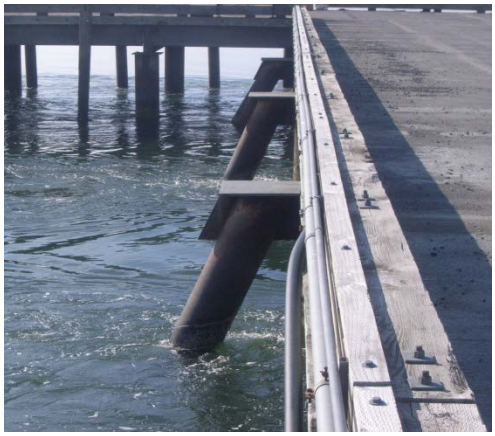

# Nelson Lagoon Coastal Erosion Study

# 20% Preliminary Design Report

Prepared For:

Aleutians East Borough

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November 2015

**PRELIMINARY**

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DATE: July 6, 2015

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# Acronyms and Abbreviations

| | |
|---|---|
| ABM | Articulating Block Mat |
| ADV | Acoustic Doppler Velocimeter |
| AEB | Aleutians East Borough |
| AOS | Apparent Opening Size |
| ASTM | American Society for Testing and Materials |
| ASCE | American Society of Civil Engineers |
| CCA | Chromated Copper Arsenate |
| EM-QAPP | Erosion Monitoring Quality Assurance Program Plan |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |
| HAT | Highest Astronomical Tide |
| HIA | Hazard Impact Assessment |
| in | Inch |
| lb | Pound |
| Metocean | Meteorologic and Oceanographic |
| MHW | Mean High Water |
| MHHW | Mean Higher High Water |
| MLW | Mean Low Water |
| MLLW | Mean Lower Low Water |
| MSL | Mean Sea Level |
| NAD | North American Datum |
| NAVD | North American Vertical Datum |
| NOAA | National Oceanic and Atmospheric Administration |
| PCF | Pounds per Cubic Foot |

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# 1 Introduction

The Aleutians East Borough (AEB) and the community of Nelson Lagoon recognize the threat posed by ongoing erosion at Nelson Lagoon and the need for taking action to minimize erosion impacts on the community. In support of these efforts, the AEB has hired HDR to conduct a coastal erosion study for Nelson Lagoon. The study included several aspects, including numerical hydrodynamic modeling (HDR 2014a and 2014b), updated aerial photography, a shoreline monitoring survey, and 20% preliminary design of three shoreline protection alternatives. This report includes a summary of recent work regarding coastal erosion in Nelson Lagoon, the alternative selection process, and the design of the selected alternatives.

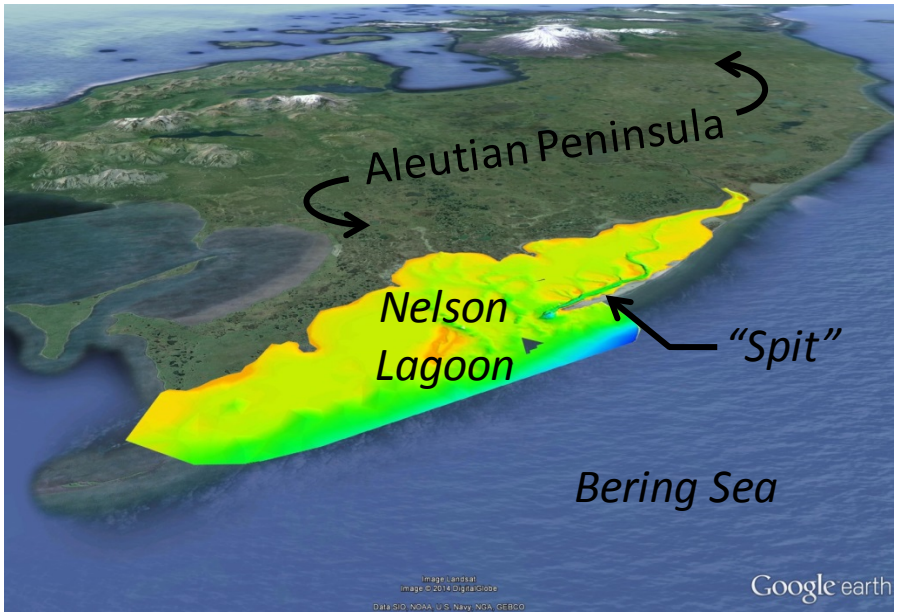


**Figure 1.1 Three-dimensional rendering of the seafloor of Nelson Lagoon.**

# 2 Summary of Previous Work

The following discussion provides a summary of HDR's previous work regarding the erosion issue at Nelson Lagoon.

## 2.1 Hazard Impact Analysis

HDR developed a hazard impact analysis (HIA) for the community of Nelson Lagoon (HDR 2011). This study, funded by a grant to the AEB, covered a broad range of hazards that may affect the community of Nelson Lagoon and helped determine which hazards warranted immediate attention. Of the hazards reviewed, shoreline erosion was determined to be a priority.

## 2.2 Erosion Monitoring-Quality Assurance Project Plan

Shoreline monitoring is an important aspect of managing a coastline that is adjacent to a community or valuable infrastructure. This monitoring is needed to help track changes to, and document the overall

condition of, the shoreline. Monitoring collects valuable data such as the rate of accretion and/or erosion due to chronic conditions and episodic events. Monitoring can also determine priority of areas in need of shoreline protection and how soon an area needs protection. In addition, community planning is greatly benefited by a better understanding of the shoreline change trends.

Unfortunately, conventional shoreline monitoring using annual surveying would be cost prohibitive for the community. Therefore, HDR developed an Erosion Monitoring – Quality Assurance Project Plan (EM-QAPP) that provides a relatively simple, cost-effective way for the community to perform the needed shoreline monitoring. The data collected using the program can be used later for shoreline change analyses.

## 2.3 Data Collection

HDR deployed two Acoustic Doppler Velocimeters (ADVs) along the Nelson Lagoon shoreline for a month during late fall 2012. The ADV instruments measured tidal currents and wave heights. This data were used to help develop hydrodynamic and wave numerical models.

## 2.4 Numerical Modeling

HDR developed hydrodynamic numerical models of waves and currents for Nelson Lagoon. The models simulated currents throughout Nelson Lagoon from tidal movements as well as wave heights within Nelson Lagoon from strong winds. These models provided a better understanding of the primary mechanisms causing shoreline erosion and supported engineering design. HDR provided model setup and results in two technical memorandums to AEB (HDR 2014a and HDR 2014b).

# 3 Metocean Data Gathering

HDR updated meteorologic and oceanographic (metocean) data previously gathered for the Nelson Lagoon HIA (HDR 2011) and used it to support the numerical modeling effort (HDR 2014a and HDR 2014b) and 20% preliminary design. The following provides updated metocean data for Nelson Lagoon. Figure 3.1 shows the location of the existing National Oceanic and Atmospheric Administration (NOAA) data collection station at Port Moller, Alaska.

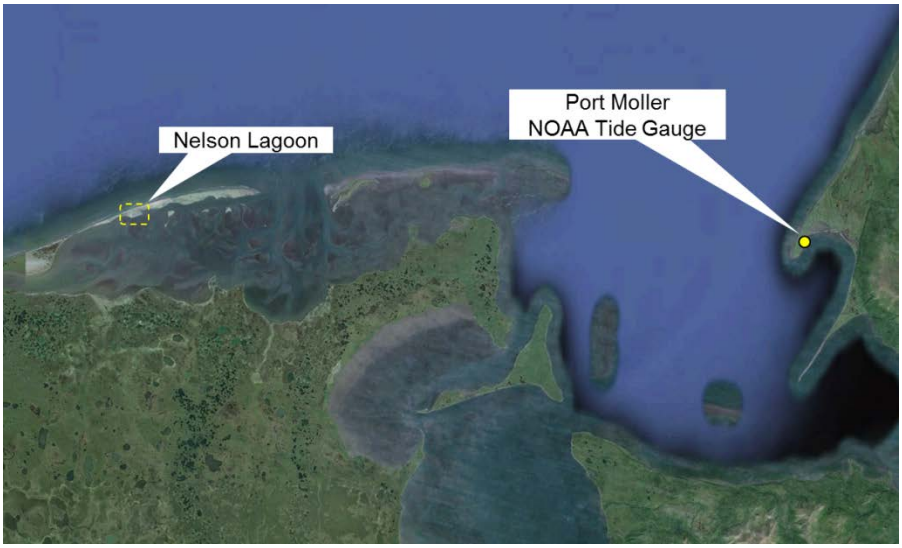


**Figure 3.1 Location of NOAA Port Moller data collection gauge.**

## 3.1 Wind

Extreme wind statistics for coastal areas within the United States are available from the American Society of Civil Engineers (ASCE; 2010). For the Nelson Lagoon region, wind speed is plotted as a function of return period as shown in Figure 3.2. Both 20-minute average and 3-second gust wind speeds are shown for comparison. The 20-minute average duration wind speeds for 5-, 10-, 25-, 50-, and 100-year return period events were applied in the numerical wave model discussed in greater detail in *Nelson Lagoon Coastal Erosion Study Numerical Wave Model Technical Memorandum* (HDR 2014b).

The nearest location having readily-available wind data is Port Moller (NOAA 2014), which is approximately 20 miles east of Nelson Lagoon (Figure 3.1). Wind data from this location is only available from 2009 to present. Figure 3.3 shows a wind rose developed from the Port Moller data from October 2009 to October 2013. Wind roses provide a graphical means of describing the intensity and direction of wind. The wind speed shown in Figure 3.3 represents the 20-minute average.

From Figure 3.3, it can be seen that the majority of the wind during this duration came from the north and southeast, with the majority of the fastest winds coming from the southeast.

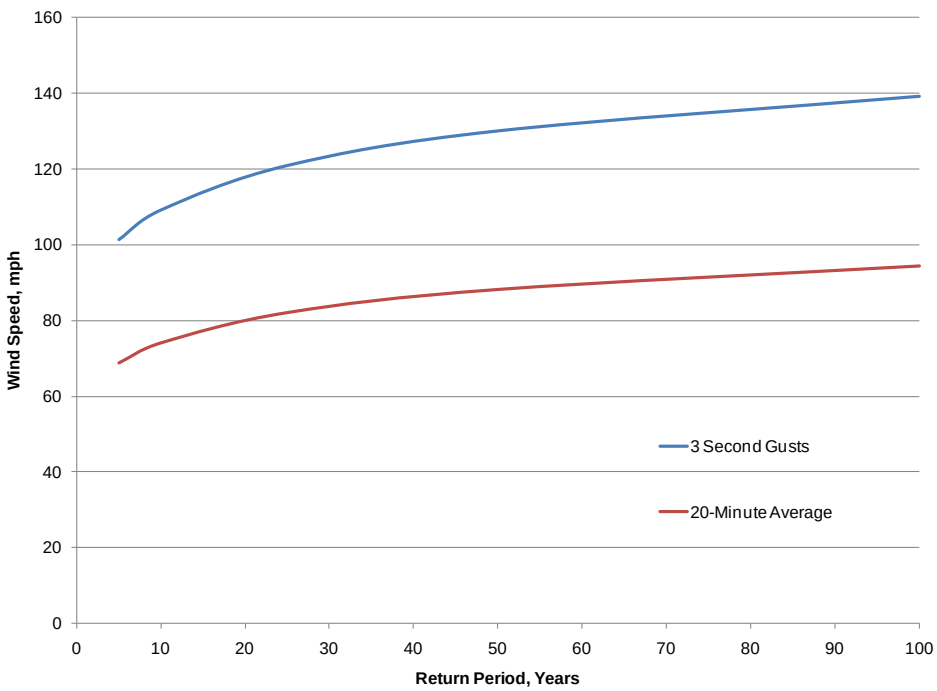


**Figure 3.2 Extreme wind speed based on return period (ASCE 2010).**

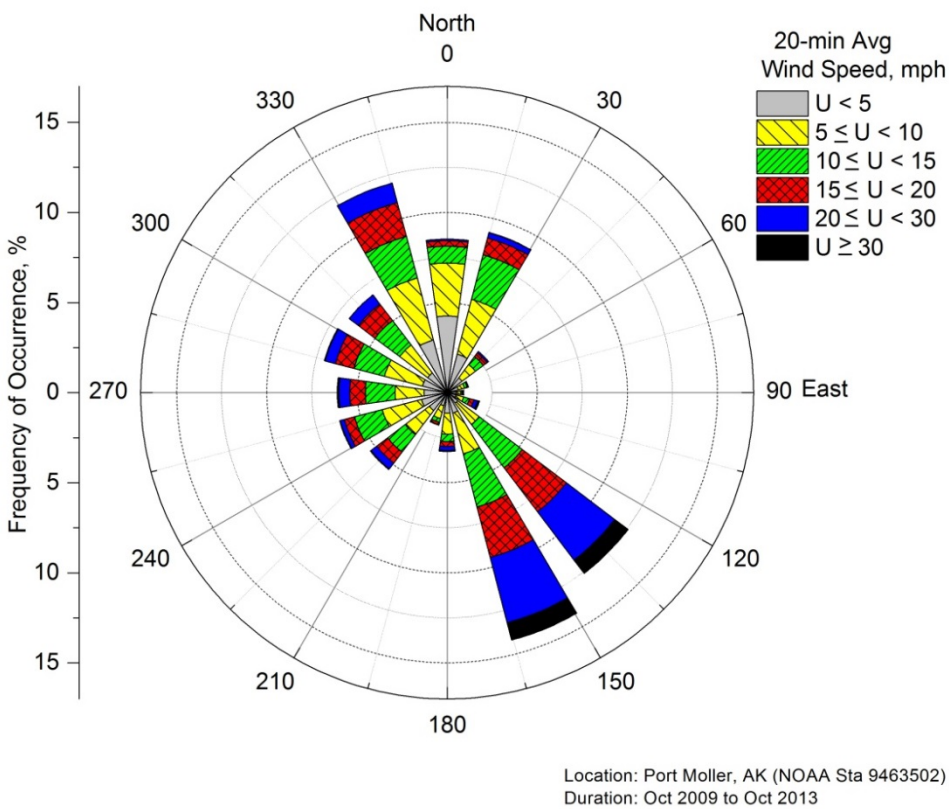


**Figure 3.3 Wind rose for Port Moller, October 2009 to October 2013 (NOAA 2014).**

## 3.2 Water Level

Table 3.1 shows the tidal datums[1] relative to Mean Lower Low Water[2] (MLLW) at Port Moller (NOAA 2014). Also included is the relationship to the North American Vertical Datum of 1988 (NAVD 88). This relationship is based on observations made by USKH during October 2013. The greater diurnal tide range[3] is approximately 10.5 feet. Using data gathered from the Port Moller Gauge between 2007 and 2011, Figure 3.4 shows the water level at Port Moller as a percent of time exceeded with the tidal datums superimposed as vertical lines.

**Table 3.1 Tidal datums at Port Moller.**

| Tidal Datum | Elevation with respect to MLLW (feet) |
|---|---|
| Mean Higher High Water (MHHW) | 10.4 |
| Mean High Water (MHW) | 9.6 |
| Mean Sea Level (MSL) | 5.8 |
| Mean Low Water (MLW) | 2.2 |
| Mean Lower Low Water (MLLW) | 0 |
| Highest Astronomical Tide (HAT) | 12.6 |
| North American Vertical Datum of 1988 (NAVD 88) | 3.1 |

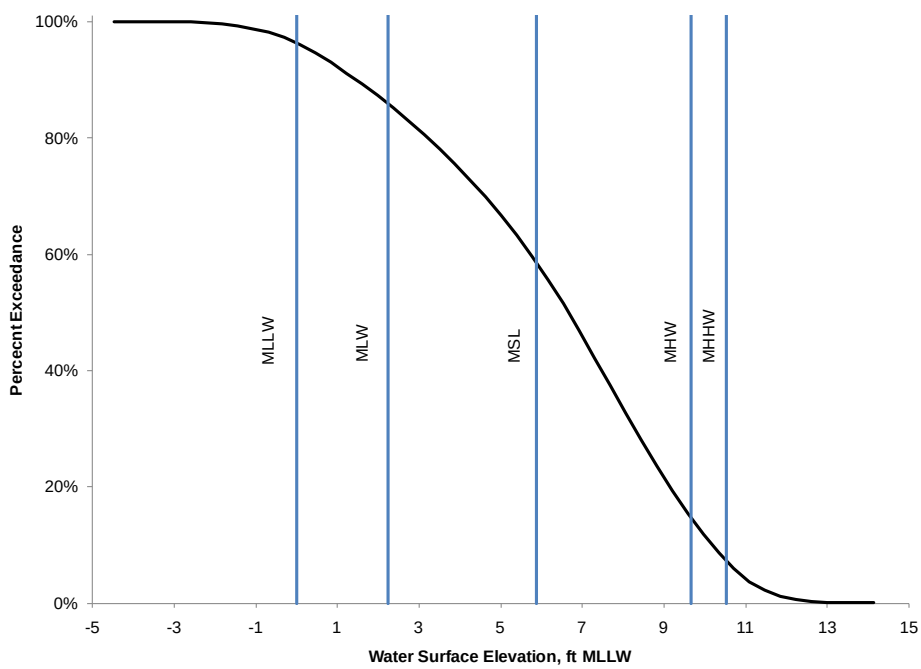


**Figure 3.4 Water level exceedance at Port Moller (HDR 2011).**

[1] A tidal datum is a standard elevation defined by a certain phase of the tide. They are used as references to measure local water levels.
[2] MLLW is the average of the lower low water height of each tidal day observed over a specific 19-year Metonic cycle.
[3] Greater diurnal tide range is defined as the difference in the MHHW and MLLW tidal datums.

## 3.3 Waves in Nelson Lagoon

Waves within Nelson Lagoon were calculated using a numerical wave model. Model setup and results are documented in *Nelson Lagoon Coastal Erosion Study Numerical Wave Model Technical Memorandum* (HDR 2014b). As previously discussed, wind speed was varied within the model to assess wave heights during different return period wind events. During the 100-year return period wind event, wave heights reached over 3 feet in height in deeper, less restricted portions of Nelson Lagoon. Wave heights immediately adjacent to the community reached 1 to 2 feet. Figure 3.5 shows an example of the model results for wave height.

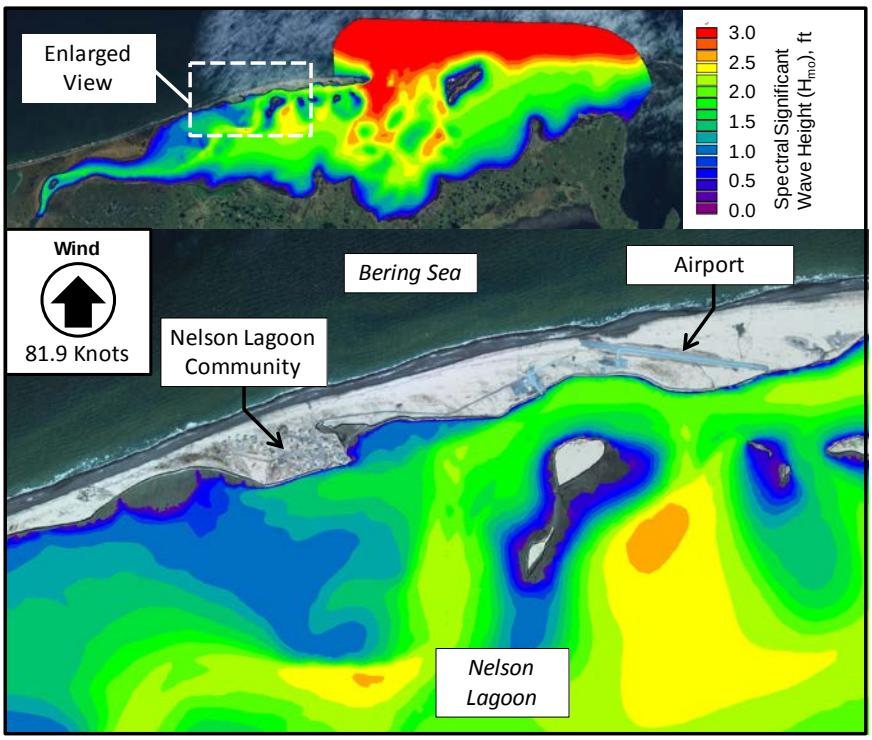


**Figure 3.5 Wave model results: 100-year wind event (81.9 knots), wind direction 180 degrees, water elevation 0 MHHW (HDR 2014b).**

## 3.4 Currents in Nelson Lagoon

HDR calculated currents (due to the large tide swings) within Nelson Lagoon using a hydrodynamic numerical model. Model setup and results are documented in *Nelson Lagoon Coastal Erosion Study Numerical Hydrodynamic Model Technical Memorandum* (HDR 2014a). It was found that strong currents occurred particularly within the natural channel (or river as commonly referred to by local residents) during incoming and outgoing tides. These currents could reach over 3.5 knots. However, next to the community it was found that currents were generally very low during all phases of the tide, with currents reaching just over 0.5 knots. Thus, the 20% design focuses primarily on protecting the community against wave attack. Figure 3.6 shows an example of the model results for currents.

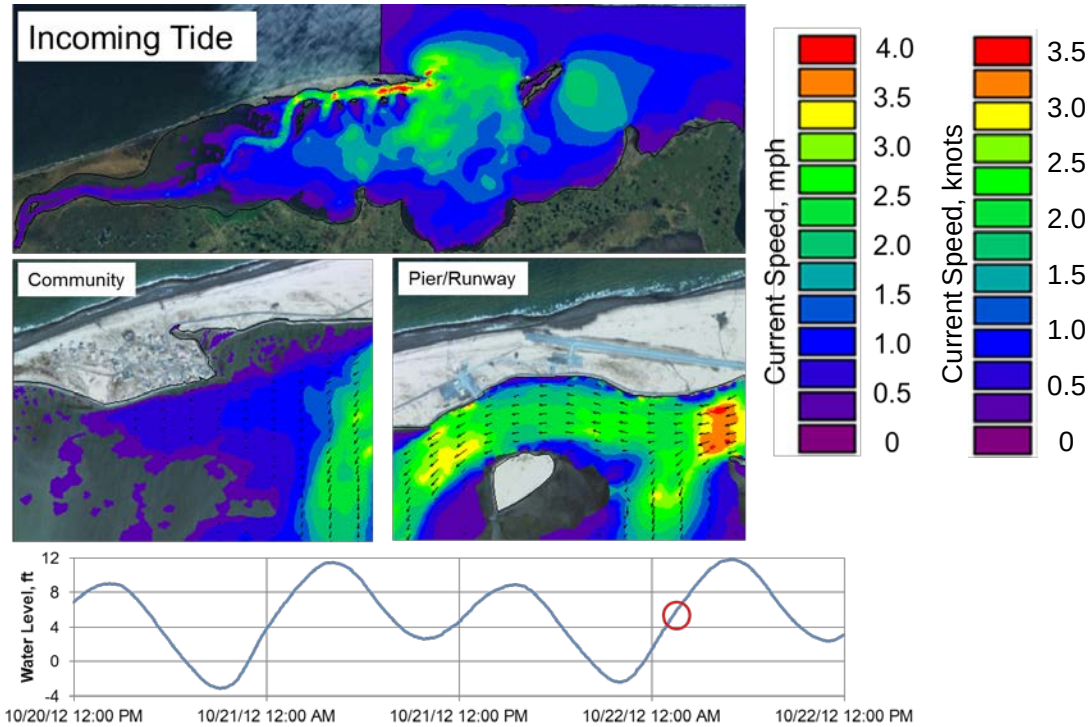


**Figure 3.6 Hydrodynamic model results during an incoming tide.**

# 4 Shoreline Erosion Mapping

HDR delineated historical shorelines of Nelson Lagoon by georeferencing the historical aerial imagery, then digitizing the shoreline based on the vegetation line along the coastline. Available historical aerial imagery covered the years 1972, 1983, 1997, and 2001. Aerial photography was also obtained in 2013 for this project. The historical shoreline mapping was used to develop a shoreline projection for 2068. The projection shows that areas with the highest risk are the townsite and the dock/airport. Shoreline erosion mapping is discussed in greater detail in the *Nelson Lagoon Coastal Erosion Study Historical Shoreline Map Report* (HDR 2014c).

# 5 Alternatives Analysis

HDR considered several shoreline protection concepts for Nelson Lagoon and presented them to the community during a public meeting held in April 2014. The following section outlines these concepts.

## 5.1 Sheetpile Wall

A sheetpile wall is vertical structure that acts as retaining wall on the landward side and protects the shoreline from waves and currents (see Figure 5.1). These walls are generally made of interlocking sheets of steel that are driven deep into the ground. A sheetpile wall is already in use at the Nelson Lagoon pier and was observed to be in good condition.

Sheetpile walls, when designed properly, are very strong, have a long lifespan, and require very little maintenance. However, they typically have a very high initial cost. Sheetpile walls require a specialized contractor, which means the community would not be able to save on costs by constructing the structure themselves. The steel used to construct the wall would need to be shipped in, which would further contribute to the high cost. Sheetpile walls also tend to have more environmental impacts. It can also take up to several years to design and permit a sheetpile wall.

**Figure 5.1 Example of a sheetpile wall.**

## 5.2 Armor Stone Revetment

An armor stone revetment is a sloped structure that is placed directly along the shoreline (see Figure 5.2). The material making up the revetment is quarried stone sized specifically to handle the waves and currents expected at the site. The advantage of an armor stone revetment is that, when designed properly, they are very resilient, have a long lifespan, and require very little maintenance. However, similar to a sheetpile wall, an armor stone revetment is likely to have a very high initial cost. The material required for an armor stone revetment is not locally available and would need to be shipped in, attributing to the high initial cost.

**Figure 5.2 Example of an armor stone revetment.**

## 5.3 Gabion Basket/Mattress Revetment

A gabion basket revetment (or gabion mattress revetment) is a structure placed directly on the shoreline comprised of wire mesh, rectangular baskets (called gabion baskets) that are filled with small stone and sealed off (see Figure 5.3). The mattress version is a larger, flatter version of the gabion basket that can be draped on the shoreline, taking the shape of the existing grade. Individual baskets are tied with wire to surrounding baskets to create a solid structure. Gabion baskets are a good alternative to an armor stone revetment when larger armor stone is not readily available.

When designed properly, a gabion basket revetment is very resilient, has a long lifespan if stainless steel or covered galvanized steel is used, and requires maintenance only when wires are damaged. They typically require a lesser amount of stone than a typical armor stone revetment. Gabion baskets are a more cost-effective solution than other types of shoreline protection.

Gabion baskets require small stones, which appear readily available at Nelson Lagoon, but not necessarily in large quantities. Importing stone would make this concept cost prohibitive.

**Figure 5.3 Example of a gabion basket revetment.**

## 5.4 Articulating Block Mat Revetment

An articulating block mat (ABM) revetment is a structure placed directly along the shoreline that is made up of concrete blocks (see Figure 5.4). The individual blocks that make up the ABM typically have a shape that interlocks them with each other like puzzle pieces and/or are tied together through cables that run through the blocks. The connection between the blocks allows for a moderate amount of movement, which allows the full ABM structure to "articulate" and contour to the foundation of the structure.

An ABM revetment requires much less construction material than other concepts. Once a foundation has been graded, the individual blocks can be placed by hand. An ABM revetment would have a high initial cost as all of the concrete block material and cabling would need to be shipped in. Geotextile fabric would need to be placed below the ABM revetment to reduce the potential for undermining.

**Figure 5.4 Example of an articulating block mat revetment under construction.**

## 5.5 Geotextile Tube

A geotextile tube is a long tube (typically ranging from 50 feet to 300 feet) made of strong geotextile fabric (see Figure 5.5). The tube is filled hydraulically with slurry (sand-water mixture). The fabric is porous enough to allow water to escape but still contain the sand. A geotextile tube is already in use near the Nelson Lagoon pier and appears to be performing well (see Figure 5.6). In general, geotextile tubes are a lower-cost alternative to more permanent shoreline protection structures. The equipment required to fill the geotextile tube (dredge or large pump) may make this concept cost prohibitive due to the remoteness of Nelson Lagoon. There may be environmental and permitting issues depending on the sources of the sand. In addition, geotextile tubes are not as resilient as other shoreline protection concepts; one tear in the tube can compromise the entire structure.

**Figure 5.5 Example of a geotextile tube.**

**Figure 5.6 Geotextile tube in Nelson Lagoon.**

## 5.6 Concrete Bag Revetment

A concrete bag revetment is a structure placed directly on the shoreline made of ready-mix concrete bags (see Figure 5.7). The bag placement creates a stable structure. Water, either from the adjacent water body, from natural rainfall, or purposely added during construction, penetrates the ready-mix bags and hardens the concrete in-place in the shape of the bags. The bags are either removed by hand

or through natural weathering, creating a brick-concrete look. Concrete bag revetments are relatively easy to construct. Most of the structure can be built by hand if required and is typically fairly resilient. It would be costly to construct a concrete bag revetment in Nelson Lagoon because all of the material would need to be shipped in. In addition, as the concrete begins to wear and break, it is difficult to repair.

**Figure 5.7 Example of a concrete bag revetment.**

## 5.7 Timber Seawall

A timber seawall is a vertical structure that acts as retaining wall on the landward side and protects the shoreline from waves and current (see Figure 5.8). Timber seawalls are made of dimensional lumber and can be designed in a variety of manners (e.g., cantilevered wall, anchored wall, batter pile wall). A timber seawall is already in place at Nelson Lagoon, although it was observed to be in poor condition. Despite its current condition, it has been the primary protection for the community for almost three decades, making it a very successful structure. In general, a timber seawall is not considered a highly resilient structure; however, the existing seawall has performed very well. Wood does not require a specialized contractor as compared to steel, and it is possible that a timber seawall could be constructed by local residents. All of the material for a timber seawall would need to be shipped in, which gives this concept a high initial cost. A new timber seawall design would need to be more resilient to undermining and would require more challenging construction techniques than the existing structure.

**Figure 5.8 Timber seawall in Nelson Lagoon.**

## 5.8 Beach Nourishment

Beach nourishment is simply the placement of additional sand along an eroding beach (see Figure 5.9). For a naturally sandy beach, this is the most natural way of protecting a shoreline. A large amount of sand is placed parallel to the shoreline to match the existing grade. Generally, the sand is either graded to slope down to the original beach or the wave action is large enough that the placed sand naturally forms a sloping beach. Sand found in Nelson Lagoon could be used for this approach, so the only costs would be the labor and equipment used to transport the material to the site and for grading. This is the most natural form of shoreline protection for the site.

However, beach nourishment provides temporary protection. Shoreline erosion will continue, requiring the beach to be nourished again and again. The interval between nourishments largely depends on the size of the original nourishment and the amount of storm activity. This concept, while a very natural solution, may not be as favorable to resource agencies as it has a large footprint. Depending on the source of the sand, there may be environmental or permitting issues to address.

**Figure 5.9 Example of beach nourishment.**

## 5.9 Geotextile Containers

Geotextile containers are essentially large engineered sand bags (see Figure 5.10). The containers are constructed with geotextile fabric very similar to the type used to construct geotextile tubes. Differing from the geotextile tubes, the containers are small enough that they can be mechanically filled offsite and then transported to the site. Despite being more portable than a geotextile tube, the containers are still extremely heavy and require heavy equipment to transport them. One advantage of geotextile containers is that unlike the geotextile tubes, if a single geotextile container is damaged, that container is easily replaced; the entire structure would not need to be replaced. This concept uses mostly sand, which is an abundantly available local resource in Nelson Lagoon. The geotextile containers themselves would need to be purchased and shipped to Nelson Lagoon.

**Figure 5.10 Example of a geotextile container wall.**

## 5.10 Reasonable Alternatives

The identification of reasonable alternatives was based on three factors: community input, initial capital cost, and constructability using existing equipment and local labor.

Many of the concepts presented at the public meeting were not considered for further development because of their relatively high cost. Being located in such a remote area of Alaska, any concept that requires a significant amount of material to be shipped in and/or requires a specialized contractor was considered cost prohibitive. The sheetpile wall and armor stone revetment, which are widely-used conventional methods of shoreline protection, require both a significant amount of material and a specialized contractor, and thus were not considered for further development. The articulating block mat revetment and concrete bag revetment would require a significant amount of material (large overall weight) being shipped in and were not considered for further development. The geotextile tube, while generally considered a lower-cost structure, would still require some specialized equipment (i.e., a dredge or heavy duty pump) that would likely make this concept too expensive. The geotextile tube that was constructed near the pier was reported to cost approximately $200,000 for one tube. Multiple tubes would be required to protect the community. The beach nourishment concept, while potentially very cost effective, was not desired by the community as it seen as a temporary solution requiring routine maintenance.

The geotextile container and gabion mattress revetment concepts were carried forward because they require a lesser amount of material being shipped in and could use mostly natural, locally-available resources (e.g., sand and cobble). In addition, both of these concepts can be constructed using labor from the community. The geotextile container option would require use of heavy equipment already owned by the community. The gabion basket revetment could be constructed almost entirely by hand.

The timber seawall was also seen favorably because it was recognized that the existing timber seawall has performed very well. It was also noted that the portions of the seawall that included gabion baskets at its base performed better than portions that did not. Thus, the timber seawall concept with a gabion basket scour pad was requested for further consideration.

The three alternatives carried forward for preliminary design were based on feedback received from Nelson Lagoon residents, initial capital costs, and ability to be constructed using local labor and resources, and included:

1) Geotextile Containers
2) Gabion Mattress Revetment
3) Timber Seawall with Gabion Scour Pad

# 6 Preliminary Design

The following section discusses preliminary design for shoreline protection structures at Nelson Lagoon. A 20% preliminary construction drawing set was prepared to accompany this report.

## 6.1 Preliminary Design Criteria

This section provides a list of preliminary design criteria for the Nelson Lagoon shoreline protection structure.

Preliminary Design Criteria

- Attenuate significant wave energy to help protect the community from erosion during storm impacts on the Nelson Lagoon side
- Withstand wave and/or current impacts from a 100-year storm event or be easily repaired if damaged during a large storm event
- Be constructible using primarily local labor and locally available equipment
- Require no or minimal specialized construction experience

All three alternatives carried forward to the preliminary design phase would meet these criteria if adequately designed and constructed.

## 6.2 Geotextile Container Revetment Design

*Description* – As discussed in Section 5.9, geotextile containers are large bags fabricated from high strength geotextile fabric that is filled with sand or gravel. The fabric needs to be woven tightly enough to prevent sand from escaping and strong enough to withstand the pressure of the sand within the container. The basic construction concept is as follows. Geotextile containers would be fabricated with all but one side of the container sewn shut. Material from a designated borrow area would be used to fill the bags on site. Based on discussions with the community, the Nelson Lagoon Corporation borrow pit, located within the village, may be a viable source of material. Once the containers are filled, the final seam would be sewn closed on site to completely seal them. The sealed containers would then be

transported to the project area and laid in a pre-specified pattern. Special hoses and pumps are not necessarily required if the filling is done mechanically. To fill the bags mechanically, a forklift or a fabricated hopper[4] would hold the bag open. Using a front-loader or similar machine, sand/gravel would be loaded into a fabricated hopper, which would be used to fill the bags. Each bag would then be sewn closed according to manufacturer specifications. Once the bags are closed, a variety of heavy machinery could be used to transport them to the project area.

*Container Dimensions* – The container dimensions initially considered are 5 feet wide by 9 feet long. Once filled, these containers are estimated to be approximately 4.5 feet wide, 8.5 feet long, and 2.25 feet tall (Figure 6.1). The actual dimension of the containers should be verified by the fabricator to ensure the container seams and fabric can withstand the weight of the sand as well as be transportable. These containers often are manufactured with two straps to help with filling and transport.

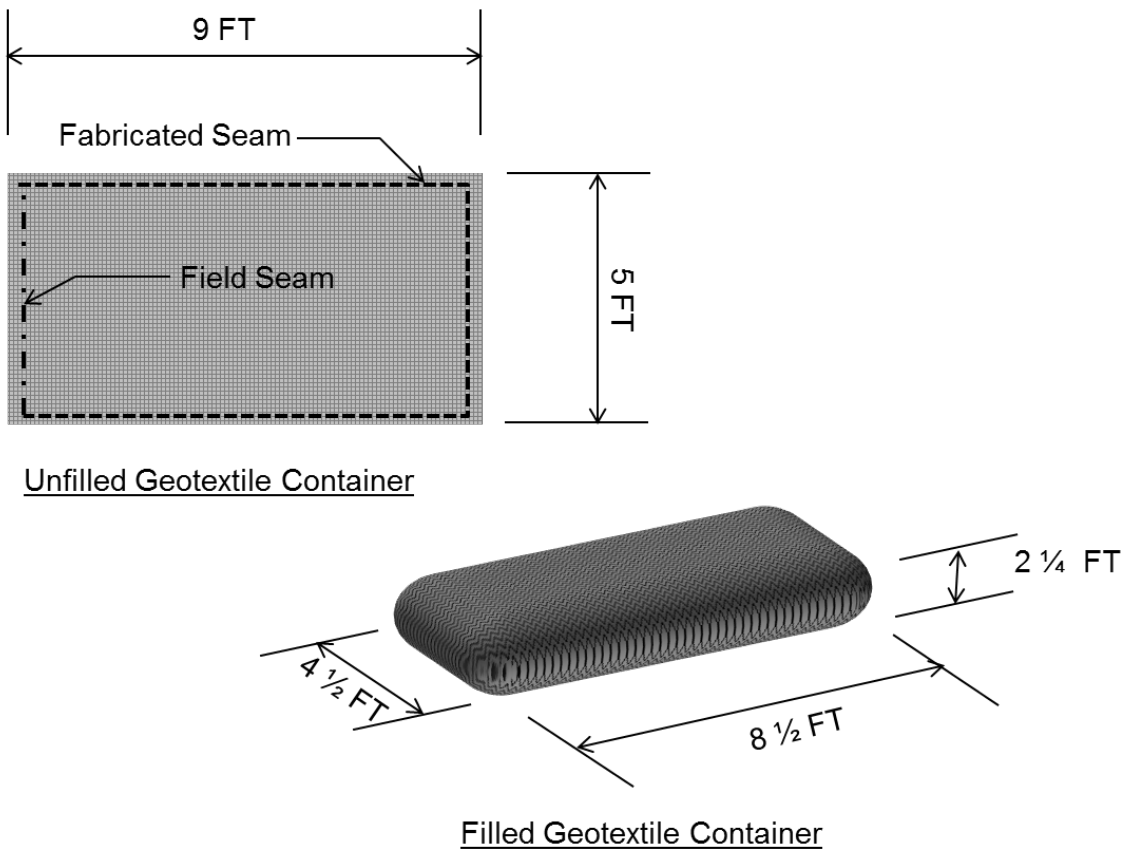


**Figure 6.1 Geotextile container schematic.**

[4] A hopper is a container for bulk materials such as grain, rock, or trash. Typically, it tapers downward and discharges its contents from the bottom.

