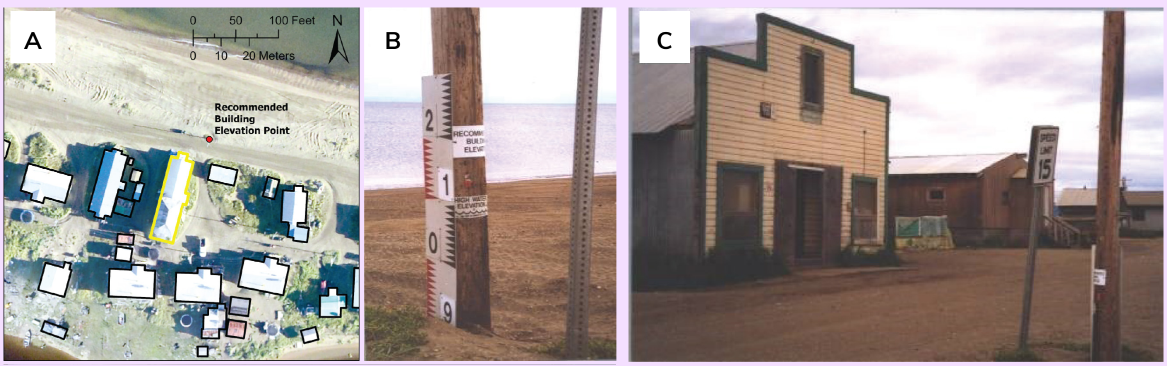

Figure 6. A. Store building (yellow) in the 2016 orthoimagery with "Recommended Building Elevation" sign location (red). **B.** 1992 photograph of flood staff and signs on power pole. **C.** Location of power pole in relation to the front of the store building.

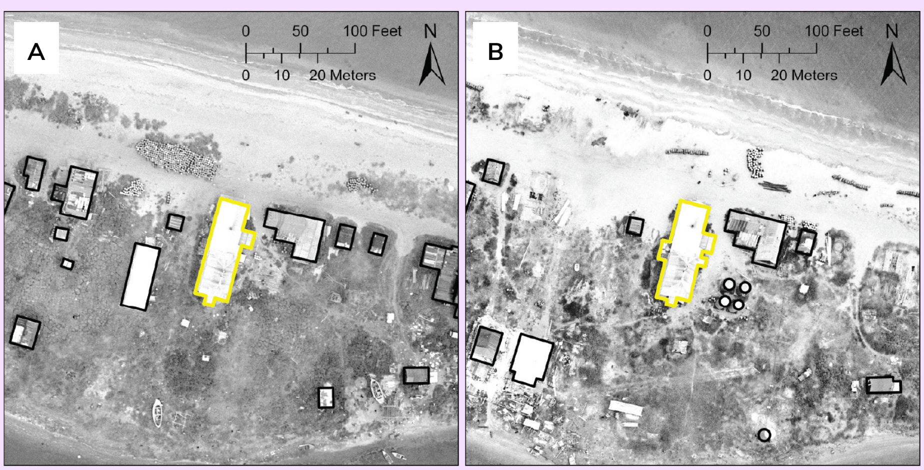

Figure 7. A. Store building (yellow) in the 1962 aerial imagery. **B.** Store building (yellow) in the 1975 aerial imagery.

reasonable to assume the sign is meant to depict the 1974 flood (USACE, 1992).

To estimate this flood, we used each of the three pieces of evidence, the 2023 first-floor height of the store, the height of the sign from the 1992 photograph as it relates to the "recommended building elevation" point from the 2023 first-floor survey, and the average ground height beneath the store extracted from the 2015 DTM. Adding 2.0 ft (0.61 m) to the first-floor height of the store results in a flood height of 12.8 ft (3.89 m) MHHW, adding 2.0 ft (0.61 m) to the average ground height beneath the store results in a flood height of 11.6 ft (3.54 m) MHHW, and subtracting 1.2 ft (0.35 m) from the height of the "recommended building elevation" point results in a flood height of 10.3 ft (3.13 m) MHHW (fig. 8). An average of these three heights was calculated to estimate a flood height of 11.5 ft (3.52 m) MHHW. The upper limit of this estimate's confidence forms the basis for the threshold between the major and extreme impact categories.

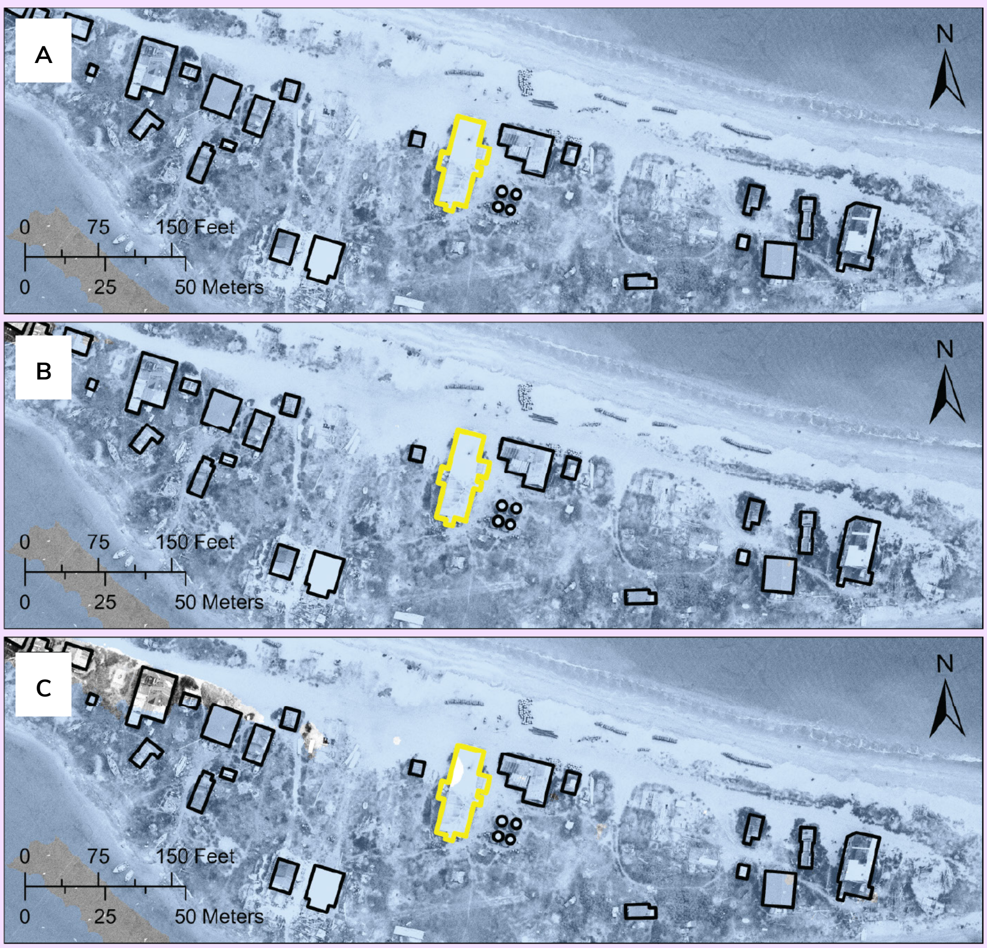

Figure 8. Store building (yellow) in the 1975 aerial imagery overlaid with simple bathtub model applied to the 2015 DTM simulating a water height of (**A**) 12.8 ft (3.89 m), (**B**) 11.6 ft (3.54 m), and (**C**) 10.3 ft (3.13 m) MHHW.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
1978-NOV-09	10.1	± 1.0	± 1.0*	3.06	± 0.30	± 0.30*	Major

The NOAA Storm Data report from November 1978 details a "coastal flood" event that impacted the Northwest region of Alaska on November 9 (NOAA, 1978).

