BIA Tribal Resilience Program Annual Report

Project: Alaska's Eroding Infrastructure: Systematic Approach to Identifying and Prioritizing Coastal Infrastructure at Risk to Erosion

Prepared by: CaSandera Johnson, Bristol Bay Native Association; Roberta Glenn and Jacquelyn Overbeck, State of Alaska Division of Geological & Geophysical Surveys Coastal Hazard Program; and Chris Maio, University of Alaska Fairbanks Arctic Coastal Geoscience Lab

Project Background

Coastal and riverine tribal communities are currently under threat by increasing coastal hazards and a lack of scientific support tools needed to effectively address risks to tribal resources, infrastructure, human health, and wellbeing. Flooding and erosion affect over 87% of Alaska Native communities and are two of the most compelling threats facing many villages in Bristol Bay. The magnitude of these hazards and their frequency of occurrence are not well documented. Most climate adaptation plans, however, require community-level hazard datasets to plan for individual parcels or infrastructure.

To address the widespread need for local-level erosion measurements, the community-based project Stakes for Stakeholders was initiated in 2016. Funded by Alaska Sea Grant and BIA, this pilot project worked with tribal environmental staff in ten Bristol Bay villages to develop a method to collect accurate erosion measurements with frequent sampling. During the 2-year project, two locations (Dillingham and Port Heiden) experienced regular erosion which was successfully measured by local participants and validated by project scientists. Communities that experience episodic (rather than continuous) erosion, however, only observed subtle changes during the project. Monitoring erosion was an effective way of introducing coastal hazards to community decision makers and tribal environmental programs. However, the question of "then what?" came up as the logical next step to address.

To build from previous work this BIA Tribal Resilience project sought to fill important data gaps and further engage with the community's tribal environmental program staff to contribute towards community's additional capacity to answer the "then what?" question. **This project had an overarching goal to develop coastal hazards data and products that would give communities the capacity to answer critical management and adaptation decisions on how to respond to erosion.** This goal was achieved by carrying out 4 key objectives:

1. Collect baseline coastal datasets to contribute to shoreline change assessments–models of historical trends (erosion or accretion) and ongoing erosion monitoring.
2. Collaborate with community members to identify community-wide concerns for erosion and flooding.
3. Integrate new cartographic design elements and geographic coverage of maps to co-produce maps, tables, and plots that directly answer community questions and data needs.
4. Create a template for integrating coastal hazard data to support the development of mitigation strategies and geotechnical surveys conducted by engineering firms.

The project included a unique collaboration between tribal environmental staff in the communities of Pilot Point, Port Heiden, Ekuk, Dillingham, and Levelock (Figure 1), the Bristol Bay Native Association (BBNA), the University of Alaska Fairbanks Arctic Coastal Geoscience Lab (UAF-ACGL), and the Alaska Division of Geological and Geophysical Surveys Coastal Hazard Program (DGGS). The significance of this collaboration cannot be overstated given the diversity of partners and the synergy and broader outcomes that were produced through the activities. For example, the project supported an Alaska Native student, produced and published an array of community prioritized mapping products, led to knowledge exchange between tribal staff and visiting scientists, and bolstered a regional network of collaborators through BBNA. These combined efforts, deliverables, and outcomes exemplifies the mission of the BIA Resiliency Program.

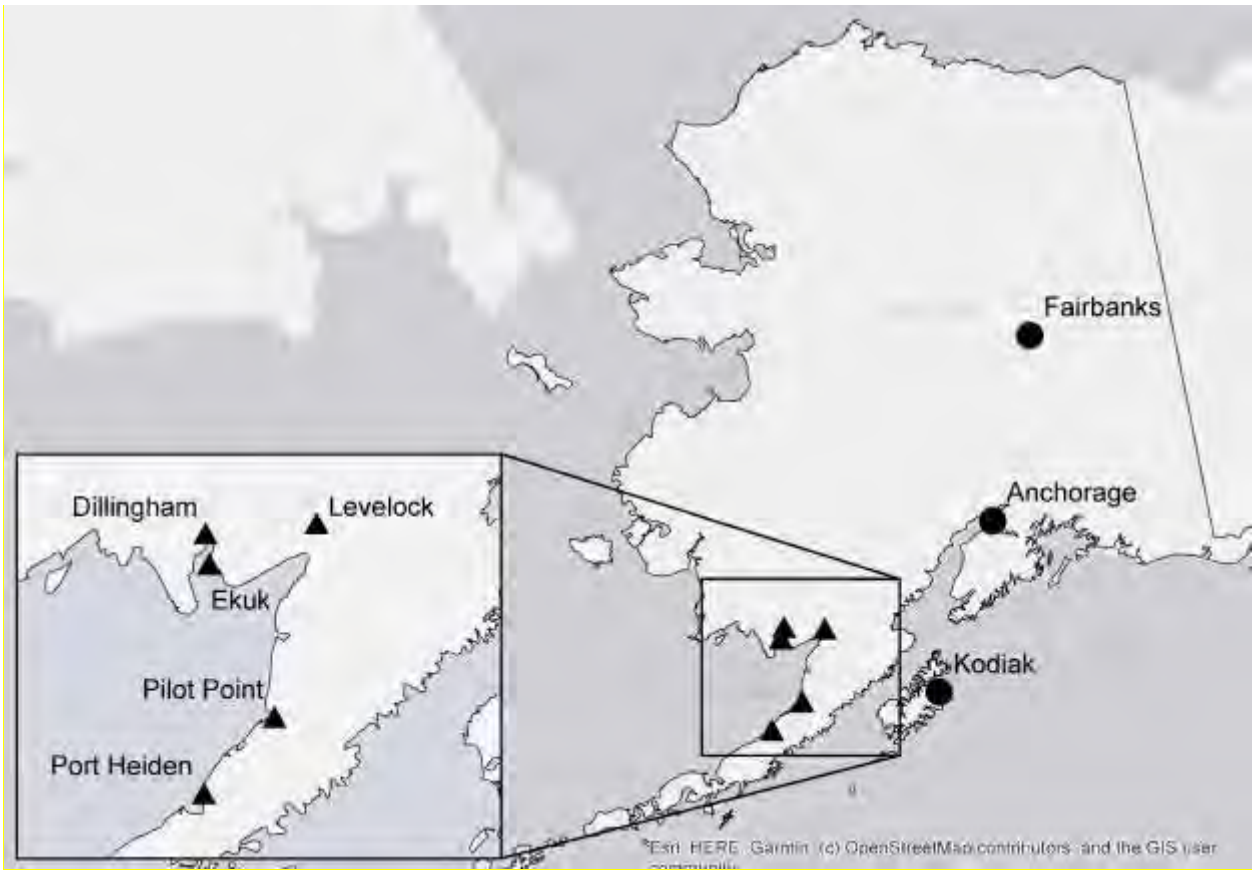

Figure 1. The five Bristol Bay communities included in this project are Dillingham, Levelock, Ekuk, Pilot Point, and Port Heiden. All of these communities participated in the 2016 Stakes for Stakeholders project and have long-running relationships with project partners.