*Container Cross-Section* – The containers should be placed in a cross-section promoting hydraulic and geotechnical stability. Schematics of recommended cross-section configurations are shown in Figure 6.2. These configurations would make the overall structure relatively stable and would not require backfill to support the structure. In addition, the containers are recommended to be placed with staggered joints (similar to how bricks are laid) to provide better interlocking between containers.

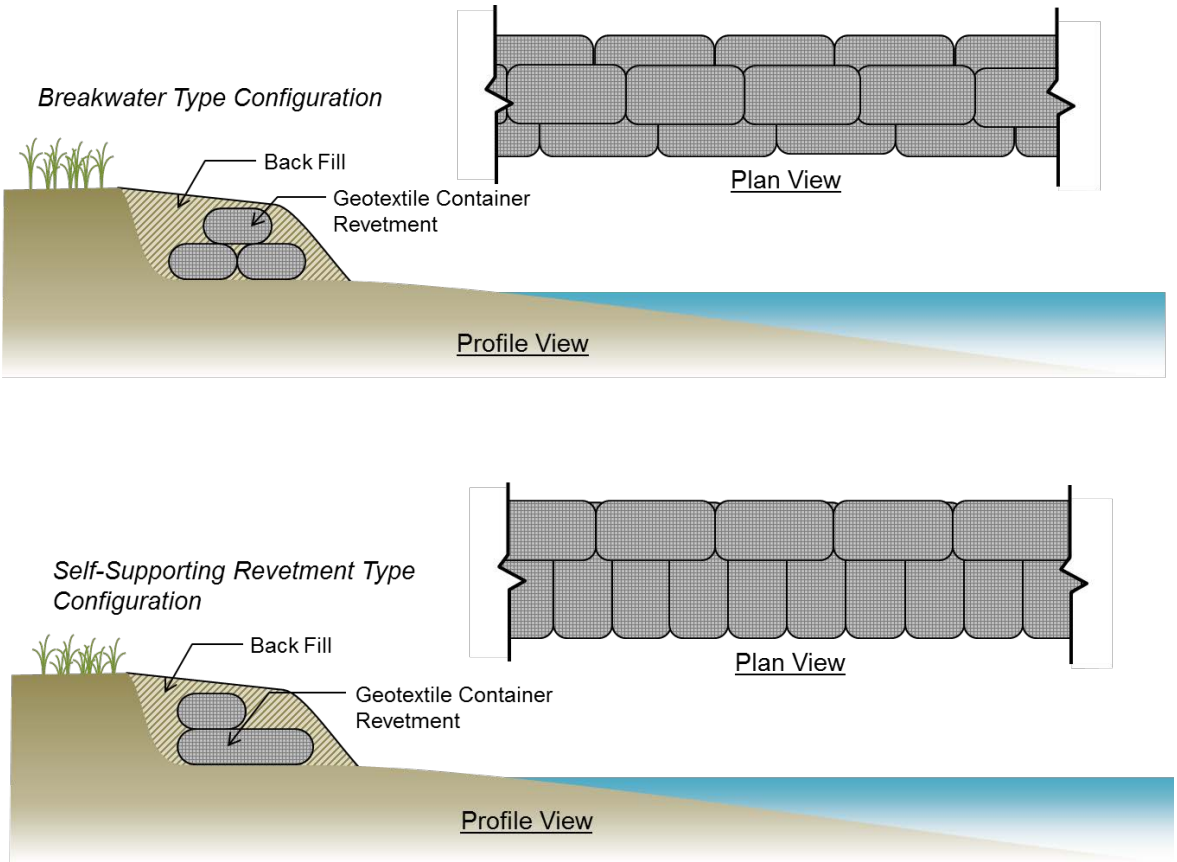


**Figure 6.2 Geotextile container revetment configurations (profile and plan view).**

*Revetment Layout* – The alignment of the revetment should follow the shoreline closely but remain as straight as practicable. Sharp changes in the alignment can focus wave energy and create weak points. The structure may be below the high tide line because it needs to be seaward of the vegetation line. By being placed as close to the vegetation line as possible (i.e., as far landward as possible), the amount of the structure below the high tide line will be reduced. In addition, it is recommended that the revetment be as continuous as possible because the primary mechanism for erosion along the Nelson Lagoon shoreline is wave impacts. Providing gaps or baffling in the revetment would allow wave energy through the gaps, and shoreline erosion would continue to occur. For this same reason, it is recommended to limit the number of beach access points through the revetment. The initial (preliminary) design included two beach access points: one on the south side and one on the east side. However, based on input provided at a public meeting on May 26, 2015, it was decided that the revetment should be designed to be a continuous structure because of the potential for increased erosion at the gaps.

A schematic showing two possible approaches for terminating the revetment at end points is shown in Figure 6.3. Both methods have their advantages and disadvantages. The benefit of keying in the revetment is that it may provide a more stable transition between the revetment and natural shoreline. The disadvantage is that it requires excavating material and vegetation from the existing shoreline and then backfilling. In addition, the remainder of the structure should be backfilled so that collection of water on the landward side of the structure is reduced. The benefit of simply ending the structure is ease of construction. The disadvantage would be that the unprotected shoreline adjacent to the terminations would have greater potential for erosion due to the focusing of wave energy. Based on feedback during a public meeting held on May 26, 2015, it was determined that a keyed-in terminal is preferred by the community.

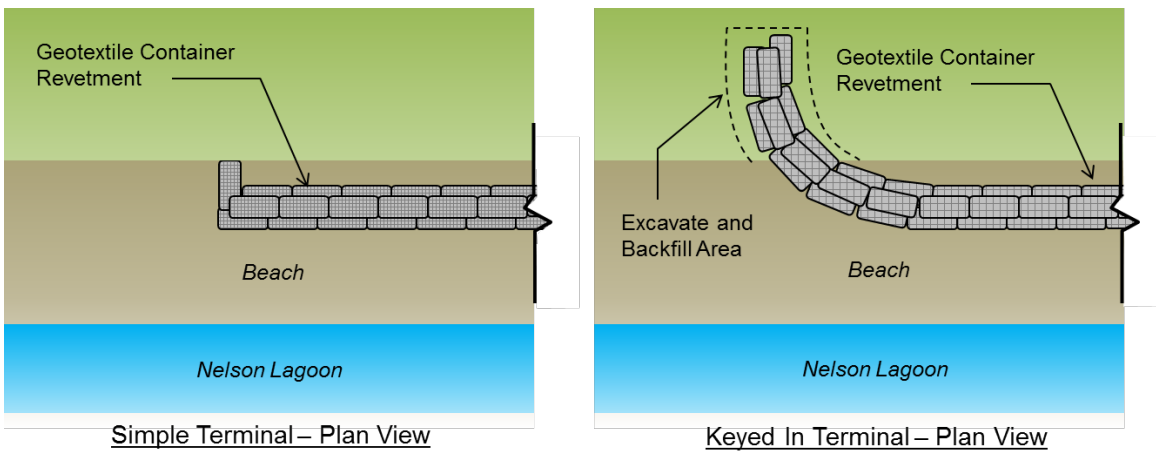


**Figure 6.3 Optional revetment terminal configurations.**

*Geotextile Material* – As previously discussed, the geotextile container material needs to be strong enough to withstand the weight of the sand when filled and be woven tight enough so that sand does not escape through the fabric. Table 6.1 provides recommended geotextile fabric specifications.

**Table 6.1 Geotextile fabric physical properties.**

| Physical Properties | Unit | Test Method | Measure | |
|---|---|---|---|---|
| | | | Type 1 - Geotextile Container | Type 2 - Scour Apron* |
| Apparent Opening Size (AOS) (minimum) | U.S. Sieve | ASTM D 4571 | #30 | #30 |
| CBR Puncture Strength (minimum) | lb | ASTM D 6241 | 2,400 | 700 |
| Trapezoid Tear Strength (MD x CD) (minimum) | lb | ASTM D 4533 | 180 x 180 | 100 x 100 |

| | | | | |
|---|---|---|---|---|
| Wide-Width Tensile Strength (MD x CD)(minimum) | lb /in | ASTM D 4595 | 1,000 x 1,000 | - |
| Wide-Width Tensile Elongation (MD x CD) (maximum) | % | ASTM D 4595 | 20 x 20 | - |
| Seam Strength (minimum) | lb /in | ASTM D 4884 | 500 | - |
| Ultraviolet Resistance (500 Hours) (minimum) | % | ASTM D 4355 | 70 | 70 |

* See following text for a description of scour aprons.
Notes: ASTM = American Society for Testing and Materials, lb = pound, in = inch

*Scour Protection* – It is also recommended that the geotextile containers be placed on some form of scour apron, which is commonly another layer of geotextile fabric. The apron fabric does not need to be as strong as the fabric used for the geotextile containers. To keep the scour apron in place, the fabric should be keyed into the existing grade as shown in Figure 6.4.

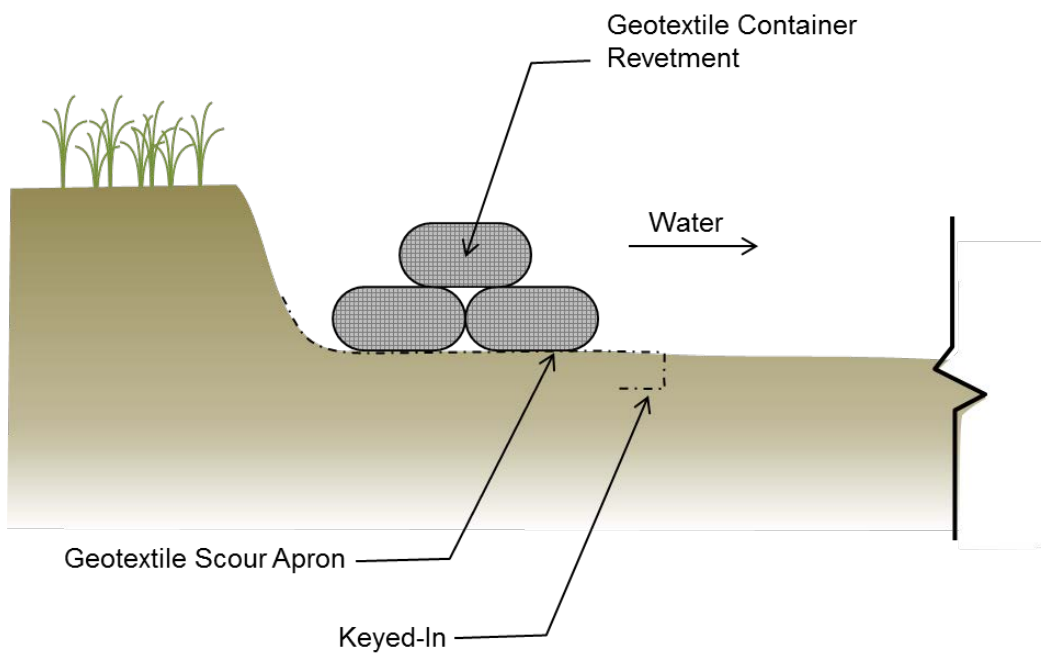


**Figure 6.4 Scour apron for geotextile container revetment**

Companies with the ability to manufacture/fabricate geotextile containers include, but are not limited to, the following:

- Industrial Fabrics (225) 273-9600
- Flint Industries (912) 685-3375

*Construction Considerations* – The containers can be filled in a variety of ways. For ease of construction and cost, it is recommended the containers be filled mechanically. This would likely require the containers to be filled at the borrow area and then transported to the project area. Another option is to hydraulically fill the containers. If resource agencies allow material to be mined in the water near the project area, this would involve a relatively straightforward method in which a mixture of sediment and water would be pumped from the seafloor and then discharged directly into the containers. However, mining material near the site is not recommended for both environmental reasons and the potential to create deeper water near the project area. Another way to hydraulically fill the containers is to construct a temporary overhead container (or "hopper," similar to a funnel) to hold the fill sand. Within this container, the sand would be slurried (mixed with water) and then discharged into the geotextile containers. This would be a slightly more complicated construction process.

With the exception of one portion, the existing seawall would need to be removed, as well as any debris along the shoreline. Debris can easily puncture the geotextile fabric, damaging the structure. The portion of the existing seawall that is recommended to remain is shown in Figure 6.5. Removal of this portion of the seawall could potentially undermine and damage the nearby structures.

**Figure 6.5 Portion of existing seawall recommended to remain in place.**

If possible, the revetment should be backfilled and covered with sand once completed (see Figure 6.2). This would provide an additional layer of protection to the shoreline and increase the longevity of the geotextile containers by reducing exposure to ultraviolet degradation from sunlight. In addition, natural vegetation will have an opportunity to grow, which will also help reduce erosion and provide a more natural appearing shoreline.

*Ice Impacts* – A common concern with structures made of geotextile fabric (i.e., geotextile containers, geotextile tubes) is damage from ice impacts such as ice shoving, freeze/thaw, ice debris during run off, etc. However, many geotextile fabric structures have been constructed in areas that experience ice and have performed well such as the geotextile tube at Nelson Lagoon. Structures made of geotextile fabric may perform well in icy conditions because ice forms directly on the fabric as the temperatures go below freezing. As additional water comes into contact with the fabric from wave action or rain/snow, it adds more layers of ice that act as a protective layer. In any case, the fabric is required to be strong enough to support the weight of the sand and be transportable. Using high-strength fabric will help increase longevity of the containers. In addition, if ice damages a container, individual containers can be easily replaced.

## 6.3 Gabion Mattress Revetment Design

*Description* – As previously described in Section 5.3, a gabion mattress revetment is a shoreline protection structure made of wire mesh formed into the shape of a mattress (slab-like) that retains stones. The basic construction concept would be to prepare the subgrade by bringing in sand fill along the shoreline to create a smooth slope. The gabion mattress would then be laid on the prepared subgrade. Mattress segments would be fastened to each other to create a continuous revetment. The gabion mattresses can be positioned unfilled or filled. To fill the gabion mattress, small stones or cobble would be placed in its compartments and then the top wire mesh piece would be fastened to the sides to contain the stones.

*Mattress Dimensions* – The initial mattress dimensions for the revetment are 24 feet wide by 6 feet long by 1.5 feet tall (Figure 6.6). This corresponds to the Maccaferri®, a gabion mattress manufacturer, standard manufactured size. However, the mattress size is subject to change based on the selected manufacturer and construction technique. While much more labor intensive, individual gabion baskets (defined in Section 5.3) could be used as a substitute for a mattress.

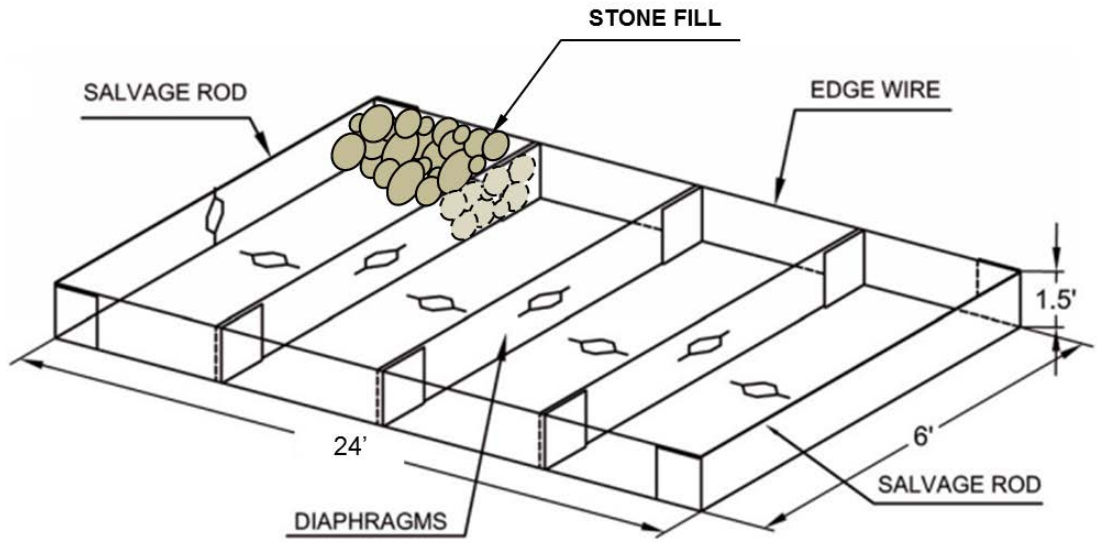


**Figure 6.6 Individual gabion mattress schematic (Maccaferri 2010).**

*Revetment Layout* – The approach for setting the alignment of the gabion mattress revetment is similar to that described for the geotextile container revetment (see Section 6.3). The revetment will require some placement and grading of fill to achieve the proper revetment slope (Figure 6.7). To reduce the volume of fill material needed, the revetment should be placed as close to the existing shoreline (vegetation line) as possible. The initial design for this revetment is to have two beach access points: one on the south side and one on the east side.

Where bends in the revetment occur, it is recommended to use smaller gabion baskets of various shapes and sizes to create the curve. Since each bend in the revetment will require a custom made gabion basket, the number of bends should be kept to a minimum. In addition, it is recommended that beach access points are lined with a gabion basket retaining wall. This will help support and retain material on the back side of the revetment at the beach access locations.

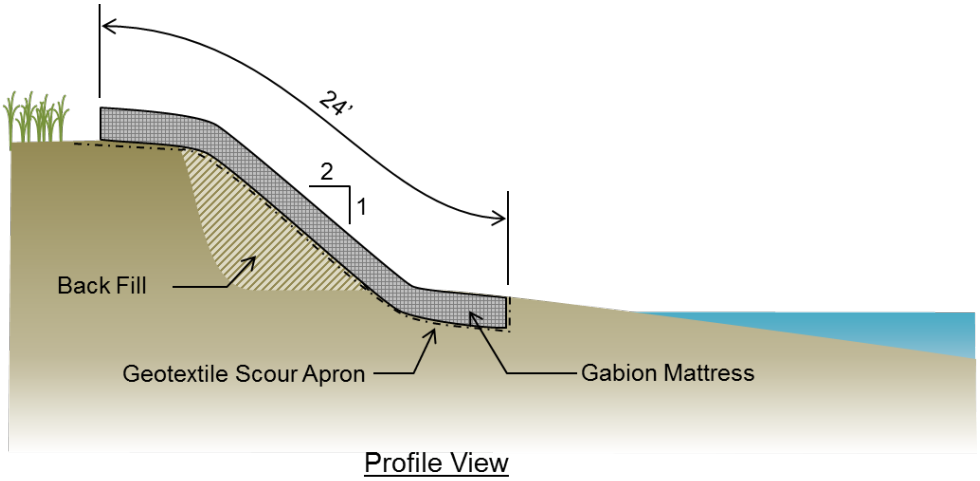


**Figure 6.7 Gabion mattress schematic cross-section.**

*Types of Material* – Gabion material is recommended to be either PVC-coated galvanized steel or stainless steel. Geotextile grid material, such as the Triton® Marine Mattress, could also be used instead of steel wire.

*Scour Protection* – A scour apron is required under the gabion mattress revetment to prevent undermining (Figure 6.7). A geotextile fabric would work well. Recommended properties for the geotextile fabric scour apron are provided in Table 6.1.

*Construction Considerations* – A significant amount of material will be required to prepare the subgrade of the revetment. This material will need to come from a suitable borrow area (such as the Nelson Lagoon spit), so it is likely the material will be transported a substantial distance. In addition, a significant amount of cobble or stones will need to be used to fill the mattresses. At the time of this report, it is unknown if there is a sufficient amount of cobble at Nelson Lagoon to fill the mattresses. If not, material will need to be transported, which could substantially increase the cost. Removing cobbles or stones from the lagoon, other water bodies, or shoreline is not recommended as additional permits would likely be needed, which would impact the project cost and schedule.

With the exception of one portion, the existing seawall would need to be removed, as well as any debris on the shoreline. The portion of the existing seawall that is recommended to remain is shown in Figure 6.5. Removal of this portion of the seawall could undermine and damage the nearby structures.

## 6.4 Timber Seawall Design

*Description* – As discussed in Section 5.7, a timber seawall is a wooden vertical wall-type structure. The preliminary design is a cantilevered wall (i.e., a single vertical wall with no support rams or tie backs). This would be a different design than the existing seawall, which used batter rams to support the seawall on the seaward side. The advantage of a cantilever wall over the existing seawall is that if the seawall is undermined and sediment escapes from behind the wall, the structure can remain relatively

stable. The primary construction concept for the timber seawall is to jet (i.e., insert using high pressure water) long soldier piles (i.e., timber posts) vertically in the ground, and then attach lag boards vertically between the soldier piles to retain land from the water and help protect land from a wave attack.

*Dimensions of Timber Seawall* – The seawall would use 12-inch wide by 12-inch long by 20-foot tall soldier piles spaced 8 feet apart. The horizontal lags would retain sand from an elevation of +5 feet to +13 feet (8 feet of wall height). The lags would be 4 inches wide by 6 inches long by 8 feet tall. Lags towards the top of the structure could be reduced to a size of 3 inches wide by 4 inches long by 8 feet tall. A schematic of the timber seawall is shown in Figure 6.8.

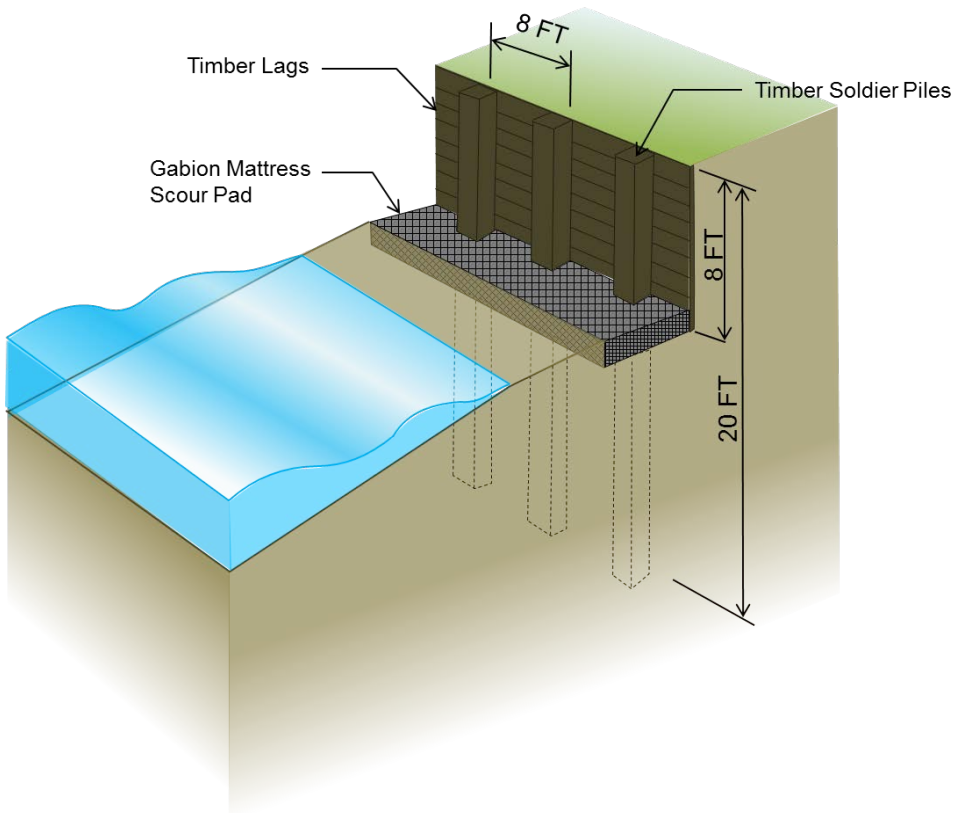


**Figure 6.8 Timber seawall schematic.**

*Seawall Layout* – The approach for setting the alignment of the seawall is similar to that described for the revetment alternatives (see Sections 6.2 and 6.3). The initial design for the seawall is to have two beach access points: one on the south side and one on the east side.

At the terminals and at beach access points, it is recommended the seawall be turned in and keyed into the land. This will help prevent flanking (i.e., erosion around the ends) of the structure.

*Material Type* – All lumber should be pressure treated to 25 pounds per cubic foot (PCF) Chromated Copper Arsenate (CCA) due to the saltwater environment. Polymer coating on the wood is

recommended, especially for the soldier piles. Metal fasteners should be hot dip galvanized. Lag bolts of ½-inch by 10-inch size should be sufficient for securing the lag boards.

*Scour Protection* – Scour protection is recommended at the toe of the seawall to minimize the potential for undermining. The method of scour protection considered for preliminary design is gabion mattresses or baskets, similar to what is currently being used at the intact portion of the seawall. In addition to the gabion mattresses, geotextile fabric should be used under the gabion mattress and on the landward side of the seawall to reduce sand escaping through the gabion mattress and timber lags. Recommended properties of the geotextile fabric is provided in Table 6.1.

*Construction Considerations* – With the exception of one portion, the existing seawall would need to be removed as well as any debris on the shoreline. The portion of the existing seawall that is recommended to remain is shown in Figure 6.5. Removal of this portion of the seawall could undermine and damage the nearby structures. In this area, it is recommended that the new seawall be constructed directly in front of the existing seawall or the existing seawall be heavily reinforced.

There is limited geotechnical data available for the location of the seawall. Prior to final design, soil borings and soil strength parameters should be obtained to assess the viability of the material to support a cantilevered seawall.

# 7 Opinion of Probable Construction Cost

HDR developed a preliminary-level opinion of probable construction cost ("cost") for each of the three alternatives. Costs for materials, shipping, local labor, local equipment rental, engineering, and permitting were included. A summary of the costs is provided in Table 7.1, and more detailed breakdowns are provided in Appendix A.

**Table 7.1 Preliminary-level opinion of probable construction cost.**

| | Geotextile Container Revetment | Gabion Mattress Revetment | Timber Seawall |
|---|---|---|---|
| Engineering & Permitting | $154,000 | $154,000 | $165,000 |
| Construction Materials | $115,000 | $462,000 | $960,000 |
| Labor & Equipment | $525,000 | $447,000 | $455,000 |
| **Total** | **$794,000** | **$1,063,000** | **$1,580,000** |

# 8 Preferred Alternative

All three alternatives meet the design criteria and would help protect the shoreline near the community of Nelson Lagoon. The AEB and the residents of Nelson Lagoon have indicated the geotextile container revetment is the preferred alternative as it has the lowest probable construction cost.

## 8.1 Phasing

As of July 2015, AEB has been successful in securing partial funding for shoreline protection for the community of Nelson Lagoon. They have been able to secure approximately $400,000 towards construction of shoreline protection. As a result, the project will be developed in phases as funding allows. To maximize available funding, the following activities should be completed as part of Phase 1:

- Perform final engineering design and develop prioritization of protection for the shoreline.
- Develop final contract documents (construction plans and specifications) for the entire project length but allow structure to be constructed in stages based on priority.
- Shift permitting responsibility to the AEB with support from a consultant.
- Purchase all material required to construct the entire project, and ship materials to Nelson Lagoon.
- Use remaining funds for labor and equipment to construct as much of the structure as possible.
- Estimated cost is $487,000.

The remaining portions of the geotextile container structure would be built as funds for labor and equipment is available. The number of phases will depend on how much funding is available.

## 8.2 Establishing Priority

With the phased approach, only partial sections of the shoreline protection can be constructed at one time. This requires the shoreline be prioritized so that the most critical sections are protected first. Figure 8.1 shows a suggested sequence of priority. This sequencing is based on an approach where all areas that are impacted directly from waves should be a high priority, with the highest priority being the area where the seawall has already collapsed. The next highest priority should be given to areas that appear to be in more stable condition but are located along the south facing shoreline (i.e., impacted more directly from waves). Sections of the shoreline that are not directly impacted are given the overall lowest priority. However, decisions on priority should ultimately be made by the community.

It was noted during the May 2015 visit that areas of the shoreline on the east side of the community have experienced additional erosion since HDR's May 2014 visit. However, as the southern shoreline is directly exposed to wave action, it should remain a higher priority.

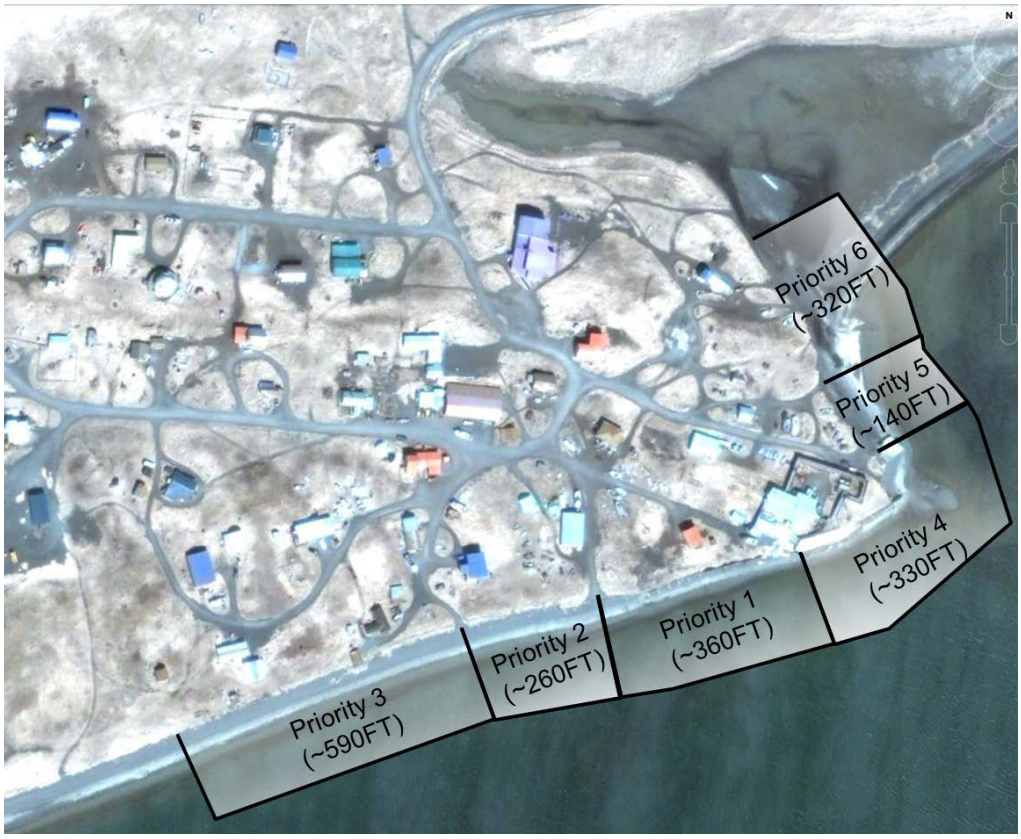


**Figure 8.1 Possible prioritization of shoreline protection.**

## 8.3 Engineering and Permitting

It is recommended that the engineering and permitting activities be completed in Phase 1. The current design is only at the 20% level, and is not signed and sealed by a professional engineer. Completing the design (i.e., bringing the design to 100%) will result in finer details and facilitate exploring the potential for more efficient constructability aspects that could help reduce overall costs. AEB, with support from a consultant (i.e., to provide quantities, figures, etc.), could acquire the permits themselves. This would greatly reduce the cost of permitting, allowing more funds to be applied to construction. It is recommended that the permits be acquired for the entire project, if possible, to reduce the need to apply for additional permits for the remaining phases. The cost for this portion of Phase 1 is estimated at $72,000.

## 8.4 Phase 1 Construction

It is also recommended that Phase 1 include purchasing and transporting the material needed to construct the entire project and constructing the highest priority reaches of the shoreline. One reason for purchasing and transporting material for the entire project is that it may be less expensive than shipping multiple orders. Having all of the materials in Nelson Lagoon would also facilitate building subsequent phases. In case of emergency (i.e., major storm events), community members could construct additional structure using their own resources.

Following engineering, permitting assistance, and material purchase, the remaining funds should be applied to labor and equipment for constructing as much of the shoreline protection as possible. The final construction drawings would be arranged to allow the structure to terminate at any location.

The purchasing and transporting of materials is estimated at $115,000, and the construction of Phase 1 is estimated at $372,000. The total for Phase 1 is estimated at $487,000.

## 8.5 Additional Phases Construction

The remaining phases could be constructed based on available funds. These phases will only need to cover the cost of labor and equipment. The engineering and permitting, completed in Phase 1, will cover the entire project length. Similar to Phase 1, the structure can be continued and terminated at any location depending on the availability of funds.

# 9 Permits

Regardless of the alternative selected, the following permits and agency coordination are likely to be needed for this project:

- Alaska Department of Fish and Game Special Area permit
- Section 404 permit
- Section 10 permit
- Section 7 consultation
- Coordination with the U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service
- State of Alaska Land Use Permit/Tideland Easement

A Fish Habitat Permit may also be needed. Prior to beginning work on the project, applicable resource agencies should be consulted to determine if additional permits are needed. Construction activity should comply with all applicable regulations and permit requirements.

# 10 Floodplains

The purpose of the shoreline protection structure is to combat erosion impacting the community. It is not intended to be a flood protection structure, preventing rising water from entering the community. However, it is important that the structure be designed to not retain water within the community if a flood were to occur. At the preliminary stage, the structure is not expected to cause any significant issues with undesired ponding or water retention based on the following:

1) The crest elevation of the shoreline protection structure is not expected to be higher than the landward grade, meaning there would be no barrier to pond or hinder surface runoff.
2) The alternatives considered are not water-tight barriers, which will allow water to escape through the structure.
3) The structure alignment does not inhibit the natural/existing drainage to the east and west of the community.

Final design will address the potential for retaining water in greater detail and, if necessary, include drainage features.

A Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), which delineates areas at risk of flooding, is not available for the Nelson Lagoon area. To determine the approximate 1% flood elevation for the area, water level records (2006 to 2015) for Port Moller, located approximately 20 miles north east of Nelson Lagoon, were assessed. Figure 10.1 provides a percent exceedance plot of the highest daily water levels recorded during this period. Based on these data, the 1% exceedance daily high water level is +13.1 feet MLLW. This is 2.7 feet above the MHHW. This value does not necessarily directly correspond the 1% flood elevation, which is a probability value meaning 1 in 100 chance of occurring in a single year as well as wave effects, as defined by FEMA. However, the value should be a close approximation. For comparison, extreme water level data published by NOAA for Unalaska, located approximately 250 miles southwest of Nelson Lagoon, was reviewed (Figure 10.2). Based on these data, the 1% extreme water level is 3.0 feet above MHHW. This supports the assumption that the 1% exceedance value calculated from the Port Moller data is likely very close to the probabilistic value.

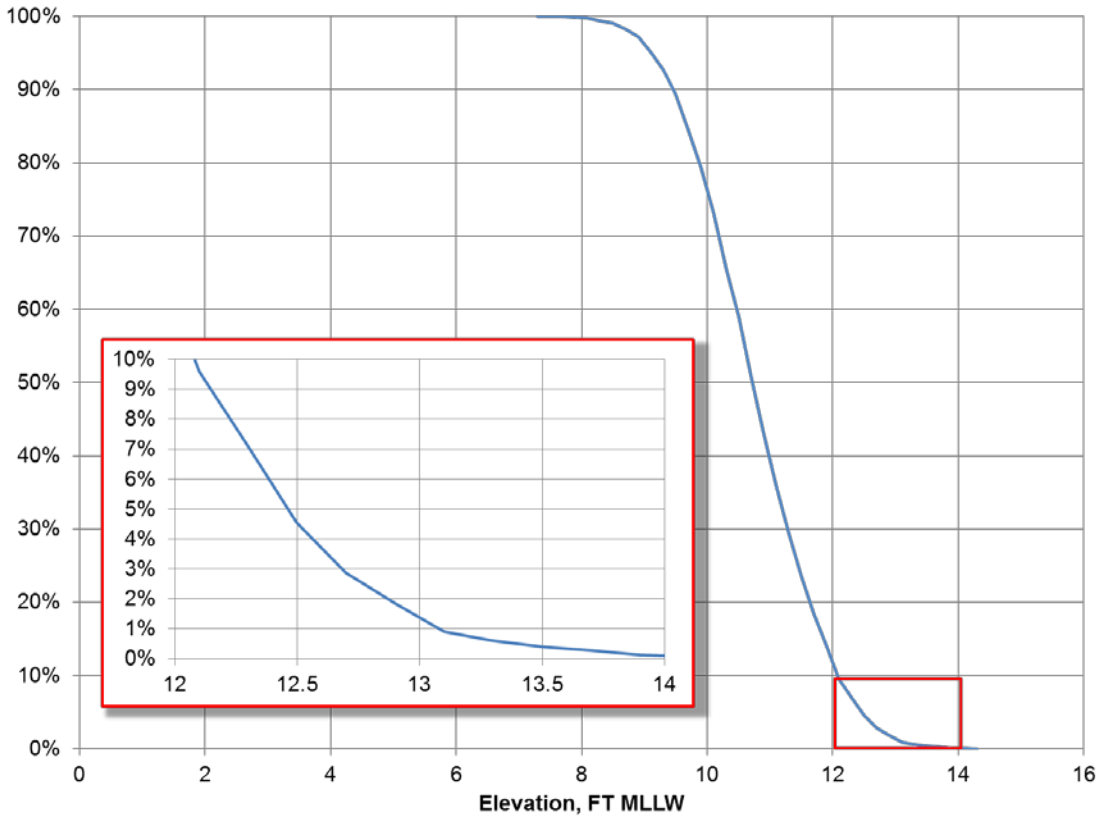


**Figure 10.1 Percent exceedance of highest daily water levels at Port Moller (2006-2015).**

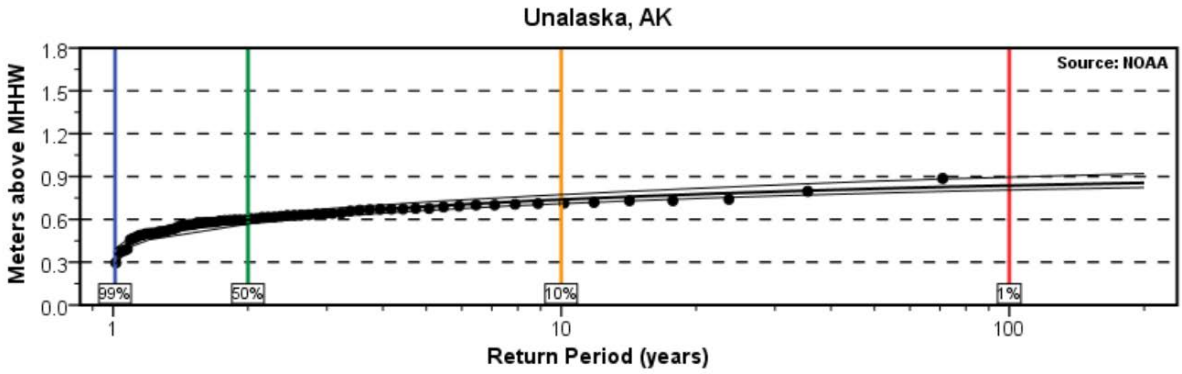


**Figure 10.2 Extreme water level probability at Unalaska (NOAA 2014).**

# 11 Summary

HDR performed preliminary-level engineering design for three alternatives to protect the community of Nelson Lagoon from wave erosion on the Nelson Lagoon (water body) shoreline of the community. Prior to selection of the three alternatives, numerous shoreline protection concepts were identified and discussed with the community during a public meeting. Three alternatives were chosen for further development based on this meeting, capital cost, and the ability to construct using local labor and equipment, including:

1) Geotextile Container Revetment
2) Gabion Mattress Revetment
3) Timber Seawall with Gabion Toe

Many of the more traditional shoreline protection alternatives were not considered due to the high cost in transporting material and mobilizing a specialized contractor. The alternatives chosen can be constructed by mostly local labor and equipment. The geotextile container revetment and gabion mattress revetment would utilize local natural resources, further helping to reduce overall cost.