The 2013 DCRA CPM for Deering lists a 1978 flood, providing a height of "14.82' (Based on this Map)" (DCRA, 2013). The DCRA CPM control diagram lists "GEOID-12A (NAVD-88)" as the vertical datum. The metadata that accompanies this CPM reports the vertical accuracy as "90% of elevations are accurate to within 1 foot" (DCRA, 2013).

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
1990	4.0	± 0.2	± 1.0*	1.22	± 0.05	± 0.30*	Moderate

The 1992 USACE Community Information Form for Deering reported the most recent flood at that time occurred in "Spring '90," resulting from "Ice jams, Spring Runoff," with a "4 ft." water depth marked on the "Local Bridge" and no homes or public facilities flooded (USACE, 1992). The Alaska Department of Transportation & Public Facilities (DOT&PF) lists the year of construction for the bridge in Deering as 1979 but does not provide a height (DOT&PF, 2023).

From the 2015 DTM, the deck height of the bridge is situated at 10.2 ft (3.11 m) MHHW, which, from the provided evidence, indicates the water depth mark must have been measured from the water surface. Our estimate assumes the reported water depth was measured from 0.0 ft (0.00 m) MHHW.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2001	-	-	-	-	-	-	No flood height estimate

The 2007 USACE Erosion Information Paper listed "high tides, storm surges, wind and waves" as erosion factors, noted "the city reports that typically some form of erosion event occurs each year" and highlighted a significant shoreline erosion event that occurred in 2001 (USACE, 2007).

A flood height could not be estimated for this event because the evidence provided neither flood height nor infrastructure impact information.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2004-OCT-18	3.4	± 0.5	± 0.6	1.04	± 0.16	± 0.18	Minor

The NOAA Storm Data report from October 2004 details a significant storm that impacted the western coast of Alaska on October 18–20, 2004, reporting coastal flooding in several communities, including Deering, where there was "…some high water, but no damage" and "flooding of the road between the community and the airport" (NOAA, 2004).

To estimate this flood, we located the airport access road within the 2013 aerial imagery and overlaid this with a simple bathtub model applied to the 2015 DTM to approximate the minimum height at which water would inundate the road across its full width, 2.9 ft (0.89 m) MHHW; this formed the lower limit of our estimate. We then added 1.0 ft (0.30 m), the maximum recommended safe depth for flooded roads (NWS, 2023), to form the upper limit of our estimate. An average of these two heights was calculated to estimate a flood height of 3.4 ft (1.04 m) MHHW (fig. 9).

Though this flood estimate is categorized as minor based on the average, the relatively large confidence range associated with this estimate could also potentially place this flood event within the moderate impact category.

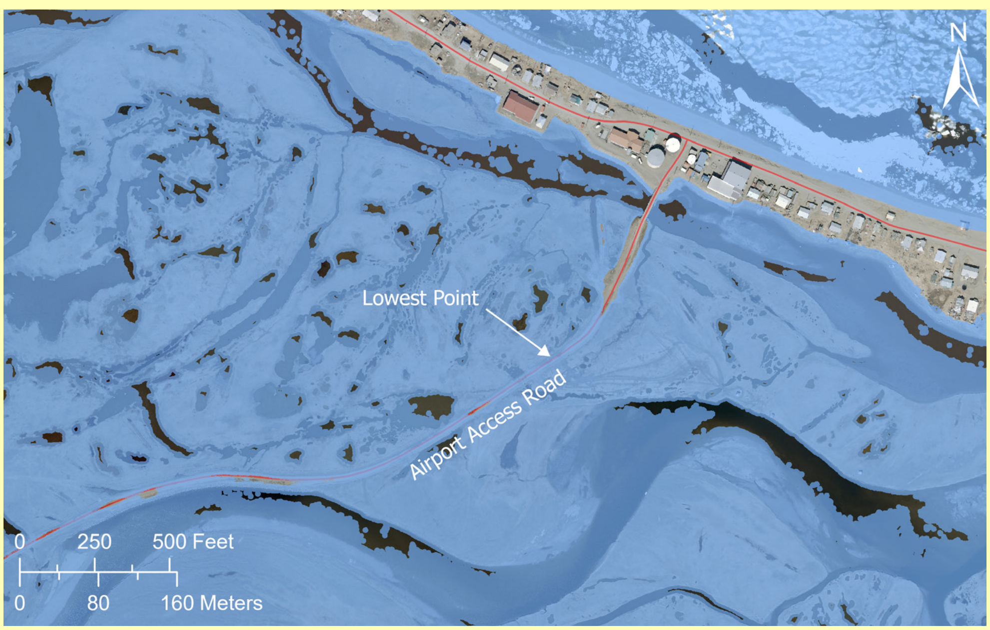

Figure 9. Airport access road within the 2013 orthoimagery overlaid with a simple bathtub model applied to the 2015 DTM simulating a water height of 3.9 ft (1.19 m) MHHW.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2006	-	-	-	-	-	-	No flood height estimate

The 2007 USACE Erosion Information Paper listed "high tides, storm surges, wind and waves" as erosion factors, noted "the city reports that typically some form of erosion event occurs each year" and highlighted a significant shoreline erosion event that occurred in 2006 (USACE, 2007).

A flood height could not be estimated for this event because the evidence provided neither flood height nor infrastructure impact information.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2007-SEP-18	3.4	± 0.5	± 0.4	1.04	± 0.16	± 0.13	Minor

The NOAA Storm Data report from September 2007 details a "coastal flood" event that impacted the "Northern & Interior Seward Peninsula", noting "a combination of locally high sea level and ocean waves which flooded the road between the village of Deering and the Deering airport during the night of the 18th. Damage amounts are unknown but expected to be minimal" (NOAA, 2007).

To estimate this flood, we used the same process as the October 2004 flood event.

Though this flood estimate is categorized as minor based on the average, the relatively large confidence range associated with this estimate could also potentially place this flood event within the moderate impact category.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2011-FEB-25	4.1	± 1.2	± 0.2	1.25	± 0.36	± 0.06	Moderate

The NOAA Storm Data report from February 2011 details a "coastal flood" event that impacted Deering on February 25, 2011, with "high water noted on both the Inmachuk River and along the Kotzebue Sound. There was water across the road from the village to the airstrip. The runway at the airport was washed out due to the inundation of water from the Kotzebue Sound" (NOAA, 2011).

To estimate this flood, we first used the same process as the October 2004 flood event, holding only the lower limit of that estimate. We then located the airport within the 2017 orthoimagery and overlaid this with a simple bathtub model applied to the 2015 DTM to approximate the height at which water would reach any portion of the airport runways, including embankments, that could be susceptible to erosion, 5.2 ft (1.60 m) MHHW (fig. 10). An average of these two heights was calculated to estimate a flood height of 4.1 ft (1.25 m) MHHW.

Though this flood estimate is categorized as moderate based on the average, the relatively large confidence range associated with this estimate could also potentially place this flood event within the minor impact category.