Summary of Project Activities

In order to identify potential hazards at communities with slow or episodic erosion and to compare current rates of erosion to historical trends, we collected additional baseline data, carried out a shoreline change assessment, and created an erosion forecast at 5 Bristol Bay communities. These data were used to create maps and reporting templates for use in local decision making throughout this project. The project ran for a duration of 3 years between 2019 and 2021 facing a number of delays and extensions. Despite the disruptions and COVID–19 related challenges the team carried out a number of successful activities,

achieved milestones, and delivered a variety of data products and outcomes contributing towards resilient tribal communities in Bristol Bay (Table 1).

Table 1. Major project activities and deliverables/outcomes

Activity/ Milestone	**Description of Activity/Milestone**	**Deliverable and/or Outcome**	**Quarter - Year Completed**
Project initiation	See discussion of delays and extensions below.		Q1 - 2018 Q4 - 2019
Hire Project Staff	Bring on project graduate student to facilitate work with 5 communities and incorporate into Master's Thesis materials. Create a new position in ACGL and hire staff member.		Q4 - 2019
Develop Interagency Agreements	Develop MOUs and financial agreements with project partners. Initially delayed due to 2018 government shutdown.		Q5 - 2019
1st Request for No-Cost Extension Approved	Request was approved moving the end date to September 30, 2020.		Q5 - 2019
Networking outreach event	Event held in Anchorage for project communities, scientists, and agency representatives during the 2019 Alaska Forum on the Environment.	Delivered draft maps in poster form to project communities	Q6 - 2020
Geospatial Data Delivery	Final delivery of NOAA contracted project data for use in shoreline change mapping.	Digital database of historical and modern aerial imagery for project communities	Q6 - 2020

COVID-19 Pandemic Disruptions	Numerous project disruptions and delays including 2020 field work season and community meetings. Tribal partners are informed of cancellations for travel.		Q6 - 2020
2nd Request for No-Cost Extension Approved	Requested for no-cost-extension due to COVID-19 pandemic. Request was approved moving the end date to September 30, 2021.		Q8 - 2020
Updated Interagency Agreements	MOU and contacts updated to reflect project end date.		Q8 - 2020
Engagement with Tribal Partners	Engaged with tribal communities to provide updates on project timeline and COVID related delays.		Q9 - 2020
Final Deliverable	DGGS completes and publishes shoreline change assessment https://dggs.alaska.gov/pubs/id/30552	Publication	Q9 - 2020
Teleconferences	Zoom meetings with project communities to gain feedback on erosion mapping products.	Field work planning and mapping feedback	Q10 - 2021
Mapping products completed	Draft mapping products for communities completed and printed in various formats to disseminate during community meetings.		Q10 - 2021
Graduate student comprehensive exams	Glenn successfully passes comprehensive exams and becomes Masters Candidate		Q10 - 2021
UAF Hazard Assessment Report Template	UAF completes draft template for Coastal Hazard Assessment reports and begins compilation of community datasets		Q11 - 2021

Travel to Port Heiden	Conduct baseline data collection, monitoring site maintenance, and community meeting. UAV survey of Goldfish Lake area.	New datasets collected Mapping products delivered	Q11 - 2021
Travel to Levelock	Conduct baseline data collection, monitoring site maintenance, and community meeting.	New datasets collected Mapping products delivered	Q11 - 2021
Travel to Dillingham	Conduct baseline data collection, monitoring site maintenance, and community meeting.	New datasets collected Mapping products delivered	Q11 - 2021
Travel to Pilot Point	Conduct baseline data collection, monitoring site maintenance, and community meeting.	New datasets collected Mapping products delivered	Q11 - 2021
Travel to Ekuk	Conduct baseline data collection, monitoring site maintenance, and community meeting.	New datasets collected Mapping products delivered	Q11 - 2021
Honorariums / Presenter Fees provided as possible	Expending honorariums proved difficult but BBNA was able to get approved presenter fees for tribal/public participation with the community meetings for their feedback and input on the project maps.	Community members compensated for their participation	Q11 - 2021
Follow up Meetings	Follow-up meetings held with project communities allowed for the delivery and discussion of final data products.		Q12 - 2021
Project Closeout			Q12 - 2021

Final Deliverable	Erosion exposure assessment completed and published. https://dggs.alaska.gov/pubs/id/30672		Q12 - 2021

Project Delays and Extensions

There were several challenges that happened during the course of this project. Early on in the project there were technical/schedule difficulties. The project was supposed to start in October of 2018 but the project was delayed for several reasons. One of the delays was that primary data necessary for conducting the spatial analysis of erosion (funded by NOAA) was delayed because the contractor was not able to collect all data for the region in 2018 due to inclement weather and low sun angle. Delivery was originally anticipated in December of 2018 but data collection had to be pushed until summer 2019 with the anticipated final delivery schedule of December of 2019. The second difficulty was the project graduate student delayed starting school until fall semester 2019 (September 2019). The project graduate student would be conducting the primary data analysis and collaboration with tribe staff (under mentorship by BBNA, DGGS, and UAF). Also, there was a 2018 government shutdown that stalled progress as well. With these delays the actual project didn't start until August 2019 with the hire of Roberta Glenn the project graduate student. During this time BBNA applied for a no-cost-extension for the project and was granted the extension pushing the project end date to September 30, 2020.

Another even more significant delay emerged in winter of 2020 when the COVID-19 pandemic began. Due to this new virus the project team had to abruptly cancel all field work for the spring and summer. Traveling to communities to hold community meetings was an essential part of the project to get feedback and document critical infrastructure, cultural sites, and tribal lands potential affected by erosion from tribal leaders. Conducting field work and establishing and maintaining erosion monitoring sites was also an important part of the project and this too had to be canceled due to the pandemic. Consequently,

BBNA applied for another no-cost-extension project to be extended to September 30, 2021 so the team would be able to accomplish the community input portion of the project.

Despite all the challenges presented within the course of this project the erosion project team was able to successfully accomplish key tasks and complete deliverables outlined in our proposal. With its completion the project has led to numerous broader impacts and outcomes.

Shoreline Change Mapping and Projections

After delays in project initiation, staffing, and data delivery, the project team began work to conduct historical shoreline change assessments with the 5 project communities. Standard methods from the U.S. Geological Survey were used to delineate historical shorelines and compare them through time to measure shoreline change rates (Figure 2). An intermediate data product of shoreline change assessments was completed and contributed to a larger DGGS publication of shoreline change for 48 coastal communities. The project graduate student worked with tribal partners to evaluate the shoreline change maps and make recommendations to improve them for use by tribal governments.