HDR developed a 20% preliminary design for the three alternatives (Appendix B), and aspects of the design have been presented herein, as well as a set of preliminary construction drawings and opinion of probable cost.

Based on the probable construction cost, the geotextile container revetment is the preferred alternative. AEB will pursue the implementation of this alternative using a phased approach.

# 12 References

American Society of Civil Engineers (2010). “Minimum Design Loads for Buildings and Other Structures.” Standard SEI/ASCE 7010, Reston, VA.

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HDR (2014a). Nelson Lagoon Coastal Erosion Study Numerical Hydrodynamic Model Technical Memorandum, Prepared for the Aleutians East Borough.

HDR (2014b). Nelson Lagoon Coastal Erosion Study Numerical Wave Model Technical Memorandum, Prepared for the Aleutians East Borough.

HDR (2014c). Nelson Lagoon Coastal Erosion Study Historical Shoreline Map Report, Prepared for the Aleutians East Borough.

Maccaferri (2010). Gabion Mat – SP, Stainless Steel & PVC Coated, Technical Data Sheet, Rev: 01, Issue Date 05.01.2010.

NOAA (2014). Center for Operational Oceanographic Products and Services (CO-OPS) Webpage, <http://tidesandcurrents.noaa.gov/>.

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# Appendix A:
# Preliminary Opinion of Probable Construction Cost

**11/25/2014**

**ALEUTIANS EAST BOROUGH**
**NELSON LAGOON SHORELINE PROTECTION**

**PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST**
**(20% DESIGN SUBMITTAL)**

**Option 1 - Geotextile Container**

| ITEM | QUANTITY | UNIT | UNIT PRICE | EXTENSION |
|---|---|---|---|---|
| **Engineering & Permitting** | | | | |
| 1. *Engineering Support* | 1 | LS | $55,000 | $55,000 |
| 2. *Permitting* | 1 | LS | $85,000 | $85,000 |
| | | | 10% Contingencies: | $14,000 |
| | | | *Subtotal:* | $154,000 |
| **Construction Materials** | | | | |
| 3. *Geotextile Containers (Material Only)* | 705 | EACH | $65 | $46,000 |
| 4. *Geotextile Filter Fabric* | 4,300 | SY | $6 | $26,000 |
| 5. *Shipping Materials (Continental US to Seattle)* | 1 | LS | $4,900 | $5,000 |
| 6. *Shipping Materials (Seattle to Nelson Lagoon)* | 2,000 | CF | $5.50 | $11,000 |
| | | | 30% Contingencies: | $27,000 |
| | | | *Subtotal:* | $115,000 |
| **Construction Labor & Equipment** | | | | |
| 7. *Labor - Existing Seawall Demolition* | 30 | DAY | $1,602 | $49,000 |
| 8. *Fuel - Existing Seawall Demolition* | 30 | DAY | $700 | $21,000 |
| 9. *Equipment Rental - Existing Seawall Demolition* | 30 | DAY | $800 | $24,000 |
| 10. *Labor - New Construction* | 90 | DAY | $1,600 | $144,000 |
| 11. *Fuel - New Construction* | 90 | DAY | $700.00 | $63,000 |
| 12. *Equipment Rental - New Construction* | 90 | DAY | $800.00 | $72,000 |
| 13. *Equipment - Container Filling Apparatus* | 1 | EACH | $2,000.00 | $2,000 |
| | | | 40% Contingencies: | $150,000 |
| | | | *Subtotal:* | $525,000 |
| | | | **TOTAL COST:** | **$794,000** |

(a) Costs shown assume that construction activities are performed by community labor, not an independent contractor. Assumes 10 hour days for 5 workers (4 general laborers and 1 project adminstrator) at $20/hour and 1 heavy equipment operator at $30/hour. Each day includes 8 hours of straight time, 2 hours of overtime (time and a half) and 12% fringe.
(b) Construction equipment rental costs assumes equipment is already on site. No shipping.
(c) Engineering includes support, additional drawings, and technical report for Option 3 only
(d) Actual prices will be dictated by timing of work. Fuel, labor, equipment, and related costs are subject to market conditions at time of construction.
(e) Cost shown assume all fill material (e.g. sand, cobble) are available on site.
(f) All costs are based on a total of 2,000 LF of shoreline protection.
(g) Permitting assumes following actions: Special Area Permit, Fish Habitat Permit, Section 404/10 Permit, Section 7 Consultation, and coordination with USACE and USFWS. Does not include mitigation if required.
(h) Assumes two pieces of heavy equipment needed for existing seawall removal (i.e. backhoe, front loader) and two pieces needed for new construction (i.e. fork lift, front loader). Equipment rental is assumed to be $400 per day per piece of equipment.
(i) Container filling appartus assumed to be fabricated on site.
(j) Existing seawall demolition includes removal and disposal

**11/25/2014**

**ALEUTIANS EAST BOROUGH**
**NELSON LAGOON SHORELINE PROTECTION**

**PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST**
**(20% DESIGN SUBMITTAL)**

**Option 2 - Gabion Mattress Revetment**

| ITEM | QUANTITY | UNIT | UNIT PRICE | EXTENSION |
|---|---|---|---|---|
| **Engineering & Permitting** | | | | |
| 1. *Engineering Support* | 1 | LS | $55,000 | $55,000 |
| 2. *Permitting* | 1 | LS | $85,000 | $85,000 |
| | | | 10% Contingencies: | $14,000 |
| | | | *Subtotal:* | $154,000 |
| **Construction Materials** | | | | |
| 3. *Gabion Mattress (Material Only)* | 48,000 | SF | $6 | $288,000 |
| 4. *Geotextile Filter Fabric* | 7,000 | SY | $6 | $42,000 |
| 5. *Shipping Materials (Continental US to Seattle)* | 1 | LS | $4,900 | $5,000 |
| 6. *Shipping Materials (Seattle to Nelson Lagoon)* | 80,000 | LB | $0.25 | $20,000 |
| | | | 30% Contingencies: | $107,000 |
| | | | *Subtotal:* | $462,000 |
| **Construction Labor & Equipment** | | | | |
| 7. *Labor - Existing Seawall Demolition* | 30 | DAY | $1,602 | $49,000 |
| 8. *Fuel - Existing Seawall Demolition* | 30 | DAY | $700 | $21,000 |
| 9. *Equipment Rental - Existing Seawall Demolition* | 30 | DAY | $800 | $24,000 |
| 10. *Labor - New Construction* | 90 | DAY | $1,600 | $144,000 |
| 11. *Fuel - New Construction* | 90 | DAY | $500.00 | $45,000 |
| 12. *Equipment Rental - New Construction* | 90 | DAY | $400.00 | $36,000 |
| | | | 40% Contingencies: | $128,000 |
| | | | *Subtotal:* | $447,000 |
| | | | **TOTAL COST:** | **$1,063,000** |

(a) Costs shown assume that construction activities are performed by community labor, not an independent contractor. Assumes 10 hour days for 5 workers (4 general laborers and 1 project adminstrator) at $20/hour and 1 heavy equipment operator at $30/hour. Each day includes 8 hours of straight time, 2 hours of overtime (time and a half) and 12% fringe.
(b) Construction equipment rental costs assumes equipment is already on site. No shipping.
(c) Engineering includes support, additional drawings, and technical report for Option 3 only
(d) Actual prices will be dictated by timing of work. Fuel, labor, equipment, and related costs are subject to market conditions at time of construction.
(e) Assumes all fill material (e.g. sand, cobble) are available on site.
(f) All costs are based on a total of 2,000 LF of shoreline protection.
(g) Permitting assumes following actions: Special Area Permit, Fish Habitat Permit, Section 404/10 Permit, Section 7 Consultation, and coordination with USACE and USFWS. Does not include mitigation if required.
(h) Assumes two pieces of heavy equipment needed for existing seawall removal (i.e. backhoe, front loader) and one piece needed for new construction (i.e. front loader). Equipment rental is assumed to be $400 per day per piece of equipment.
(i) Existing seawall demolition includes removal and disposal

**11/25/2014**

**ALEUTIANS EAST BOROUGH**
**NELSON LAGOON SHORELINE PROTECTION**

**PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST**
**(20% DESIGN SUBMITTAL)**

**Option 3 - Timber Seawall**

| ITEM | QUANTITY | UNIT | UNIT PRICE | EXTENSION |
|---|---|---|---|---|
| **Engineering & Permitting** | | | | |
| 1. *Engineering Support* | 1 | LS | $65,000 | $65,000 |
| 2. *Permitting* | 1 | LS | $85,000 | $85,000 |
| | | | 10% Contingencies: | $15,000 |
| | | | *Subtotal:* | $165,000 |
| **Construction Materials** | | | | |
| 3. *Geotechnical Borings* | 1 | LS | $250,000 | $250,000 |
| 4. *Lumber, Soldier Piles* | 250 | EACH | $480 | $120,000 |
| 5. *Lumber, Lags* | 4,500 | EACH | $15 | $68,000 |
| 6. *Hardware* | 9,000 | EACH | $13 | $117,000 |
| 7. *Geotextile Filter Fabric* | 3,400 | SY | $6 | $21,000 |
| 8. *Gabion Basket Toe (Material Only)* | 12,000 | SF | $6 | $72,000 |
| 9. *Shipping Gabions (Continental US to Seattle)* | 1 | LS | $4,900 | $5,000 |
| 10. *Shipping Materials (Seattle to Nelson Lagoon)* | 340,000 | LB | $0.25 | $85,000 |
| | | | 30% Contingencies: | $222,000 |
| | | | *Subtotal:* | $960,000 |
| **Construction Labor & Equipment** | | | | |
| *11. Labor - Existing Seawall Demolition* | 30 | DAY | $1,602 | $49,000 |
| *12. Fuel - Existing Seawall Demolition* | 30 | DAY | $700 | $21,000 |
| *13. Equipment Rental - Existing Seawall Demolition* | 30 | DAY | $800 | $24,000 |
| *14. Labor - New Construction* | 90 | DAY | $1,602 | $145,000 |
| *15. Fuel - New Construction* | 90 | DAY | $500 | $45,000 |
| *16. Equipment Rental - New Construction* | 90 | DAY | $400 | $36,000 |
| *17. Equipment - Water Pump (Jetting Piles)* | 1 | EACH | $5,000 | $5,000 |
| | | | 40% Contingencies: | $130,000 |
| | | | *Subtotal:* | $455,000 |
| | | | **TOTAL COST:** | **$1,580,000** |

(a) Costs shown assume that construction activities are performed by community labor, not an independent contractor. Assumes 10 hour days for 5 workers (4 general laborers and 1 project adminstrator) at $20/hour and 1 heavy equipment operator at $30/hour. Each day includes 8 hours of straight time, 2 hours of overtime (time and a half) and 12% fringe.
(b) Construction equipment rental costs assumes equipment is already on site. No shipping.
(c) Engineering includes support, additional drawings, and technical report for Option 3 only
(d) Actual prices will be dictated by timing of work. Fuel, labor, equipment, and related costs are subject to market conditions at time of construction.
(e) All costs are based on a total of 2,000 LF of shoreline protection.
(f) Permitting assumes following actions: Special Area Permit, Fish Habitat Permit, Section 404/10 Permit, Section 7 Consultation, and coordination with USACE and USFWS. Does not include mitigation if required.
(g) Assumes two pieces of heavy equipment needed for existing seawall removal (i.e. backhoe, front loader) and one piece needed for new construction (i.e. backhoe). Equipment rental is assumed to be $400 per day per piece of equipment.
(i) Existing seawall demolition includes removal and disposal

# Appendix B:
# Plan Set

AKUTAN • COLD BAY • NELSON LAGOON
ALEUTIANS EAST
BOROUGH
FALSE PASS • KING COVE • SAND POINT

**PRELIMINARY**

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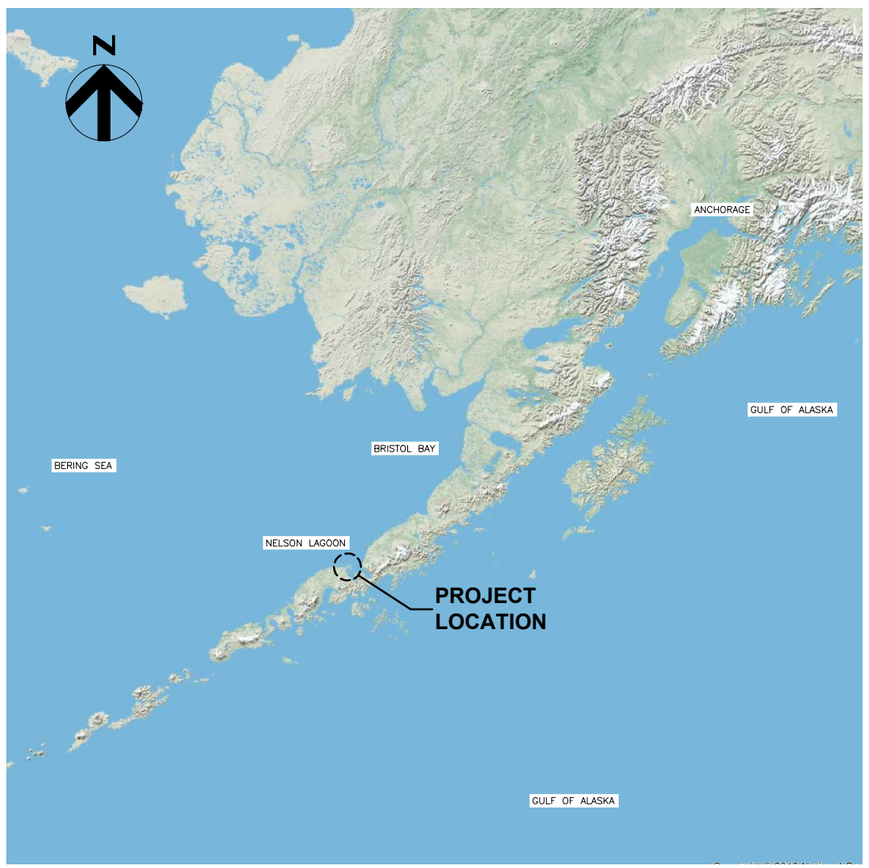
ENGINEER: RONALD L. McPHERSON

REGISTRATION NO.: 13591

DATE: 07-06-2015




Construction Drawings For

# ALEUTIANS EAST BOROUGH

## Nelson Lagoon Shoreline Protection 20% Preliminary Design

Project No.
213165

NELSON LAGOON, ALASKA
JULY 2015

INDEX OF DRAWINGS


| DRAWING NO. | DESCRIPTION |
|---|---|
| GENERAL | |
| 00G-00 | COVER SHEET AND INDEX |
| 00G-01 | KEY MAP AND LEGEND |
| 00G-02 | GENERAL NOTES |
| CIVIL | |
| 01C-01 | EXISTING SITE PLAN |
| 02C-01 | PROJECT LAYOUT OPTION 1 |
| 02C-02 | PROJECT LAYOUT OPTION 1 |
| 02C-03 | PROJECT LAYOUT OPTION 1 |
| 03C-01 | PROJECT LAYOUT OPTION 2 |
| 03C-02 | PROJECT LAYOUT OPTION 2 |
| 03C-03 | PROJECT LAYOUT OPTION 2 |
| 04C-01 | PROJECT LAYOUT OPTION 3 |
| 04C-02 | PROJECT LAYOUT OPTION 3 |
| 04C-03 | PROJECT LAYOUT OPTION 3 |
| 05C-01 | POTENTIAL BORROW AREA |
| 06C-01 | TYPICAL SECTIONS AND DETAILS OPTION 1 |
| 06C-02 | TYPICAL SECTIONS AND DETAILS OPTION 1 |
| 07C-01 | TYPICAL SECTIONS AND DETAILS OPTION 2 |
| 07C-02 | TYPICAL SECTIONS AND DETAILS OPTION 2 |
| 08C-01 | TYPICAL SECTIONS AND DETAILS OPTION 3 |

## GENERAL LINE SYMBOLOGY

- SURVEY TRANSECT LOCATION
- APPROXIMATE EXISTING GRADE
- SILT FENCE

## SHEET NAMING CONVENTION

### DISCIPLINE DESIGNATOR & DISCIPLINE ORDER

| | |
|---|---|
| G | GENERAL |
| V | SURVEYING/MAPPING |
| X | DEMOLITION |
| C | CIVIL |
| U | MULTI–DISCIPLINE |
| S | STRUCTURAL |
| A | ARCHITECTURAL |
| D | PROCESS |
| M | MECHANICAL (HVAC) |
| P | PLUMBING |
| E | ELECTRICAL |
| Y | INSTRUMENTATION |

### EXAMPLE

| | | | | | |
|---|---|---|---|---|---|
| 0 | 0 | | | | |

SERIES DESIGNATION

| | | | | | |
|---|---|---|---|---|---|
| | | A | | | |

DISCIPLINE DESIGNATOR

| | | | | | |
|---|---|---|---|---|---|
| | | | – | | |

PLACEHOLDER

| | | | | | |
|---|---|---|---|---|---|
| | | | | 0 | 1 |

SHEET NUMBER

## SITE PLAN SYMBOLOGY

- BORROW AREA
- BACKFILL
- GABION BASKET REVETMENT
- GEOTEXTILE CONTAINER
- EARTH
- TIMBER SEAWALL (PLAN)
- *–15.3 SPOT ELEVATION, FT
- A1 GEOTEXTILE CONTAINER ALIGNMENT POINT
- B1 GABION BASKET ALIGNMENT POINT
- C1 TIMBER SEAWALL ALIGNMENT POINT
- D1 BORROW AREA COORDINATE
- C2 SURVEY CONTROL POINT

## GENERAL SYMBOLOGY

N

ARROW INDICATES DIRECTION OF PLAN NORTH

**PLAN**
1"=200'
PLAN TITLE

DETAIL NUMBER

**DETAIL**
3" = 1'–0"
# / XXX

SHEET WHERE DETAIL WAS CALLED OUT *
DETAIL TITLE

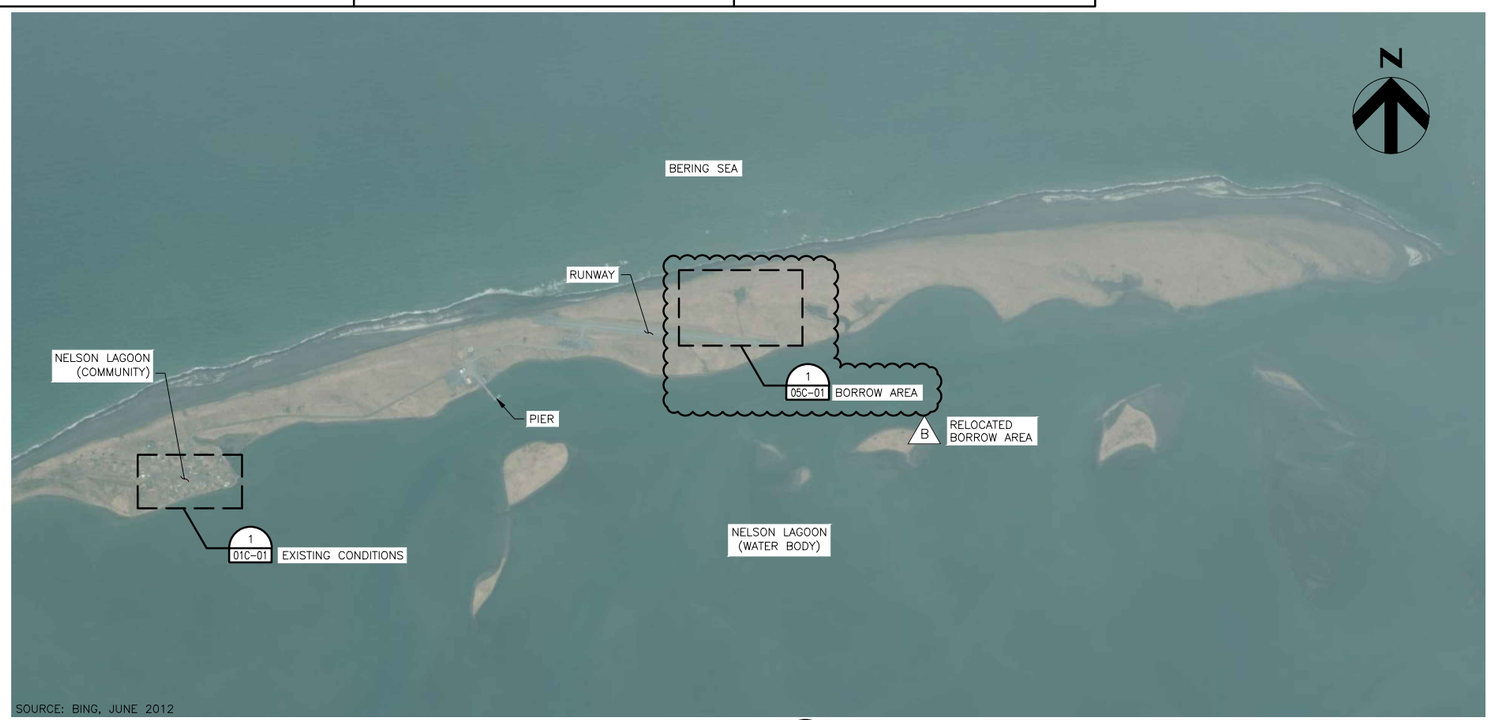
SECTION LETTER
FLAG INDICATES DIRECTION OF SECTION CUT
X / XXX
SHEET WHERE SECTION IS LOCATED
SECTION CUT MARKER

SECTION LETTER

**SECTION**
3/8" = 1'–0"
X / XXX

SHEET WHERE SECTION VIEW IS FIRST CUT *
SECTION TITLE

* FOR COMMON DETAILS AND SECTIONS OR DETAILS THAT ARE CUT OR CALLED OUT ON MULTIPLE SHEETS, THE SHEET NUMBER IS REPLACED BY A DASH (–).




SOURCE: BING, JUNE 2012

**KEYMAP** 1 / –
SCALE: N.T.S.

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07–06–2015 | ISSUED TO CLIENT |
| A | 10–24–2014 | ISSUED TO CLIENT |

| | |
|---|---|
| PROJECT MANAGER | LAURIE CUMMINGS |
| DESIGNED BY | R. McPHERSON |
| DRAWN BY | F. MARTINEZ |
| CHECKED BY | D. HEILMAN |
| PROJECT NUMBER | 213165 |

**PRELIMINARY**

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ENGINEER: RONALD L. McPHERSON
REGISTRATION NO.: 13591
DATE: 07–06–2015

AKUTAN • COLD BAY • NELSON LAGOON
ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

KEY MAP AND LEGEND

| | |
|---|---|
| FILENAME | 00G-01.dwg |
| SCALE | 0.001297 |

SHEET 00G-01

## GENERAL NOTES:

1. PROJECT IS WITHIN AND ADJACENT TO ENVIRONMENTALLY SENSITIVE AREAS. CONSTRUCTION ACTIVITIES SHALL AVOID IMPACTS TO ENVIRONMENTALLY SENSITIVE AREAS DURING THE COURSE OF WORK TO THE EXTENT PRACTICABLE. ENVIRONMENTALLY SENSITIVE AREAS SHALL NOT BE USED FOR STAGING. DAMAGE CAUSED BY CONSTRUCTION ACTIVITIES SHALL BE RESTORED TO THE SATISFACTION OF RESOURCE PROTECTION AGENCIES.
2. CONSTRUCTION ACTIVITIES SHALL BE COORDINATED WITH RESOURCE AGENCIES. ALL PERMITS REQUIRED FOR CONSTRUCTION SHALL BE OBTAINED AND COMPLIED WITH.
3. ALL EXISTING CONDITIONS SHALL BE VERIFIED PRIOR TO COMMENCING CONSTRUCTION ACTIVITIES. DISCREPANCIES SHALL BE REPORTED TO ENGINEER OF RECORD IMMEDIATELY.
4. ALL ABOVE GROUND AND UNDERGROUND UTILITIES SHALL BE LOCATED WITHIN THE WORK AREA PRIOR TO CONSTRUCTION.
5. THIS SITE IS EXPOSED TO LARGE WAVES. PRECAUTIONS SHALL BE TAKEN TO SECURE EQUIPMENT AND PROTECT THE WORK AGAINST ADVERSE WEATHER AND MARINE CONDITIONS.
6. STAGING AREA LOCATION(S) SHALL BE COORDINATED WITH PROPERTY OWNER PRIOR TO MOBILIZATION. ANY STAGING AREAS USED SHALL BE RETURNED TO PRE-CONSTRUCTION CONDITIONS OR BETTER PRIOR TO FINAL COMPLETION OF PROJECT.
7. AERIAL PHOTOGRAPH SHOWN WAS FLOWN DURING JULY 2013.
8. MEASURES SHALL BE TAKEN TO PREVENT DAMAGE TO FACILITIES, HOUSES, AND OTHER EXISTING IMPROVEMENTS DURING WORK.
9. GROUNDWATER, SURFACE WATER, TIDAL WATER, AND WAVES ENTERING THE PROJECT SITE SHOULD BE ANTICIPATED AND APPROPRIATE MEANS AND METHODS FOR CONSTRUCTION IN SOFT/WET/SATURATED SOILS SHALL BE APPLIED.
10. WITH EXCEPTION OF PORTION OF EXISTING TIMBER SEAWALL TO REMAIN IN PLACE AS SHOWN ON SHEET 02C-02, 03C-02, 04C-02, REMAINS OF EXISTING TIMBER SEAWALL AND DEBRIS SHALL BE REMOVED FROM SHORELINE AND PROPERLY DISPOSED OF.

## SURVEY NOTES:

1. ELEVATIONS SHOWN ON THESE DRAWINGS ARE BASED ON SURVEY PERFORMED BY USKH DURING JUNE 29 THROUGH JULY 11 2013.
2. HORIZONTAL CONTROL BASED ON ALASKA STATE PLANE GRID COORDINATE SYSTEM, ZONE 7, NAD 83 (FEET).
3. ALL ELEVATIONS SHOWN ARE IN FEET REFERENCED TO MLLW VERTICAL DATUM.
4. MONUMENTS FOR SURVEY CONTROL:

SURVEY CONTROL MONUMENTS

| NAME | NORTHING | EASTING | ELEVATION | DESCRIPTION |
|---|---|---|---|---|
| 412 | 732024.11 | 1804647.47 | 12.09 | SET RBR/2IN AC:XS-12 2013 |
| 413 | 731283.92 | 1804389.8 | 14.38 | SET RBR/2IN AC:XS-13 2013 |
| 414 | 731141.45 | 1803930.3 | 15.49 | SET RBR/2IN AC:XS-14 2013 |
| 415 | 731003.59 | 1803419.65 | 18.45 | SET RBR/2IN AC:XS-15 2014 |
| 416 | 730820.68 | 1802952.99 | 12.8 | SET RBR/2IN AC:XS-16 2014 |
| 417 | 730694.3 | 1802484.42 | 14.15 | SET RBR/2IN AC:XS-17 2014 |
| 418 | 730860.4 | 1801915.87 | 13.02 | SET RBR/2IN AC:XS-18 2015 |
| 419 | 731026.57 | 1801327.74 | 16.96 | SET RBR/2IN AC:XS-19 2015 |
| 420 | 731080.48 | 1800754.76 | 17.35 | SET RBR/2IN AC:XS-20 2015 |

5. TIDAL DATUM RELATIONSHIPS SHOWN ON THIS SHEET ARE APPROXIMATE AND ARE BASED ON THOSE PUBLISHED FOR THE NOAA PORT MOLLER TIDAL STATION (SID: 9463502). NAVD TO MLLW RELATIONSHIP BASED ON NGS CORS USING NAD83(2011) WITH GEOID12A.
6. TIDAL DATUM RELATIONSHIPS

   MHHW = 10.41'

   MHW = 9.58'

   MSL = 5.83'

   MLW = 2.2'

   MLLW = 0'

   NAVD = 3.11'

## GEOTEXTILE CONTAINER REVETMENT NOTES:

1. RECOMMENDED GEOTEXTILE MATERIAL PHYSICAL CHARACTERISTICS:

RECOMMENDED GEOTEXTILE MATERIAL PHYSICAL CHARACTERISTICS

| PHYSICAL PROPERTIES | UNIT | TEST METHOD | MEASURE | |
|---|---|---|---|---|
| | | | TYPE 1 – GEOTEXTILE CONTAINER | TYPE 2 – SCOUR APRON |
| APPARENT OPENING SIZE (AOS) (MIN.) | U.S. SIEVE | ASTM D 4571 | #30 | #30 |
| CBR PUNCTURE STRENGTH (MIN.) | Lb | ASTM D 6241 | 2,400 | 700 |
| TRAPEZOID TEAR STRENGTH (MD x CD) (MIN.) | Lb | ASTM D 4533 | 180 x 180 | 100 x 100 |
| WIDE-WIDTH TENSILE STRENGTH (MD x CD) (MIN.) | % | ASTM D 4595 | 1,000 x 1,000 | – |
| WIDE-WIDTH TENSILE ELONGATION (MD x CD) (MAX.) | Lb/in | ASTM D 4884 | 500 | – |
| ULTRAVIOLET RESISTANCE (500 HOURS) (MIN.) | % | ASTM D 4355 | 70 | 70 |

2. GEOTEXTILE CONTAINER (INDIVIDUAL BAGS) DIMENSIONS, MATERIAL STRENGTH, AND SEAM STRENGTH SHALL BE CONFIRMED BY MANUFACTURER TO SUPPORT THE WEIGHT OF FILLED CONTAINER AND ABILITY TO BE TRANSPORTED OVER UNEVEN TERRAIN. IT IS RECOMMENDED PROTOTYPE CONTAINER IS FABRICATED AND TESTED PRIOR TO SHIPMENT OF GEOTEXTILE CONTAINERS TO PROJECT AREA.
3. GEOTEXTILE CONTAINERS SHALL BE FABRICATED WITH 3 SIDES SEWN CLOSED AND WITH TRANSPORT STRAPS. THE 4TH SIDE SHALL BE FIELD-SEWN AFTER FILLING PER MANUFACTURES INSTRUCTIONS.
4. POTENTIAL SUPPLIERS OF GEOTEXTILE CONTAINERS INCLUDE:
   a. INDUSTRIAL FABRICS (225) 273-9600
   b. FLINT INDUSTRIES (912) 685-3375
5. KEYING REVETMENT TERMINALS INTO SHORELINE IS OPTIONAL. IF KEYED IN, GEOTEXTILE CONTAINER REVETMENT SHALL BE BACKFILLED AT THE TERMINAL.
6. IT IS RECOMMENDED TO BACKFILL WITH SAND FROM BORROW AREA BETWEEN THE REVETMENT AND EXISTING SHORELINE TO PROVIDE ADDITIONAL STRENGTH TO THE STRUCTURE.
7. IT IS RECOMMENDED TO COVER REVETMENT WITH SAND FROM BORROW AREA TO PROVIDE ADDITIONAL UV PROTECTION AND CREATE A NATURAL SHORELINE APPEARANCE.

## GABION MATTRESS REVETMENT NOTES:

1. GABION MATERIAL SHALL BE PVC COATED GALVANIZED STEEL OR STAINLESS STEEL.
2. REFER TO GEOTEXTILE CONTAINER REVETMENT NOTE 1 FOR SCOUR APRON GEOTEXTILE FABRIC PHYSICAL CHARACTERISTICS.
3. STONES USED TO FILL GABION MATTRESSES SHALL BE LARGER IN DIAMETER THAN GABION GRID OPENINGS.
4. REFER TO GABION MATTRESS MANUFACTURER REQUIREMENTS FOR SPECIFIC MATERIAL DIMENSIONS, FILLING REQUIREMENTS, AND TRANSPORTATION LIMITATIONS.

## TIMBER SEAWALL NOTES:

1. METAL FASTENERS SHALL BE HOT DIPPED GALVANIZED.
2. WOOD MATERIAL SHALL BE PRESSURED TO A MINIMUM OF 2.5 PCF CHROMATED COPPER ARSENATE (CCA).
3. IT IS RECOMMENDED THAT POLYMER COATING BE APPLIED TO WOOD MATERIAL, ESPECIALLY PILINGS.
4. REFER TO GEOTEXTILE CONTAINER REVETMENT NOTE 1 FOR SCOUR APRON GEOTEXTILE FABRIC PHYSICAL CHARACTERISTICS.
5. REFER TO GABION MATTRESS REVETMENT NOTES FOR MATERIAL AND FILLING REQUIREMENTS OF GABION BASKET SCOUR PAD.

## BORROW AREA NOTES:

1. VEGETATED AREAS WITHIN AND/OR NEAR BORROW AREA SHALL NOT BE DISTURBED.
2. ALL VEHICLES SHALL USE PRE-EXISTING VEHICLE ROADWAYS (SEE SHEET 05C-01).
3. SAND SHALL BE REMOVED FROM BORROW AREA IN COMPLIANCE WITH ALL APPLICABLE REGULATIONS AND PERMIT REQUIREMENTS.

## B REVISION NOTES:

1. BASED ON COMMUNITY FEEDBACK DURING PUBLIC MEETING HELD ON MAY 27, 2015, GEOTEXTILE CONTAINER REVETMENT IS THE PREFERRED ALTERNATIVE. THUS, NO REVISIONS TO GABION MATTRESS REVETMENT AND TIMBER SEAWALL ALTERNATIVES WERE PERFORMED.
2. GEOTEXTILE CONTAINER REVETMENT LAYOUT REVISED TO ELIMINATE ACCESS AREA GAPS.
3. BORROW AREA WAS RELOCATED FROM END OF SPIT TO THE CORPORATION BORROW PIT LOCATED NORTH OF THE NELSON LAGOON RUNWAY.

