February 2018

Prepared for:

Chefornak Traditional Council

Attention: Bernadette Lewis

101 Complex Drive

City of Chefornak Head Start Building Replacement

Project No. 181012

Prepared by:

PND Project No. 181012

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P N D
ENGINEERS, INC.

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1.0 INTRODUCTION

At the request of the Chefornak Tribal Council and based on discussions with representatives from the Bureau of Indian Affairs (BIA) and Alaska Native Tribal Health Consortium (ANTHC), a visit to the community of Chefornak was conducted by PND Engineers in preparation for the upcoming agency meeting to be held on February 21st in Anchorage. The purpose of this visit was to validate and characterize the civil and structural issues of concern in Chefornak and propose a series of tasks to improve the health, safety and welfare of the community.

On February 8 and 9th two Principal engineers from PND, Sean Baginski, P.E., S.E. and Torsten Mayrberger Ph.D., P.E. visited the city of Chefornak with the following goals established:

1. Meet with Tribal, City and Corporation representatives to discuss issues affecting their community.
2. Issues included:
    a. Erosion
    b. Housing
    c. Head Start Building
    d. Potable Water
    e. Sewer
    f. Boardwalks
    g. Fuel
    h. Power Generation-Distribution
    i. Workforce Development
3. Conduct City Wide Cursory Observation/Reconnaissance
4. Field Reconnaissance of nearby resources

Figure 1. City of Chefornak

1.1 Background

Chefornak, Alaska is a Yupik village located on the south bank of the Kinia River 16 miles upriver from its mouth in Etolin Strait, an arm of the Bering Sea. As of 2000 there were approximately 400 people in Chefornak.

Chefornak is founded on the northern extension of a Tertiary Basalt Formation (Figure 2) tied to the extinct volcano, Tern Mountain approximately 3 miles south of the city.