The second phase of data analysis was to incorporate local infrastructure and culturally important sites with the shoreline change assessment to determine the exposure of these sites to erosion over a 60-year timeframe into the future. The project graduate student worked with tribal staff to identify important sites to include in the mapping project as well as to share existing datasets on infrastructure. A DGGS shoreline forecast tool was used to project shorelines 60 years into the future. The final deliverable included a report and maps showing the exposure of infrastructure and sites at each of the 5 communities which was also integrated into an existing DGGS publication for the broader set of 48 communities. Iterations of maps were shared with tribal staff for specific projects and areas of interest to assist with ongoing local planning efforts.

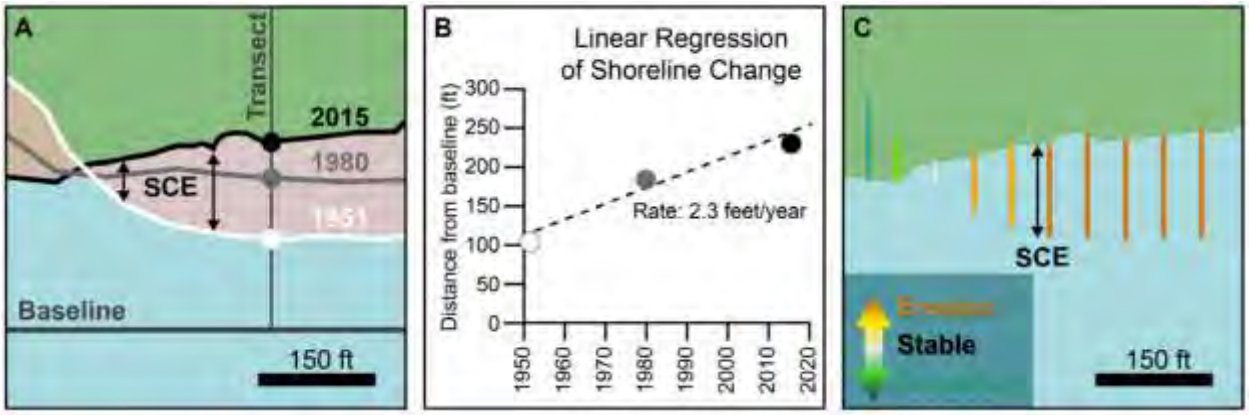

Figure 2. Example of how the shoreline change analysis is used to compute rates of erosion and accretion. The shoreline change envelope (SCE) is the total change measured over the study period. This distance is divided by the number of years between measurements to determine a linear regression rate of change.

Community Engagement and Travel

Community engagement was a critical component of gaining feedback and adjusting maps throughout the project. The project graduate student nimbly adjusted expectations to utilize phone, email, and web interactions with tribal partners as opposed to field travel in 2020. However, in 2021, the project teams were successful in meeting in person to provide additional feedback and continue engagement with tribal staff.

In the early spring, the project team met to detail travel logistics for all five tribal communities, discuss stakeholder/community meeting logistics, and the travel agenda. The complicated travel agenda included working with tribal staff in each of five communities to collect data, maintain erosion monitoring sites, conduct community outreach, and carry out training in the collection of erosion monitoring data. In addition, field teams would conduct repeat topographic surveys in each of five communities using a real time kinematic global positioning system and when possible collect aerial imagery and videos of coastal hazard sites using an unmanned aerial vehicle (UAV). It was planned that DGGS, Rich Buzard, would lead the Port Heiden and Levelock trip with Glenn, the project graduate student, and

Faren Crow, DGGS undergraduate intern. Maio with UAF-ACGL led the Dillingham, Pilot Point, and Ekuk trips with Glenn and graduate student Reyce Bogardus.

The DGGS trip dates were May 6 through May 15 with six days spent in Port Heiden and four days in Levelock. The field team worked with tribal staff to conduct repeat topographic surveys and maintain monitoring sites in both communities (Figure 3). UAV mapping surveys were carried out within coastal hazard zones at Port Heiden acquiring the data necessary to produce a digital surface model. Community meetings were held on May 8 for Port Heiden (6 participants) and May 12 for Levelock (8 participants) where Glenn and tribal/community leaders discussed project deliverables (Figure 4).

Figure 3. Project team members working with Port Heiden IGAP staff to re-install erosion monitoring camera, May 2021.

Figure 4. Project team members meet with community members in Levelock, May 2021. The team shared information on this resiliency project and discussed local issues and priorities.

UAF-ACGL traveled from May 24 through June 10. The hub city of Dillingham served as a base of operations for the UAF field team who spent 6 days surveying the area, meeting with individual partners, and holding a community stakeholder meeting. The field team worked closely with the Curyung Tribal IGAP environmental coordinator to maintain the two existing erosion monitoring sites and identify a new site based on the input of local tribal leaders. The new site was then installed and surveyed. Training was carried out with tribal staff in the maintenance and operation of the three sites.

The field team also conducted aerial surveys at areas associated with extreme erosion including the sewage lagoon and hospital. For the stakeholder meeting in Dillingham, Glenn and BBNA worked collaboratively to detail meeting logistics and identify and invite key stakeholders for the meeting on May 29th. Glenn gave a presentation on the draft shoreline change maps and held an open discussion to gain feedback on mapping products and identify local priorities (Figure 5). Feedback and input was sought on areas of cultural significance, subsistence sites, important infrastructure, and more (Figure 6).

Figure 5. Project graduate student Roberta Glenn gains feedback on mapping products from BBNA's CaSandera Johnson during the Dillingham community meeting. The production of these maps, gaining feedback, and revising them was a major component of Glenn's MS Thesis.

Figure 6. Project team members meet with local leaders during a community meeting in Dillingham. The team shared information on this resiliency project and discussed local issues and priorities.

The UAF field team traveled to Pilot Point from June May 30 to June 4 for six days and worked with tribal staff to carry out a number of survey tasks (Figure 7). The tribal staff and other area stakeholders had previously identified areas of severe erosion impacting the main road and bulkhead, infrastructure critical to commercial and subsistence fishing (Figure 8). In addition to carrying out a complete GPS survey of the coastline, ground control points were measured for use in the production of digital topographic maps. The

two erosion monitoring sites were also maintained and resurveyed. Site maps were developed to aid data collection being carried out by the local high school students.

Figure 7. Project team members (left to right - Roberta Glenn, Chris Maio, and Reyce Bogardus) prepare for surveying in Pilot Point. During this visit over 8 km of shoreline was surveyed.

We held a well-attended (14 participants) community meeting in Pilot Point. During the meeting Glenn and Maio led a discussion with residents and tribal staff regarding the project goals and local priorities. Attendants were also given the opportunity to provide feedback on Glenn's mapping products. The team followed up with extensive surveys in the areas of most concern including the bulkhead and washed out road.

As a special note to the work in Pilot Point, the maps and other data products we provided to the community has led to a new collaboration between the tribe, ANTHC, UAF, DGGS, and an engineering firm who is excited to utilize our existing data in the development of potential solutions to address the eroding bulkhead and road. Addressing these risks will make way for a planned multimillion-dollar seafood processing facility.