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07-06-2015 | ISSUED TO CLIENT |
| A | 10-24-2014 | ISSUED TO CLIENT |

| | |
|---|---|
| PROJECT MANAGER | LAURIE CUMMINGS |
| DESIGNED BY | R. McPHERSON |
| DRAWN BY | F. MARTINEZ |
| CHECKED BY | D. HEILMAN |
| PROJECT NUMBER | 213165 |

**PRELIMINARY**

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ENGINEER: RONALD L. McPHERSON

REGISTRATION NO.: 13591

DATE: 07-06-2015

AKUTAN • COLD BAY • NELSON LAGOON ALEUTIANS EAST BOROUGH FALSE PASS • KING COVE • SAND POINT

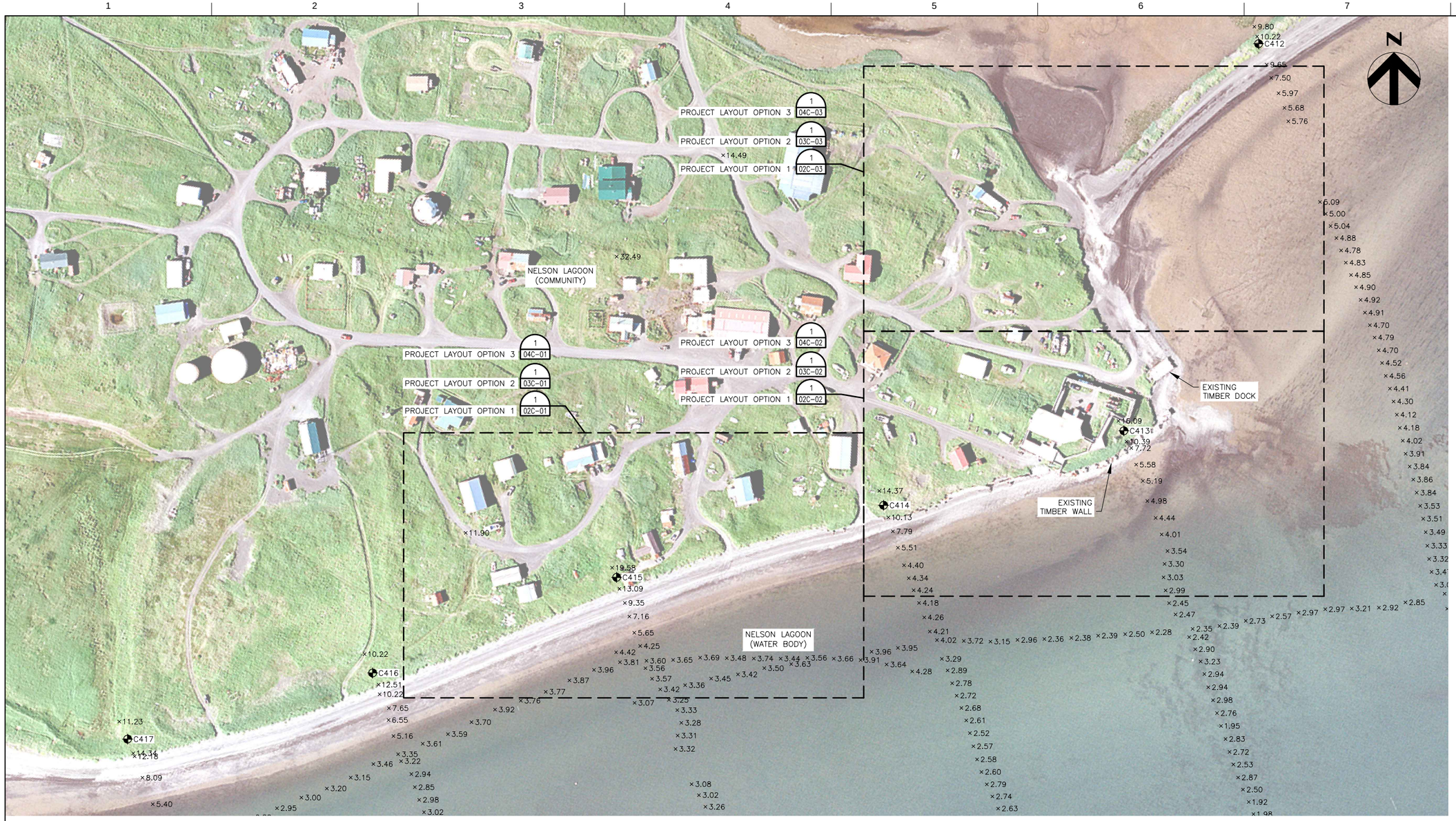
**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

GENERAL NOTES

FILENAME 00G-02.dwg

SCALE NONE

SHEET 00G-02




EXISTING SITE PLAN 1 00G-01

SCALE 0 100' 200'

| | | |
|---|---|---|
| B | 07-06-2015 | ISSUED TO CLIENT |
| A | 10-24-2014 | ISSUED TO CLIENT |
| ISSUE | DATE | DESCRIPTION |

| | |
|---|---|
| PROJECT MANAGER | LAURIE CUMMINGS |
| DESIGNED BY | R. McPHERSON |
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ENGINEER: RONALD L. McPHERSON

REGISTRATION NO.: 13591

DATE: 07-06-2015

AKUTAN • COLD BAY • NELSON LAGOON
ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION**
**NELSON LAGOON, ALASKA**

EXISTING SITE PLAN

| | | | |
|---|---|---|---|
| FILENAME | 01C-01.dwg | SHEET | 01C-01 |
| SCALE | AS NOTED | | |

PROJECT LAYOUT OPTION 1 (1 / 01C-01)

SCALE 0 40' 80'

| OPTION 1 ALIGNMENT COORDINATES | | |
|---|---|---|
| DESIGNATION | NORTHING | EASTING |
| A01 | 730,842.81 | 1,803,109.43 |
| A02 | 730,881.36 | 1,803,201.71 |
| A03 | 730,919.84 | 1,803,294.00 |
| A04 | 730,956.34 | 1,803,387.00 |
| A05 | 730,990.50 | 1,803,480.87 |
| A06 | 731,024.85 | 1,803,574.79 |
| A07 | 731,042.39 | 1,803,627.16 |
| A08 | 731,055.10 | 1,803,665.09 |
| A09 | 731,076.58 | 1,803,735.68 |
| A10 | 731,080.34 | 1,803,834.47 |

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
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| A | 10-24-2014 | ISSUED TO CLIENT |

| | |
|---|---|
| PROJECT MANAGER | LAURIE CUMMINGS |
| DESIGNED BY | R. McPHERSON |
| DRAWN BY | F. MARTINEZ |
| CHECKED BY | D. HEILMAN |
| PROJECT NUMBER | 213165 |

**PRELIMINARY**

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ENGINEER: RONALD L. McPHERSON

REGISTRATION NO.: 13591

DATE: 07-06-2015

AKUTAN • COLD BAY • NELSON LAGOON
ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

PROJECT LAYOUT OPTION 1

FILENAME 02C-01.dwg

SCALE AS NOTED

SHEET 02C-01

PROJECT LAYOUT OPTION 1 (1 / 01C-01)

SCALE 0 40' 80'

| OPTION 1 ALIGNMENT COORDINATES | | |
|---|---|---|
| DESIGNATION | NORTHING | EASTING |
| A11 | 731,098.54 | 1,803,910.18 |
| A12 | 731,116.19 | 1,803,980.70 |
| A13 | 731,138.24 | 1,804,033.75 |
| A14 | 731,157.99 | 1,804,081.28 |
| A15 | 731,167.81 | 1,804,134.46 |
| A16 | 731,191.69 | 1,804,212.59 |
| A17 | 731,190.96 | 1,804,299.96 |
| A18 | 731,192.72 | 1,804,299.94 |
| A19 | 731,217.28 | 1,804,367.67 |
| A20 | 731,240.65 | 1,804,403.82 |
| A21 | 731,259.70 | 1,804,418.79 |
| A22 | 731,283.29 | 1,804,466.01 |
| A23 | 731,299.57 | 1,804,469.39 |
| A24 | 731,328.12 | 1,804,453.41 |
| A25 | 731,350.51 | 1,804,448.23 |
| A26 | 731,377.14 | 1,804,456.65 |
| A27 | 731,401.16 | 1,804,490.83 |
| A28 | 731,402.80 | 1,804,443.09 |
| A29 | 731,426.70 | 1,804,407.25 |
| A30 | 731,467.20 | 1,804,377.70 |

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07-06-2015 | ISSUED TO CLIENT |
| A | 10-24-2014 | ISSUED TO CLIENT |

| | |
|---|---|
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FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

PROJECT LAYOUT OPTION 1

FILENAME 02C-02.dwg

SCALE AS NOTED

SHEET 02C-02

## PROJECT LAYOUT OPTION 1

1 / 01C-01

SCALE 0 40' 80'

**OPTION 1 ALIGNMENT COORDINATES**

| DESIGNATION | NORTHING | EASTING |
|---|---|---|
| A31 | 731,519.71 | 1,804,339.38 |
| A32 | 731,540.09 | 1,804,335.44 |
| A33 | 731,588.74 | 1,804,325.07 |
| A34 | 731,675.52 | 1,804,305.02 |
| A35 | 731,745.13 | 1,804,258.32 |
| A36 | 731,787.71 | 1,804,219.39 |

| ISSUE | DATE | DESCRIPTION |
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REGISTRATION NO.: 13591

DATE: 07–06–2015

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ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

PROJECT LAYOUT OPTION 1

FILENAME 02C-03.dwg

SCALE AS NOTED

SHEET 02C-03

PROJECT LAYOUT OPTION 2 (1 / 01C-01)

SCALE 0 40' 80'

| OPTION 2 ALIGNMENT COORDINATES | | |
|---|---|---|
| DESIGNATION | NORTHING | EASTING |
| B01 | 730,880.85 | 1,803,060.41 |
| B02 | 730,851.99 | 1,803,131.63 |
| B03 | 731,041.14 | 1,803,624.98 |
| B04 | 731,055.85 | 1,803,663.26 |
| B05 | 731,074.29 | 1,803,711.73 |
| B06 | 731,087.72 | 1,803,827.37 |

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07-06-2015 | ISSUED TO CLIENT |
| A | 10-24-2014 | ISSUED TO CLIENT |

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|---|---|
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| PROJECT NUMBER | 213165 |

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REGISTRATION NO.: 13591

DATE: 07-06-2015

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ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION**
**NELSON LAGOON, ALASKA**

PROJECT LAYOUT OPTION 2

FILENAME 03C-01.dwg

SCALE AS NOTED

SHEET 03C-01

## PROJECT LAYOUT OPTION 2

SCALE 0 40' 80'

1
01C-01

| OPTION 2 ALIGNMENT COORDINATES | | |
|---|---|---|
| DESIGNATION | NORTHING | EASTING |
| B07 | 731,111.30 | 1,803,910.89 |
| B08 | 731,115.58 | 1,803,980.31 |
| B09 | 731,200.36 | 1,804,210.60 |
| B10 | 731,192.26 | 1,804,299.92 |
| B11 | 731,278.70 | 1,804,471.46 |
| B12 | 731,377.61 | 1,804,452.29 |
| B13 | 731,424.29 | 1,804,406.30 |

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07-06-2015 | ISSUED TO CLIENT |
| A | 10-24-2014 | ISSUED TO CLIENT |

| | |
|---|---|
| PROJECT MANAGER | LAURIE CUMMINGS |
| DESIGNED BY | R. McPHERSON |
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| CHECKED BY | D. HEILMAN |
| PROJECT NUMBER | 213165 |

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ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

PROJECT LAYOUT OPTION 2

FILENAME 03C-02.dwg

SCALE AS NOTED

SHEET 03C-02

## PROJECT LAYOUT OPTION 2

1 01C-01

SCALE 0 40' 80'

| OPTION 2 ALIGNMENT COORDINATES | | |
|---|---|---|
| DESIGNATION | NORTHING | EASTING |
| B14 | 731,517.71 | 1,804,336.82 |
| B15 | 731,670.82 | 1,804,297.64 |
| B16 | 731,789.35 | 1,804,213.66 |
| B17 | 731,792.19 | 1,804,161.53 |

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
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|---|---|
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| DESIGNED BY | R. McPHERSON |
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| CHECKED BY | D. HEILMAN |
| PROJECT NUMBER | 213165 |

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ENGINEER: RONALD L. McPHERSON

REGISTRATION NO.: 13591

DATE: 07–06–2015

AKUTAN • COLD BAY • NELSON LAGOON
ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

PROJECT LAYOUT OPTION 2

FILENAME 03C-03.dwg

SCALE AS NOTED

SHEET 03C-03

## PROJECT LAYOUT OPTION 3

1 / 01C-01

SCALE 0 40' 80'

### OPTION 3 ALIGNMENT COORDINATES

| DESIGNATION | NORTHING | EASTING |
|---|---|---|
| C01 | 730,878.65 | 1,803,098.80 |
| C02 | 730,848.20 | 1,803,111.52 |
| C03 | 730,885.21 | 1,803,200.10 |
| C04 | 730,925.15 | 1,803,296.12 |
| C05 | 730,960.22 | 1,803,385.47 |
| C06 | 730,995.79 | 1,803,483.20 |
| C07 | 731,028.76 | 1,803,573.36 |
| C08 | 731,046.62 | 1,803,626.43 |
| C09 | 731,062.22 | 1,803,629.98 |
| C10 | 731,070.04 | 1,803,627.55 |
| C11 | 731,076.30 | 1,803,642.61 |
| C12 | 731,069.03 | 1,803,645.95 |
| C13 | 731,057.07 | 1,803,656.71 |
| C14 | 731,089.45 | 1,803,763.87 |
| C15 | 731,098.13 | 1,803,810.95 |
| C16 | 731,092.51 | 1,803,825.93 |

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07-06-2015 | ISSUED TO CLIENT |
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|---|---|
| PROJECT MANAGER | LAURIE CUMMINGS |
| DESIGNED BY | R. McPHERSON |
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| PROJECT NUMBER | 213165 |

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ENGINEER: RONALD L. McPHERSON

REGISTRATION NO.: 13591

DATE: 07-06-2015

AKUTAN • COLD BAY • NELSON LAGOON
ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

PROJECT LAYOUT OPTION 3

FILENAME 04C-01.dwg

SCALE AS NOTED

SHEET 04C-01

PROJECT LAYOUT OPTION 3 (1 / 01C-01)

SCALE 0 40' 80'

| OPTION 3 ALIGNMENT COORDINATES | | |
|---|---|---|
| DESIGNATION | NORTHING | EASTING |
| C17 | 731,118.04 | 1,803,918.47 |
| C18 | 731,121.52 | 1,803,974.36 |
| C19 | 731,171.04 | 1,804,083.67 |
| C20 | 731,198.66 | 1,804,208.66 |
| C21 | 731,191.67 | 1,804,242.91 |
| C22 | 731,198.06 | 1,804,301.80 |
| C23 | 731,219.71 | 1,804,362.10 |
| C24 | 731,243.51 | 1,804,403.91 |
| C25 | 731,263.85 | 1,804,416.63 |
| C26 | 731,288.59 | 1,804,467.24 |
| C27 | 731,324.79 | 1,804,450.32 |
| C28 | 731,355.74 | 1,804,442.66 |
| C29 | 731,377.42 | 1,804,452.68 |
| C30 | 731,409.17 | 1,804,398.87 |
| C31 | 731,415.50 | 1,804,403.76 |
| C32 | 731,423.60 | 1,804,404.36 |

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| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07-06-2015 | ISSUED TO CLIENT |
| A | 10-24-2014 | ISSUED TO CLIENT |

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|---|---|
| PROJECT MANAGER | LAURIE CUMMINGS |
| DESIGNED BY | R. McPHERSON |
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| PROJECT NUMBER | 213165 |

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ENGINEER: RONALD L. McPHERSON

REGISTRATION NO.: 13591

DATE: 07-06-2015

AKUTAN • COLD BAY • NELSON LAGOON
ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

PROJECT LAYOUT OPTION 3

FILENAME 04C-02.dwg

SCALE AS NOTED

SHEET 04C-02

MATCHLINE SEE SHEET 04C-02

## PROJECT LAYOUT OPTION 3

1
01C-01

SCALE 0 40' 80'

| OPTION 3 ALIGNMENT COORDINATES | | |
|---|---|---|
| DESIGNATION | NORTHING | EASTING |
| C35 | 731,520.48 | 1,804,333.67 |
| C36 | 731,583.31 | 1,804,321.85 |
| C37 | 731,676.95 | 1,804,300.42 |
| C38 | 731,742.75 | 1,804,254.89 |
| C39 | 731,784.07 | 1,804,217.08 |
| C40 | 731,767.87 | 1,804,199.38 |

| ISSUE | DATE | DESCRIPTION |
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ENGINEER: RONALD L. McPHERSON

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ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION**
**NELSON LAGOON, ALASKA**

PROJECT LAYOUT OPTION 3

FILENAME 04C-03.dwg
SCALE AS NOTED
SHEET 04C-03

POTENTIAL BORROW AREA

SCALE 0 100' 200'

1 / 00G-01

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07-06-2015 | ISSUED TO CLIENT |
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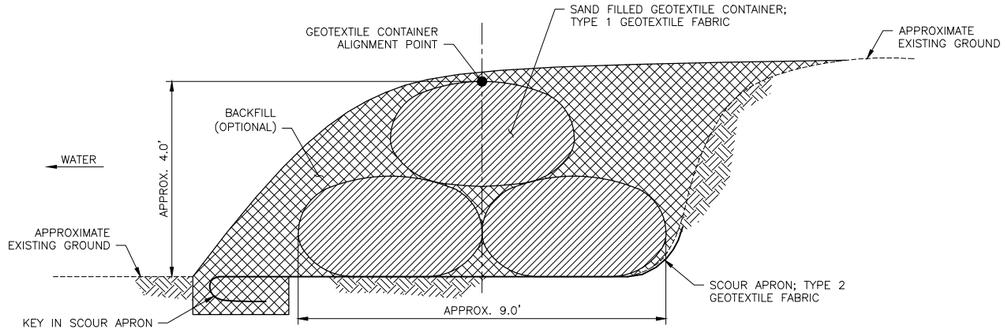
**NELSON LAGOON SHORELINE PROTECTION**
**NELSON LAGOON, ALASKA**

POTENTIAL BORROW AREA

FILENAME 05C-01.dwg

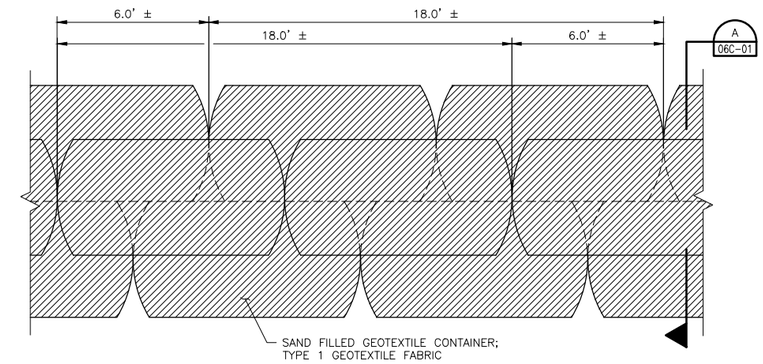
SCALE AS NOTED

SHEET 05C-01



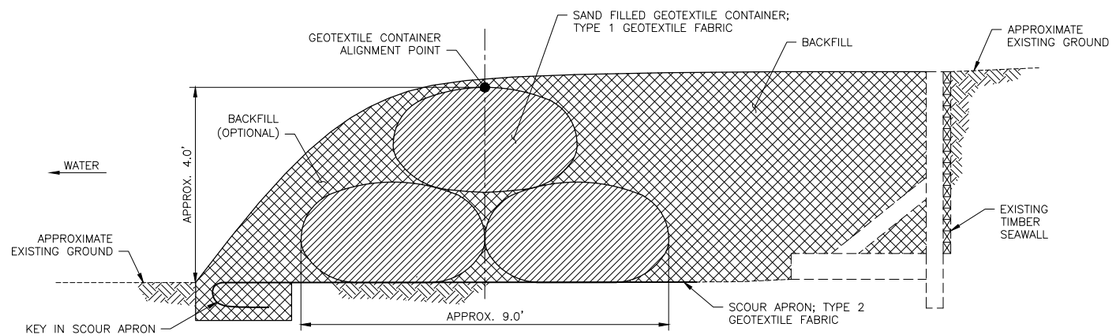

TYPICAL SECTION – GEOTEXTILE CONTAINER REVETMENT (A / –)

SCALE: NOT TO SCALE



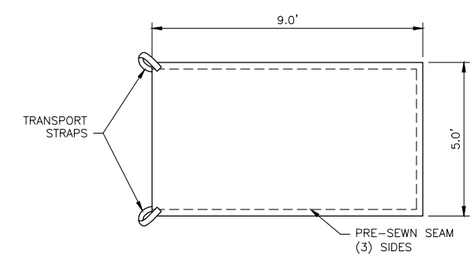

TYPICAL DETAIL – GEOTEXTILE CONTAINER REVETMENT (1 / –)

SCALE: NOT TO SCALE




TYPICAL SECTION – GEOTEXTILE CONTAINER REVETMENT WITH EXISTING TIMBER SEAWALL (A16 THRU A25) (B / –)

SCALE: NOT TO SCALE




TYPICAL DETAIL – GEOTEXTILE CONTAINER, UNFILLED (2 / –)

SCALE: NOT TO SCALE

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07–06–2015 | ISSUED TO CLIENT |
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| PROJECT MANAGER | LAURIE CUMMINGS |
| DESIGNED BY | R. McPHERSON |
| DRAWN BY | F. MARTINEZ |
| CHECKED BY | D. HEILMAN |
| PROJECT NUMBER | 213165 |

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REGISTRATION NO.: 13591

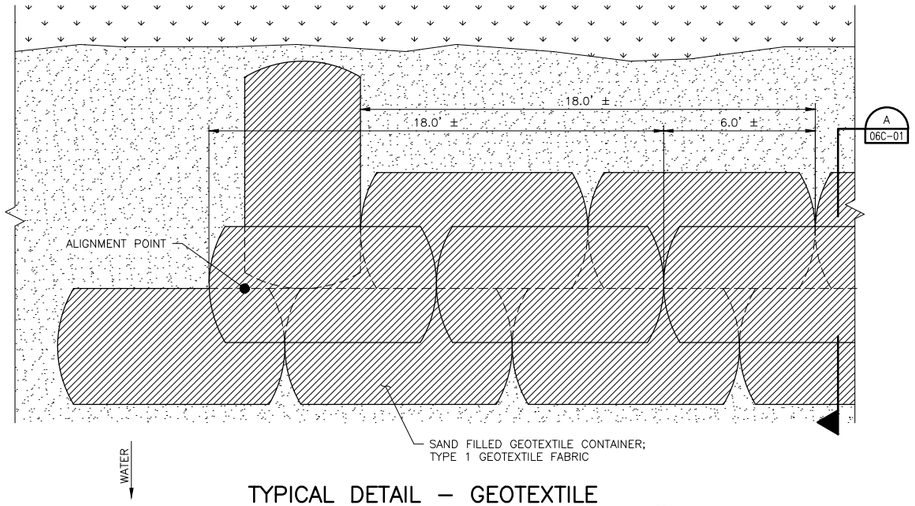
DATE: 07–06–2015

AKUTAN • COLD BAY • NELSON LAGOON
ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION**
**NELSON LAGOON, ALASKA**

TYPICAL SECTIONS AND DETAILS OPTION 1

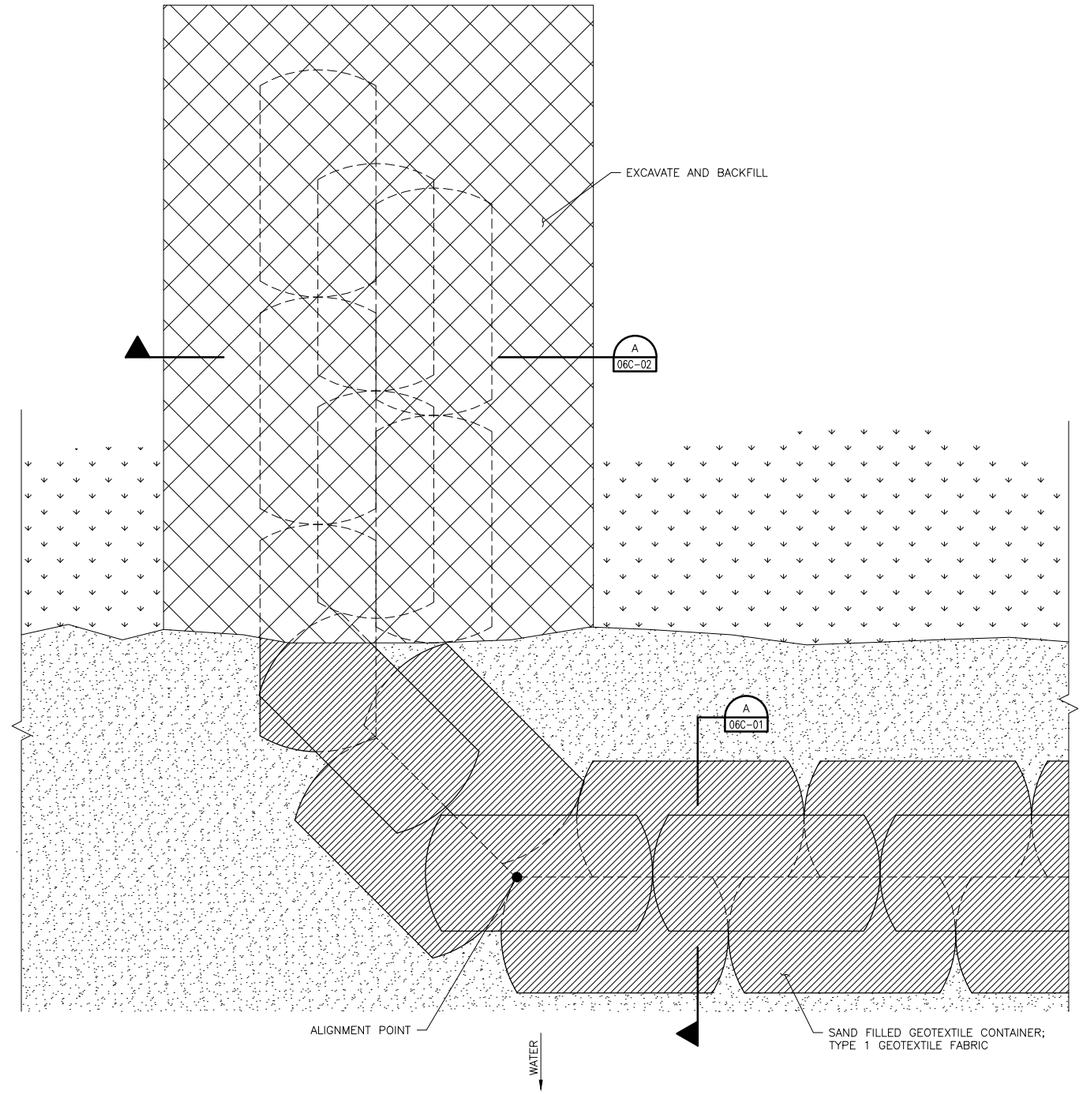
FILENAME: 06C-01.dwg
SCALE: AS NOTED
SHEET: 06C-01




## TYPICAL DETAIL – GEOTEXTILE CONTAINER REVETMENT TERMINAL (1 / –)

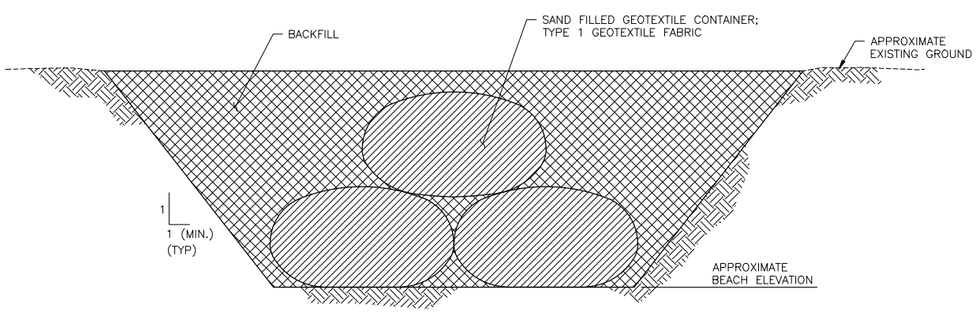
SCALE: NOT TO SCALE

SEE (2 / 06C-02) FOR OPTIONAL GEOTEXTILE CONTAINER REVETMENT TERMINAL




## TYPICAL DETAIL – GEOTEXTILE CONTAINER REVETMENT TERMINAL (OPTIONAL) (2 / –)

SCALE: NOT TO SCALE




## TYPICAL SECTION – GEOTEXTILE CONTAINER REVETMENT KEYED–IN (A / –)

SCALE: NOT TO SCALE

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07–06–2015 | ISSUED TO CLIENT |
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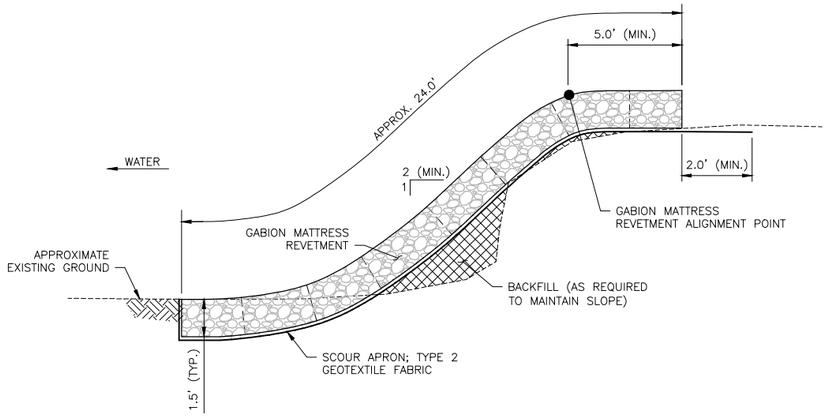
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION**
**NELSON LAGOON, ALASKA**

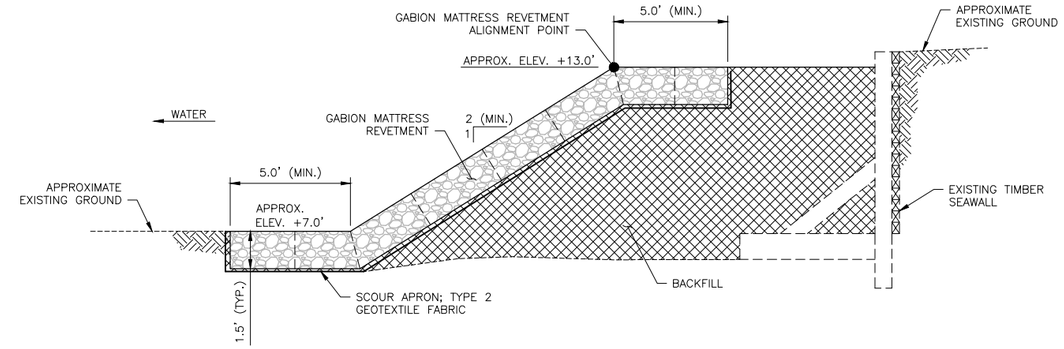
TYPICAL SECTIONS AND DETAILS OPTION 1

FILENAME: 06C-02.dwg
SCALE: AS NOTED
SHEET: 06C-02



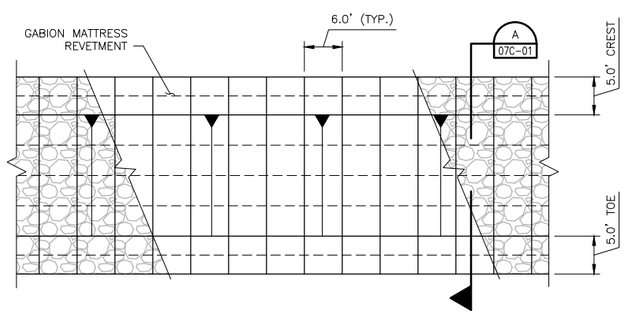

## TYPICAL SECTION – GABION MATTRESS REVETMENT (A)

SCALE: NOT TO SCALE



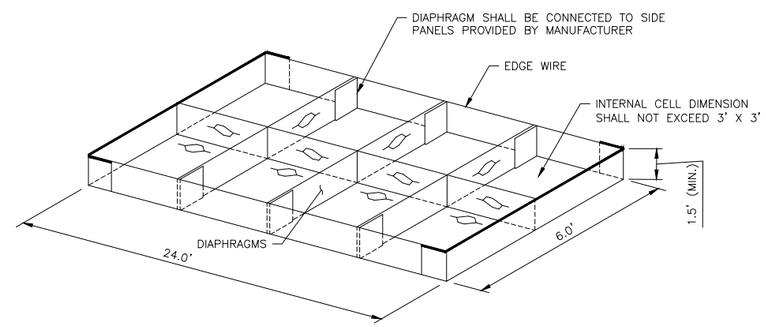

## TYPICAL SECTION – GABION MATTRESS REVETMENT WITH EXISTING TIMBER SEAWALL (B09 THRU B12) (B)

SCALE: NOT TO SCALE



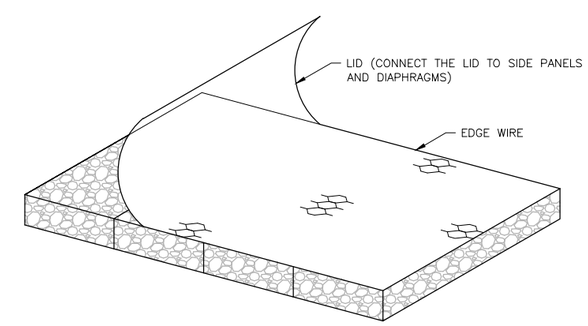

## TYPICAL DETAIL – GABION MATTRESS REVETMENT (1)

SCALE: NOT TO SCALE




## TYPICAL CONFIGURATION – FABRICATED GABION MATTRESS (2)

SCALE: NOT TO SCALE




## TYPICAL CONFIGURATION – FILLED GABION MATTRESS (3)

SCALE: NOT TO SCALE

| ISSUE | DATE | DESCRIPTION |
|---|---|---|
| B | 07–06–2015 | ISSUED TO CLIENT |
| A | 10–24–2014 | ISSUED TO CLIENT |

| | |
|---|---|
| PROJECT MANAGER | LAURIE CUMMINGS |
| DESIGNED BY | R. McPHERSON |
| DRAWN BY | F. MARTINEZ |
| CHECKED BY | D. HEILMAN |
| PROJECT NUMBER | 213165 |

**PRELIMINARY**

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ENGINEER: RONALD L. McPHERSON

REGISTRATION NO.: 13591

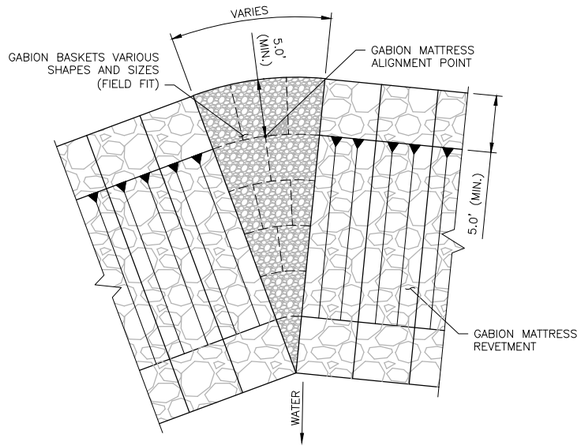
DATE: 07–06–2015

AKUTAN • COLD BAY • NELSON LAGOON
ALEUTIANS EAST BOROUGH
FALSE PASS • KING COVE • SAND POINT

**NELSON LAGOON SHORELINE PROTECTION**
**NELSON LAGOON, ALASKA**

TYPICAL SECTIONS AND DETAILS OPTION 2

FILENAME: 07C-01.dwg
SCALE: AS NOTED
SHEET: 07C-01




DETAIL – GABION MATTRESS REVETMENT INNER BEND (1 / –)

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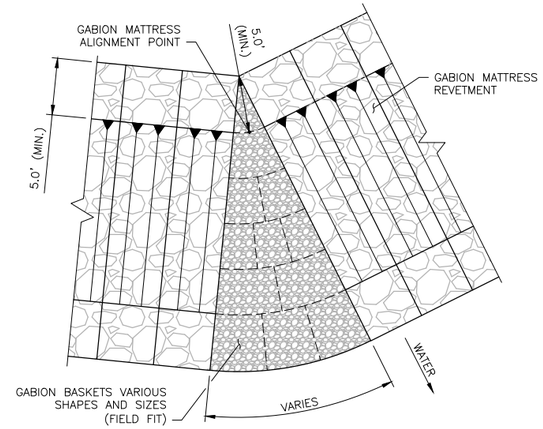


DETAIL – GABION MATTRESS REVETMENT OUTER BEND (2 / –)

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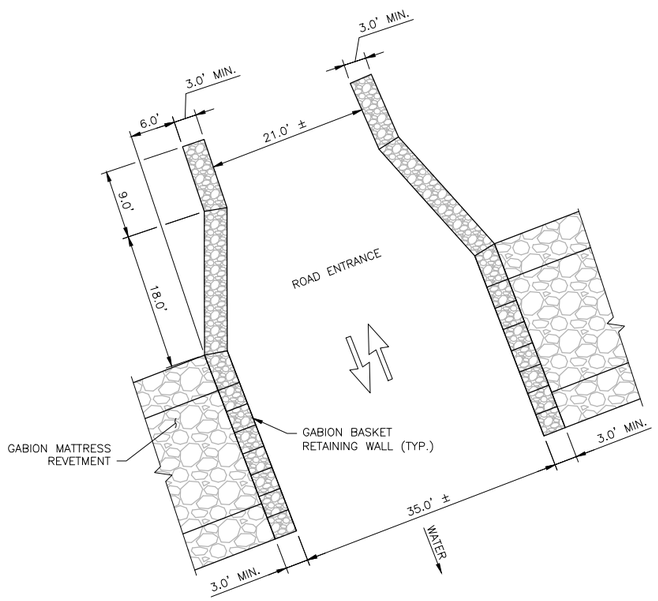


DETAIL – GABION MATTRESS REVETMENT ENTRANCE (3 / –)

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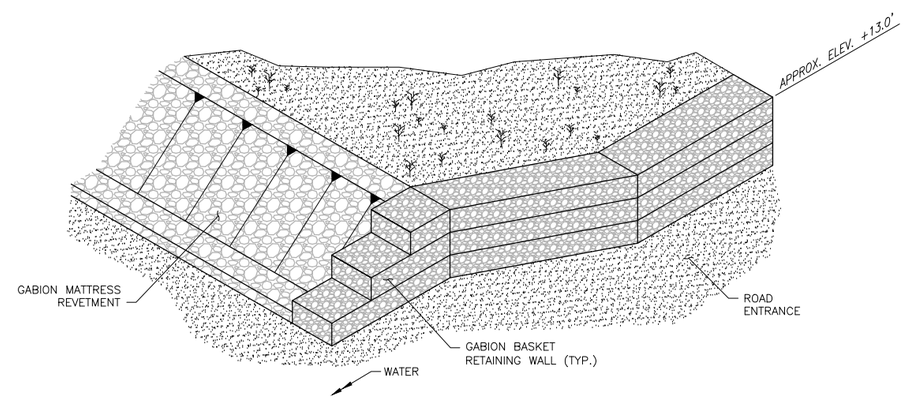


DETAIL – GABION BASKET RETAINING WALL (4 / –)

SCALE: NOT TO SCALE

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DATE: 07–06–2015

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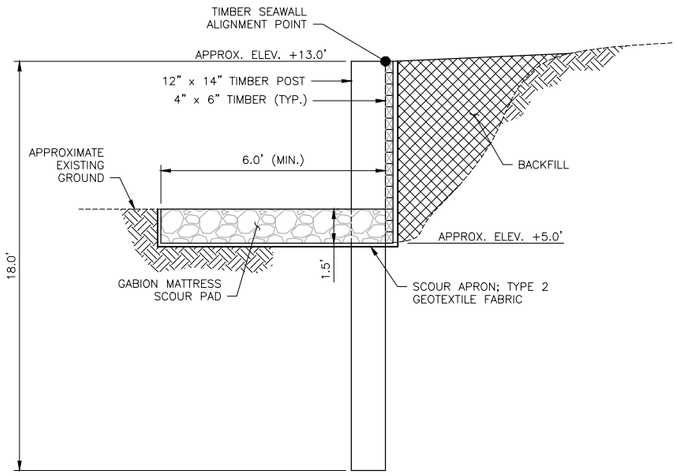
**NELSON LAGOON SHORELINE PROTECTION**
**NELSON LAGOON, ALASKA**