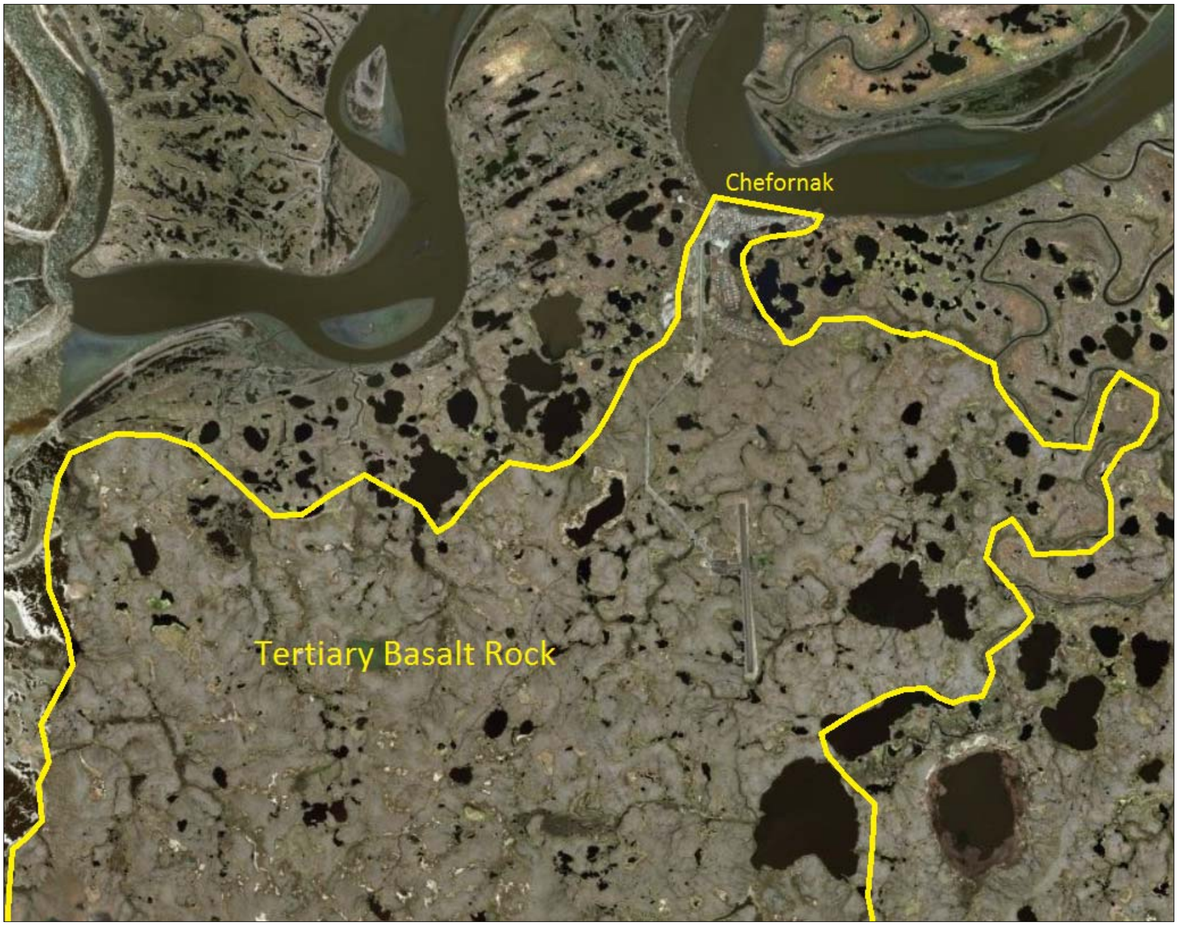


Figure 2. Tertiary Volcanic Basalt Rock (Image Courtesy of Microsoft Bing Maps)

The banks of the river on either side of this Basalt extension, as well as the sands and gravels (Figure 3) within the exposed edge of the formation have been eroding due to spring breakup flooding. In addition to this, due to the low elevation of Chefornak, storm surge and wind driven wave action has exacerbated this problem.

Figure 3. Contact between Basalt Rock and Soil (Image Courtesy of Microsoft Bing Maps)

Recent flooding events have caused numerous problems within the community including: settlement and failure of building foundations due to increased thaw of the underlying permafrost, caused by the introduction of flood waters; disruption of transportation to essential parts of the community; and accelerated degradation of the remaining river bank. In an effort to combat the effects of the flooding on their community, representatives from the City of Chefornak, Chefornak Traditional Council, and the Chefarnrmute Corporation requested assistance in developing a plan to address these issues.

To begin assessing the needs of the community, a meeting with Chefornak officials and concerned community members was conducted at 7:00 PM on February 8, 2018 at the Chefarnrmute Corporate Conference Room. Approximately 20 people were in attendance including representatives from the Tribal, City, and Corporation Councils. This report summarizes one of the key areas of concern identified in this meeting, the Head Start Building.

1.2 Flooding Event

October 4-6, 2017- In early October of last year, a strong gale force wind event struck the eastern Bering Sea. Sustained winds of approximately 40 to 50 mph out of the West and Southwest were recorded at the airports in Toksook Bay (Figure 5, 44 miles NW) and Quinhagak (Figure 6, 86 miles SE).

Figure 4. Regional Map (Image Courtesy of Microsoft Bing Maps)