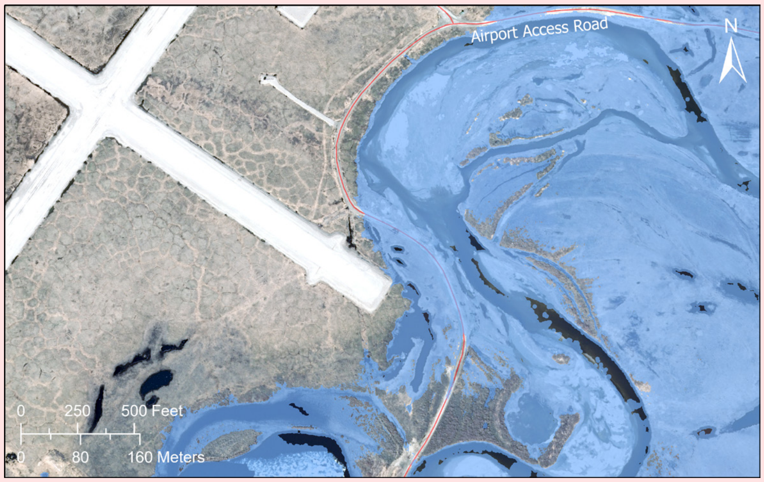

Figure 10. East end of east-west runway of Deering airport in 2017 orthoimagery overlaid with a simple bathtub model applied to the 2015 DTM simulating a water height of 5.2 ft (1.60 m) MHHW.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2011-NOV-09	-	-	-	-	-	-	Major

The Anchorage Daily News (ADN) reported on a storm that impacted the western coast of Alaska on Wednesday, November 9, 2011, noting "the villages of Deering and Kotlik had already reported water in town early Wednesday" and "flooding in the Kotzebue Sound village of Deering forced evacuation of about 100 people to the school… That's nearly everyone in the village, according to state population estimates" (ADN, 2011).

The National Centers for Environmental Information (NCEI) Storm Event Database details a "coastal flood" event that impacted the Seward Peninsula region from November 8 to 10, stating "the storm was one of the strongest storms to impact the west coast of Alaska since November 1974" (NCEI, 2011).

The "evacuation of about 100 people" (ADN, 2011) due to flooding made this a major flood event at the time based on DGGS's categorization criteria, though there is not enough specific information to form an estimate of the flood height.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2013-NOV-13	4.6	± 0.2	± 0.1	1.40	± 0.06	± 0.03	Moderate

The NCEI Storm Events Database details a "coastal flood" event that impacted the "Chukchi Sea Coast" from November 9 to 11, 2011, reporting "minor flooding occurred at Deering as the road to the airport was flooded during the late evening of the 10th through mid-morning on the 11th" (NCEI, 2013).

Photographs were posted on social media on November 11, stating "water went right behind our house."

To estimate this flood, we identified the buildings in the images within the 2013 orthoimagery and overlaid this with a simple bathtub model applied to the 2015 DTM to approximate the flood height depicted in the photographs. These images matched flood heights of 4.7 ft (1.44 m) MHHW and 4.5 ft (1.37 m) MHHW (fig. 11).

An average of these two heights was calculated to estimate a flood height of 4.6 ft (1.40 m) MHHW.

Figure 11. A. Left. Structures (yellow) identified within 2013 orthoimagery overlaid with a simple bathtub model applied to the 2015 DTM simulating a water height of 4.7 ft (1.44 m) MHHW to approximate the flooding depicted in the photographic evidence (right). **B.** Left. Structures (yellow) identified within 2013 orthoimagery overlaid with a simple bathtub model applied to the 2015 DTM simulating a water height of 4.5 ft (1.37 m) MHHW to approximate the flooding depicted in the photographic evidence (right).

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2016-MAY-13	6.2	± 0.3	± 0.2	1.88	± 0.09	± 0.06	Moderate

The NOAA Storm Data report from May 2016 details a flood event that impacted Deering from May 11 to 13, 2016, stating "village officials reported two ice jams along the Inmachuk river near Deering Alaska. The combination of the ice jams along with warm temperatures and snow melt helped raise the river levels of the Inmachuk river. Water began to flood the road leading to the Deering Airport on May 11th. A spokesman with the state division of homeland security and emergency management said the waters over the road were 3 feet deep…The flood caused minor damage to the road" (NOAA, 2016).

The Alaska DHS&EM detailed this flood event in their May 12, 2016, Situation Report stating that "on Tuesday night, flooding around the community of Deering overtopped the access road to the airport… A recent period of warm weather and pronounced rainfall has swollen the Inmachuk River near Deering and several ice jams have developed upstream of the village" (DHS&EM, 2016). Aerial images of the flood event were provided by DHS&EM and posted on social media (DHS&EM, 2016).

To estimate this flood, we used the same process as the October 2004 flood event, adding 3.0 ft (0.91 m) to the minimum height at which water would inundate the road across its full width, resulting in a water height of 5.9 ft (1.80 m) MHHW. We then located the areas depicted in the DHS&EM photographs (DHS&EM, 2016) within the 2016 and 2017 orthoimagery and overlaid these with a simple bathtub model applied to the 2015 DTM to simulate the inundation that would occur at the estimated water height. Photographs showing flood waters near the eastern end of the east-west runway at the airport indicated a water height of 6.4 ft (1.95 m) MHHW (fig. 12), though other photographs indicated greater water heights south of the airport (fig. 13) while several more indicated lesser water heights along the airport access road nearer to the village (fig. 14). An average of the height described at the airport access road and the height depicted east of the airport was calculated to estimate a flood height of 6.2 ft (1.88 m) MHHW.

It should be noted that riverine flooding, especially ice jam flooding, can be variable along the reach of the river because the flood source is finite, meaning flood heights and inundation extents may not be consistent in all affected locations. Additionally, the exact times of the photographic evidence and correlation to peak flooding are not known, which may account for the inconsistency of water heights depicted.

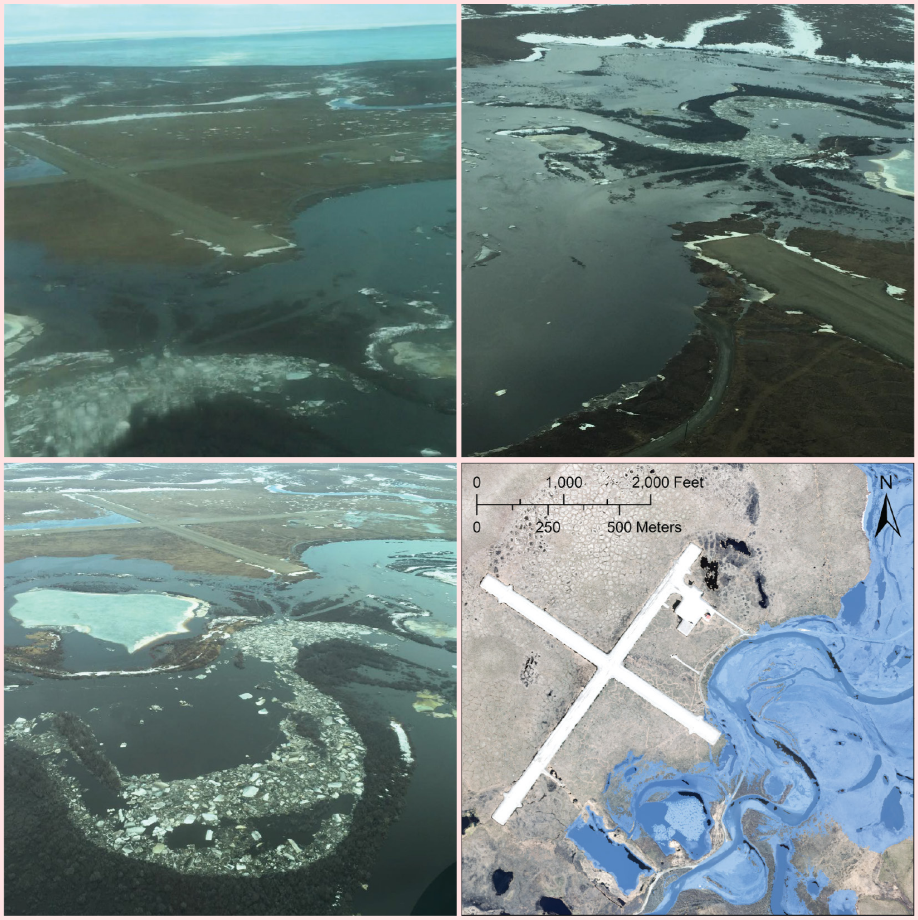

Figure 12. Photographic evidence of flooding near the eastern end of east-west runway at Deering airport and the 2017 orthoimagery overlaid with a simple bathtub model applied to the 2015 DTM simulating a water height of 6.4 ft (1.95 m) MHHW to approximate the flooding depicted.