TYPICAL SECTIONS AND DETAILS OPTION 2

FILENAME: 07C-02.dwg

SCALE: AS NOTED

SHEET: 07C-02




## TYPICAL SECTION – TIMBER SEAWALL (A)

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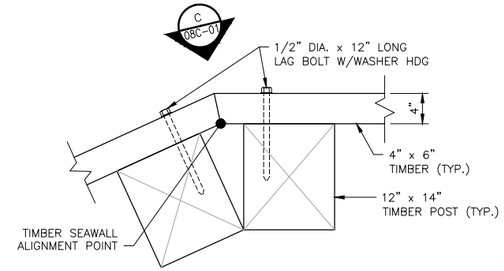
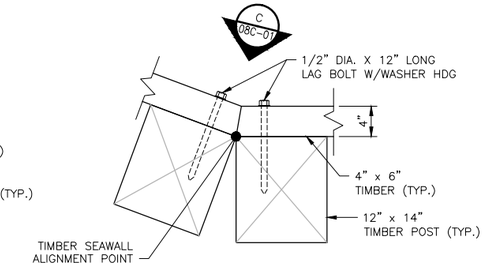



## TYPICAL DETAIL – TIMBER SEAWALL (1)

SCALE: NOT TO SCALE

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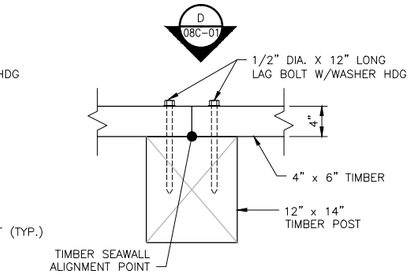


## TYPICAL DETAIL – TIMBER SEAWALL (3)

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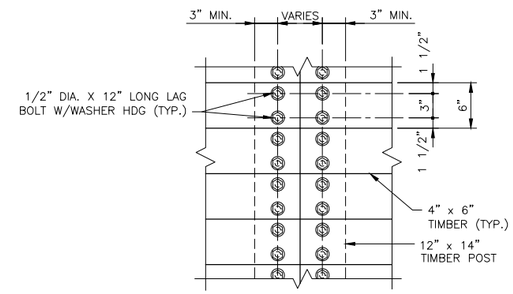


## TYPICAL ELEVATION – TIMBER SEAWALL (C)

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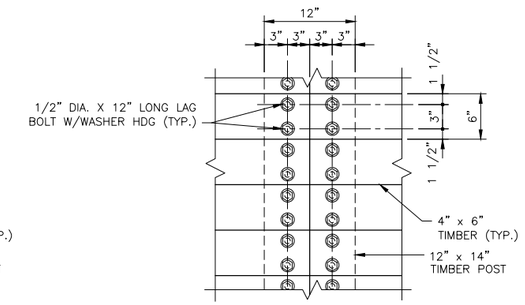


## TYPICAL ELEVATION – TIMBER SEAWALL (D)

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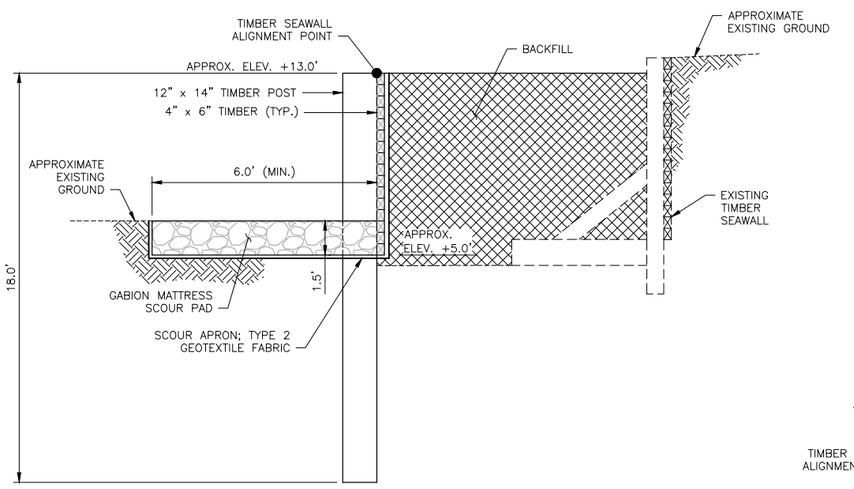


## TYPICAL SECTION – TIMBER SEAWALL WITH EXISTING TIMBER SEAWALL (C21 THRU C28) (B)

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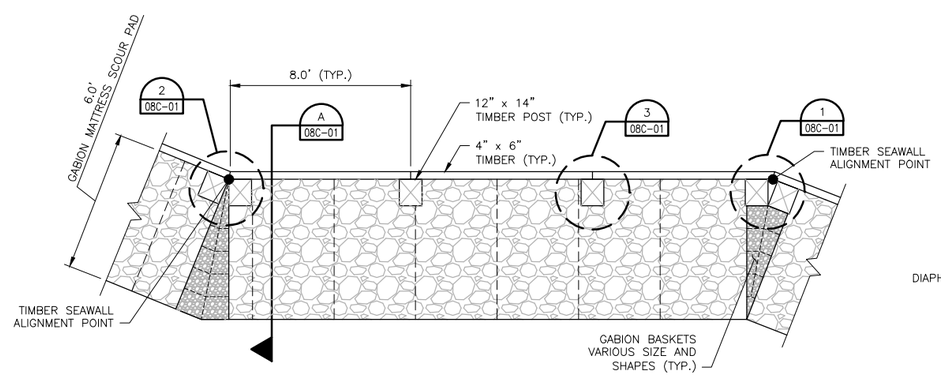


## TYPICAL DETAIL – TIMBER SEAWALL (4)

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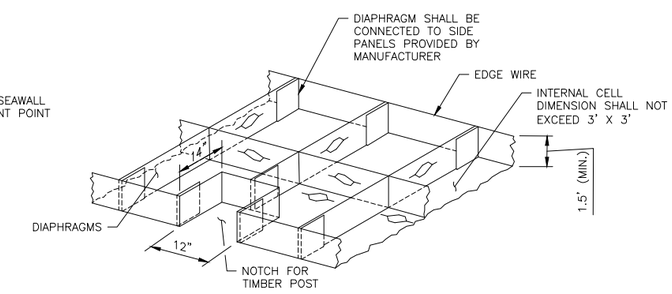


## TYPICAL DETAIL – GABION MATTRESS SCOUR PAD (5)

SCALE: NOT TO SCALE

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| DESIGNED BY | R. McPHERSON |
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| CHECKED BY | D. HEILMAN |
| PROJECT NUMBER | 213165 |

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ENGINEER: RONALD L. McPHERSON

REGISTRATION NO.: 13591

DATE: 07–06–2015

AKUTAN • COLD BAY • NELSON LAGOON
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**NELSON LAGOON SHORELINE PROTECTION NELSON LAGOON, ALASKA**

TYPICAL SECTIONS AND DETAILS OPTION 3

| | | | |
|---|---|---|---|
| FILENAME | 08C-01.dwg | SHEET | 08C-01 |
| SCALE | AS NOTED | | |

# Appendix C:
# Public Involvement Summary

Appendix C. Public Involvement

Appendix C contains the following items:

Public Meeting #1

- Flyer
- Meeting summary
- Presentation
- Sign in sheet

Public Meeting #2

- Flyer
- Meeting summary
- Presentation
- Sign in sheet

# Informational Meeting

**What?**

## NELSON LAGOON COASTAL EROSION STUDY

**When?**

**Monday, May 12, 2014**
**2:00 PM**

**Where?**

**Community Center**

**Your questions, comments, and input are important!**

**Why?**

**This will be an informal meeting to talk about the coastal erosion study and provide input regarding potential shoreline protection measures. All are welcome!**

Come and learn about:

- The coastal erosion study process
- Shoreline erosion projections
- Potential ways to address erosion in Nelson Lagoon

**Who?**

**If you have questions, contact:**

Laurie Cummings
HDR Alaska, Inc.
(907) 644-2065
laurie.cummings@hdrinc.com

# Meeting Notes

| | |
|---|---|
| Date and Time: | Monday, May 12, 2014 |
| Project: | Nelson Lagoon Coastal Erosion Study |
| Meeting Location: | Community Center |
| Subject: | **Public Meeting #1 Meeting Notes** |

On Monday, May 12, 2014, a public meeting was held in Nelson Lagoon to discuss the coastal erosion study. The purpose of this meeting was to present the results of the coastal erosion projection and to discuss potential erosion protection measures.

Two historical shoreline projections for 2068 were presented to the community. The shoreline projection was based on historical shoreline positions (from 1963, 1972, 1983, 1997, 2001, 2009, and 2013). The 1963 dataset was developed using a USGS base map rather than from an aerial photograph like the other datasets. As it was not developed in the same manner as the other shorelines, any projections using the dataset may contain large amounts of error. The projection based on the 1972-2013 data was presented as the more likely shoreline forecast. A projection for the community with and without the seawall was also presented.

The community indicated that the shoreline projection was concerning because it shows that multiple buildings and the airport could be affected by erosion. Identifying and implementation a solution to address the erosion is one of the community's top concerns.

Next, potential erosion protection measures were presented to the community. The intent of this was to inform community residents about what type of erosion protection measures are available as well as the pros and cons of the different methods. Meeting attendees were also asked about what they liked and what they were concerned about regarding each of the different measures.

The community feedback on each measure is summarized below:

Traditional:

- Sheetpile Wall
    - Would be most protective but cost prohibitive to build.
    - Would take too long to implement
    - May not get permission to construct
- Armor Stone Revetment
    - Likely to be too cost prohibitive

Non-Traditional:

- Gabion Baskets
    - Successfully used with the existing seawall
    - Local small rocks are available
    - Could be successfully implemented by the community
    - Could be implemented in less time than some other solutions

- Articulating Block Mats
    - Likely to be cost prohibitive
- Geotextile Tubes
    - Successfully used near the dock
    - Cost may be an issue. The existing geotextile tubes cost approximately $100,000 and multiple geotextile tubes would be required.
    - The ability to stack tubes to create more of an angled wall was desired.
    - Has the potential to be phased.
- Concrete Bag Revetment
    - No local source of concrete
    - Could be cost prohibitive
    - Could be implemented in less time than some other solutions
    - Could be successfully implemented by the community
    - Some concern regarding the appearance and ability to repair the revetment if it was damaged
- Timber Seawall
    - Similar to the existing seawall which was successful and did its job
    - Some concern regarding the cost of materials
- Beach Nourishment
    - Was intriguing for some but a hard structure was generally preferred
    - Concern regarding environment impacts
- Geotextile Containers
    - Less expensive than some other options
    - Could be built with community labor and equipment
    - Local sand/stones could be used to fill containers
    - Could be implemented in the near future
    - Overall, had the most community support

Other issues that were raised during the meeting:

- A combination of alternatives such as a timber seawall with gabion baskets may be effective
- Environmental concerns will need to be addressed as the area is part of the Port Moller Critical Habitat Area. HDR and Aleutians East Borough will meet with US Fish and Wildlife Service and other agencies to identify their concerns so they can be addressed early in the alternative development process.
- The appearance of the structures can be improved by covering the structure with local sand and either allowing plants to natural grow from surrounding areas or plant indigenous plants. This creates a natural appearing shoreline while having a structure in place to maintain the shoreline in the case of a major event.
- Access to the beach is of importance to the community. They would like to preserve the beach access points if possible. However, openings in the structure can reduce their effectiveness. The closure of some access points may be considered if needed to provide effective shoreline protection.
- FEMA funds may become available for the community.

The meeting concluded at 3:15 PM.

Attachments: Sign In Sheet
Presentation

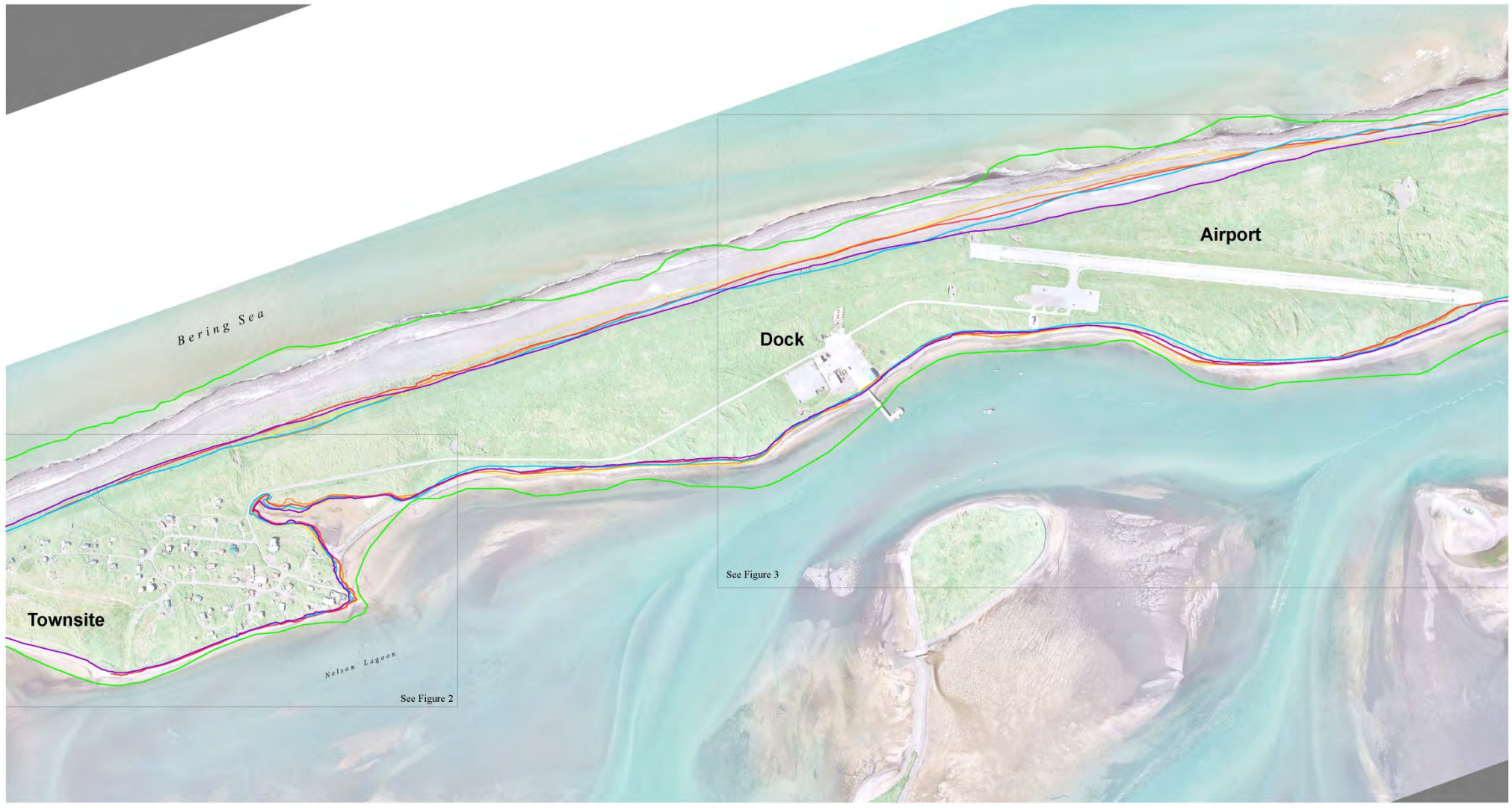
# Coastal Erosion Study
# Nelson Lagoon

May 12, 2014

# Historical Studies

- Historical Shoreline Mapping
- Hazard Impact Assessment
- Erosion Management Quality Assurance Program Plan
- Coastal Erosion Study
  - Shoreline Survey
  - Shoreline Projection
  - Wave and Hydrodynamic Modeling
  - Conceptual Alternatives

# Existing Shoreline - 2013




**Nelson Lagoon Historical Shoreline Location (1963-2013)** **Figure 1**

**Date of Shoreline**

1963 1972 1983 1997 2001 2013

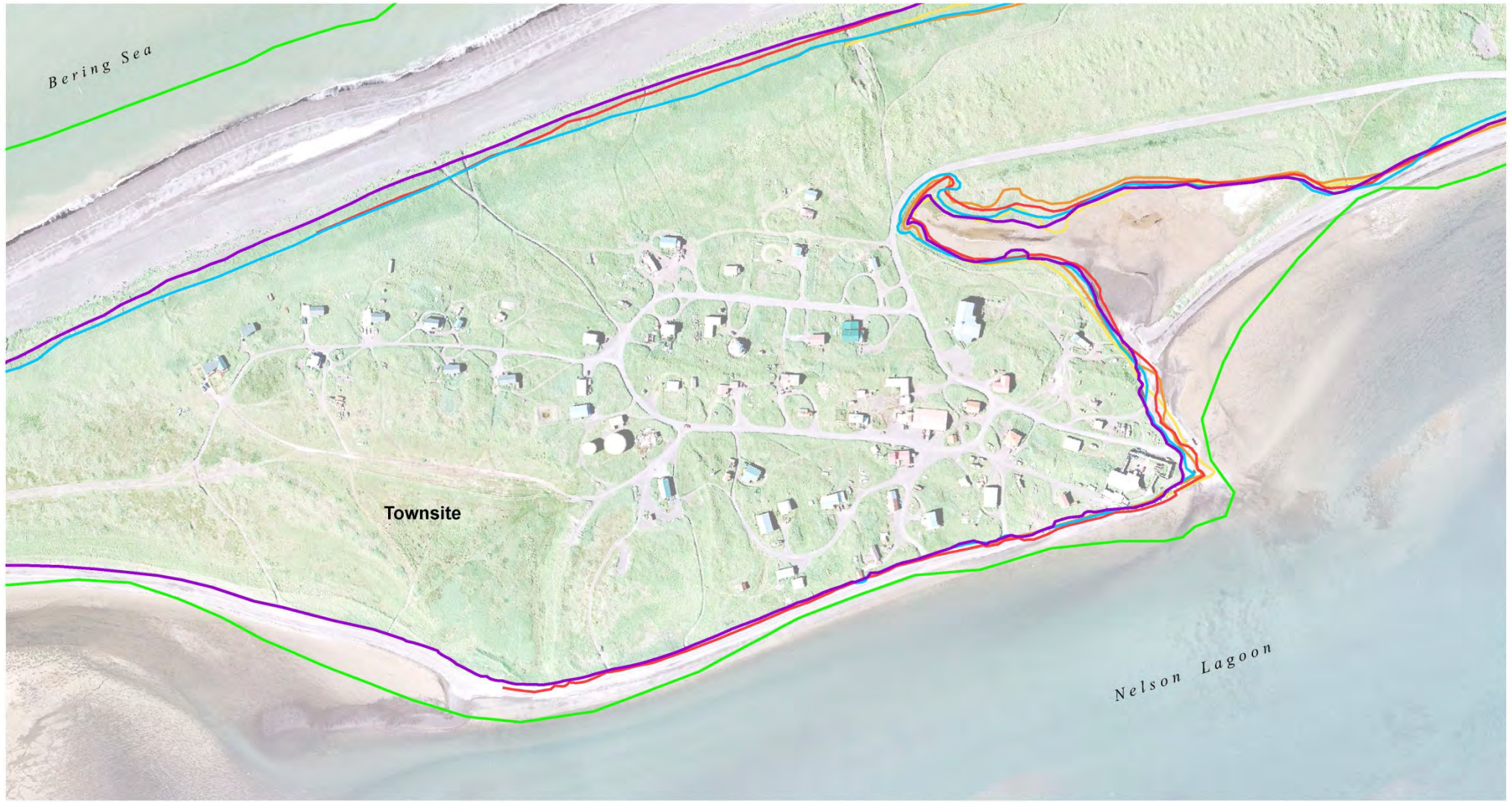
0 250 500 Feet

N

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/10/2014

# Existing Shoreline - 2013




**Nelson Lagoon Historical Shoreline Erosion (1963-2013) - Townsite** **Figure 2**

**Date of Shoreline**

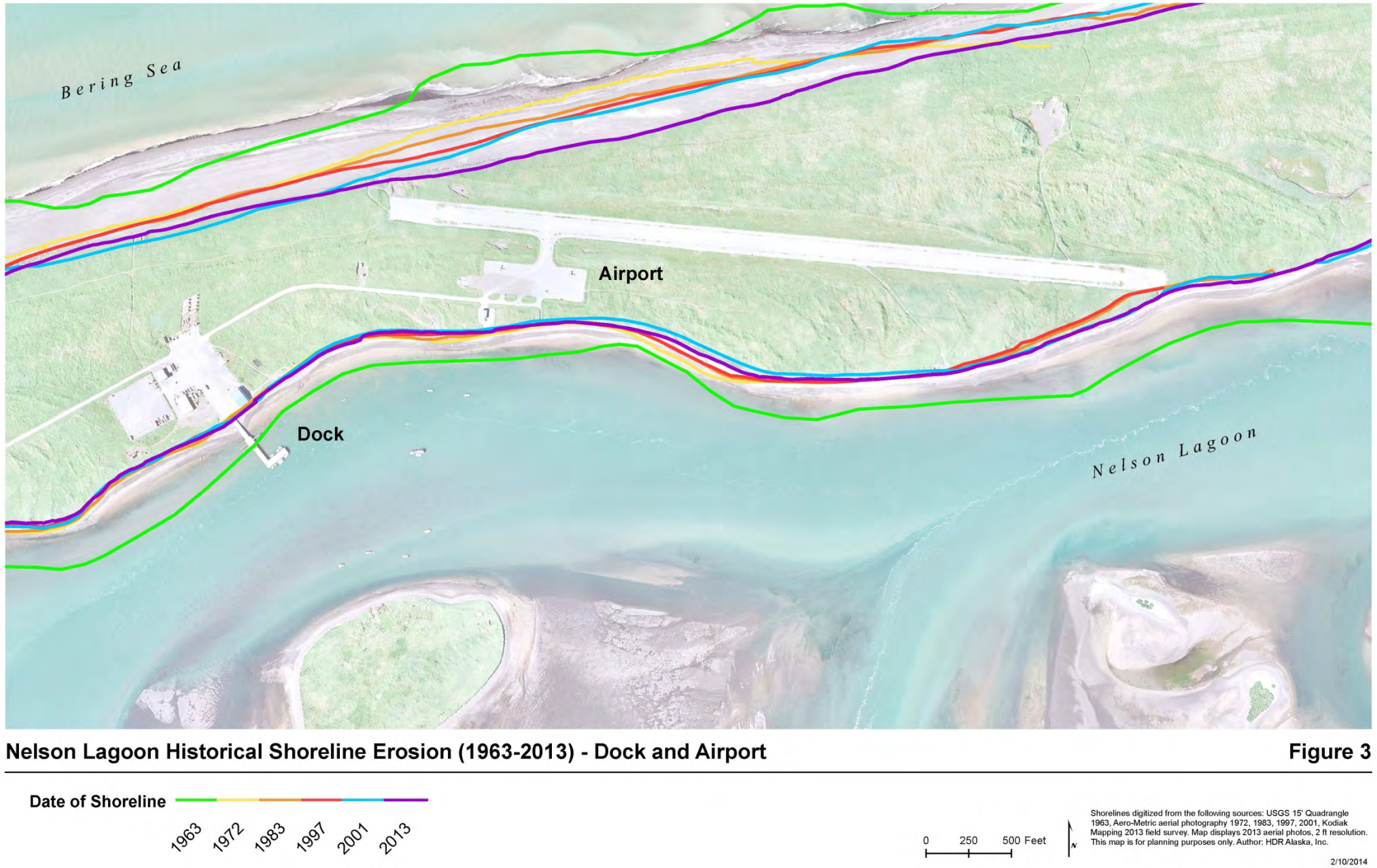
1963 1972 1983 1997 2001 2013

0 250 500 Feet

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/10/2014

# Existing Shoreline - 2013



# Shoreline Projection - 2068

**Projected shoreline in 2068 using 1972 - 2013 erosion rate** **Figure 7**

**Date of Shoreline**

1963 1972 1983 1997 2001 2013 2068

The 2068 projected shorelines are based on 1972–2013 erosion rates.

Bering Sea/Nelson Lagoon

0 250 500 Feet

N

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/12/2014

# Shoreline Projection - 2068

**Projected shoreline in 2068 using 1972 - 2013 erosion rate - Townsite** **Figure 8**

**Date of Shoreline**

1963 1972 1983 1997 2001 2013 2068

The 2068 projected shorelines are based on 1972–2013 erosion rates.

Bering Sea/Nelson Lagoon

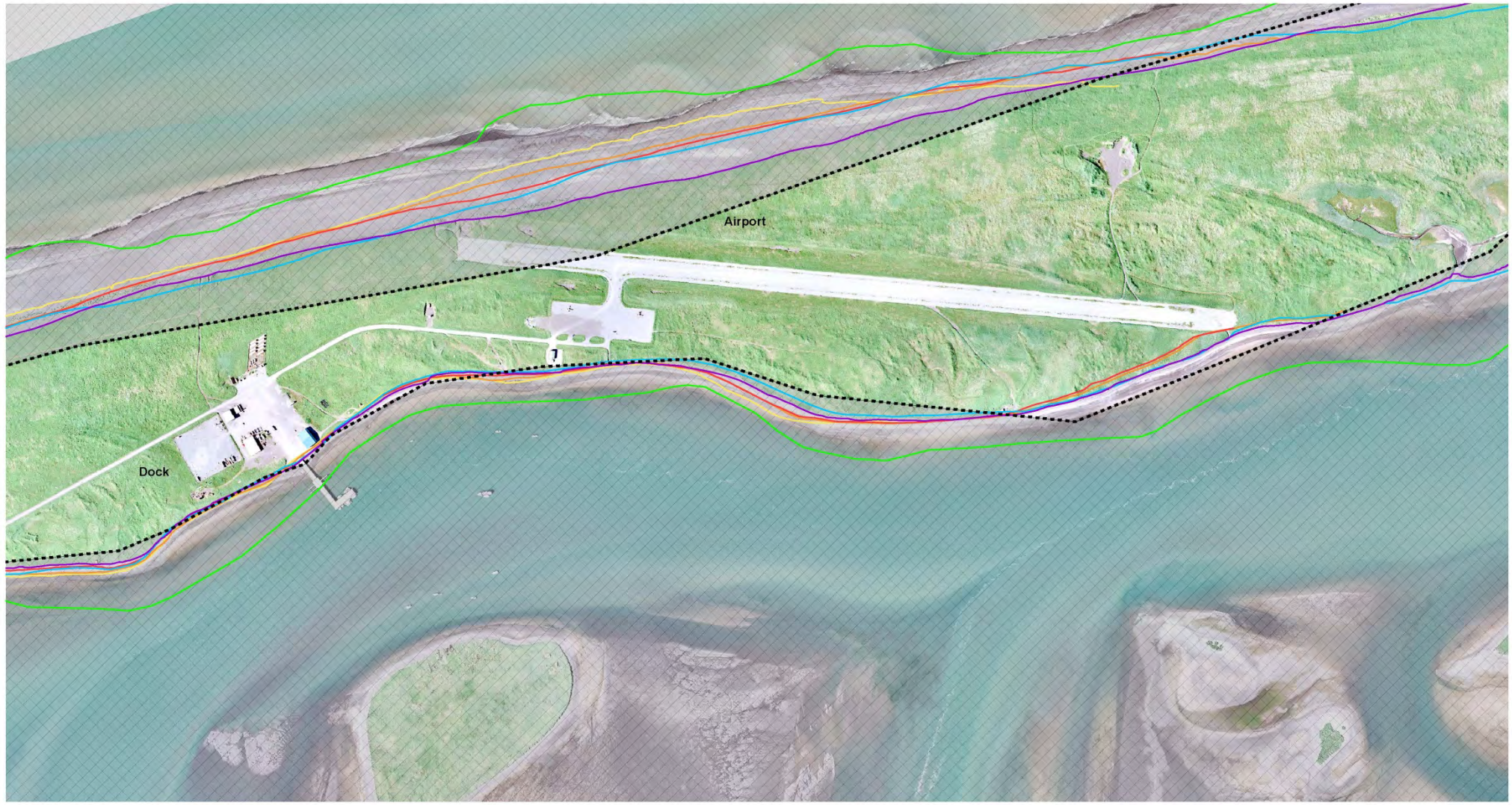
0 250 500 Feet

N

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/14/2014

# Shoreline Projection - 2068




**Projected shoreline in 2068 using 1972 - 2013 erosion rate - Dock and Airport** **Figure 9**

**Date of Shoreline**

1963 1972 1983 1997 2001 2013 2068

The 2068 projected shorelines are based on 1972–2013 erosion rates.

Bering Sea/Nelson Lagoon

0 250 500 Feet

N

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/12/2014

# Shoreline Projection - 2068

**Seawall Area Projection (2068)** **Figure 10**

**Projected Shoreline (1963-2013 rate)**

- Projection with no seawall
- Projection with seawall

**Projected Shoreline (1973-2013 rate)**

- Projection with no seawall
- Projection with seawall

0 100 200 Feet

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/12/2014

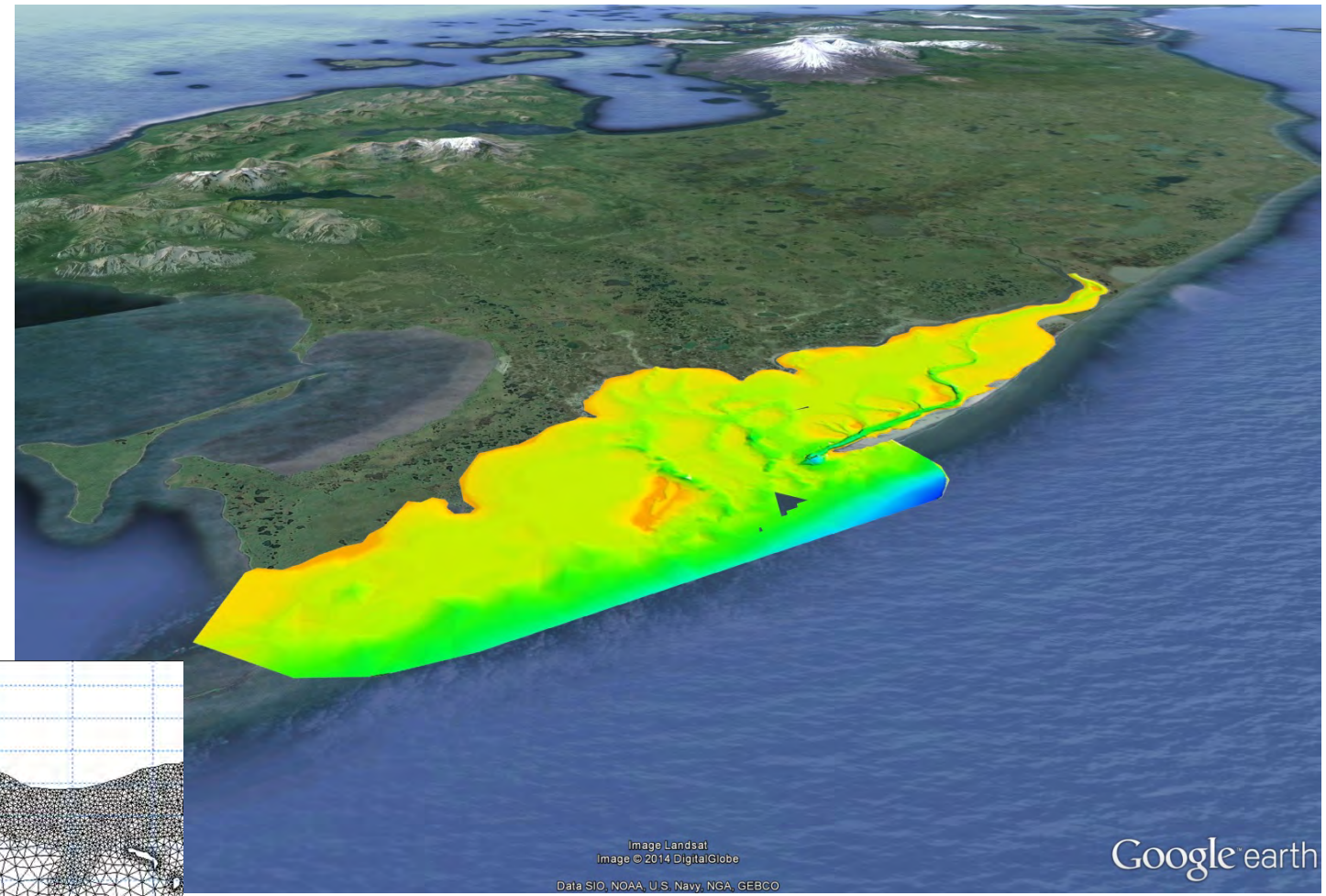
# Wave and Hydrodynamic Modeling

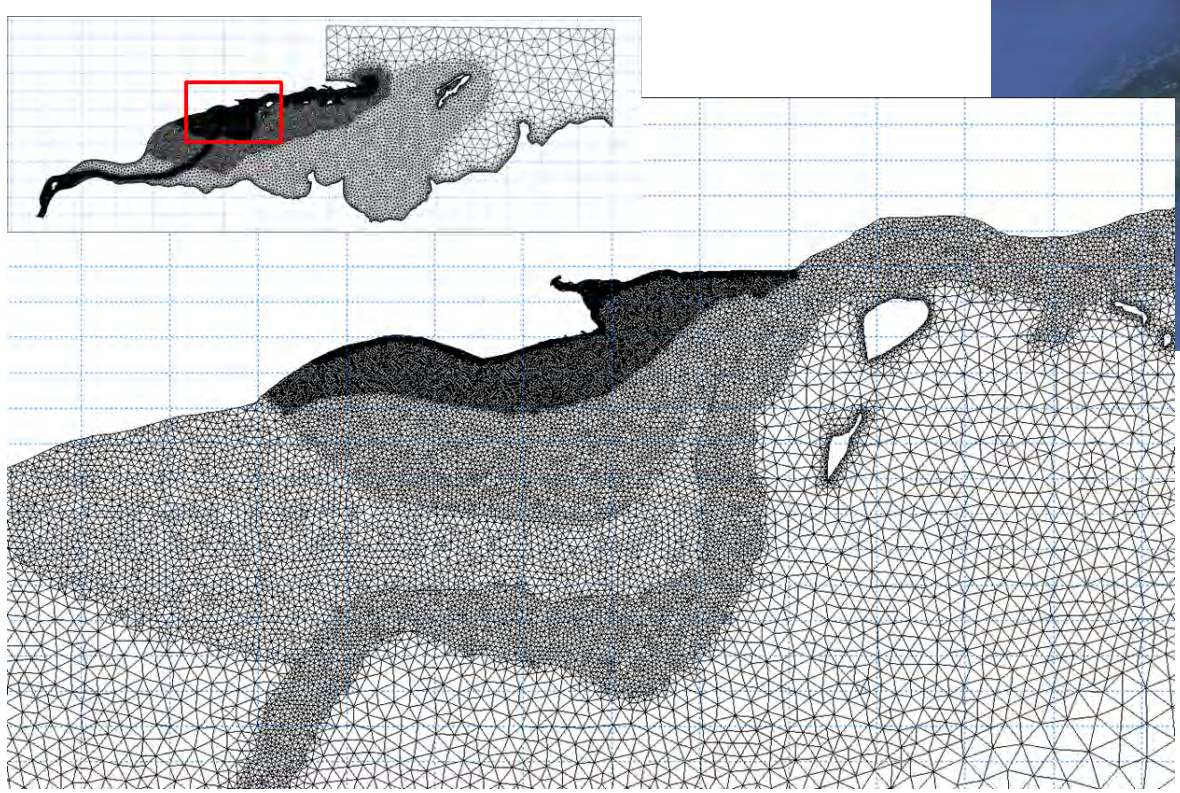
- Computer model that calculates and helps predict waves and currents
- Uses actual measured data as input
- Provides information helpful for design