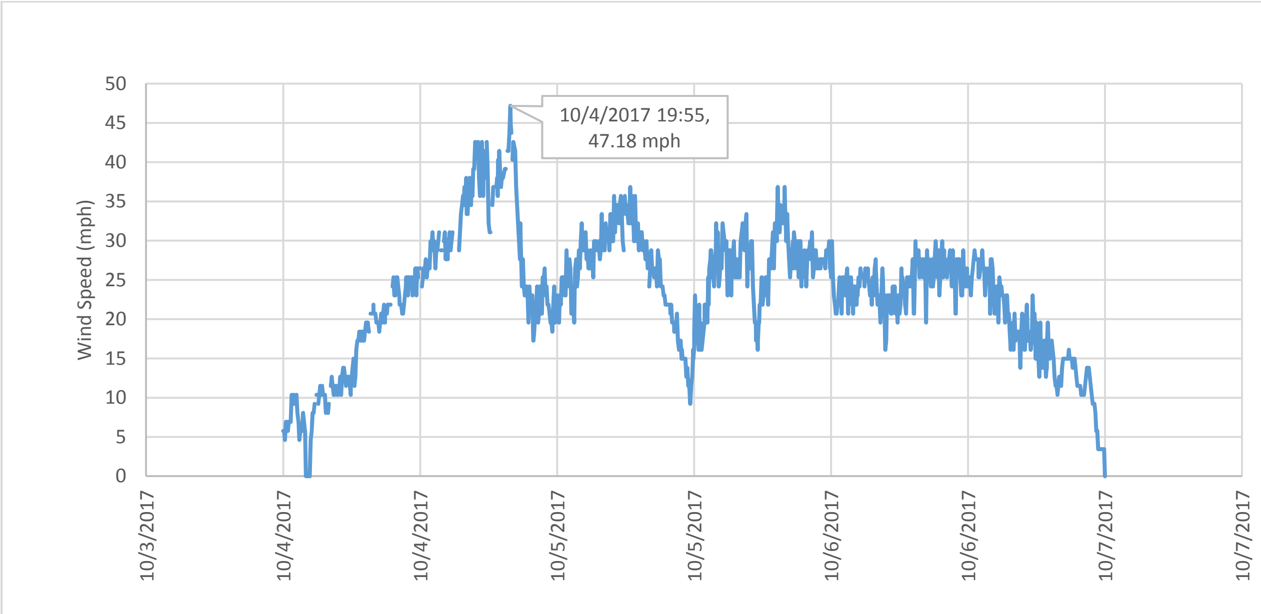


Figure 5. Wind speed record for Toksook Bay Airport, October 2017 (NWS data)

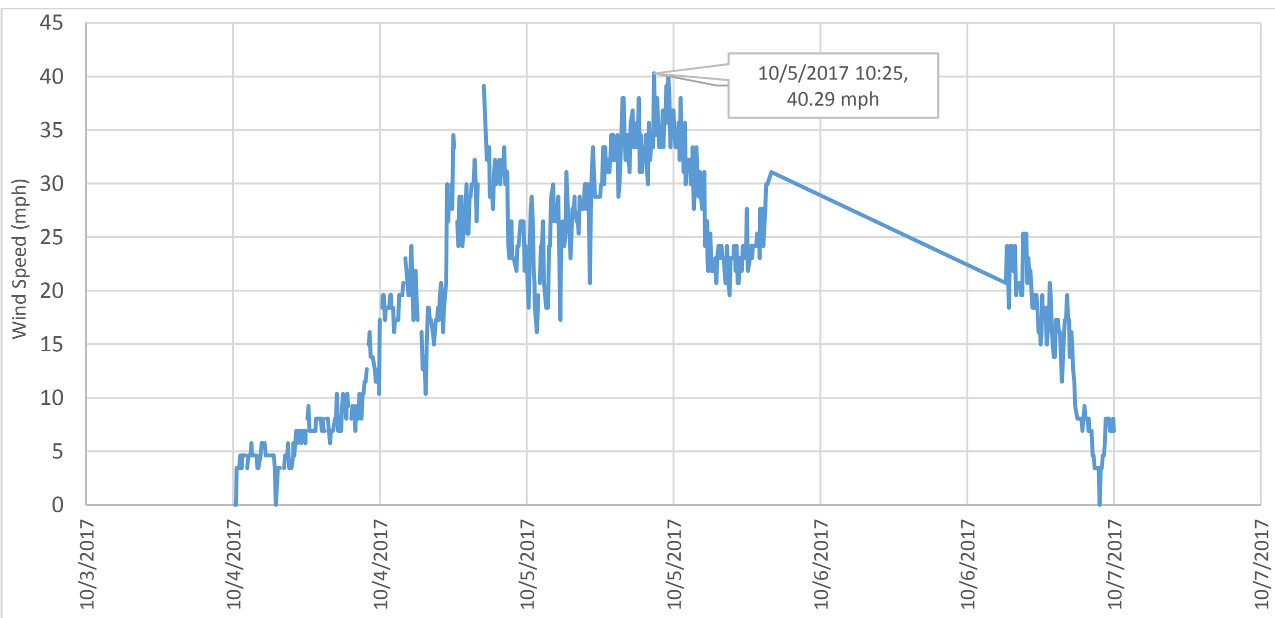


Figure 6. Wind speed record for Quinhagak Airport, October 2017 (NWS data)