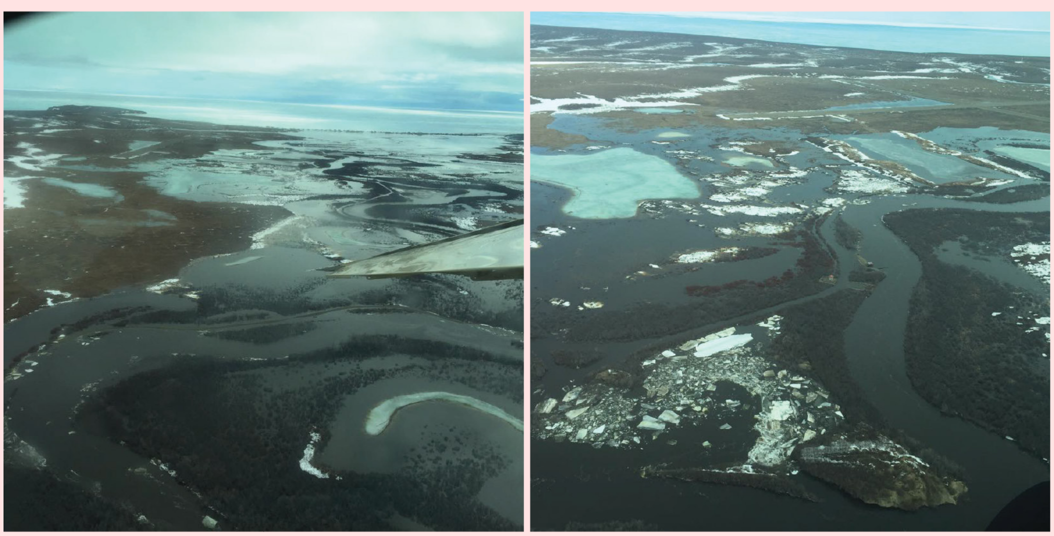

Figure 13. Photographic evidence of flooding south of the Deering airport.

Figure 14. Photographic evidence of flooding along the Deering airport access road just south of the village.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2017-NOV-12	6.0	± 1.2	± 0.1	1.82	± 0.38	± 0.03	Moderate

The ADN published an article on November 15, 2017, detailing storm-related flooding in multiple villages over the previous weekend, November 11 and 12. Speaking with Northwest Arctic Borough Deputy Director of Public Services, Dickie Moto, about flooding in Deering, ADN quoted, "The high water got right to the houses, right to the foundations on Front Street. The high water took a lot of people's stuff away. It impacted a couple of local shops, took their foundations off" (ADN, 2017). Photographs retrieved from social media show water reaching a home on the south side of the village (fig. 15).

Figure 15. Photographic evidence (top) of flooding south of residence (yellow) in the 2016 orthoimagery, overlaid with a simple bathtub model applied to the 2015 DTM simulating a water height of 4.7 ft (1.44 m) MHHW to approximate the flooding depicted.

To estimate this flood, we identified the residence from which the photographs were taken, located it within the 2016 orthoimagery, and overlaid this with a simple bathtub model applied to the 2015 DTM to approximate the water height depicted in the photographs, 4.7 ft (1.44 m) MHHW (fig. 15). We then identified occupied buildings along Front Street, extracted the ground heights from beneath building footprints digitized from the 2016 orthoimagery, and determined the lowest of these to be 6.0 ft (1.84 m) MHHW (fig. 16). Finally, using the 2023 first-floor survey, we determined the lowest first-floor height from among the identified buildings, 7.2 ft (2.18 m) MHHW (fig. 17). An average of these three heights was calculated to estimate a flood height of 6.0 ft (1.82 m) MHHW.

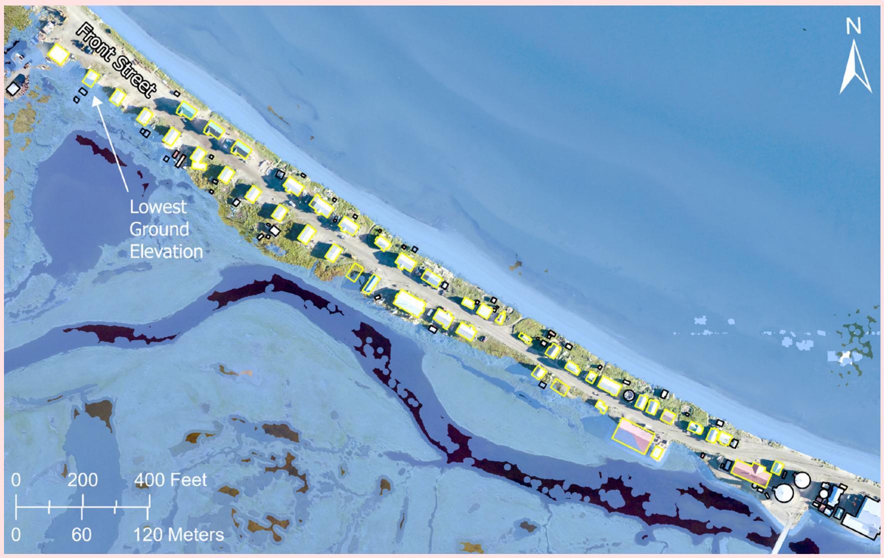

Figure 16. Occupied buildings (yellow) in the 2016 orthoimagery, overlaid with a simple bathtub model applied to the 2015 DTM simulating a water height of 6.0 ft (1.84 m) MHHW to approximate the flooding described.

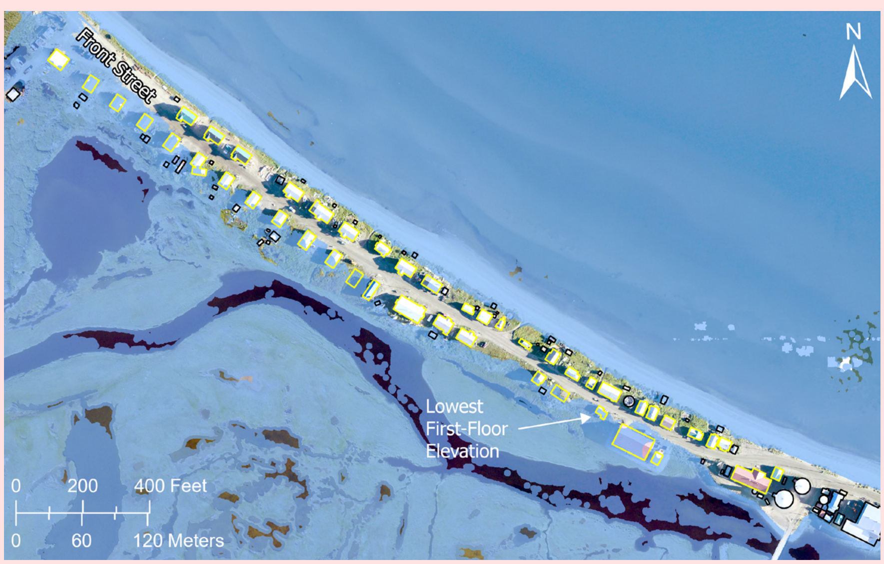

Figure 17. Occupied buildings (yellow) in the 2016 orthoimagery, overlaid with a simple bathtub model applied to the 2015 DTM simulating a water height of 7.2 ft (2.18 m) MHHW to approximate the flooding described.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2022-SEP-18	3.3	± 0.2	± 0.0	0.99	± 0.06	± 0.00	Minor

In September 2022, Extratropical Typhoon Merbok struck the west coast of Alaska causing severe flooding and erosion. The NCEI Storm Events Database details a “Coastal Flood” event that impacted the “Chuckchi Sea Coast” on September 17 and 18 (NCEI, 2022a).