Figure 8. Unmanned aerial vehicle (UAV) photograph of the Pilot Point bulkhead taken during summer field work. The bulkhead is currently being damaged by erosion and flooding. This infrastructure is critical to the commercial salmon fishery including the planning for a new seafood processing plant. Data provided through this project has contributed towards developing mitigation strategies for its possible fortification and/or replacement.

The UAF field team traveled to Ekuk June 7-9 with the tribal environmental coordinator Jenifer Robinette and carried out extensive topographic surveys (Figure 9). In addition to the area directly fronting the community, coastal profiles and bluff edge surveys were carried out along a 10 km section of the beach to the south. The areas south of Ekuk including a number of set net cabins are important to the local subsistence and commercial fishing industry. This point was made clear during earlier meetings with tribal staff and we placed a special emphasis on providing mapping products and survey data focused on these community-prioritized locations. As with Pilot Point, the data products provided by this project were integrated within a successful BIA proposal submitted by the tribe in Ekuk which is now funding an engineering firm to develop solutions for the issues identified.

Figure 9. Project team members (in survey vests) work with the Tribal Environmental Coordinator in Ekuk. The team surveyed over 10 km of shoreline, an area important to subsistence and commercial fishing.

In Dillingham at the Ekuk Village Council offices, we held a community outreach event for Ekuk tribal/community members to review and provide input on Glenn's mapping products (Figure 10). Eight tribal/community members participated in the event and held discussions with Glenn. Discussions were informative and assisted Glenn in her final products.

Figure 10. Ekuk community outreach event. Pictured: Ekuk environmental coordinator, Roberta Glenn, and Ekuk tribal members reviewing mapping products.

Deliverables Narrative

Throughout this project, participating tribes gained access to both statewide standardized maps and data products but also adjusted products based on feedback to fit community needs. The state received recommendations for adjustments to map products to improve

the relevance of future maps to tribal community planning. Below is a listing of the project deliverables with example figures provided. See Appendix for additional maps and other deliverables produced. Since the completion of the project tribal offices have received the latest shoreline change maps and links to the reports. In addition, these mapping products are available upon request.

1. Historical and current shoreline positions and shoreline changes rates for the 10 Bristol Bay communities (ArcGIS shapefiles and community geodatabases). Available at https://dggs.alaska.gov/pubs/id/30552 (Figure 11).

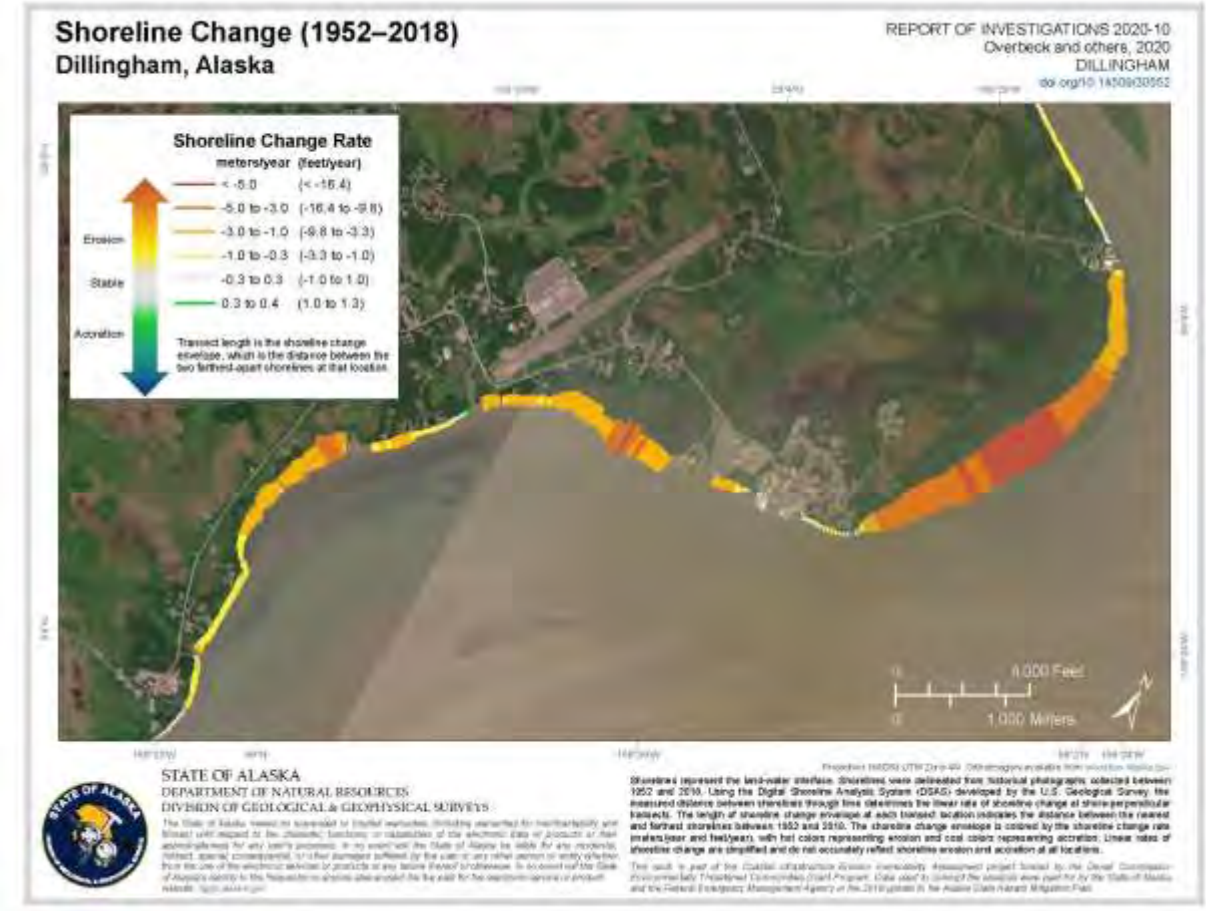

Figure 11. Dillingham shoreline change map produced by DGGS as part of statewide assessment. Hotter colors indicate erosion. Notice the dramatic erosion occurring to the east of Dillingham.

2. Timelines for community-identified critical infrastructure, tribal lands, or cultural resources at Pilot Point, Dillingham, Levelock, Port Heiden, and Ekuk, identified as priority resources by tribal leadership (Figure 12).