The storm peaked at Toksook Bay at approximately 8:00 PM on October 4th and 11:30 AM on October 5th in Quinhagak. The approximate storm peak in Chefornak would have occurred during the late night hours of October 4th. The flooding extended over a 3 day period during and immediately following the storm.

Figure 7. Head Start building access, morning October 5, 2017.

The flood water left behind after substantial late season storm surge events such as this one, introduce salt water both at the surface and below the surface within the thawed active layer. Salt water acts as a type of antifreeze, lowering the freezing point of the soil and reducing its long term bearing capacity due to soil creep. The direct effects of these flooding events, beyond immediate erosion due to wind driven waves and hydraulic action do not manifest themselves immediately. Early October in this region is directly prior to the beginning of freezeback of the active layer soils, which typically begins in mid to late October. Introduction of the salt water at this time would prevent adequate freezing of the soil during that winter (October 2017-April 2018) and begin to manifest itself first with soil creep deformation under load, as would typically be found under building foundations. It is anticipated that this problem will become much more pronounced as the soil thaws and warms during this coming summer and fall.

Late season storm surges such as this also significantly increase the erosion rates observed along the banks of the river. This is because the soil is in its most permeable state, having achieved its maximum depth of thaw in late September or early October. The soil condition is much different in this time frame than when the spring breakup flooding occurs. During spring, the active layer is mostly frozen and impermeable allowing relatively little penetration of the water into the soil. Any water that does manage to permeate the soil is, for the most part, fresh water that does not significantly impact the thermal response of the soil. However during late summer and fall, the active layer, having reached its maximum thaw depth, is at its maximum permeability and maximum temperature. When this occurs and is coupled with an active layer that consists primarily of coarse sands and gravels, the saltwater intrusion can penetrate the embankment deeply. For silty soils the penetration is less but the thaw settlement resulting from the thermal modification is more severe. The introduction of saltwater weakens the soil, retarding or preventing ice bonding between soil particles and thaws previously unthawed permafrost.

The immediate effects of late season storm events are most often not apparent until the following summer thaw season during which the compromised soil is vulnerable to river bank erosion, ice plucking and further thaw settlement.

This set of conditions is highly localized to areas of transition between regions exposed constantly to saltwater and those never influenced by salt water. This would typically include areas above the tidal range that are subjected to periodic extreme storm surge events. The reason for this is, areas within the tidal influence range will have already undergone any erosion attributable to the saltwater intrusion and reached a new equilibrium state. Areas above any influence from the saltwater would obviously be unaffected by definition.

Very little documentation exists regarding the direct and indirect effects of this set of conditions. Studies should be conducted to determine the extent and severity of the problem in coastal and near coastal communites across the state where permafrost exists. These studies would, at a minimum require determination of site soil conditions through geotechnical investigations and require data including soil classification, permeability characteristics, periodic salinity measurements and long term temperature monitoring. To date very few of these types of studies have existed due to lack of funding and lack of understanding of the problem.

1.3 Head Start Building

Building Condition- The Head Start Building, located at the east end of Chefornak on the bank of the river, was constructed in the 1960's. It is in poor condition (Figure 8, Figure 9, and Figure 10), showing signs of wood rot, sagging floor support beams and a failing foundation. Adjacent and connected structures are settling differentially with respect to the Head Start Building causing cracking walls and windows, sticking doors, and an uneven floor.