# Where does the input data come from?

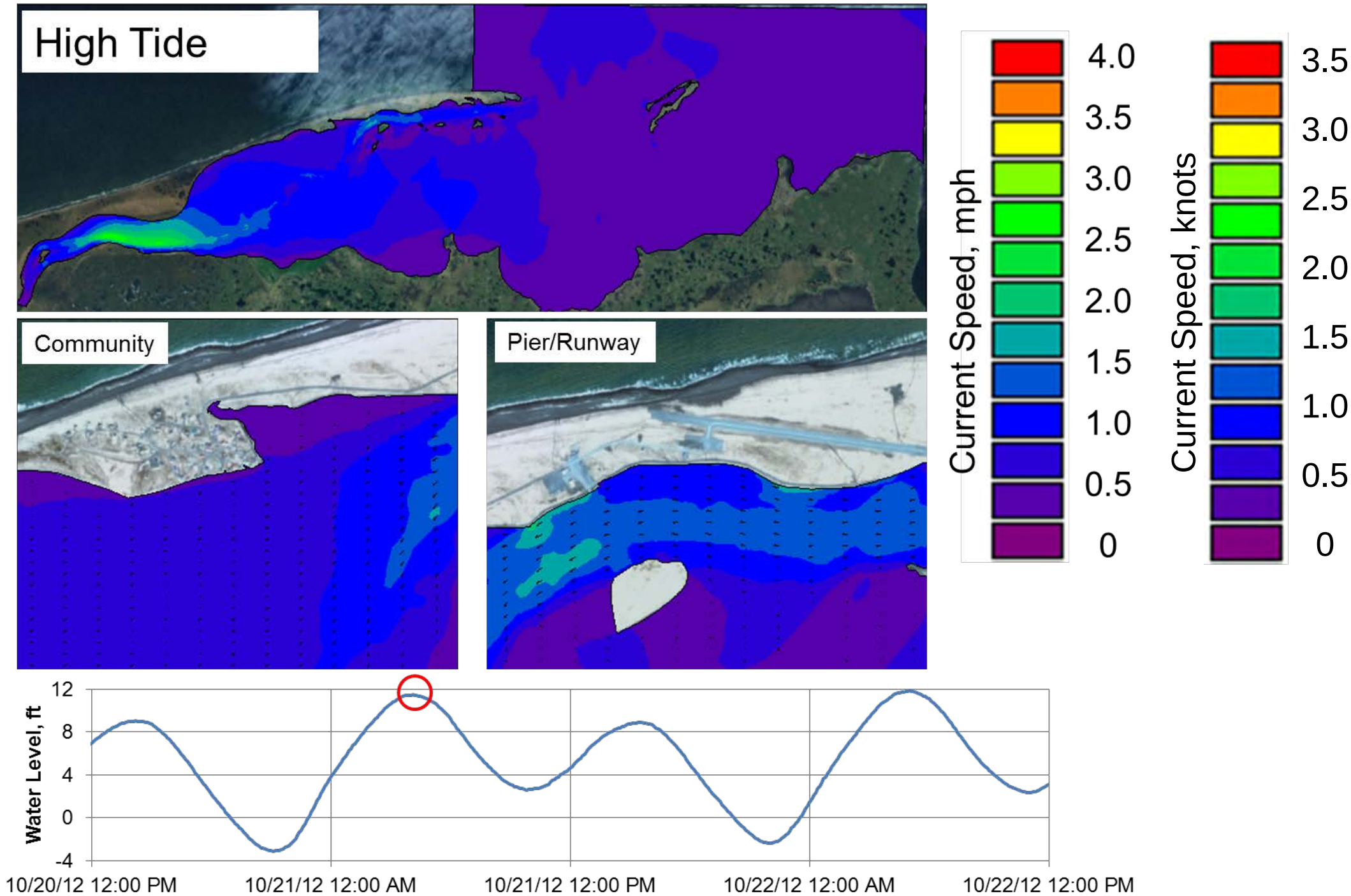
- Survey Data Collected in 2013
- Field Data Collected in 2012
- NOAA Station at Port Moller

# Numerical Model Mesh and Domain

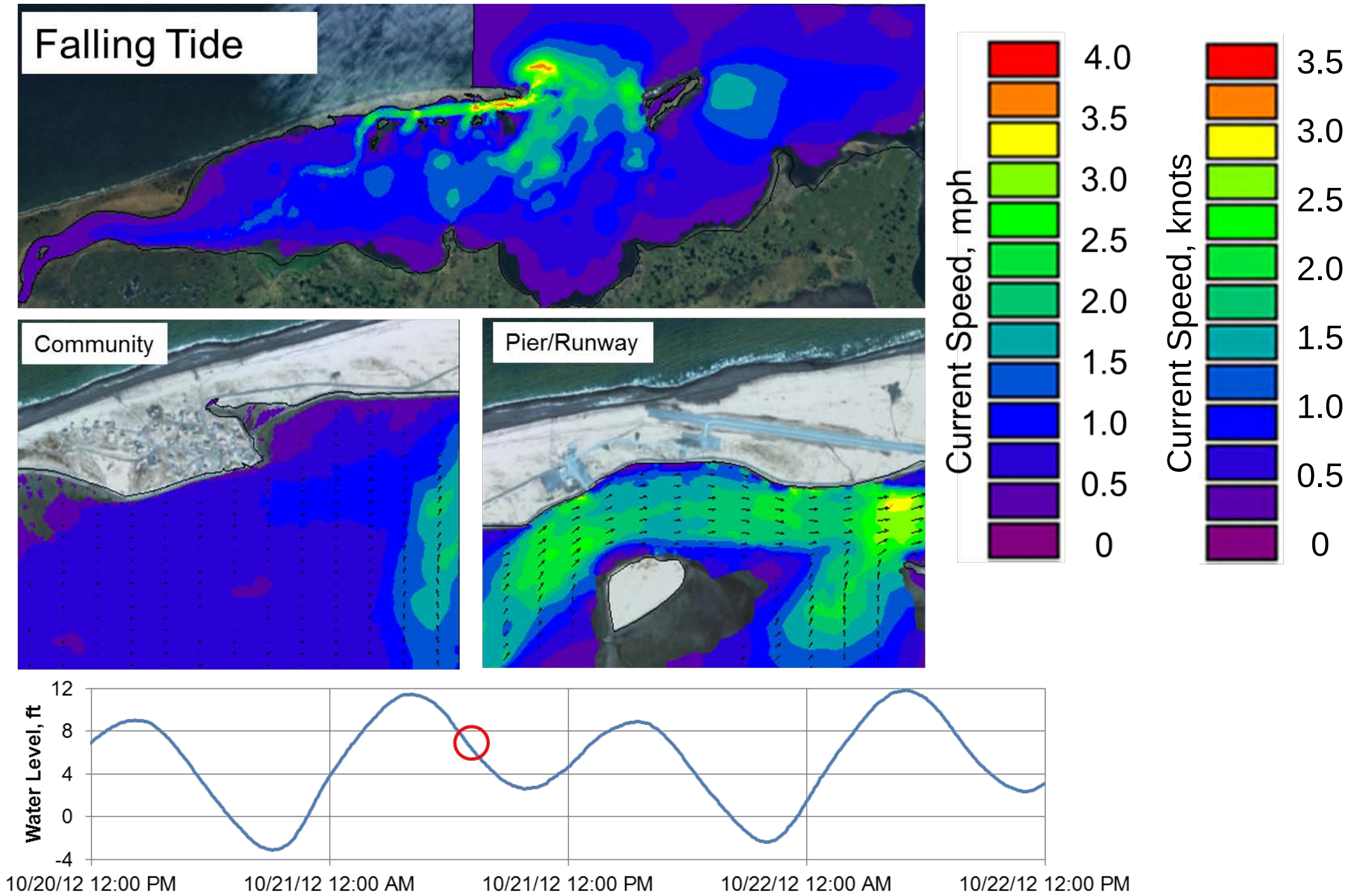


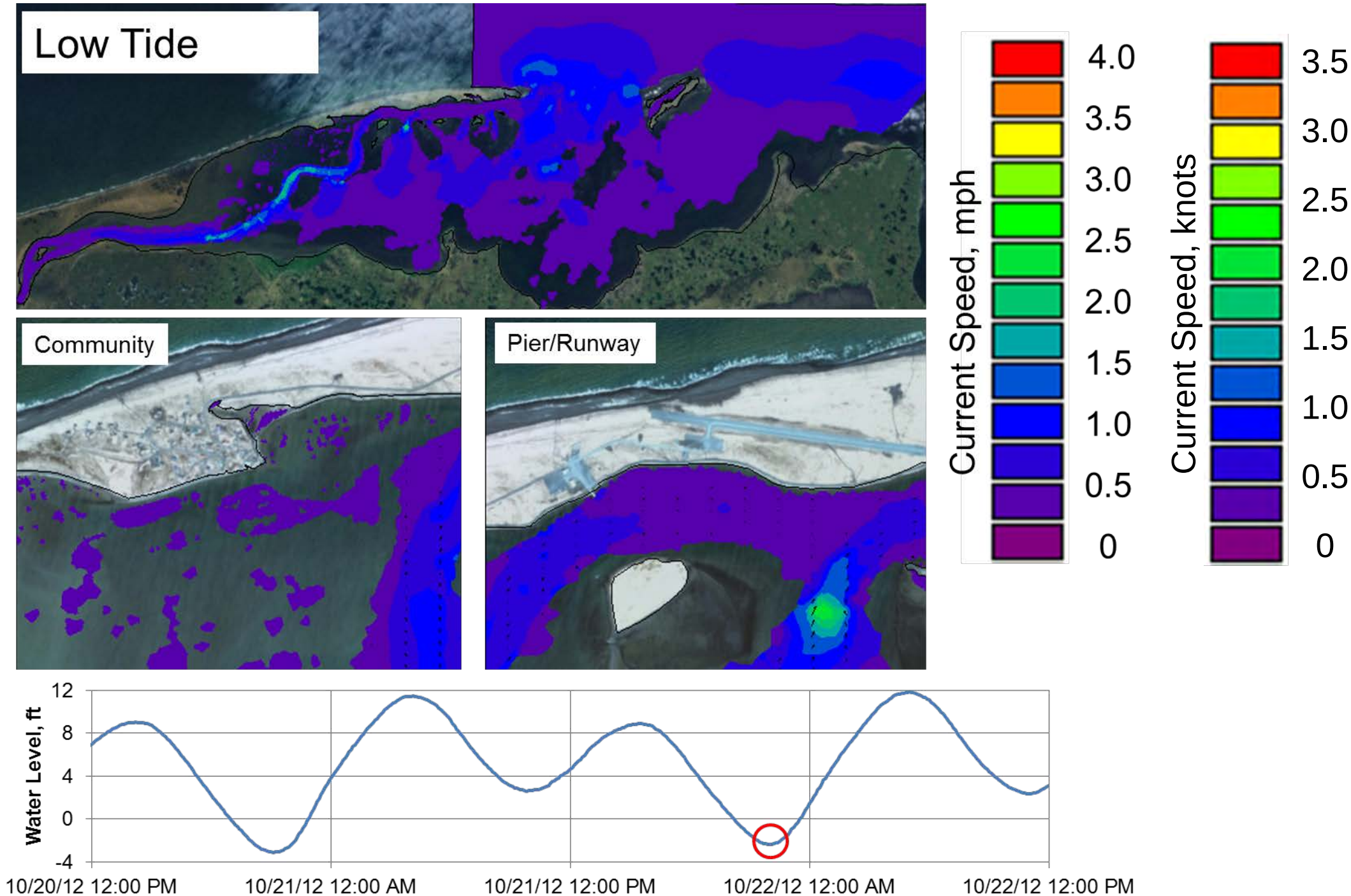
# Model Results: Currents



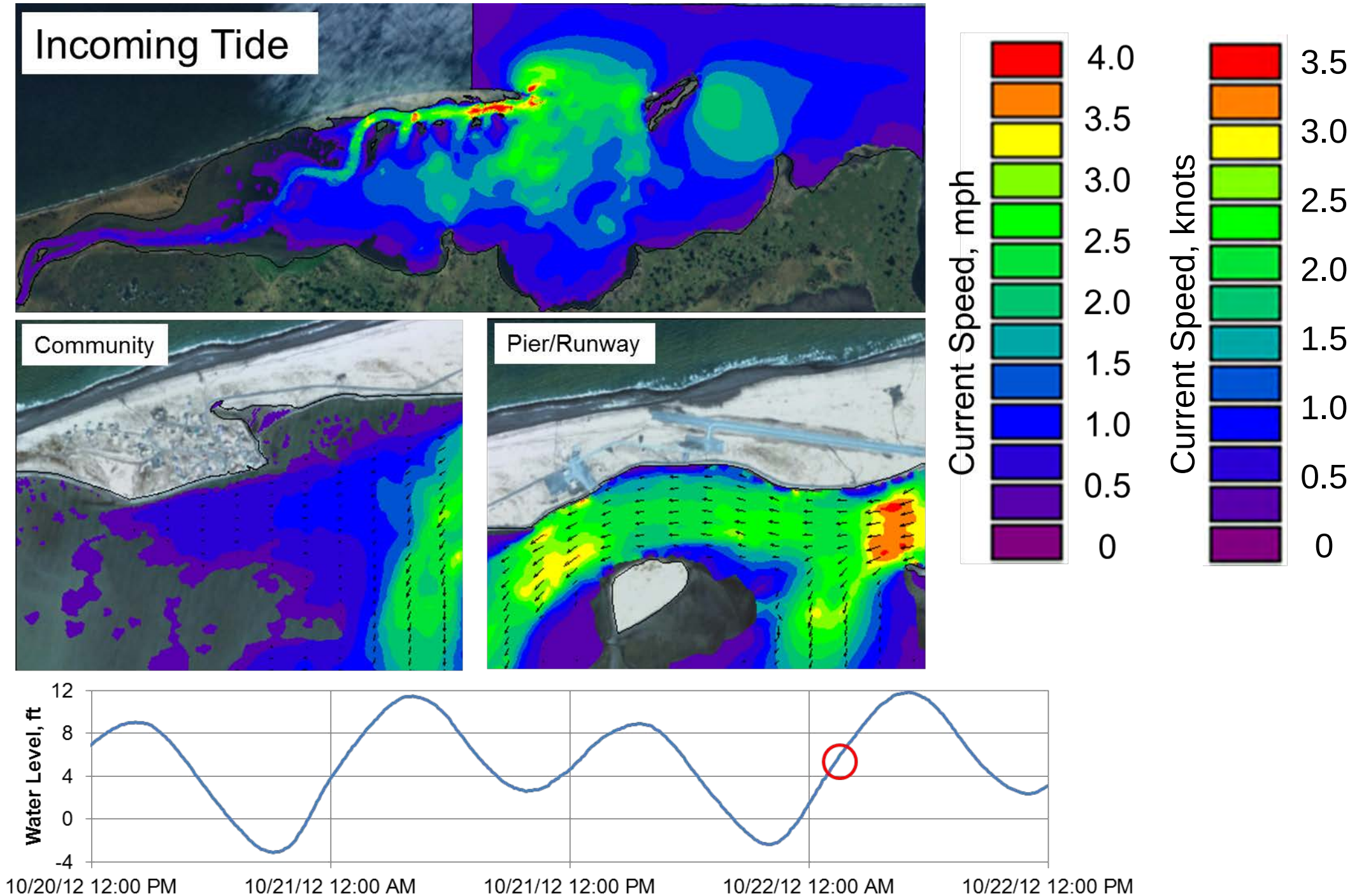
# Model Results: Currents



# Model Results: Currents

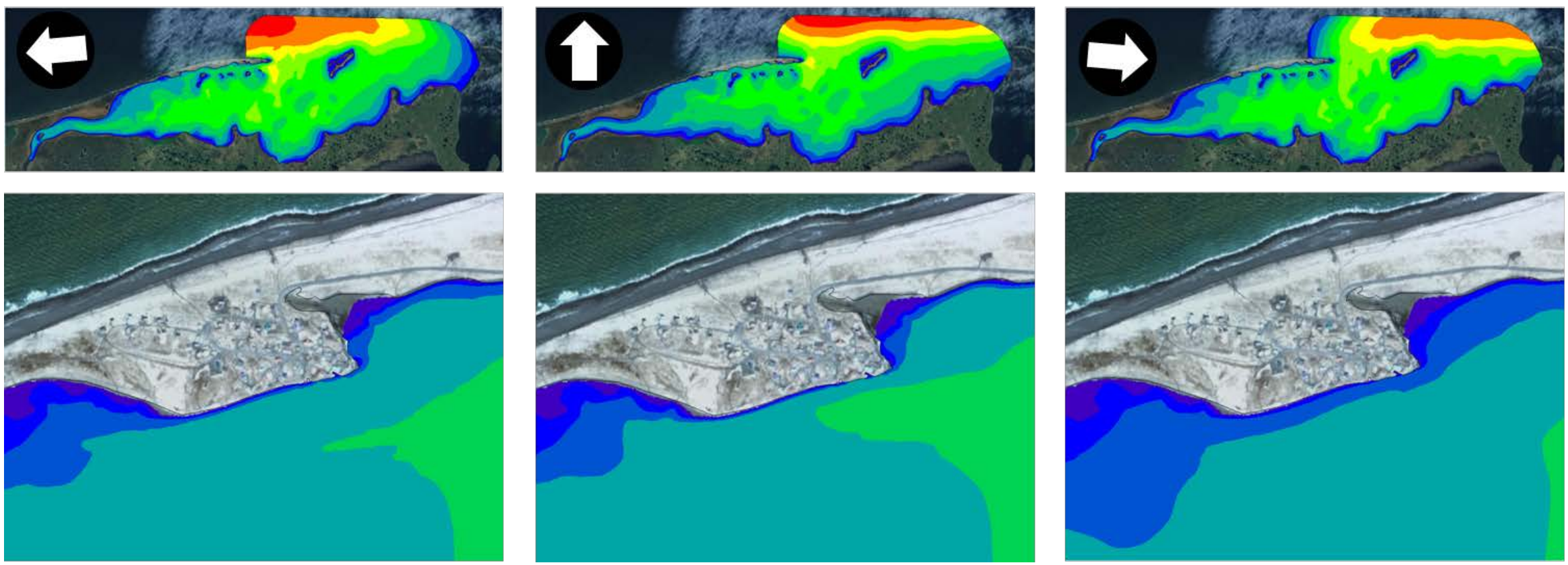


# Model Results: Currents



# Model Results: Waves

Water Level: 10 Feet
Wind Speed: 94 mph



# Existing Seawall

- Severely damaged
- Limited time before structure is not functional
- Should be considered a <u>successful</u> structure
  - A common shoreline protection structure lifespan is 20 to 25 years

# Shoreline Protection Challenges

- Waves, currents, large tides, and ice
- Limited time – Failing existing shoreline protection
- Limited locally-available construction materials and resources
- Short (seasonal) construction window
- Limited available construction funds
- Other challenges? (regulatory/environmental?)

# Conceptual Alternatives - Traditional

- Sheetpile Wall
  - Interlocking steel sheets/panels driven into the ground to create a vertical wall
  - Example of this is located at the pier

<u>Pros</u>
- Long lifespan
- Low maintenance

<u>Cons</u>
- Requires specialized contractor
- Requires outside material
- High construction cost

# Conceptual Alternatives - Traditional

- Armor Stone Revetment
  - Layers of stone of a specific size placed along the shoreline to help reduce erosion

Pros
- Long lifespan
- Low maintenance

Cons
- Requires specialized contractor
- Requires outside material
- High construction cost

# Conceptual Alternatives – Non-Traditional

- Gabion Baskets
  - Containers fabricated from galvanized or stainless steel wire (sometimes coated with plastic) to form box-like "baskets" that can be stacked and tied together. Baskets are filled with stones.

Photo Credit: www.snh.org.uk/

<u>Pros</u>
- Moderate lifespan
- Moderate maintenance
- Performed with local labor

<u>Cons</u>
- Requires outside material
- Moderate construction cost

# Conceptual Alternatives – Non-Traditional

- Articulating Block Mats
  - Concrete blocks that fit together similar to a puzzle, and often cabled together, to form mattresses.

<u>Pros</u>
- Moderate lifespan
- Moderate maintenance
- Performed with local labor

<u>Cons</u>
- Easily undermined
- Requires outside material
- High construction cost

# Conceptual Alternatives – Non-Traditional

- Geotextile Tubes
  - Long tubes constructed from high strength geotextile fabric and filled with sand.

Pros
- Moderate maintenance
- Uses local available sand

Cons
- Requires specialized contractor
- Easily damaged, punctured, etc.
- Requires outside geotextile material
- High construction cost

# Conceptual Alternatives – Non-Traditional

- Concrete Bag Revetment

Photo Credit: www.slingbag.net

<u>Pros</u>

- Moderate maintenance
- Performed with local labor
- Easily repaired

<u>Cons</u>

- Requires outside material
- Moderate construction cost

# Conceptual Alternatives – Non-Traditional

- Timber Seawall
  - Vertical structure made of lumber. Existing shoreline protection at Nelson Lagoon.

Pros
- Moderate maintenance
- Performed with local labor

Cons
- Requires outside material
- Moderate construction cost

# Conceptual Alternatives – Non-Traditional

- Beach Nourishment
  - Artificial advance of the shoreline
  - Will continue to erode and require maintenance
  - Methods
    - Method 1 – Dredge
    - Method 2 – Truck Haul

<u>Pros</u>

- Performed with local labor (Method 2)
- Uses local sand resource

<u>Cons</u>

- High maintenance requirements
- Requires specialized contractor (Method 1)
- Moderate to high construction cost
- Potential environmental restrictions

# Conceptual Alternatives – Non-Traditional

- Geotextile Containers
  - Bags fabricated from high strength geotextile fabric are filled with sand and placed as a revetment. As bags are damaged, they are replaced.

Pros
- Inexpensive construction cost
- Inexpensive maintenance cost
- Performed with local labor
- Easily repaired

Cons
- High maintenance requirement

# Conceptual Alternatives

- Traditional
  - Sheetpile Wall
  - Stone Revetment
- Non-Traditional
  - Gabion Basket
  - Articulating Block Mats
  - Geotextile Tube
  - Concrete Bags
  - Timber Seawall
  - Beach Nourishment
  - Geotextile Containers
- Other Ideas?

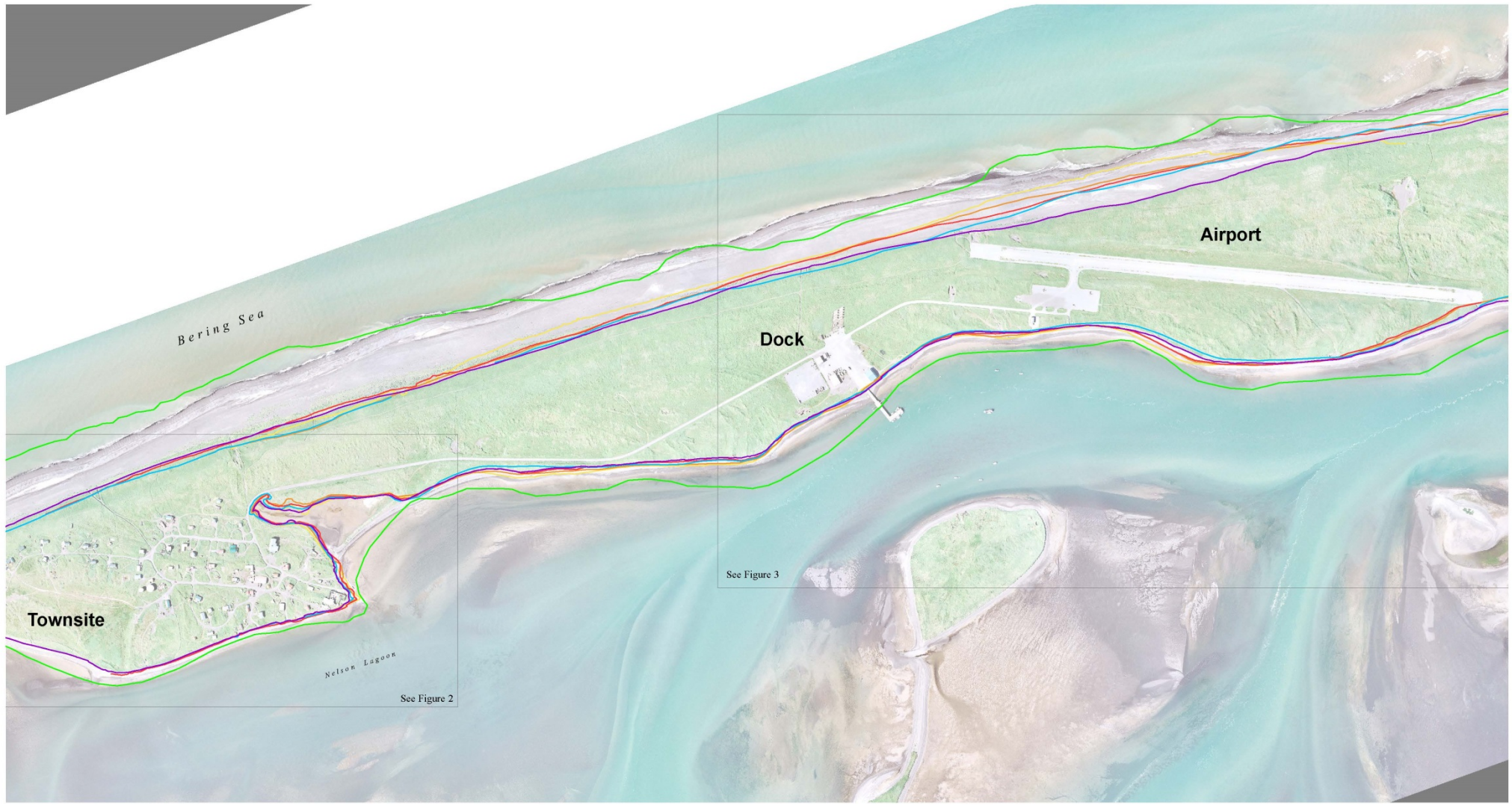
# Coastal Erosion Study
# Nelson Lagoon

May 12, 2014

# Historical Studies

- Historical Shoreline Mapping
- Hazard Impact Assessment
- Erosion Management Quality Assurance Program Plan
- Coastal Erosion Study
  - Shoreline Survey
  - Shoreline Projection
  - Wave and Hydrodynamic Modeling
  - Conceptual Alternatives

# Existing Shoreline - 2013




**Nelson Lagoon Historical Shoreline Location (1963-2013)** **Figure 1**

**Date of Shoreline**

1963 1972 1983 1997 2001 2013

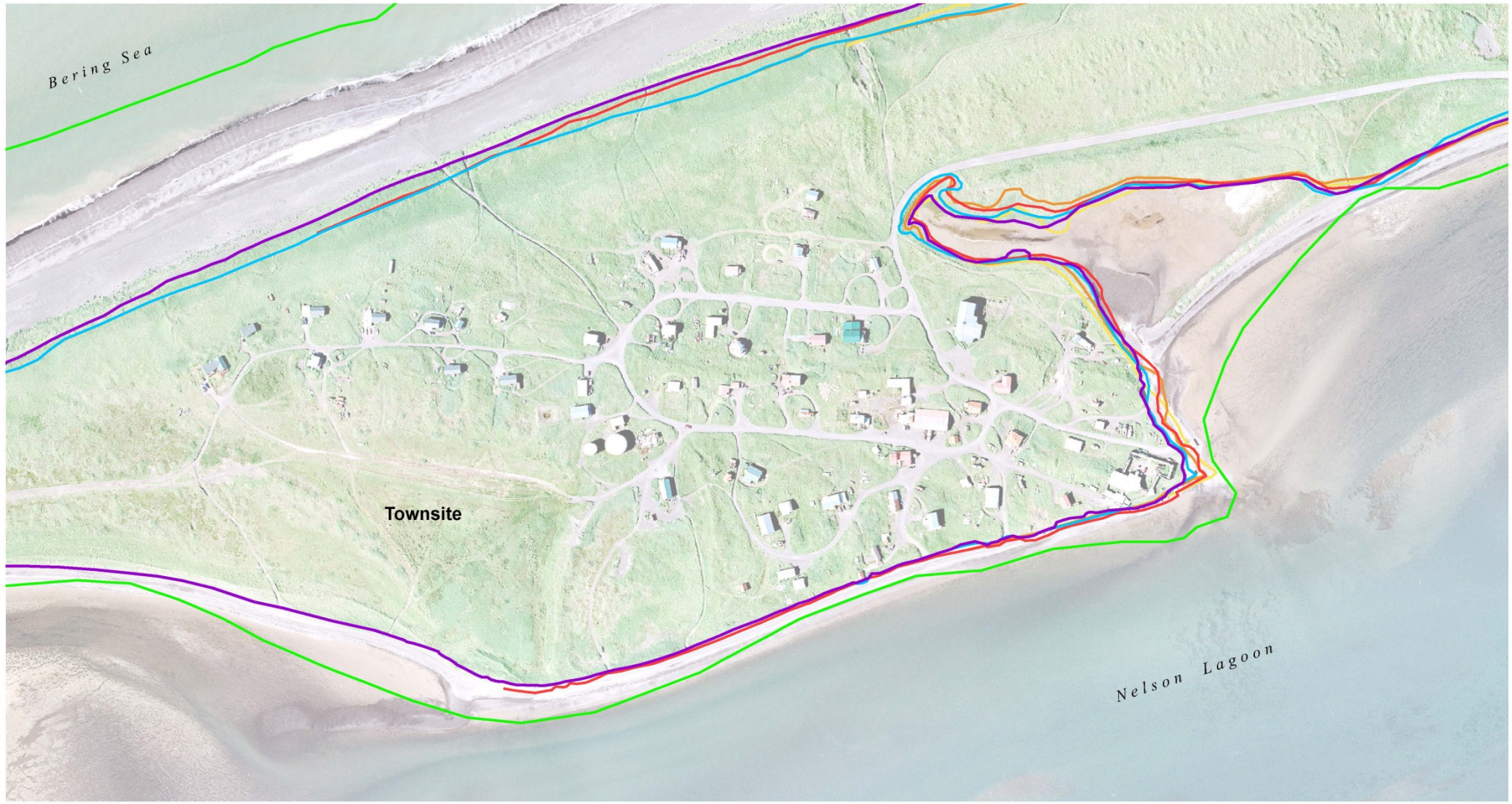
0 250 500 Feet

N

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/10/2014

# Existing Shoreline - 2013




**Nelson Lagoon Historical Shoreline Erosion (1963-2013) - Townsite** **Figure 2**

**Date of Shoreline**

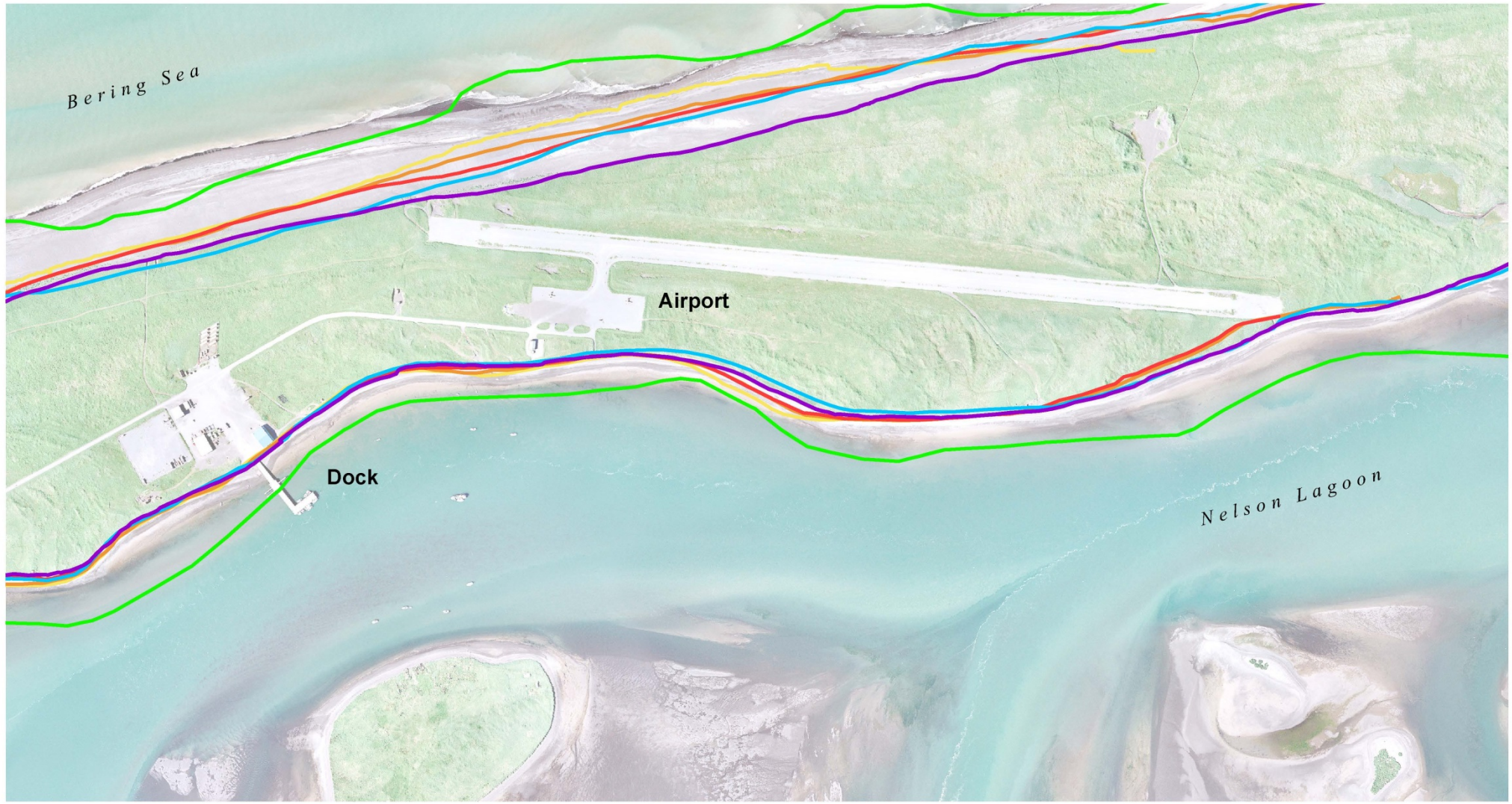
1963 1972 1983 1997 2001 2013

0 250 500 Feet

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/10/2014

# Existing Shoreline - 2013




**Nelson Lagoon Historical Shoreline Erosion (1963-2013) - Dock and Airport** **Figure 3**

**Date of Shoreline**

1963 1972 1983 1997 2001 2013

0 250 500 Feet

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/10/2014

# Shoreline Projection - 2068

**Projected shoreline in 2068 using 1972 - 2013 erosion rate** **Figure 7**

**Date of Shoreline**

1963 1972 1983 1997 2001 2013 2068

The 2068 projected shorelines are based on 1972–2013 erosion rates.

Bering Sea/Nelson Lagoon

0 250 500 Feet

N

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/12/2014

# Shoreline Projection - 2068

**Projected shoreline in 2068 using 1972 - 2013 erosion rate - Townsite** **Figure 8**

**Date of Shoreline**

1963 1972 1983 1997 2001 2013 2068

The 2068 projected shorelines are based on 1972–2013 erosion rates.

Bering Sea/Nelson Lagoon

0 250 500 Feet

N

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/14/2014

# Shoreline Projection - 2068

**Projected shoreline in 2068 using 1972 - 2013 erosion rate - Dock and Airport** **Figure 9**

**Date of Shoreline**

1963 1972 1983 1997 2001 2013 2068

The 2068 projected shorelines are based on 1972–2013 erosion rates.

Bering Sea/Nelson Lagoon

0 250 500 Feet

N

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/12/2014

# Shoreline Projection - 2068

**Seawall Area Projection (2068)** **Figure 10**

**Projected Shoreline (1963-2013 rate)**

- Projection with no seawall
- Projection with seawall

**Projected Shoreline (1973-2013 rate)**

- Projection with no seawall
- Projection with seawall

0 100 200 Feet

Shorelines digitized from the following sources: USGS 15' Quadrangle 1963, Aero-Metric aerial photography 1972, 1983, 1997, 2001, Kodiak Mapping 2013 field survey. Map displays 2013 aerial photos, 2 ft resolution. This map is for planning purposes only. Author: HDR Alaska, Inc.