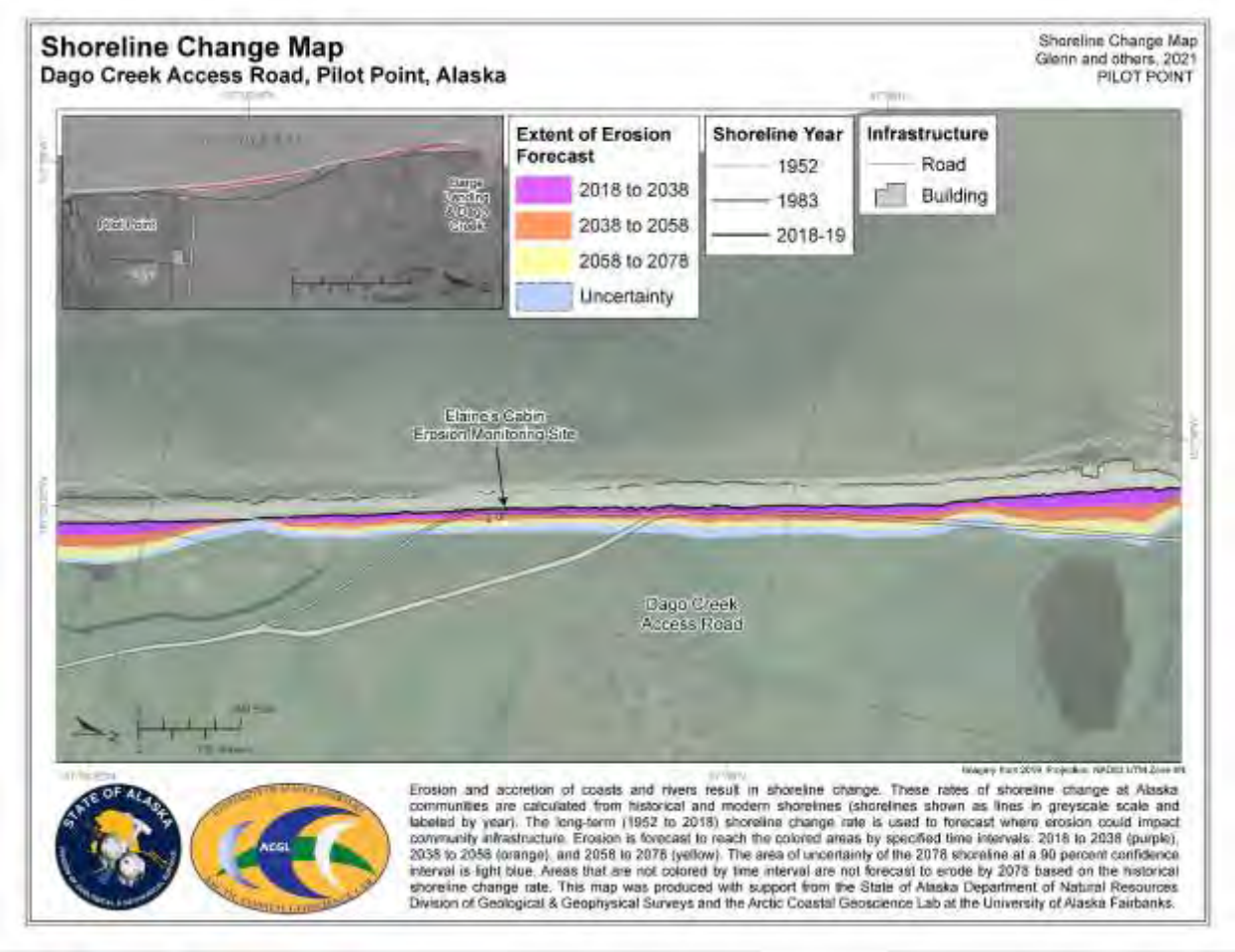

Figure 12. Shoreline change forecast map created at the request of tribal staff in Pilot Point. The map shows the projected shoreline positions based on the linear regression rate of historical shoreline change trends. The location depicted in the map was identified as being a priority area by local stakeholders as it includes the main access road to the bulkhead used for loading and unloading fishing vessels.

3. Format guidance for state developed online tool or other resources to provide to 42 Alaska Native Tribes. Final report (with format) at https://dggs.alaska.gov/pubs/id/30672 for 48 communities (Figure 13).

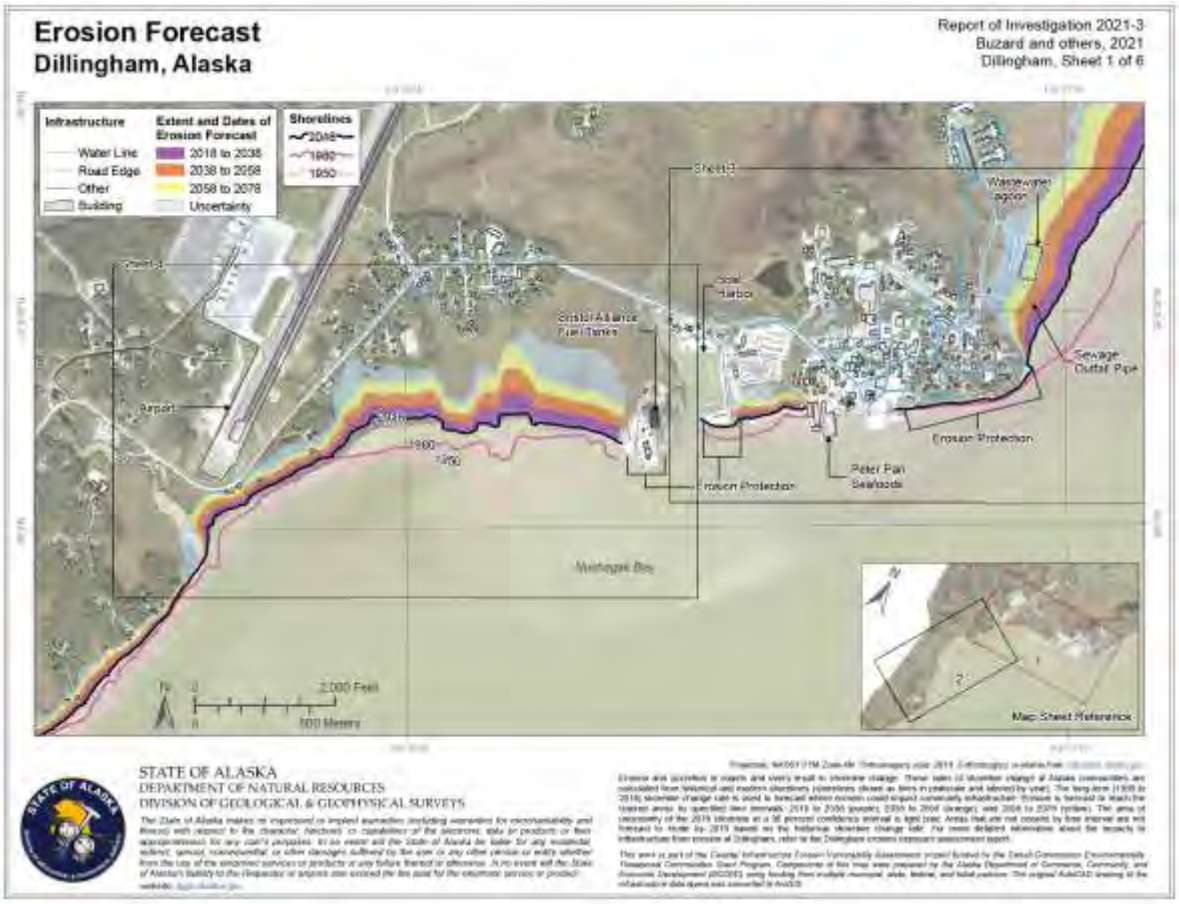

Table 1. Quantity of infrastructure with estimated erosion exposure by linear footage (LF), square footage (SF), or count (n).