Figure 8. Head Start Building Foundation

The entire building is tilting on its post and pad foundation due to surface thaw settlement. This problem has been exacerbated dramatically by the additional rapid rate of thaw caused by the October 2017 flood event and the introduction of salt water into the thawed active layer as described in section 1.2. Some of the pad foundations are not in contact with the ground surface and are providing no support to the structure. This causes other members and foundations to support loads for which they were not designed. Additional thaw settlement is expected once the soil begins warming and thawing during spring and summer months. If similar storm surge events occur in the late summer or fall again, further thaw settlement under the structure is to be expected. This may result in its ultimate collapse of the structure given its current condition.

Non-structural problems identified by members of the community regarding this building include: excessive heat loss due to inadequate insulation, and otherwise compromised building envelope; hazardous insulation (asbestos); and unsafe, limited access to the building during and after flooding events.

Figure 9. Head Start Building - Shifting Towards River Bank

Figure 10. Flooding of Head Start Utility Building, morning of October 5, 2017

1.4 Head Start Utility Building

The Head Start Building and adjoining Utility Building are two of the lowest elevation structures in the community making them the first structures to experience the effects of increased flood elevations. In years past this has not presented itself as a concern, however recent break up events, summer/fall storms and high-water events have presented unsafe conditions for the children or adults to walk to or from the school during or immediately after major floods. While the river bank at this location appears to be stable, flooding at its present location makes it a problematic site. This problem is especially critical for the Utility Building, shown in Figure 10, which sits at a lower elevation than the Head Start Building itself and is in considerably worse condition.

2.0 RECOMMENDATIONS-COST

2.1 Demolish the buildings

These buildings should be demolished as they are likely be abandoned and eventually collapse into the river. If this were to happen, it would create potential health and safety concerns due to the asbestos, lead paint and other contaminants that would be released into one of the community's food and water sources.

Both Buildings

Demolition (Asbestos/Hazardous Material Abatement): $150,000

2.2 Replacement of the buildings

These buildings should be replaced at a location secure from the influence of river bank erosion and storm surge related flooding. They are in imminent threat of collapse due to the combination of thaw settlement and their current structural condition. This buildings are not likely to survive any attempts to move to a new location and shoring in place does not address any of the underlying issues highlighted in this report.

Head Start Building-5000 sq ft

Architecture/Engineering Design: $210,000

- *Architectural Design $150,000*
- *Geotechnical assessment/Foundation Design $5,000*
- *Structural Design $25,000*
- *Mechanical-Electrical $20,000*
- *Contract Administration (C.A.), Inspection-$10,000*

Construction: $3,000,000

Utility Building-4000 sq ft

Architecture/Engineering Design: $200,000

- *Architectural Design $130,000*
- *Geotechnical assessment/Foundation Design $5,000*
- *Structural Design $20,000*
- *Mechanical-Electrical $35,000*
- *Contract Administration (C.A.), Inspection-$10,000*

Construction: $2,600,000

2.3 Contingency Planning

To allow time for design and construction of the buildings, presumably to be completed by summer 2019, it is recommended that the community develop and implement a contingency plan in the event that a structure does collapse and become unserviceable before completion of the replacement structures. It is recommended that these buildings not be occupied once summer thaw begins as there is significant potential for foundation failure, should additional settlement occur. They should be inspected by a structural engineer prior to re-occupancy to ensure sufficient safety can be maintained.

Contingency Plan

Develop contingency plan, implementation schedule and scope, structural inspection: $15,000

3.0 APPENDIX

AERIAL PHOTO AND TOPOGRAPHY DATE: 2015
VERTICAL DATUM: NAVD 88

Overbeck, J.R., Hendricks, M.D., and Kinsman, N.E.M., 2016, Photogrammetric digital surface models and orthoimagery for 26 coastal communities of western Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2016-1, 3 p

Overbeck, J.R., 2017, Storm water level feature extraction from digital elevation models using intra-storm photographs: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2017-6, 10 p.