2/12/2014

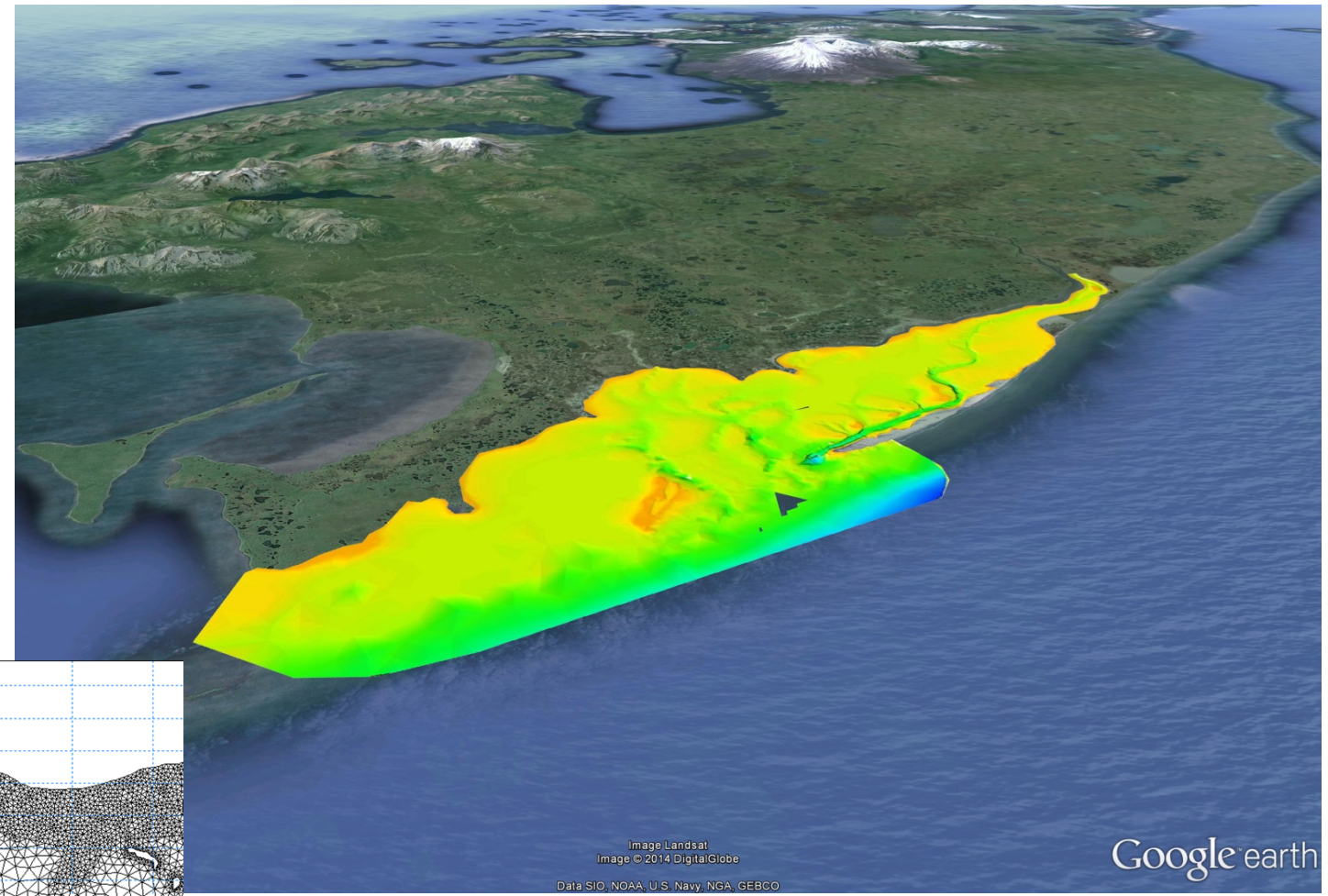
# Wave and Hydrodynamic Modeling

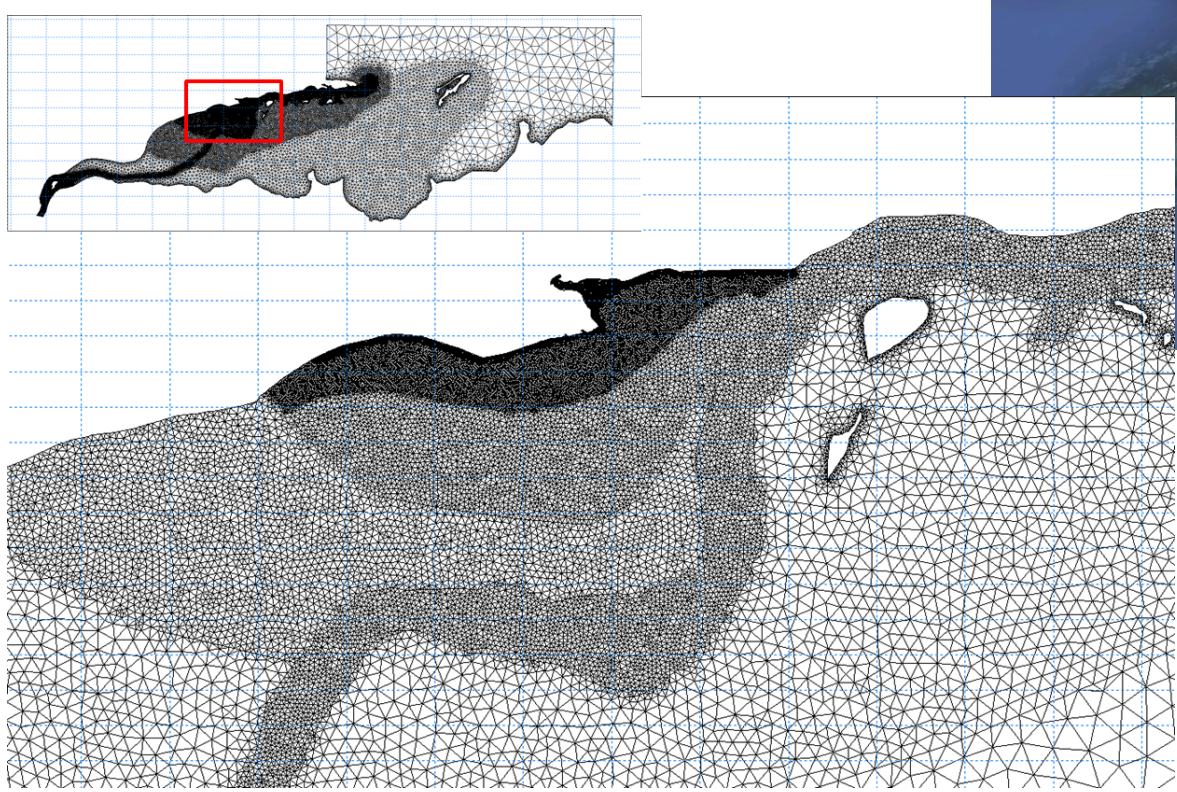
- Computer model that calculates and helps predict waves and currents
- Uses actual measured data as input
- Provides information helpful for design

# Where does the input data come from?

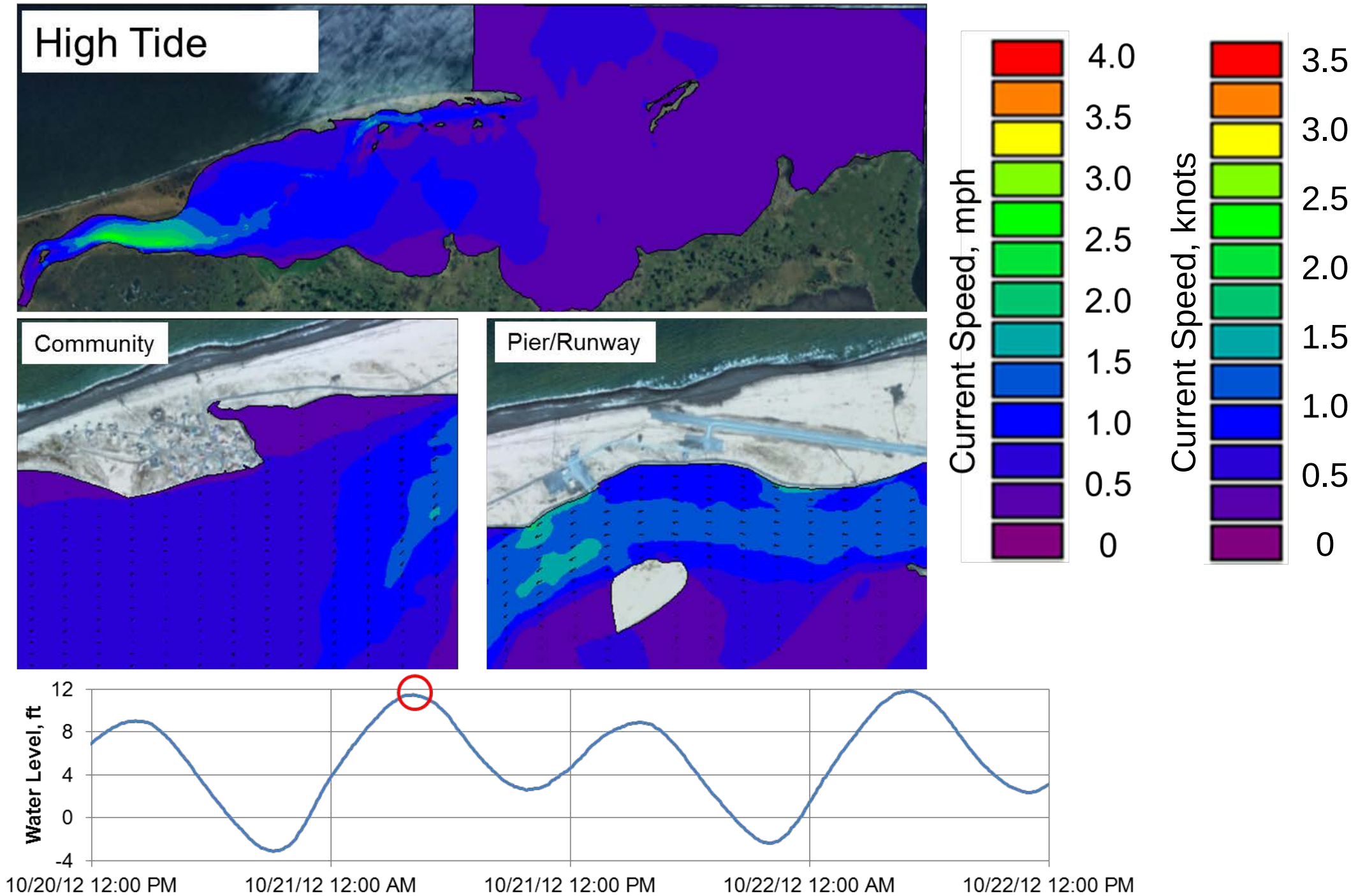
- Survey Data Collected in 2013
- Field Data Collected in 2012
- NOAA Station at Port Moller

# Numerical Model Mesh and Domain

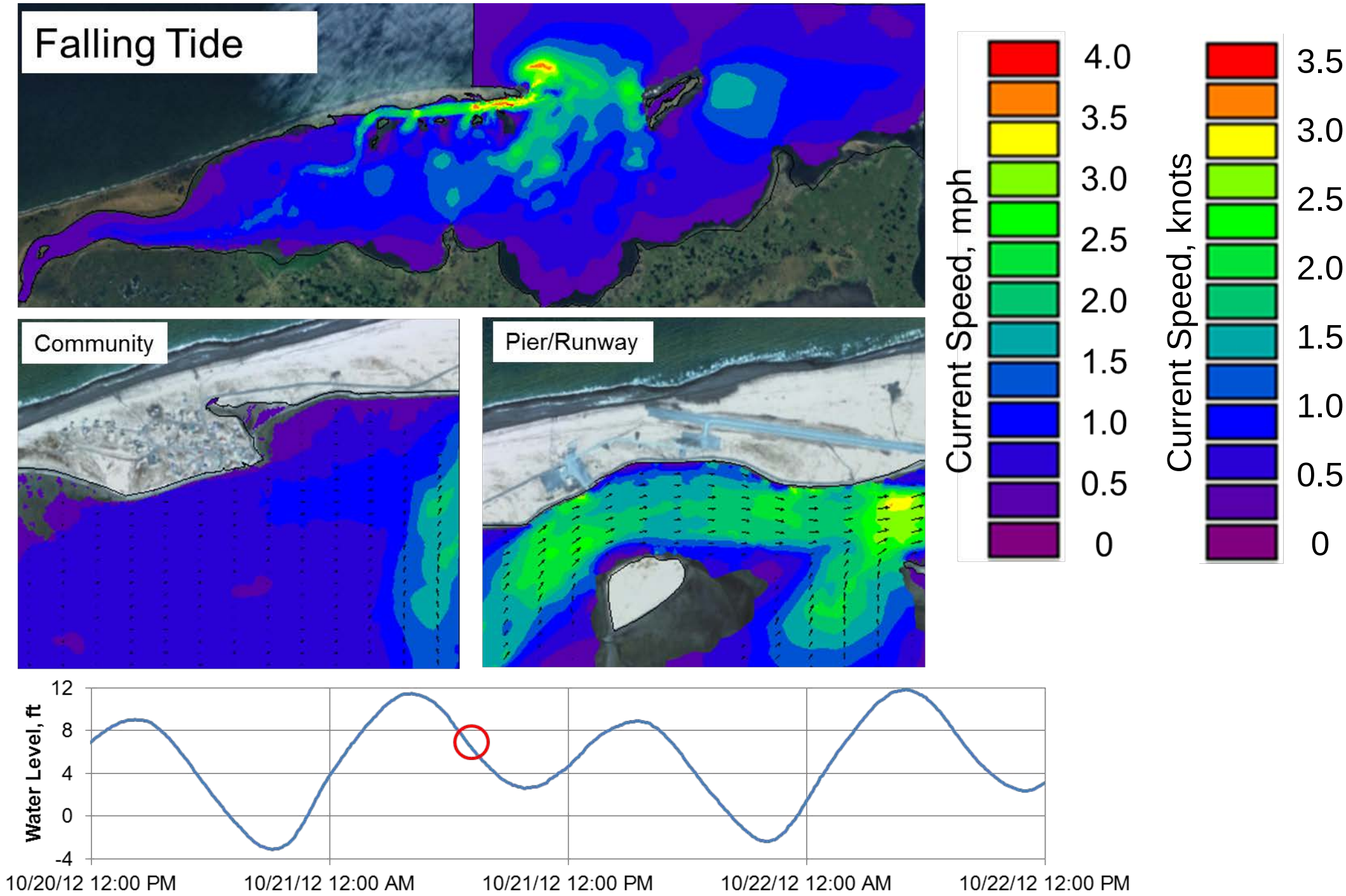


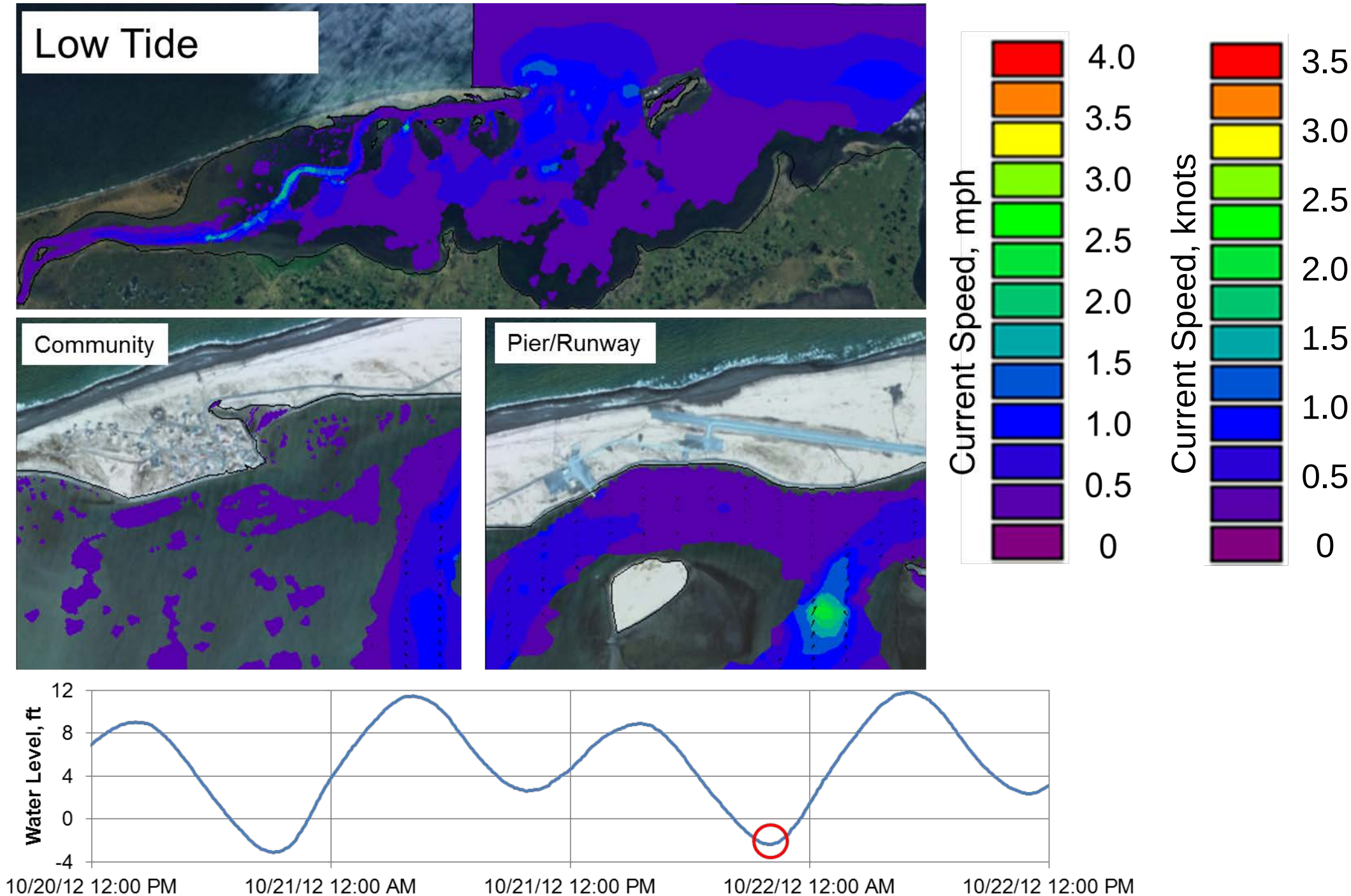
# Model Results: Currents



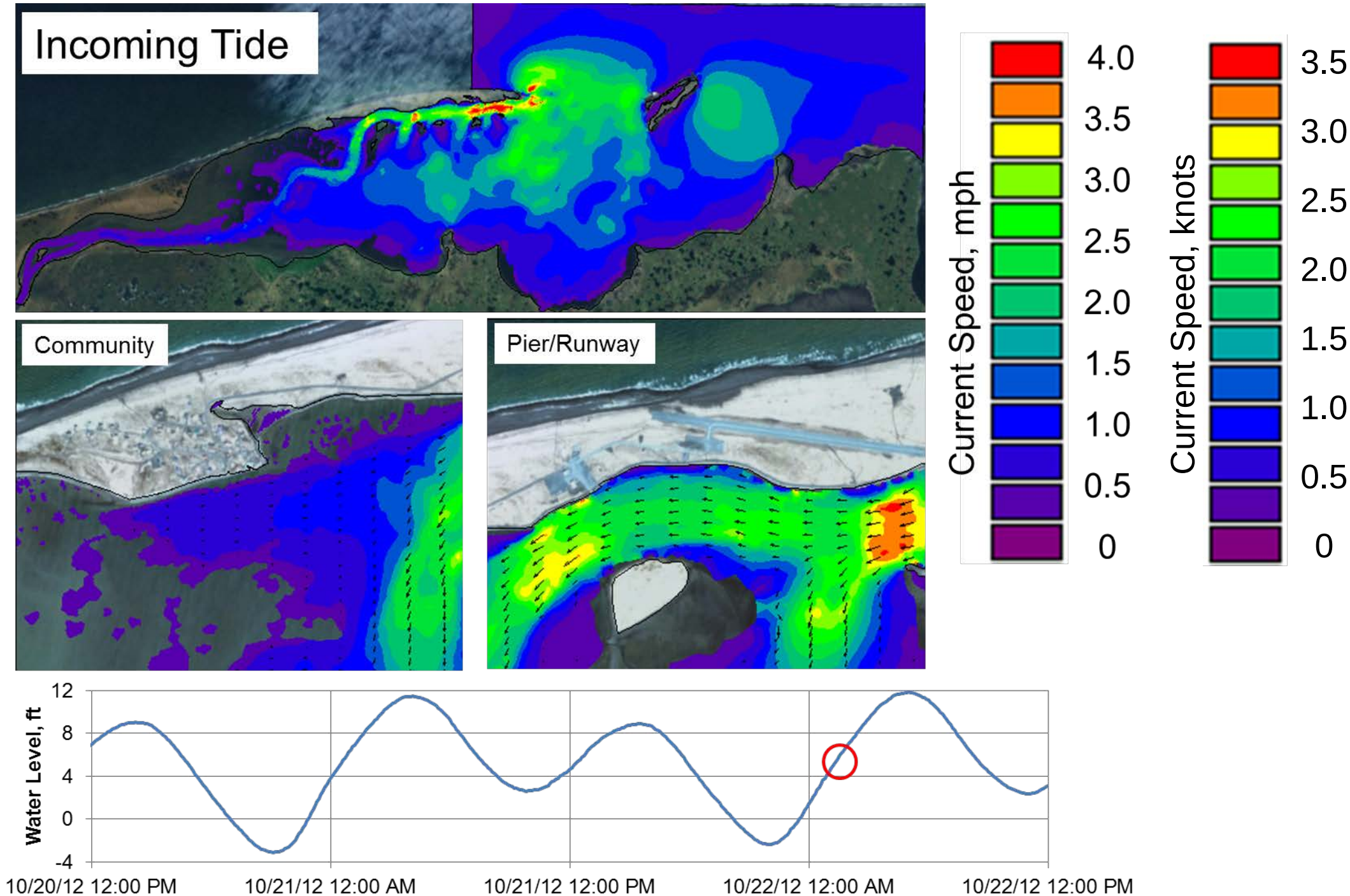
# Model Results: Currents



# Model Results: Currents

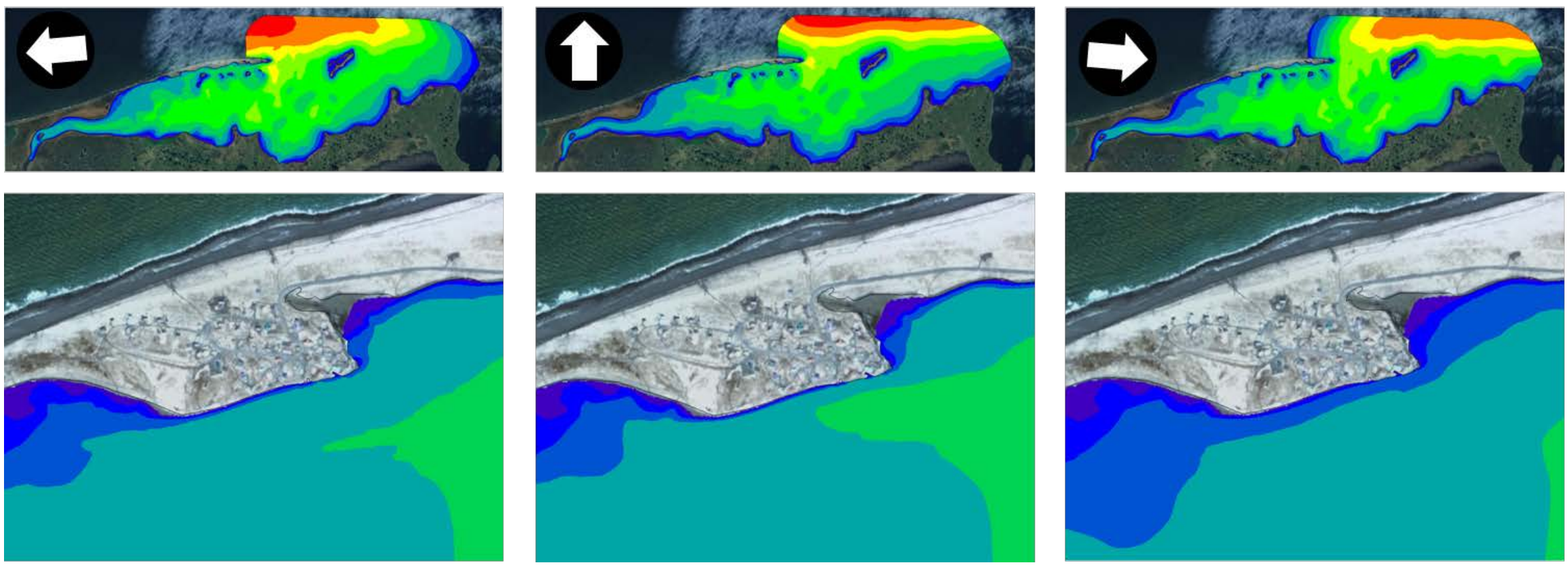


# Model Results: Currents



# Model Results: Waves

Water Level: 10 Feet
Wind Speed: 94 mph



# Existing Seawall

- Severely damaged
- Limited time before structure is not functional
- Should be considered a <u>successful</u> structure
  - A common shoreline protection structure lifespan is 20 to 25 years

# Shoreline Protection Challenges

- Waves, currents, large tides, and ice
- Limited time – Failing existing shoreline protection
- Limited locally-available construction materials and resources
- Short (seasonal) construction window
- Limited available construction funds
- Other challenges? (regulatory/environmental?)

# Conceptual Alternatives - Traditional

- Sheetpile Wall
  - Interlocking steel sheets/panels driven into the ground to create a vertical wall
  - Example of this is located at the pier

<u>Pros</u>
- Long lifespan
- Low maintenance

<u>Cons</u>
- Requires specialized contractor
- Requires outside material
- High construction cost

# Conceptual Alternatives - Traditional

- Armor Stone Revetment
  - Layers of stone of a specific size placed along the shoreline to help reduce erosion

Pros
- Long lifespan
- Low maintenance

Cons
- Requires specialized contractor
- Requires outside material
- High construction cost

# Conceptual Alternatives – Non-Traditional

- Gabion Baskets
  - Containers fabricated from galvanized or stainless steel wire (sometimes coated with plastic) to form box-like "baskets" that can be stacked and tied together. Baskets are filled with stones.

Photo Credit: www.snh.org.uk/

<u>Pros</u>
- Moderate lifespan
- Moderate maintenance
- Performed with local labor

<u>Cons</u>
- Requires outside material
- Moderate construction cost

# Conceptual Alternatives – Non-Traditional

- Articulating Block Mats
  - Concrete blocks that fit together similar to a puzzle, and often cabled together, to form mattresses.

<u>Pros</u>
- Moderate lifespan
- Moderate maintenance
- Performed with local labor

<u>Cons</u>
- Easily undermined
- Requires outside material
- High construction cost

# Conceptual Alternatives – Non-Traditional

- Geotextile Tubes
  - Long tubes constructed from high strength geotextile fabric and filled with sand.

Pros
- Moderate maintenance
- Uses local available sand

Cons
- Requires specialized contractor
- Easily damaged, punctured, etc.
- Requires outside geotextile material
- High construction cost

# Conceptual Alternatives – Non-Traditional

- Concrete Bag Revetment

Photo Credit: www.slingbag.net

<u>Pros</u>

- Moderate maintenance
- Performed with local labor
- Easily repaired

<u>Cons</u>

- Requires outside material
- Moderate construction cost

# Conceptual Alternatives – Non-Traditional

- Timber Seawall
  - Vertical structure made of lumber. Existing shoreline protection at Nelson Lagoon.

<u>Pros</u>

- Moderate maintenance
- Performed with local labor

<u>Cons</u>

- Requires outside material
- Moderate construction cost

# Conceptual Alternatives – Non-Traditional

- Beach Nourishment
  - Artificial advance of the shoreline
  - Will continue to erode and require maintenance
  - Methods
    - Method 1 – Dredge
    - Method 2 – Truck Haul

<u>Pros</u>

- Performed with local labor (Method 2)
- Uses local sand resource

<u>Cons</u>

- High maintenance requirements
- Requires specialized contractor (Method 1)
- Moderate to high construction cost
- Potential environmental restrictions

# Conceptual Alternatives – Non-Traditional

- Geotextile Containers
  - Bags fabricated from high strength geotextile fabric are filled with sand and placed as a revetment. As bags are damaged, they are replaced.

Pros
- Inexpensive construction cost
- Inexpensive maintenance cost
- Performed with local labor
- Easily repaired

Cons
- High maintenance requirement

# Conceptual Alternatives

- Traditional
  - Sheetpile Wall
  - Stone Revetment
- Non-Traditional
  - Gabion Basket
  - Articulating Block Mats
  - Geotextile Tube
  - Concrete Bags
  - Timber Seawall
  - Beach Nourishment
  - Geotextile Containers
- Other Ideas?

5/11/14 SIGN IN

Barrett Taylor
Melinda
Laura L. Jaks
Chris Diaz
Pete Johnson
John Nelson Sr.
Angela R. Johnson
Samantha McKelvey
John Nelson Sr
Justine Candelaria

# Informational Meeting

**What?**

## NELSON LAGOON COASTAL EROSION STUDY

**When?**

**May 27, 2015**
**2:00 PM**

**Where?**

**Community Center**

**Your questions, comments, and input are important!**

**Why?**

**This will be an informal meeting to talk about the coastal erosion study and provide input regarding potential shoreline protection measures. All are welcome!**

Come and learn about:

- Potential ways to address erosion in Nelson Lagoon
- Geotextile Container Wall

**Who?**

**If you have questions, contact:**

Laurie Cummings
HDR Alaska, Inc.
(907) 644-2065
laurie.cummings@hdrinc.com

# Meeting Notes

| | |
|---|---|
| Date and Time: | Wednesday, May 27, 2015 |
| Project: | Nelson Lagoon Coastal Erosion Study |
| Meeting Location: | Community Center |
| Subject: | **Public Meeting #2 Meeting Notes** |

On Wednesday, May 27, 2015, a public meeting was held in Nelson Lagoon to discuss the coastal erosion study. The purpose of this meeting was to present the results of the draft coastal erosion study and the recommended shoreline protection structure.

The meeting started with a summary of the project history and a review of the conceptual alternatives considered as part of the erosion study. Next, the three reasonable alternatives were presented to the community. The identification of reasonable alternatives was based on initial capital costs, ability to be constructed with local resources, and feedback received from Nelson Lagoon residents. The design criteria for each alternative were also reviewed.

Then, an overview including a description and cost estimate[1] of each reasonable alternative was presented. A more in-depth discussion regarding the recommended alternative, geotextile container revetment followed including container size, construction methods, phasing, and funding status.

Suggestions/issues that were raised by the community during the meeting included:

- Eliminate both of the access points
- Additional shoreline erosion has occurred since Public Meeting #1 on east side of community
- Revise preliminary revetment design to account for changes to the wooden seawall that have occurred over the past year

The meeting concluded at 3:30 PM.

Attachments: Sign In Sheet
Presentation

[1] The cost estimates presented were those developed for the draft coastal erosion study and were used in the presentation to be consistent with the draft report. The cost estimates have subsequently been revised. The final coastal erosion study will incorporate the revised cost estimates.

# Coastal Erosion Study
# Nelson Lagoon

May 22, 2015

# Existing Seawall

- Severely damaged
- Limited time before structure is not functional
- Should be considered a <u>successful</u> structure
  - A common shoreline protection structure lifespan is 20 to 25 years

# Conceptual Alternatives Considered

- Traditional
  - Sheetpile Wall
  - Stone Revetment
- Non-Traditional
  - Gabion Basket/Mattress
  - Articulating Block Mats
  - Geotextile Tube
  - Concrete Bags
  - Timber Seawall
  - Beach Nourishment
  - Geotextile Containers

# Reasonable Alternatives

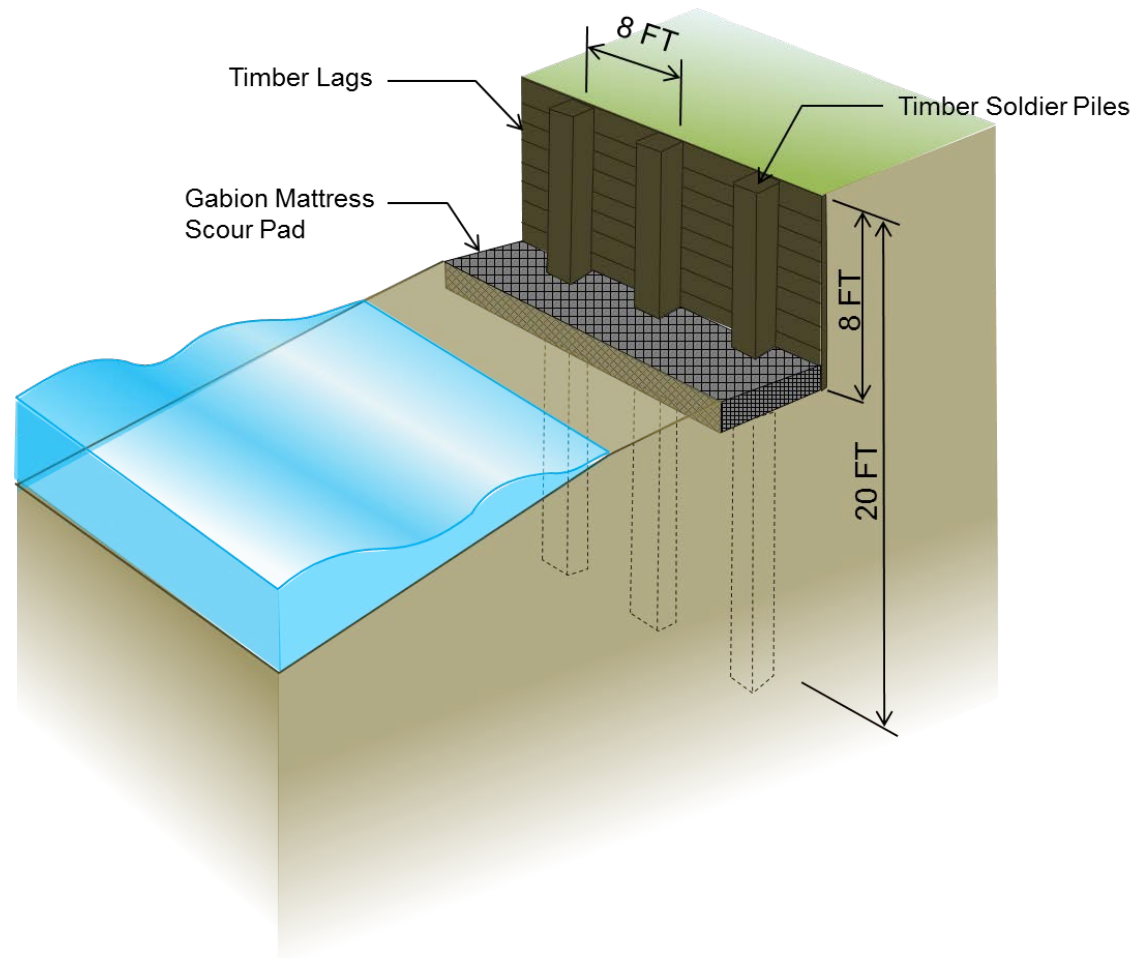
- Gabion Mattress
- Timber Seawall with Gabion Scour Pad
- Geotextile Containers

- Based on:
  - Initial capital costs
  - Ability to be constructed with local resources
  - Feedback received from Nelson Lagoon residents

- Design Criteria
  - Attenuate sufficient wave energy to protect the community from erosion during storm impacts on the Nelson Lagoon side
  - Withstand wave and/or current impacts from a 100-year storm or be easily repaired if damaged during storm
  - Be mostly constructible using local labor and equipment
  - Require no or minimal specialized construction experience

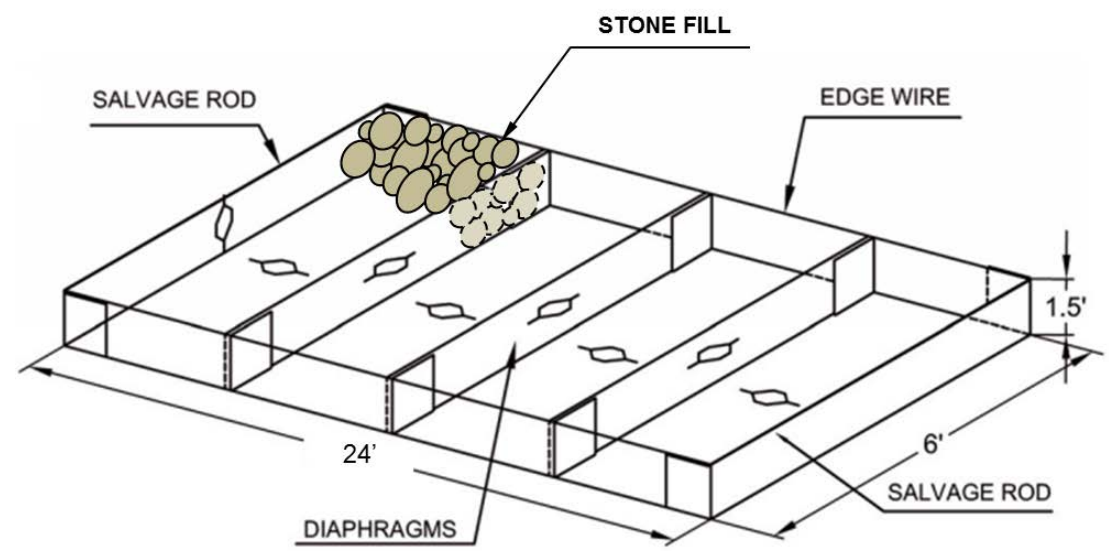
# Timber Seawall

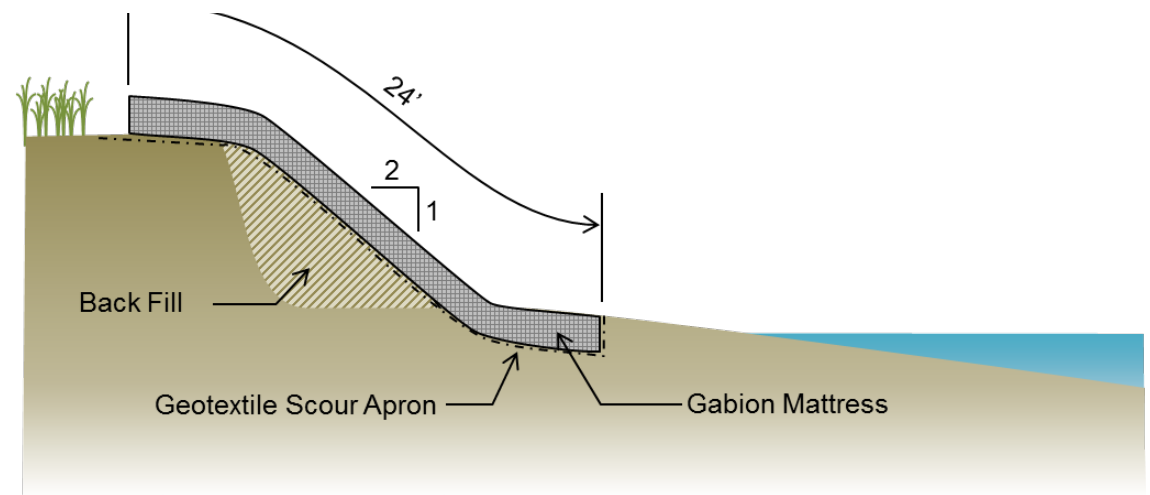
- Cantilevered wall (no support rams or tie backs)
- 2 beach access points
- Gabion mattress at base
- Estimated cost: $1.4M



# Gabion Mattress Revetment

- Shoreline protection structure made from wire mesh
- Need substantial amount of cobble or stones
- Estimated cost: $902,000

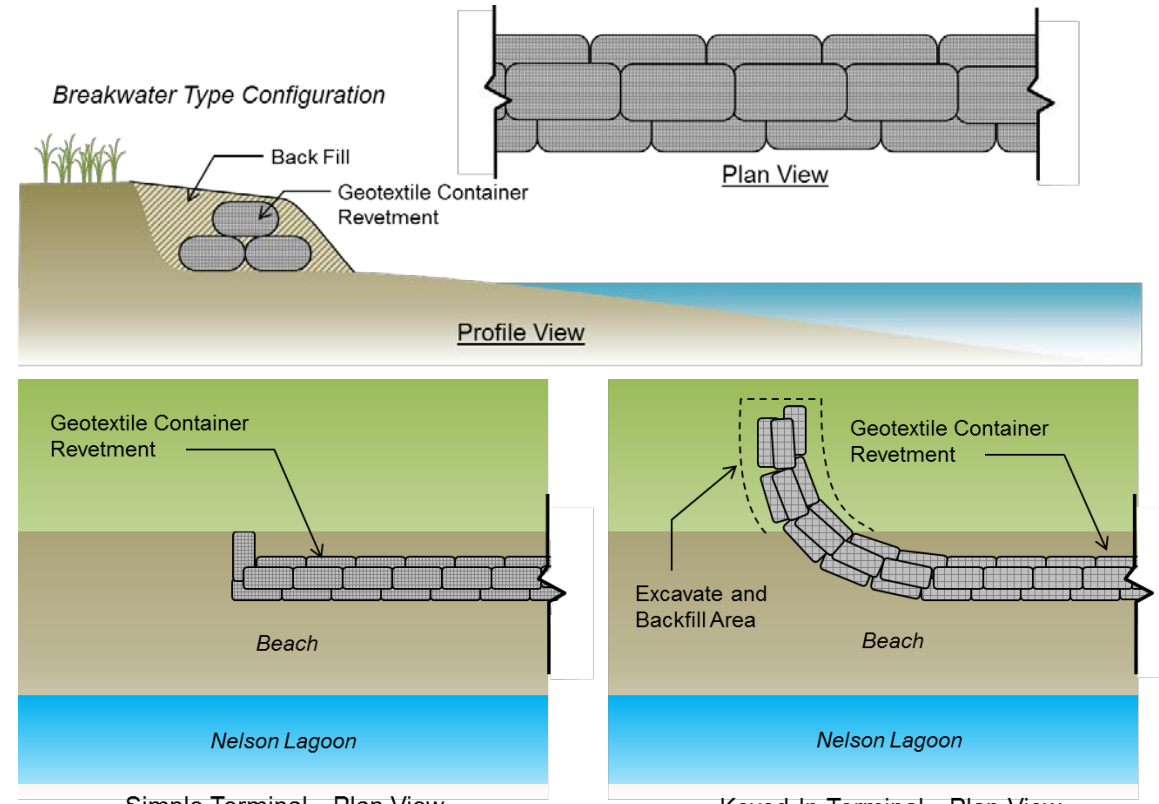



Profile View

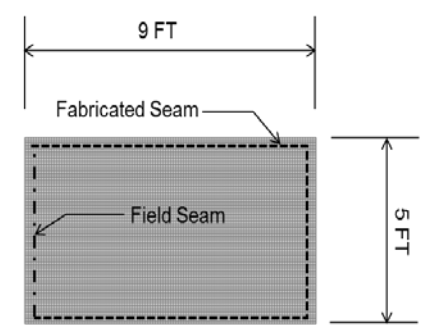
# Geotextile Container Revetment

- Preferred Alternative
- Bags fabricated from high strength geotextile fabric are filled with sand and placed as a revetment. As bags are damaged, they are replaced.
- Filled with sand from Nelson Lagoon spit
- 2 beach access points
- Estimated cost: $608,000

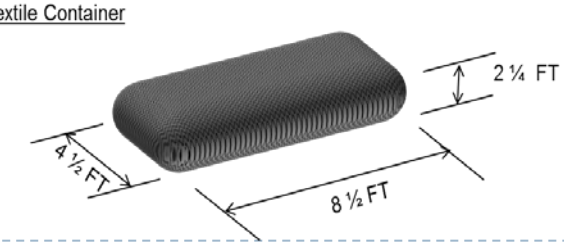



Simple Terminal – Plan View

Keyed In Terminal – Plan View




Unfilled Geotextile Container




Filled Geotextile Container

# Coastal Erosion Study – Nelson Lagoon
## May ~~22~~ 27, 2015
### Public Meeting – Sign in Sheet

| Name | Address/City/Zip | Phone | Email |
|---|---|---|---|
| Samantha McNeley | P.O. Box 933 NLG AK 99571 | 1-907-989-4088 | sam.an_tha@hotmail.com |
| Dessert Rudolph | | | |
| Justine Gundersen | POB 939 NLG AK 99571 | 9894000 | JGUNDE1125@AOL.com |
| Anne Bailey | 3380 C Street, Ste 205 Anch, AK 99503 | 907-274-7580 | abailey@aebonn.org |
| Angela Johnson | PO Box 912 Nelson Lagoon AK 99571 | 907-989-4014 | angela_j94@hotmail.com |
| Darren K Johnson | P.O. Box 924 NLG, AK 99571 | 907-989-4004 | dirtryder_90@hotmail.com |
| Shannon Johnson | PO Box 924 NLG AK 99571 | 907-989-4069 | shannon_danelle_11@hotmail.com |
| Katie Johnson | PO Box 12 NLG AK 99571 | 907-989-2202 | ——— |
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# Appendix D:
# Shoreline Monitoring Survey Results

# Appendix D - Shoreline Monitoring Survey Results

## Survey Datasets

Three shoreline monitoring surveys have been performed. USKH performed the first survey from June 29, through July 11, 2013. During this survey, 27 survey transects were established. All transects are located on the Nelson Lagoon (water body) side of the spit. For each transect, USKH established a brace survey monument. Also during July 2013, a high-resolution aerial was taken of Nelson Lagoon and some of the neighboring landmass.