To estimate this flood, we gathered water level data from the Stilltek iGage water level sensor (fig. 1 and 2) during the relevant period. Our estimate is the peak recorded water level (fig. 18).

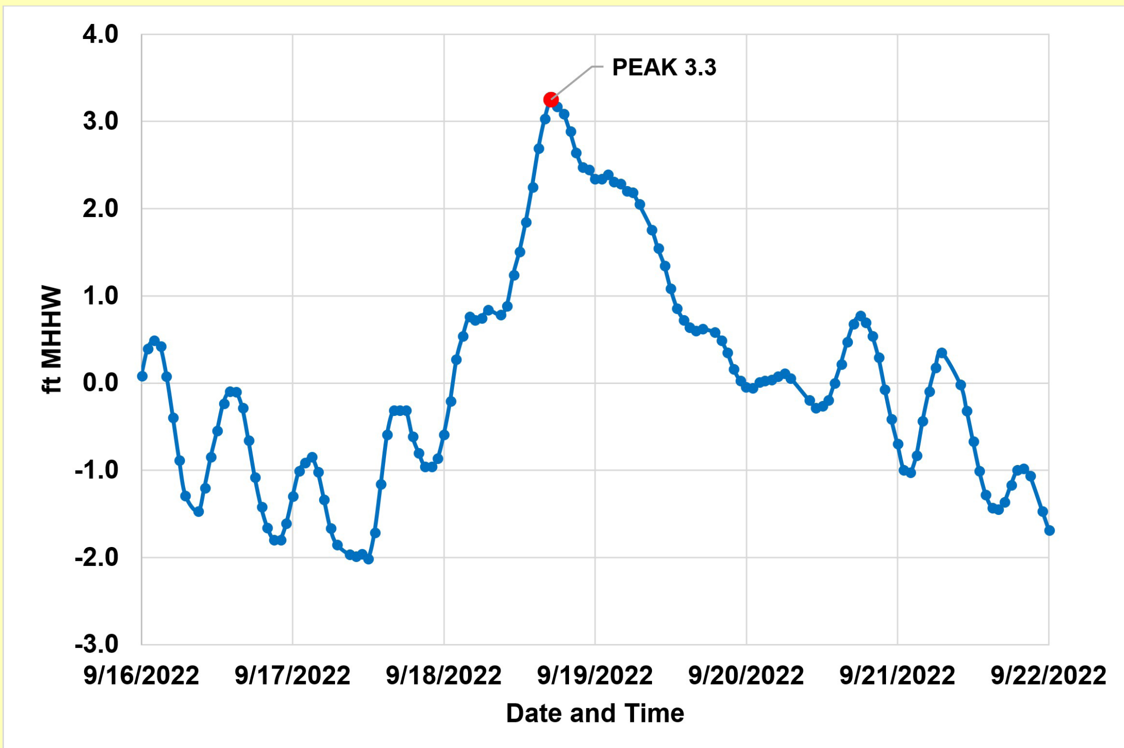

Figure 18. Water level sensor readings from 12:00 AM AKDT on September 16, 2022, to 12:00 AM AKDT on September 22, 2022.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2022-OCT-06	2.7	± 0.2	± 0.0	0.84	± 0.06	± 0.00	Minor

The NCEI Storm Events Database details a "Coastal Flood" event that impacted the "Chuckchi Sea Coast" on October 6 (NCEI, 2022b).

To estimate this flood, we gathered water level data from the Stilltek iGage water level sensor (fig. 1 and 2) during the relevant period. Our estimate is the peak recorded water level (fig. 19).

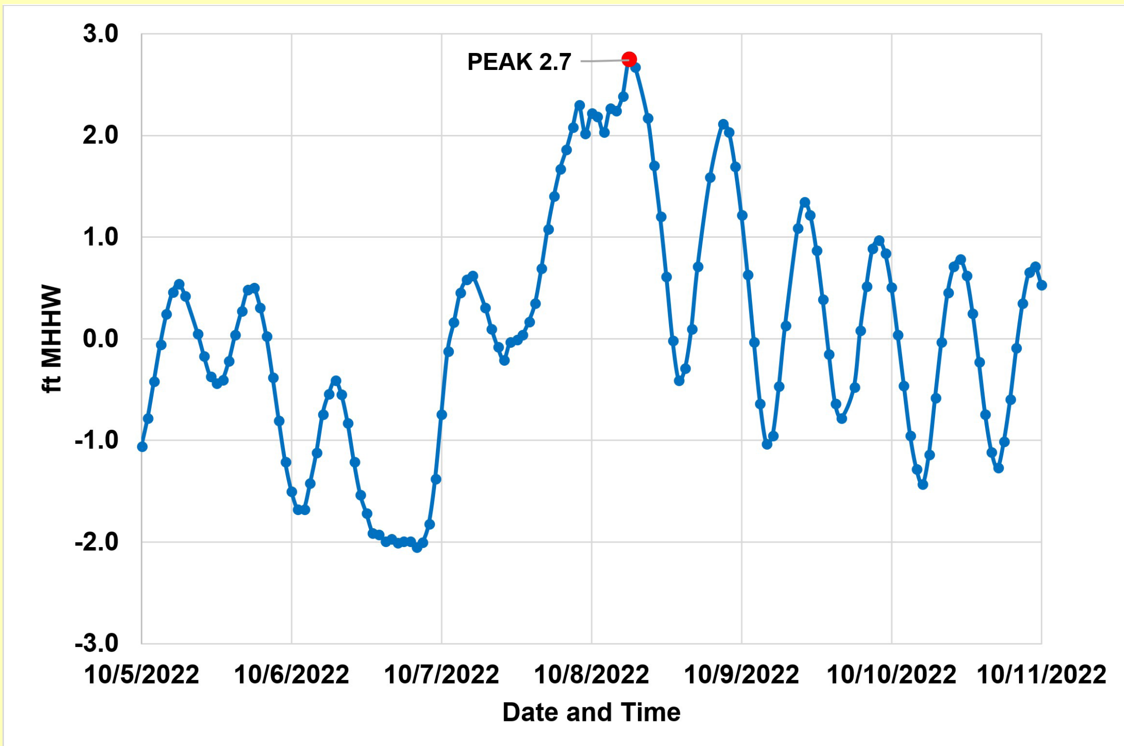

Figure 19. Water level sensor readings from 12:00 AM AKDT on October 5, 2022, to 12:00 AM AKDT on October 11, 2022.

Flood Date	Height (ft MHHW)	Estimate Confidence (ft)	Temporal Confidence (ft)	Height (m MHHW)	Estimate Confidence (m)	Temporal Confidence (m)	Category
2024-OCT-22	5.2	± 0.2	± 0.0	1.59	± 0.06	± 0.00	Moderate

Beginning on October 21, DOT&PF provided periodic updates regarding reported infrastructure impacts in multiple communities, including Deering, from a severe storm that struck the west coast of Alaska (DOT&PF, 2024). The October 28 update noted of Deering "[s]evere erosion along the spit, but no infrastructure loss due to community efforts in reinforcing the beach with materials."

To estimate this flood, we gathered water level data from the Stilltek iGage water level sensor (fig. 1 and 2) during the relevant period. Our estimate is the peak recorded water level (fig. 20).