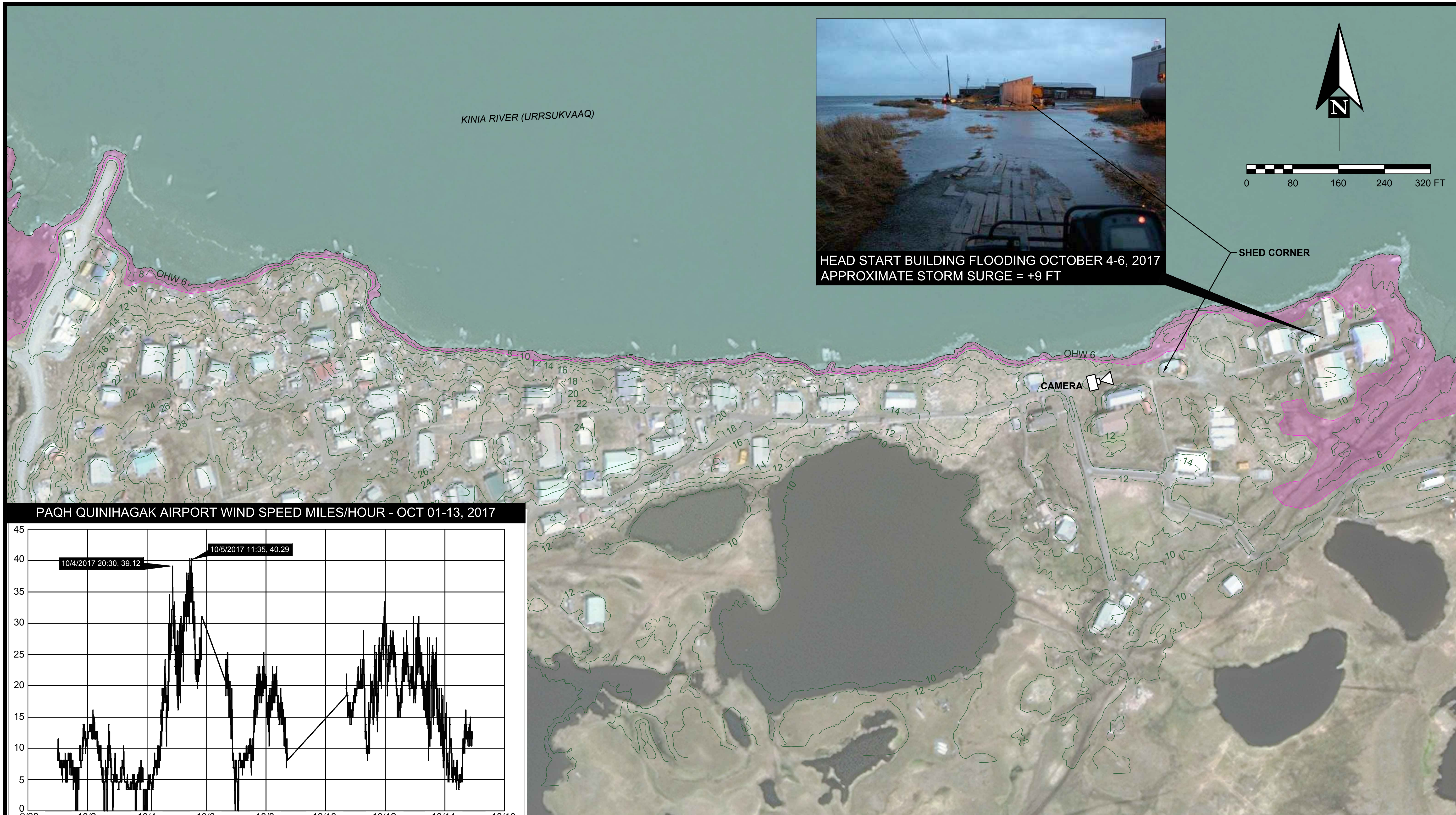
STATE OF ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

PND ENGINEERS, INC.

CHEFORNAK SHORELINE EROSION

1952 COMPARISON

DESIGNED BY: RC	DATE: 3/16/18	**FIG 1**
CHECKED BY: SB	PROJECT NO: 181011	



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CHEFORNAK FLOOD INUNDATION

OCTOBER 4-7, 2017 FLOODING

DESIGNED BY: RC	DATE: 3/16/18	FIG 2
CHECKED BY: SB	PROJECT NO: 181011	

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