Quantity of Exposed Infrastructure				
Erosion Forecast Date Range	Buildings & Tank Facilities (n)	Water Lines (LF)	Roads (LF)	Wastewater Lagoon (SF)
2018 to 2038	0	610	0	0
2038 to 2058	9	981	0	2,006
2058 to 2078	8	1,258	856	97,854
Combined Total	17	2,849	856	99,860

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

Cost to Replace Exposed Infrastructure					
Erosion Forecast Date Range	Buildings & Tank Facilities	Water Lines	Roads	Wastewater Lagoon	Sum
2018 to 2038	$0	$244,100	$0	$0	$244,100
2038 to 2058	$4,506,200	$392,500	$0	$6,000,000	$10,898,700
2058 to 2078	$2,480,100	$503,100	$342,300	$0	$3,325,500
Combined Total	$6,986,300	$1,139,700	$342,300	$6,000,000	$14,468,300

Figure 13. Example erosion exposure map and associated cost of exposed infrastructure tables for Dillingham.

4. Tribal environmental staff erosion monitoring site maps (Figure 14).

Figure 14. Erosion monitoring site map from the sewage lagoon in Dillingham. Repeat surveys document over 100 ft of erosion during the past five years. The green line represents the vegetation line surveyed during the summer 2021 field work campaign.

5. Processed and archived GPS survey data to include cross-shore profiles and bluff edge topographic measurements (Figure 15 & 16).

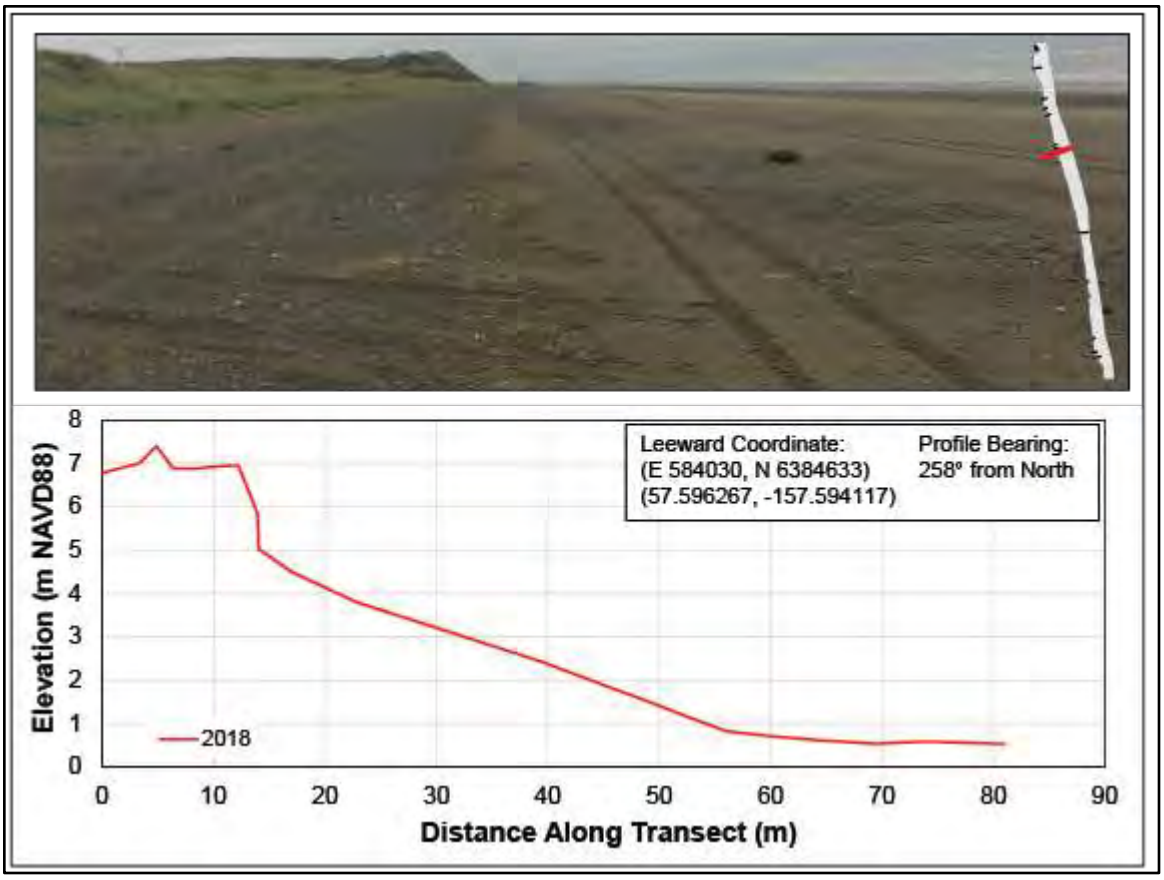

Figure 15. Example of cross-shore profile data collected in Pilot Point. Repeat surveys will allow for the identification of local geomorphic processes and is an important dataset for engineering firms conducting geotechnical surveys and providing mitigation and adaptation plans.