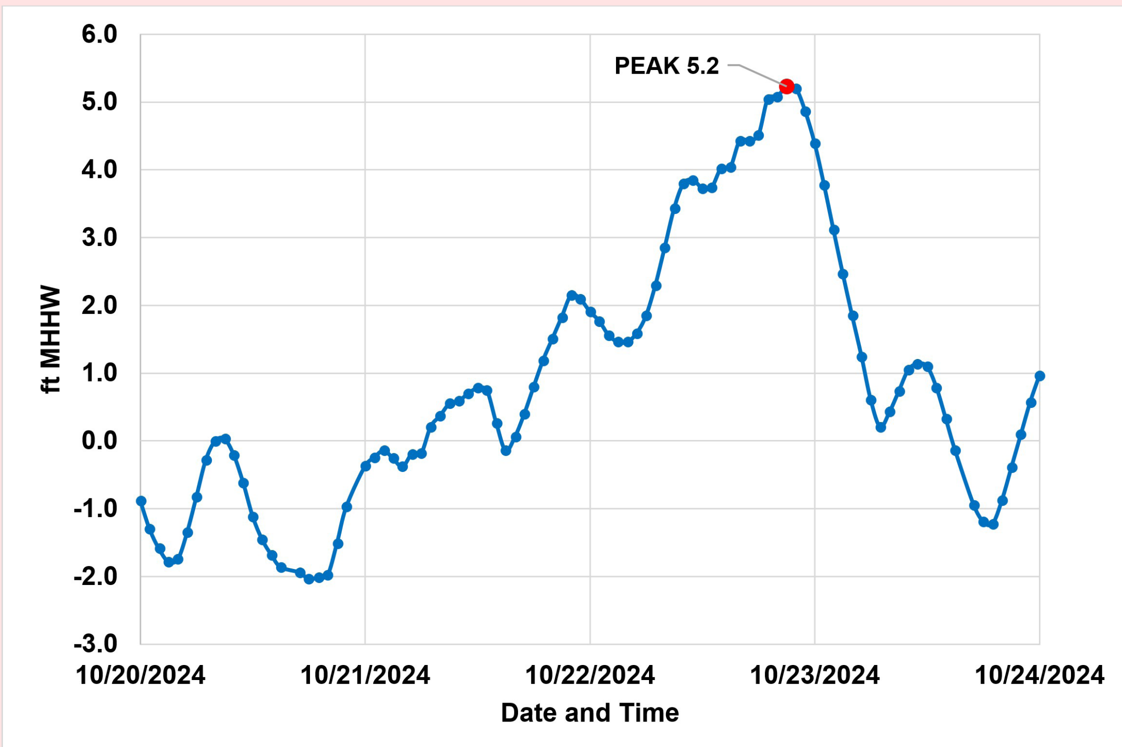

Figure 20. Water level sensor readings from 12:00 AM AKDT on October 20, 2024, to 12:00 AM AKDT on October 24, 2024.

ACKNOWLEDGMENTS

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APPENDIX A: DEERING, ALASKA, FIRST-FLOOR HEIGHT SURVEY

ALASKA NATIVE TRIBAL HEALTH CONSORTIUM
Environmental Health & Engineering

January 27, 2023

Deering, Alaska Finish Floor Elevation Study
ANTHC Project No. 10-0189-01-01

The data provided is from a field survey completed by ANTHC on January 25, 2023. Project elevations are NAVD88 Orthometric heights (U.S. Feet), computed using GEOID12B, and were measured utilizing Trimble R10 GPS Receivers using RTK GPS.

BASIS OF HORIZONTAL CONTROL:
The Basis of Horizontal Control is ANTHC Point 701, a recovered 3-1/2” brass cap monument marking Corner 2, Lot 32 of the ANSCA 14(c) Survey for the NANA Regional Corporation, Inc., in Deering, AK. The position for this point was derived through a static GPS session using a Trimble R10 GPS Receiver post processed using the National Geodetic Survey (NGS) Online Positioning User Service (OPUS). Said point has the following coordinates:

NAD83(2011)(EPOCH2010.00) Geodetic Coordinates:
Latitude = 66° 04’ 26.90083” N
Longitude = 162° 43’ 22.05293” W

NAD83(2011)(EPOCH2010.00) Alaska State Plane Zone 7, U.S. Feet:
Northing = 4,413,522.6132’
Easting = 1,533,070.9461’

BASIS OF VERTICAL CONTROL:
The Basis of Vertical Control is ANTHC Point 701, a recovered 3-1/2” brass cap monument marking Corner 2, Lot 32 of the ANSCA 14(c) Survey for the NANA Regional Corporation, Inc., in Deering, AK. The position for this point was derived through a static GPS session using a Trimble R10 GPS Receiver post processed using the National Geodetic Survey (NGS) Online Positioning User Service (OPUS). Said point has a NAVD88 Orthometric height of 2.100m/6.89’.

Sincerely,

Paul Russell, PLS
Survey Manager

Enclosures:

- Deering-FF_AKSPZ7.csv
- Deering-FF_NAVD83(2011).csv
- OPUS Report_Pt-701_20230125.pdf

Alaska Native Tribal Health Consortium//Division of Environmental Health & Engineering
4500 Diplomacy Drive, Suite 454, Anchorage, Alaska 99508//Main: (907) 729-3600 //Fax: (907) 729-4090//anthc.org

FF = Finish Floor

701	4413522.613	1533070.946	6.89	BRSCAP 3.25IN
4001	4415866.844	1530633.514	15.08	FF SOLAR PANEL CONNEX
4002	4415897.025	1530512.099	16.82	FF SOLAR PANEL CONNEX
4003	4415720.457	1530857.865	22.99	FF FUEL CONTAINMENT TOP
4004	4415725.234	1530869.041	18.8	FF FUEL CONTAINMENT BOTTOM
4005	4415296.634	1531179.315	12.26	FF CITY SHOP
4006	4415197.503	1531295.763	15.08	FF HOME
4007	4415149.737	1531353.814	15.49	FF HOME
4008	4415050.858	1531574.742	20.19	FF HOME
4009	4414986.849	1531652.047	20.22	FF HOME
4010	4414932.213	1531736.392	20.19	FF HOME
4011	4414815.086	1531847.868	20.44	FF HOME
4012	4414746.976	1531933.956	20.75	FF HOME
4013	4414691.855	1532003.486	20.39	FF HOME
4014	4414583.987	1532058.393	16.05	FF NEW BLDG
4015	4414570.687	1532172.682	20.92	FF HOME
4016	4414513.302	1532279.176	20.36	FF HOME
4017	4414438.644	1532311.627	19.31	FF HOME
4018	4414391.535	1532383.757	19.34	FF HOME
4019	4414068.136	1532965.127	18.32	FF HOME
4020	4414005.184	1532914.491	14.16	FF CLINIC GARAGE
4021	4413982.961	1532879.489	16.33	FF CLINIC
4022	4414098.292	1532916.186	16.93	FF HOME
4023	4414129.032	1532855.555	17.12	FF HOME
4024	4414165.162	1532800.882	17.68	FF CHURCH
4026	4414234.315	1532685.724	18.78	FF HOME
4027	4413936.274	1533221.236	15.97	FF WATER TREATMENT PLANT
4028	4413931.731	1533256.831	16	FF STORAGE BLDG
4029	4413865.042	1533199.351	15.76	FF WATER TANK
4030	4413826.558	1533240.197	18.9	FF STORAGE BLDG
4031	4413812.495	1533286.39	16.23	FF WATER TANK
4032	4413857.637	1533357.489	14.5	FF WATER TANK
4033	4413840.511	1533470.115	18.46	FF TEACHER HOUSING
4034	4413797.414	1533464.567	17.26	FF SCHOOL GARAGE
4035	4413803.823	1533587.682	18.43	FF SCHOOL
4037	4413460.086	1534510.059	16.17	FF RECOMMENDED BLDG ELEV
5002	4416237.164	1530448.687	16.24	FF VACUUM SEWER BLDG
5003	4415889.386	1530583.533	14.9	FF SOLAR PANEL CONNEX
5004	4415698.409	1530904.241	14.16	FF FUEL PUMP
5006	4415057.477	1531407.466	14.7	FF HOME
5007	4415010.746	1531531.633	15.91	FF HOME
5008	4414966.494	1531590.624	16.86	FF HOME
5009	4414891.164	1531693.285	16.48	FF HOME
5010	4414824.952	1531766.76	15.61	FF HOME
5011	4414778.898	1531825.147	16.35	FF HOME
5012	4414700.871	1531922.971	16	FF HOME

5013	4414653.999	1531980.401	16.01	FF HOME
5014	4414624.765	1532125.43	17.76	FF HOME
5015	4414511.145	1532084.502	17.9	FF POST OFFICE
5016	4414496.439	1532163.025	17.21	FF NANA OFFICE
5017	4414442.393	1532384.762	16.59	FF HOME
5018	4414333.984	1532539.744	14.97	FF UNOCCUPIED HOME
5019	4414253.186	1532594.013	17.51	FF HOME
5020	4414218.194	1532628.652	16.71	FF NANA OFFICE
5021	4414205.411	1532737.09	14.5	FF UNOCCUPIED HOME
5022	4414129.075	1532771.316	11.93	FF UNOCCUPIED HOME
5023	4414214.828	1532710.527	13.69	FF UNOCCUPIED HOME
5024	4414408.533	1532421.758	18.97	FF HOME
5025	4414390.282	1532464.893	15.71	FF HOME
5026	4414298.208	1532597.691	20.15	FF HOME
5027	4414031.521	1533046.952	15.04	FF HOME
5028	4414000.082	1533089.141	17.42	FF HOME
5029	4413990.522	1533112.748	17.81	FF HOME
5030	4413914.262	1533303.314	17.74	FF CITYT GARAGE
5031	4413821.621	1533380.329	12.68	FF SCHOOL BLDG
5032	4413841.736	1533390.567	12.67	FF WATER TANK
5033	4413868.34	1533420.48	16.87	FF SCHOOL BLDG
5034	4413743.132	1533600.73	16.53	FF HOME
5035	4413701.696	1533688.415	15.85	FF HOME
5036	4413653.755	1533755.885	16.86	FF HOME
5037	4413659.323	1533873.701	17.58	FF HOME
5038	4413608.357	1533866.546	14.59	FF HOME
5039	4413615.582	1533973.966	18.47	FF HOME
5040	4413600.979	1534070.925	14.64	FF HOME
5041	4413547.376	1534123.117	17.47	FF HOME
5042	4413488.844	1534239.812	18.05	FF HOME
5043	4413384.202	1534261.524	14.75	FF HOME
5044	4413397.363	1534300.768	19.13	FF HOME
5045	4413322.864	1534339.689	15.38	FF HOME
5046	4413375.581	1534378.23	17.22	FF HOME
5047	4413320.004	1534418.265	16.24	FF HOME
5048	4413311.877	1534494.832	16.06	FF HOME
5049	4413320.207	1534580.656	17.5	FF HOME
5050	4413279.423	1534648.011	11.99	FF HOME
5051	4413300.417	1534679.156	15.35	FF HOME
5052	4413296.297	1534800.522	16.89	FF HOME
5053	4413344.759	1534780.617	18.28	FF HOME
5054	4413366.267	1534714.097	16.84	FF HOME
5055	4413401.2	1534610.827	15.77	FF HOME
5056	4413443.126	1534484.031	15.52	FF STORE
5051	4413300.417	1534679.156	15.35	FF HOME
5052	4413296.297	1534800.522	16.89	FF HOME
5053	4413344.759	1534780.617	18.28	FF HOME
5054	4413366.267	1534714.097	16.84	FF HOME

5055	4413401.2	1534610.83	15.77	FF HOME
5056	4413443.13	1534484.03	15.52	FF STORE

FF = Finish Floor GS = Ground Shot

701	66° 04' 26.90083" N	162° 43' 22.05293" W	6.89	BRSCAP 3.25IN
4001	66° 04' 49.68951" N	162° 44' 21.80044" W	15.08	FF SOLAR PANEL CONNEX
4002	66° 04' 49.97240" N	162° 44' 24.75261" W	16.82	FF SOLAR PANEL CONNEX
4003	66° 04' 48.27501" N	162° 44' 16.31960" W	22.99	FF FUEL CONTAINMENT TOP
4004	66° 04' 48.32331" N	162° 44' 16.05003" W	18.8	FF FUEL CONTAINMENT BOTTOM
4005	66° 04' 44.14155" N	162° 44' 08.40604" W	12.26	FF CITY SHOP
4006	66° 04' 43.17950" N	162° 44' 05.55491" W	15.08	FF HOME
4007	66° 04' 42.71615" N	162° 44' 04.13409" W	15.49	FF HOME
4008	66° 04' 41.76858" N	162° 43' 58.75039" W	20.19	FF HOME
4009	66° 04' 41.14760" N	162° 43' 56.85827" W	20.22	FF HOME
4010	66° 04' 40.61965" N	162° 43' 54.79816" W	20.19	FF HOME
4011	66° 04' 39.47986" N	162° 43' 52.06274" W	20.44	FF HOME
4012	66° 04' 38.81950" N	162° 43' 49.95666" W	20.75	FF HOME
4013	66° 04' 38.28504" N	162° 43' 48.25563" W	20.39	FF HOME
4014	66° 04' 37.22987" N	162° 43' 46.89422" W	16.05	FF NEW BLDG
4015	66° 04' 37.11207" N	162° 43' 44.12007" W	20.92	FF HOME
4016	66° 04' 36.55955" N	162° 43' 41.52247" W	20.36	FF HOME
4017	66° 04' 35.82858" N	162° 43' 40.71483" W	19.31	FF HOME
4018	66° 04' 35.37326" N	162° 43' 38.95316" W	19.34	FF HOME
4019	66° 04' 32.25706" N	162° 43' 24.77036" W	18.32	FF HOME
4020	66° 04' 31.63182" N	162° 43' 25.98010" W	14.16	FF CLINIC GARAGE
4021	66° 04' 31.40916" N	162° 43' 26.82230" W	16.33	FF CLINIC
4022	66° 04' 32.54825" N	162° 43' 25.96507" W	16.93	FF HOME
4023	66° 04' 32.84385" N	162° 43' 27.44334" W	17.12	FF HOME
4024	66° 04' 33.19317" N	162° 43' 28.77869" W	17.68	FF CHURCH
4026	66° 04' 33.86057" N	162° 43' 31.58943" W	18.78	FF HOME
4027	66° 04' 30.98852" N	162° 43' 18.52574" W	15.97	FF WATER TREATMENT PLANT
4028	66° 04' 30.94785" N	162° 43' 17.66169" W	16	FF STORAGE BLDG
4029	66° 04' 30.28508" N	162° 43' 19.03631" W	15.76	FF WATER TANK
4030	66° 04' 29.91101" N	162° 43' 18.03551" W	18.9	FF STORAGE BLDG
4031	66° 04' 29.77785" N	162° 43' 16.91194" W	16.23	FF WATER TANK
4032	66° 04' 30.23012" N	162° 43' 15.20121" W	14.5	FF WATER TANK
4033	66° 04' 30.07433" N	162° 43' 12.46655" W	18.46	FF TEACHER HOUSING
4034	66° 04' 29.64961" N	162° 43' 12.58904" W	17.26	FF SCHOOL GARAGE
4035	66° 04' 29.72659" N	162° 43' 09.60672" W	18.43	FF SCHOOL
4037	66° 04' 26.44774" N	162° 42' 47.15501" W	16.17	FF RECOMMENDED BLDG ELEV
5002	66° 04' 53.31216" N	162° 44' 26.38739" W	16.24	FF VACUUM SEWER BLDG
5003	66° 04' 49.90553" N	162° 44' 23.01861" W	14.9	FF SOLAR PANEL CONNEX
5004	66° 04' 48.06342" N	162° 44' 15.18901" W	14.16	FF FUEL PUMP
5006	66° 04' 41.81445" N	162° 44' 02.80727" W	14.7	FF HOME
5007	66° 04' 41.36890" N	162° 43' 59.78404" W	15.91	FF HOME
5008	66° 04' 40.94022" N	162° 43' 58.34148" W	16.86	FF HOME
5009	66° 04' 40.21075" N	162° 43' 55.83151" W	16.48	FF HOME
5010	66° 04' 39.56763" N	162° 43' 54.03165" W	15.61	FF HOME
5011	66° 04' 39.12114" N	162° 43' 52.60329" W	16.35	FF HOME
5012	66° 04' 38.36454" N	162° 43' 50.20990" W	16	FF HOME