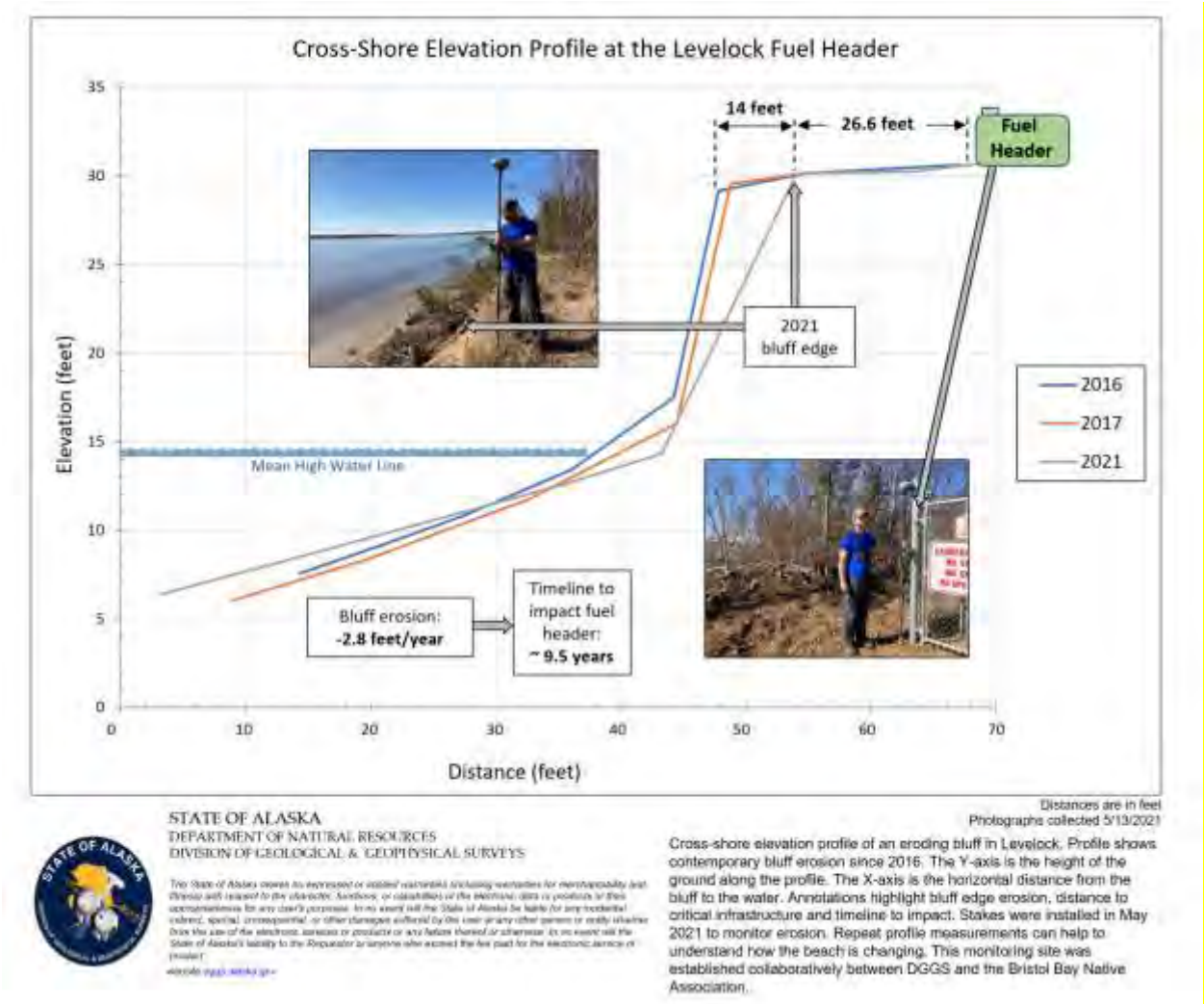

Figure 16. Coastal profile data collected between 2016 and 2021 in Levelock. The repeat topographic surveys allow for an accurate assessment of coastal change at this location and its impact on infrastructure identified as a concern by community members.

6. Unmanned aerial vehicle survey data to include photographs, videos, and digital surface models for Pilot Point, Dillingham, and Port Heiden (Figure 17).

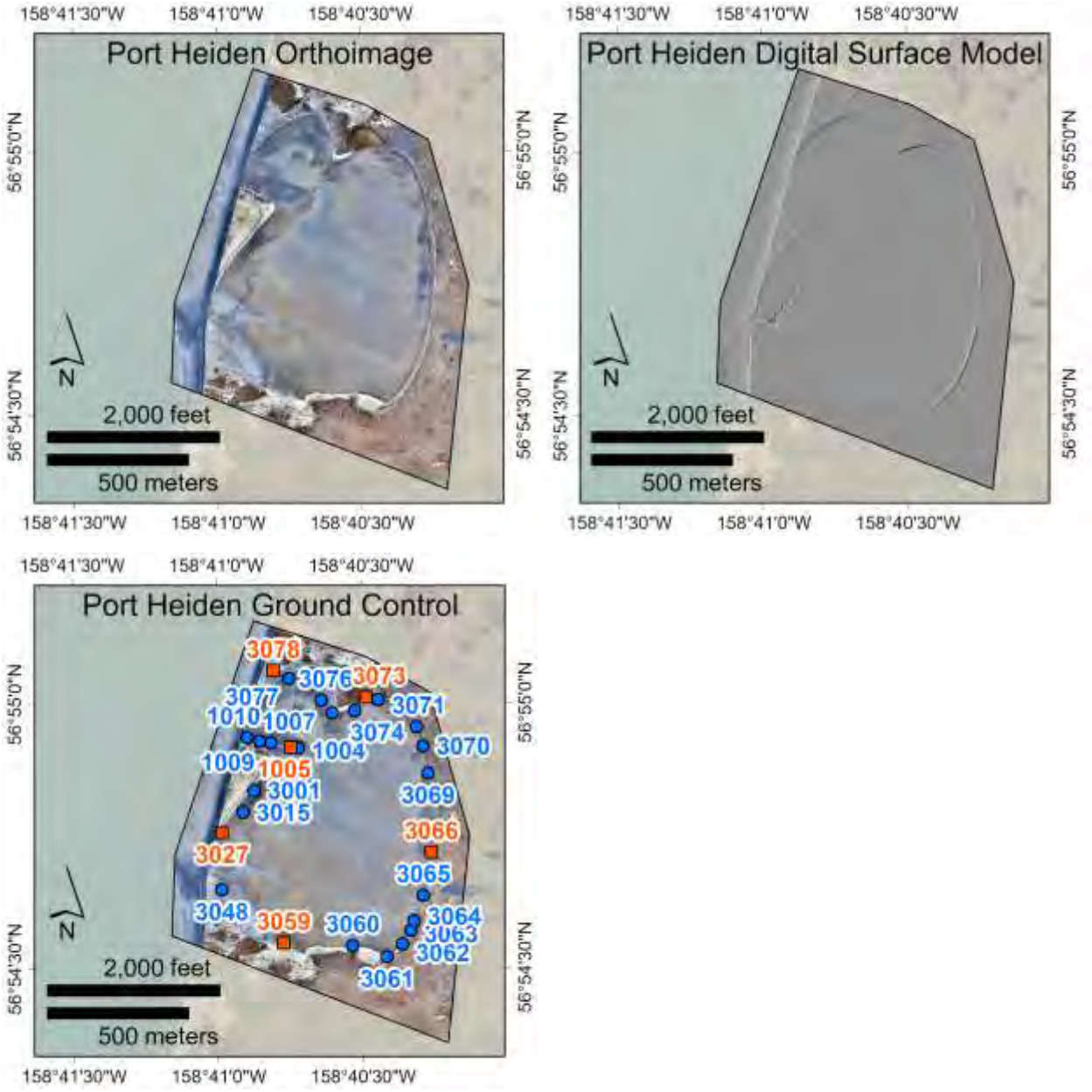

Figure 17. Orthoimage, digital surface model, and GPS points used to control data from UAV survey at Port Heiden. These data are being released through a raw data file publication with DGGS. These data are a critical component to understanding coastal hazards and informing planning for mitigation and adaptation strategies.