5013	66° 04' 37.90988" N	162° 43' 48.80454" W	16.01	FF HOME
5014	66° 04' 37.63882" N	162° 43' 45.28072" W	17.76	FF HOME
5015	66° 04' 36.51605" N	162° 43' 46.24078" W	17.9	FF POST OFFICE
5016	66° 04' 36.38032" N	162° 43' 44.33322" W	17.21	FF NANA OFFICE
5017	66° 04' 35.87384" N	162° 43' 38.94311" W	16.59	FF HOME
5018	66° 04' 34.82473" N	162° 43' 35.15589" W	14.97	FF UNOCCUPIED HOME
5019	66° 04' 34.03581" N	162° 43' 33.81776" W	17.51	FF HOME
5020	66° 04' 33.69542" N	162° 43' 32.96828" W	16.71	FF NANA OFFICE
5021	66° 04' 33.58199" N	162° 43' 30.33624" W	14.5	FF UNOCCUPIED HOME
5022	66° 04' 32.83469" N	162° 43' 29.48522" W	11.93	FF UNOCCUPIED HOME
5023	66° 04' 33.67163" N	162° 43' 30.98275" W	13.69	FF UNOCCUPIED HOME
5024	66° 04' 35.54487" N	162° 43' 38.03679" W	18.97	FF HOME
5025	66° 04' 35.37018" N	162° 43' 36.98608" W	15.71	FF HOME
5026	66° 04' 34.47928" N	162° 43' 33.74122" W	20.15	FF HOME
5027	66° 04' 31.90604" N	162° 43' 22.77676" W	15.04	FF HOME
5028	66° 04' 31.60144" N	162° 43' 21.74536" W	17.42	FF HOME
5029	66° 04' 31.51005" N	162° 43' 21.17048" W	17.81	FF HOME
5030	66° 04' 30.78121" N	162° 43' 16.53013" W	17.74	FF CITYT GARAGE
5031	66° 04' 29.87829" N	162° 43' 14.63758" W	12.68	FF SCHOOL BLDG
5032	66° 04' 30.07739" N	162° 43' 14.39502" W	12.67	FF WATER TANK
5033	66° 04' 30.34257" N	162° 43' 13.67739" W	16.87	FF SCHOOL BLDG
5034	66° 04' 29.13083" N	162° 43' 09.27359" W	16.53	FF HOME
5035	66° 04' 28.73298" N	162° 43' 07.13675" W	15.85	FF HOME
5036	66° 04' 28.26881" N	162° 43' 05.48808" W	16.86	FF HOME
5037	66° 04' 28.33688" N	162° 43' 02.63401" W	17.58	FF HOME
5038	66° 04' 27.83455" N	162° 43' 02.79329" W	14.59	FF HOME
5039	66° 04' 27.91774" N	162° 43' 00.19165" W	18.47	FF HOME
5040	66° 04' 27.78494" N	162° 42' 57.83753" W	14.64	FF HOME
5041	66° 04' 27.26333" N	162° 42' 56.55768" W	17.47	FF HOME
5042	66° 04' 26.70044" N	162° 42' 53.71307" W	18.05	FF HOME
5043	66° 04' 25.67314" N	162° 42' 53.15791" W	14.75	FF HOME
5044	66° 04' 25.80706" N	162° 42' 52.21039" W	19.13	FF HOME
5045	66° 04' 25.07831" N	162° 42' 51.24647" W	15.38	FF HOME
5046	66° 04' 25.60140" N	162° 42' 50.32689" W	17.22	FF HOME
5047	66° 04' 25.05897" N	162° 42' 49.34122" W	16.24	FF HOME
5048	66° 04' 24.98758" N	162° 42' 47.48322" W	16.06	FF HOME
5049	66° 04' 25.07916" N	162° 42' 45.40537" W	17.5	FF HOME
5050	66° 04' 24.68535" N	162° 42' 43.76166" W	11.99	FF HOME
5051	66° 04' 24.89542" N	162° 42' 43.01257" W	15.35	FF HOME
5052	66° 04' 24.86844" N	162° 42' 40.06987" W	16.89	FF HOME
5053	66° 04' 25.34311" N	162° 42' 40.56564" W	18.28	FF HOME
5054	66° 04' 25.54733" N	162° 42' 42.18383" W	16.84	FF HOME
5055	66° 04' 25.87954" N	162° 42' 44.69644" W	15.77	FF HOME
5056	66° 04' 26.27793" N	162° 42' 47.78119" W	15.52	FF STORE
5041	66° 04' 27.26333" N	162° 42' 56.55768" W	17.47	FF HOME
5042	66° 04' 26.70044" N	162° 42' 53.71307" W	18.05	FF HOME
5043	66° 04' 25.67314" N	162° 42' 53.15791" W	14.75	FF HOME
5044	66° 04' 25.80706" N	162° 42' 52.21039" W	19.13	FF HOME

5045	66° 04' 25.07831" N	162° 42' 51.24647" W	15.38	FF HOME
5046	66° 04' 25.60140" N	162° 42' 50.32689" W	17.22	FF HOME
5047	66° 04' 25.05897" N	162° 42' 49.34122" W	16.24	FF HOME
5048	66° 04' 24.98758" N	162° 42' 47.48322" W	16.06	FF HOME
5049	66° 04' 25.07916" N	162° 42' 45.40537" W	17.5	FF HOME
5050	66° 04' 24.68535" N	162° 42' 43.76166" W	11.99	FF HOME
5051	66° 04' 24.89542" N	162° 42' 43.01257" W	15.35	FF HOME
5052	66° 04' 24.86844" N	162° 42' 40.06987" W	16.89	FF HOME
5053	66° 04' 25.34311" N	162° 42' 40.56564" W	18.28	FF HOME
5054	66° 04' 25.54733" N	162° 42' 42.18383" W	16.84	FF HOME
5055	66° 04' 25.87954" N	162° 42' 44.69644" W	15.77	FF HOME
5056	66° 04' 26.27793" N	162° 42' 47.78119" W	15.52	FF STORE
5045	66° 04' 25.07831" N	162° 42' 51.24647" W	15.38	FF HOME
5046	66° 04' 25.60140" N	162° 42' 50.32689" W	17.22	FF HOME
5047	66° 04' 25.05897" N	162° 42' 49.34122" W	16.24	FF HOME
5048	66° 04' 24.98758" N	162° 42' 47.48322" W	16.06	FF HOME
5049	66° 04' 25.07916" N	162° 42' 45.40537" W	17.5	FF HOME
5050	66° 04' 24.68535" N	162° 42' 43.76166" W	11.99	FF HOME
5051	66° 04' 24.89542" N	162° 42' 43.01257" W	15.35	FF HOME
5052	66° 04' 24.86844" N	162° 42' 40.06987" W	16.89	FF HOME
5053	66° 04' 25.34311" N	162° 42' 40.56564" W	18.28	FF HOME
5054	66° 04' 25.54733" N	162° 42' 42.18383" W	16.84	FF HOME
5055	66° 04' 25.87954" N	162° 42' 44.69644" W	15.77	FF HOME
5056	66° 04' 26.27793" N	162° 42' 47.78119" W	15.52	FF STORE