7. Mitigation Strategies Template for tribes to organize and present their data, identify risks, and determine potential mitigation and/or adaptation strategies to apply (See Appendix).
    a. As part of this project the UAF-ACGL has produced a hazard assessment template (see Appendix) that can be used to integrate information, resources, and data products for coastal communities. The template outline was developed through funding support from this BIA project while the content is based on the work carried out in a separate project within the Native Village of Nelson Lagoon.
    b. Through additional funding support being provided through the EPA IGAP program and Alaska Sea Grant this template will serve as the framework in which to integrate data products from this BIA resiliency project.
    c. The hazard assessments will then serve as an integrated resource and baseline data product that can contribute towards acquiring additional funding to support geotechnical surveys conducted by certified engineering firms. Products and information within the reports will also directly feed into FEMA required Hazard Mitigation Plans.
    d. In 2022 a draft hazard assessment report will be provided to each of the project communities supporting tribal resiliency and mitigation and adaptation planning.

Outcomes Narrative

This project was highly successful in the fact that it led to numerous positive outcomes and broader impacts. This included supporting an Alaska Native graduate student at UAF and DGGS, establishing a new staff position at UAF, and through the leadership of BBNA, building a network of collaboration between local tribal staff, the ACGL, and DGGS. This project also has provided numerous new mapping and information products that are

directly informing decision-making and fostering resilient tribal communities. For example, data products produced for the communities of Pilot Point and Ekuk were included in recent successful proposals leading to contracts with engineering firms to carry out geotechnical surveys and develop potential solutions to the identified risks.

Specific outcomes and broader impacts to this tribal resilience project include:

1. Strengthened reciprocal relationships between project partners including the five communities participating in the ongoing erosion monitoring efforts.
    a. BBNA facilitated a meeting between UAF, the Curyung Tribe, DGGS, and Alaska Sea Grant to discuss the coastal erosion monitoring efforts and how to build from this BIA project to developing sustainable funding pathways through the EPA-IGAP program.
2. Recruited and funded Alaska Native graduate student Roberta Glenn.
    a. Glenn took a GIS class on spatial analysis and methods of symbolizing spatial data to inform shoreline change map development.
    b. Glenn took a class to further develop background on connecting Indigenous knowledge with western science and to form ideas for altering shoreline change maps to better fit Indigenous community's needs.
    c. Glenn began training sessions for UAF graduate students, including Jessie Christian, on shoreline change analysis protocols for future data processing. This allowed her the opportunity and experience passing down her knowledge developed during this project.
    d. Glenn submitted her final thesis proposal, completed her Masters of Science comprehensive exam, and advanced to candidacy in the UAF graduate program.
3. Established a new staff position aimed at recruiting Alaska Natives within the ACGL
    a. Alaska Native Cheryl Kriska was hired to assist with the production of mapping products and erosion monitoring protocols (Figure 18).

Figure 18. Project staff Cheryl Kriska works with a graduate student Bogardus within the ACGL. Kriska developed mapping products for the coastal erosion monitoring component of the work (Photo by JR Ancheta).

4. UAF graduate student Jessie Christian was trained in erosion monitoring protocols and began to organize and process existing data.
5. Maps, plots, and data were adjusted based on feedback which will contribute to future products developed by the state:

    - Shoreline change maps were confusing in the format showing alongshore profiles, however, through this project, we found that a simple line showing shoreline change rate along the coast was most effective.

- Shoreline change and erosion exposure maps did not always provide the geographic coverage a community was interested in. In Ekuk, a subsistence camp down shore from the community was not originally mapped, however, added to the assessment because of the community's feedback.
- Shoreline change and erosion exposure maps did not always focus on the community's area of interest in the correct zoom level for easy viewing. This was due to focusing on the location of current infrastructure, whereas, communities had interests in other sites as well, because of planned future development. For example, in Pilot Point, the tribe was considering utilizing a section of coast for access to a planned fish processing facility that did not yet exist. We zoomed into particular areas of interest to provide maps that would be useful for future planning.
- Shoreline change and erosion exposure maps alone did not meet community needs. A component of this project was to maintain community monitoring sites. Data from these sites are much more localized to infrastructure (for example, a fuel header, singular building, etc.). Additional plots were created and updated to provide to tribal staff for hazard assessment.

6. Data products from this project were integrated into new BIA proposals for the communities of Ekuk and Pilot Point leading to funding to support geotechnical surveys carried out by engineering firms. This represents the ideal outcome to this work as the products we produced are now contributing to the development of mitigation and adaptation strategies and other information products for decision makers.
7. The DGGS publications on shoreline change and erosion exposure represents the most substantial contributions to shoreline change research in Alaska to-date and provide the baseline in which to understand past, present, and future shoreline change and potential impacts. The reports not only provide coverage of the communities in the Bristol Bay region, but northern and western Alaska as well

(Figure 19). These publications should allow communities, government agencies, and other partners to move away from broad descriptions of erosion across hundreds of communities to identifying community-level needs for adaptation to erosion.

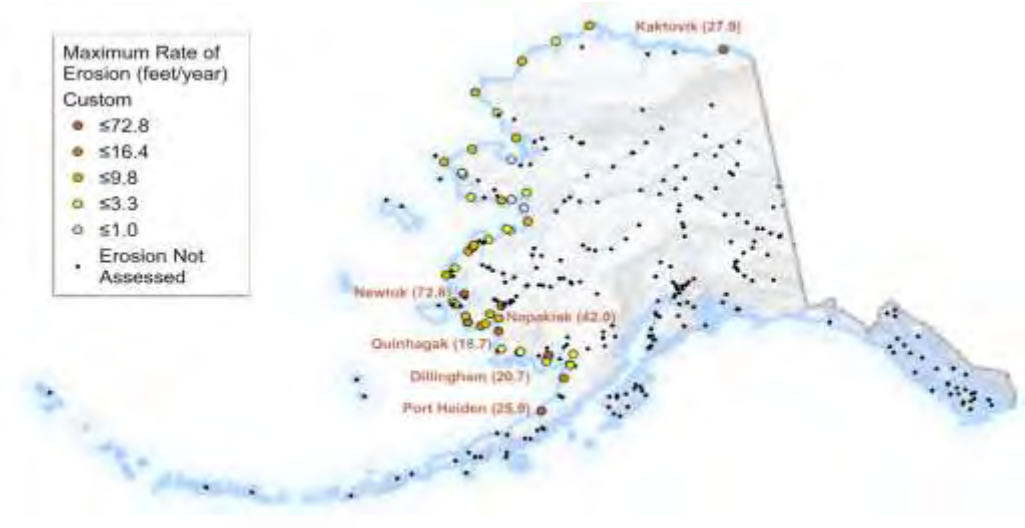

Figure 19. Statewide shoreline change map showing the maximum erosion rate for a given community.

Conclusion

The work completed as a part of this project was a major contribution to coastal hazards science, baseline data collection, and erosion response in Alaska not only for the Bristol Bay region, but statewide. The products developed as a part of the project will assist in community-level decision making for many years to come and the monitoring sites maintained during this project will allow community members to assess erosion forecasts in future conditions. This work was completed in collaboration with community members, ensuring that products are usable and relevant for local decision making. This project also enhanced the opportunities for Alaska Native workforce development and training, which will hopefully bring many force multipliers into this field of study into the future.

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Bruce Baltar
Acting President & CEO
Bristol Bay Native Association