HDR performed the second survey on May 12, 2014, corresponding with the first public meeting to discuss shoreline protection options for the community. This survey reoccupied 17 transects from the 2013 survey, which included all of the survey transects near the community. An additional transect was surveyed on the Bering Sea side of the Nelson Lagoon runway, and the end of the spit was also surveyed.

HDR performed the third survey on May 26, 2015, corresponding with the second public meeting to discuss the selected shoreline protection alternative and design. This survey reoccupied all transects performed in 2014.

Figure D.1 and Figure D.2 show the location of the reoccupied transects surveyed in 2014 and 2015 with an aerial photograph in plan-view. Transects are labeled 1 through 18 on Figure D.1 and Figure D.2. Following the plan-view transect locations, cross-sectional plots of the survey transects are provided for each of the 18 transects and for all years surveyed (see Figure D.3 through Figure D.8).

## Observations and Results

Based on the cross-section plots, there appears to be very small amounts of shoreline advance and retreat. These differences are generally no more than 5 feet between surveys. The overall beach profile shapes also appear to have changed very little. In addition to the surveyed elevations, the approximate edge of vegetation was also noted for most of the transects in both the 2014 and 2015 datasets. Based on these locations in comparison with the visual vegetation line in the July 2013 aerial photograph, no significant/discernable advance or retreat of the vegetation line was observed.

Thus, based on the results of the 2014 and 2015 survey in comparison with the 2013 survey and aerial photography, very little erosion has occurred at the transect locations. However, many areas of the seawall have continued to fail during this same monitoring period. This is likely due to undermining and flanking of the seawall.

It is also important to note that many coastal erosion issues are episodic. This means that very little change in shoreline position, or even advances, may occur during normal years. However, a single, major storm may occur and cause significant erosion.

Transect 18 provides a survey transect on the Bering Sea side of the runway. Based on the results from 2015, a shoreline retreat of approximately 70 feet was observed in the tidal zone. It is difficult to say if

this is a meaningful erosional trend without additional data/information. This is a snapshot of a single section of a highly dynamic beach.

The end of the spit was recorded in 2014 and 2015. Based on these locations in comparison to the 2013 aerial, the spit has been grown approximately 610 feet between July 2013 and May 2014, and 350 feet between May 2014 and May 2015. Figure D.9 shows the location of the end of the spit in 2014 and 2015 in reference to the 2013 aerial.

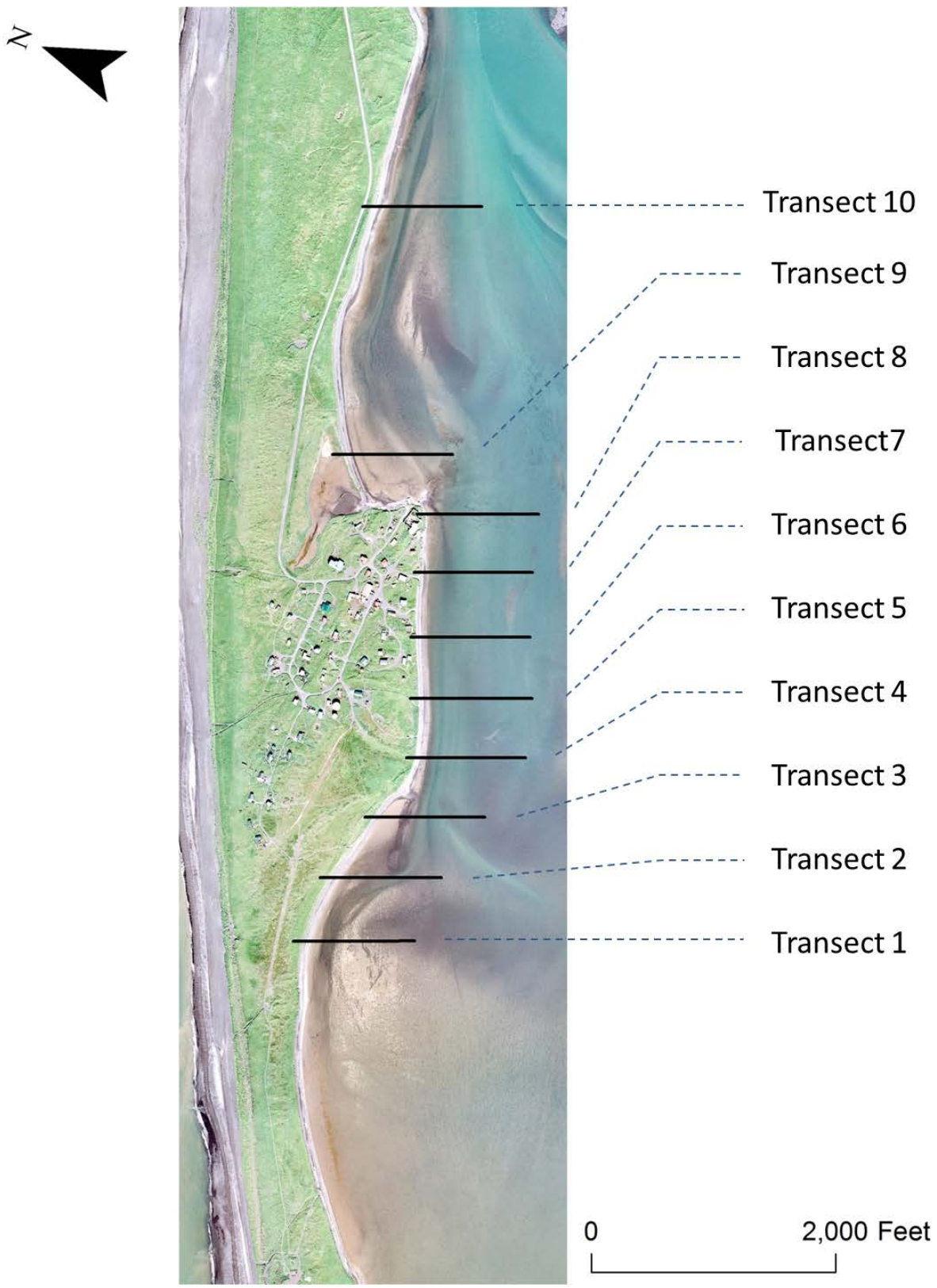



**Figure D.1 Plan-view transect locations, Transects 1 though 10**

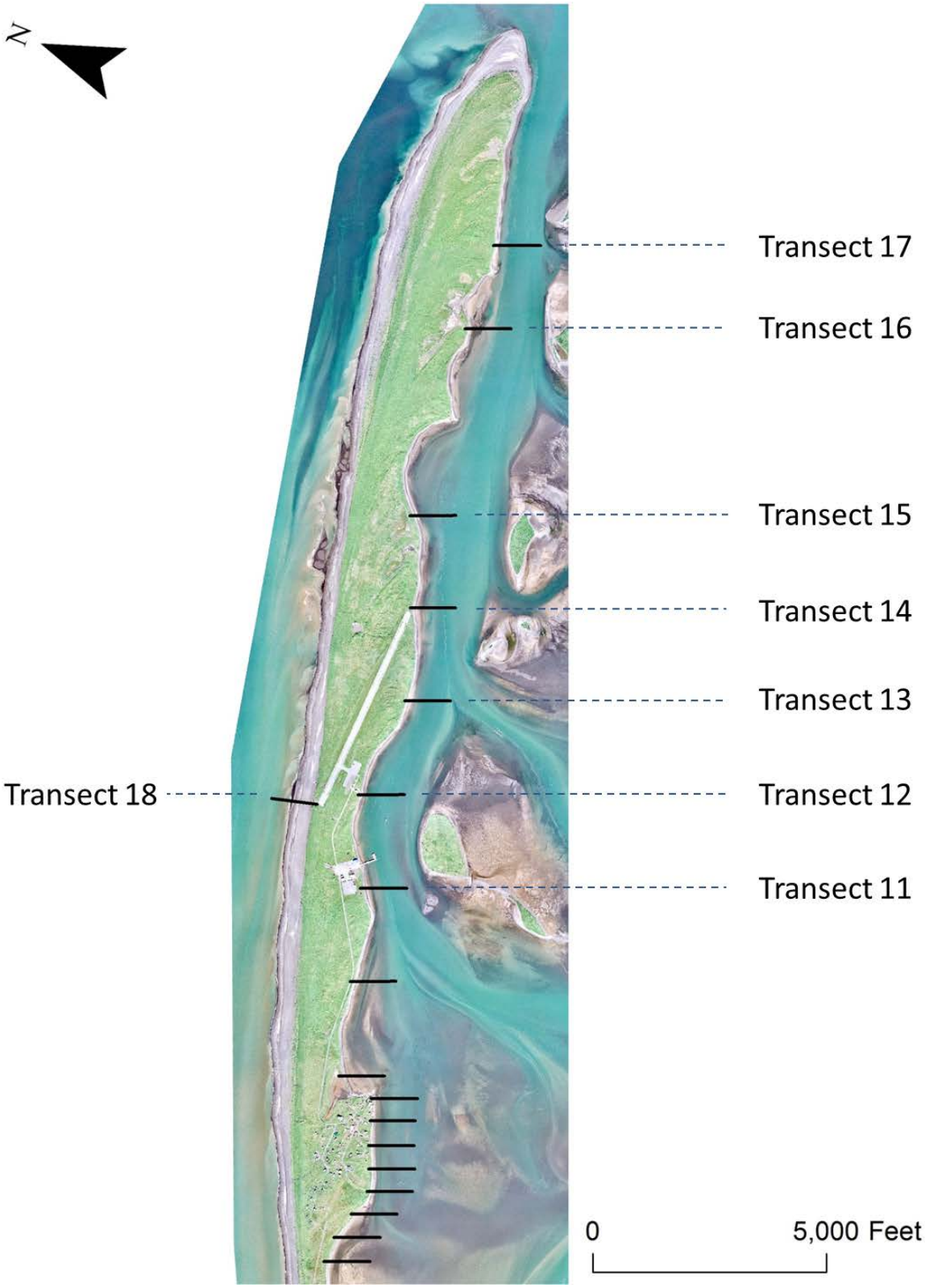
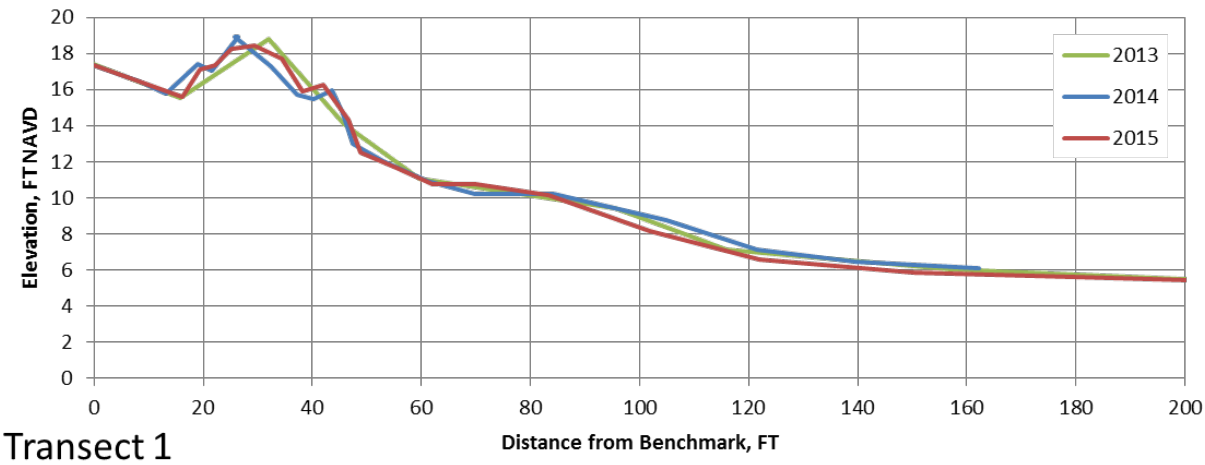
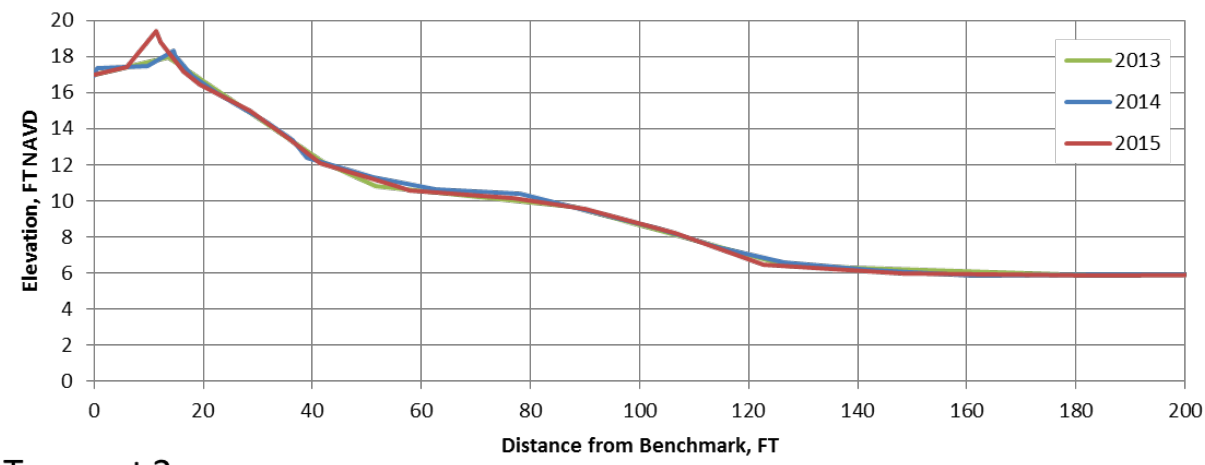


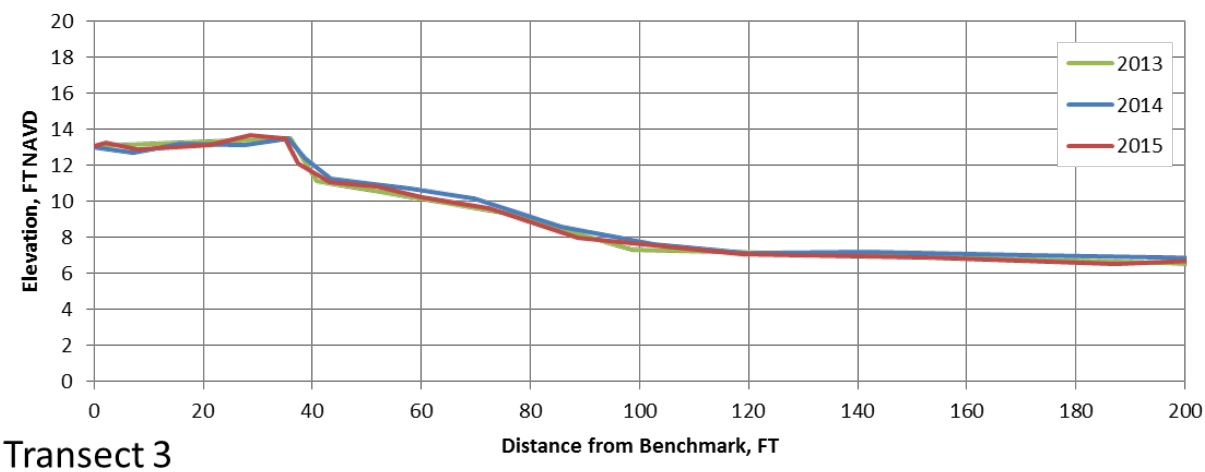

Figure D.2 Plan-view transect locations, Transects 11 though 18




Transect 1

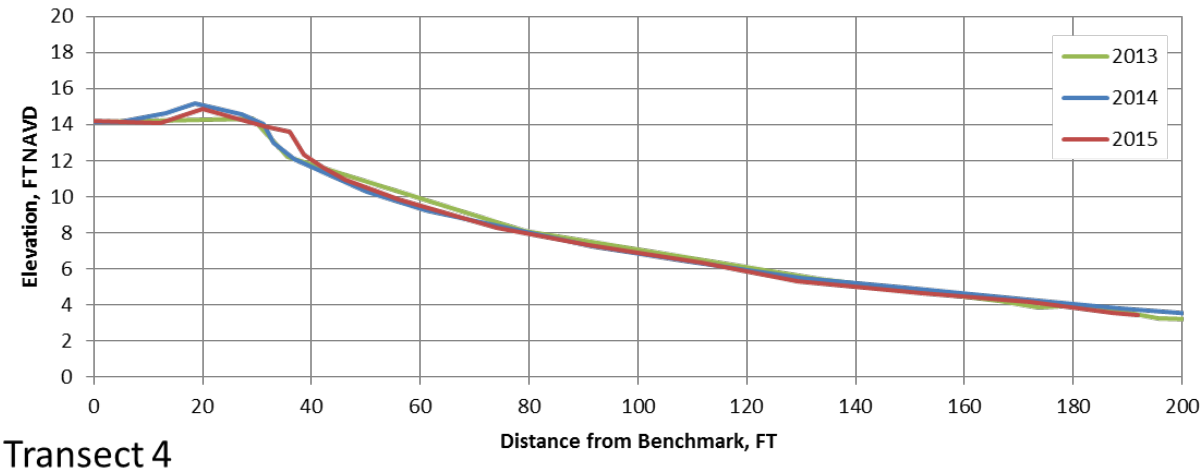



Transect 2

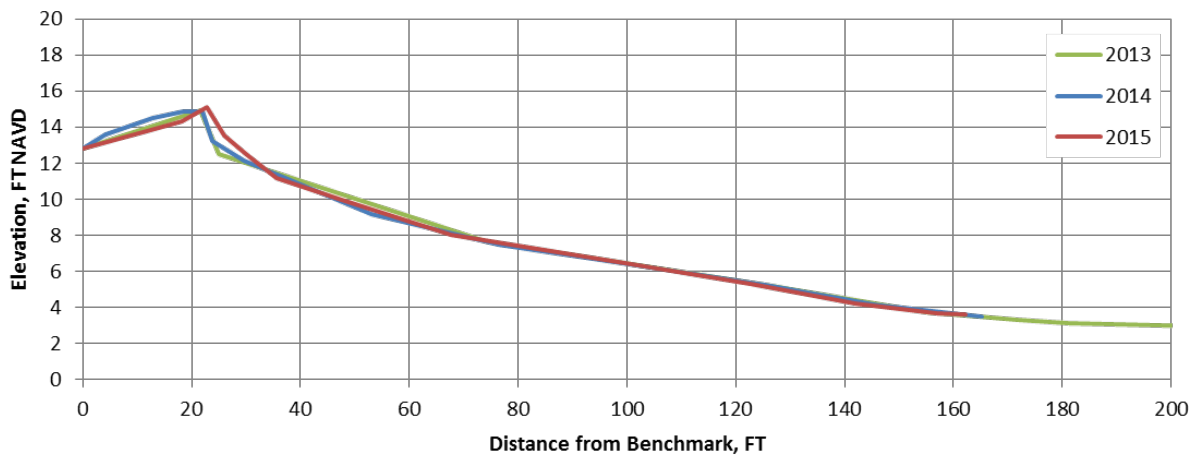



Transect 3

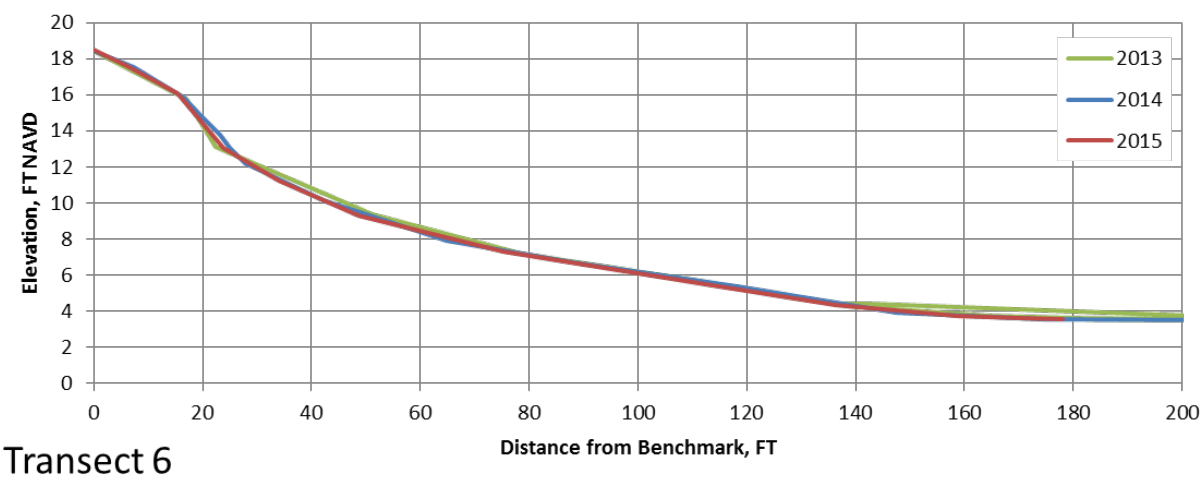
**Figure D.3** **Cross-sectional plots of the survey transects, Transects 1 though 3**




Transect 4

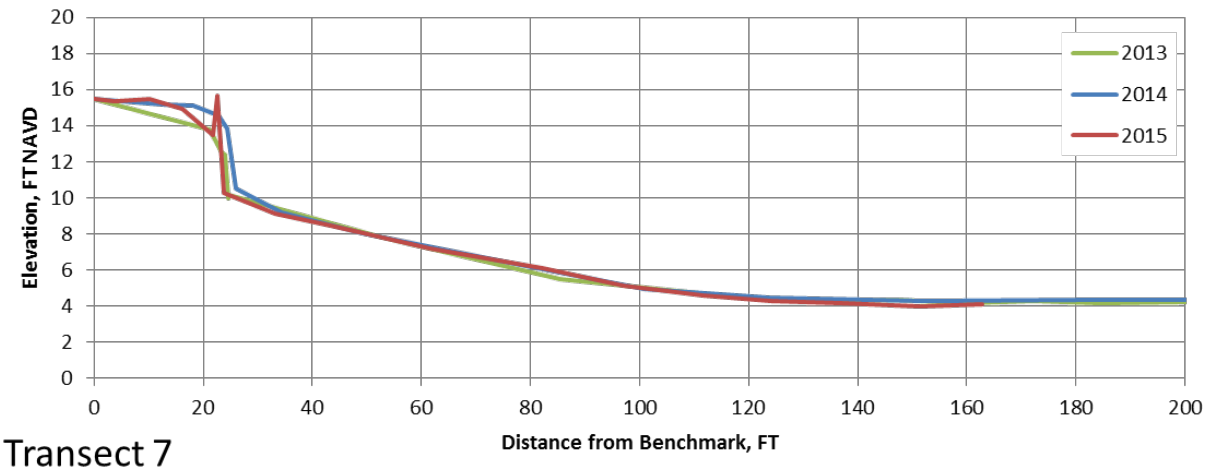



Transect 5

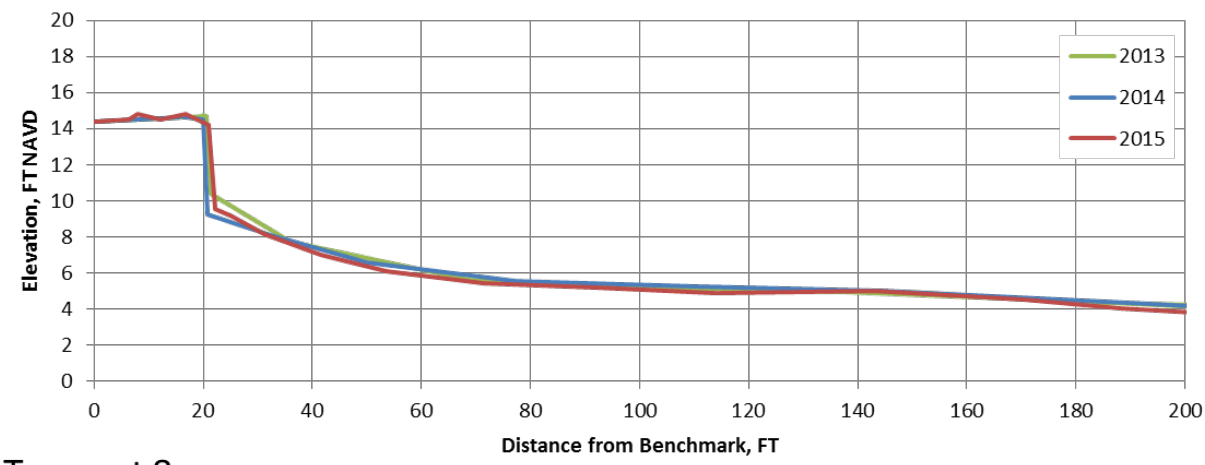



Transect 6

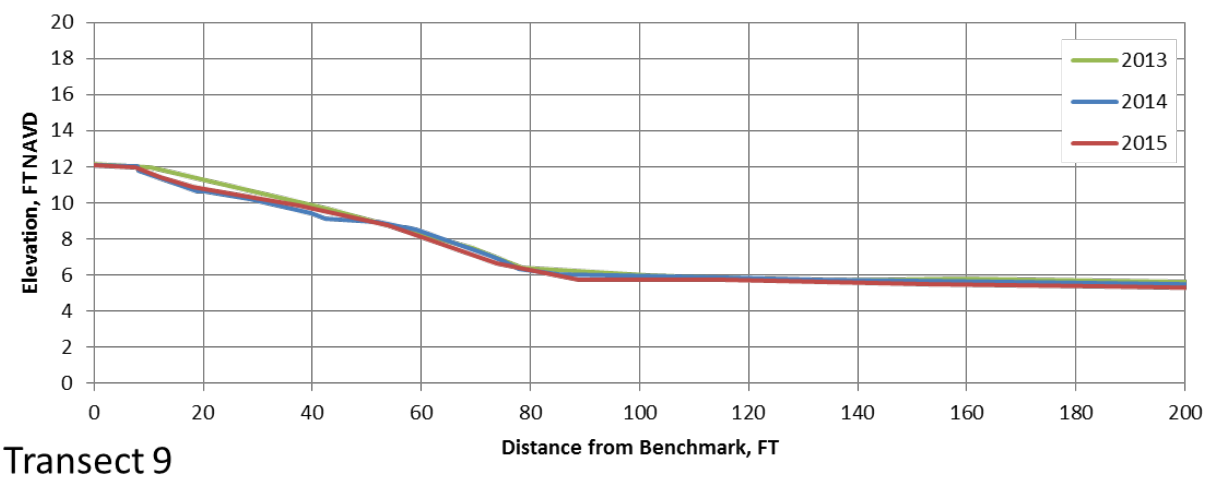
**Figure D.4 Cross-sectional plots of the survey transects, Transects 4 though 6**




Transect 7

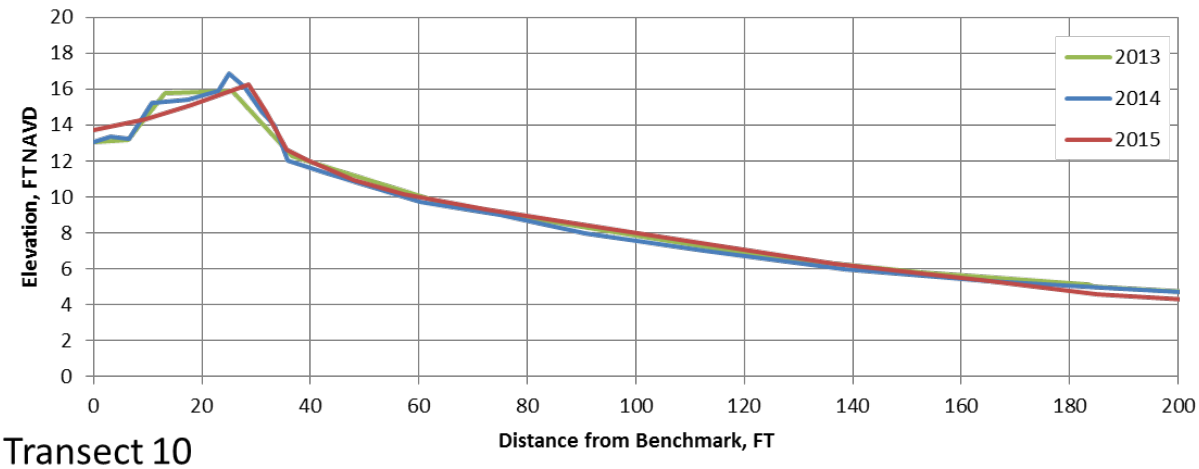



Transect 8

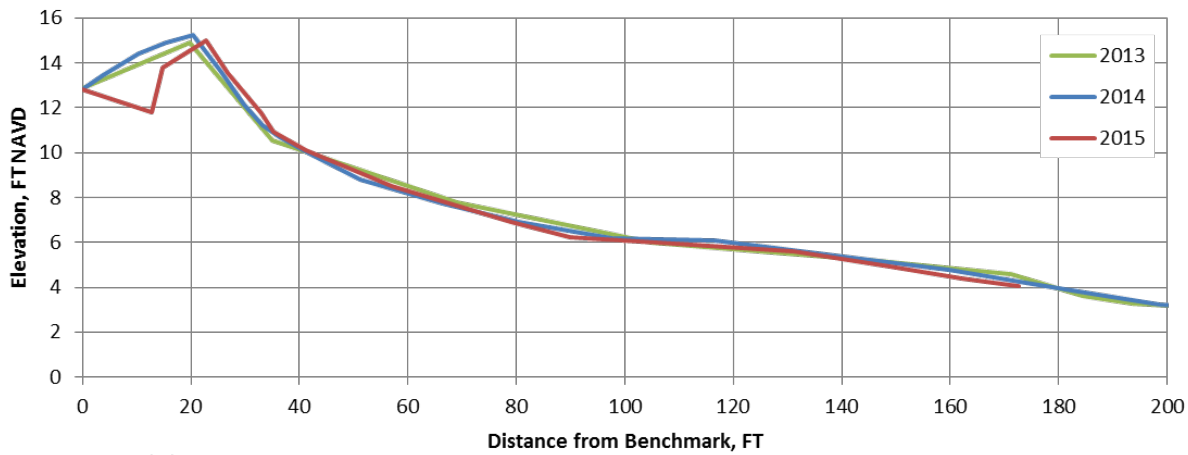



Transect 9

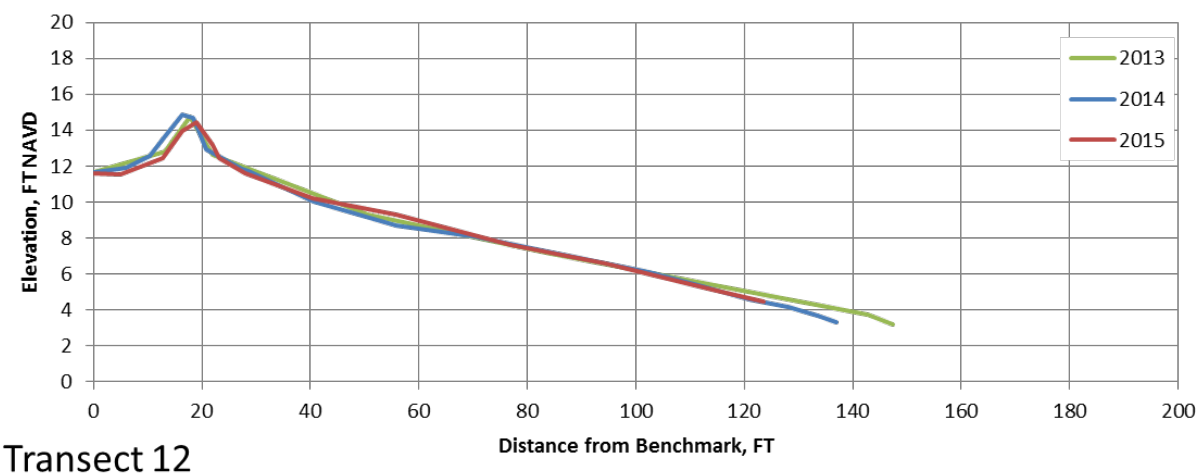
**Figure D.5 Cross-sectional plots of the survey transects, Transects 7 though 9**




Transect 10

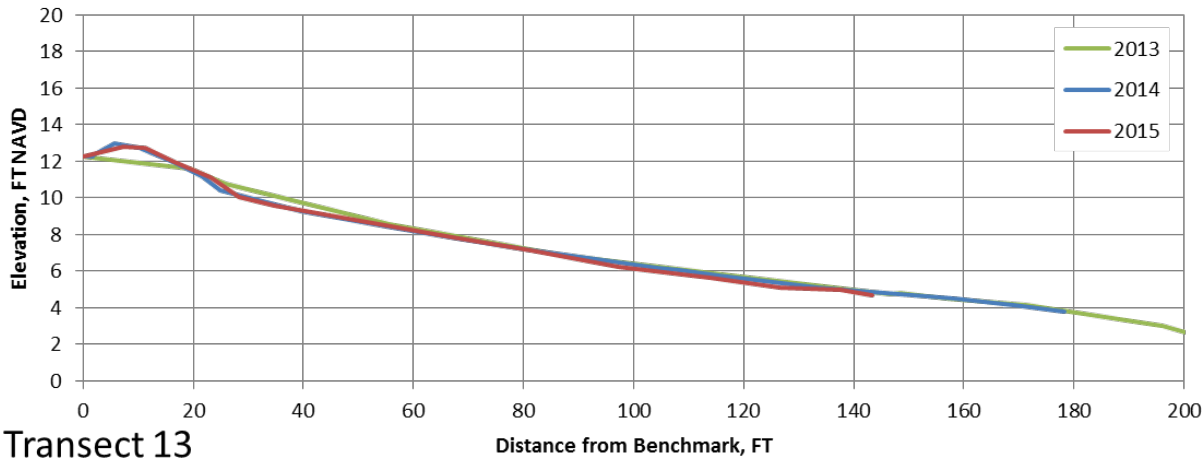



Transect 11

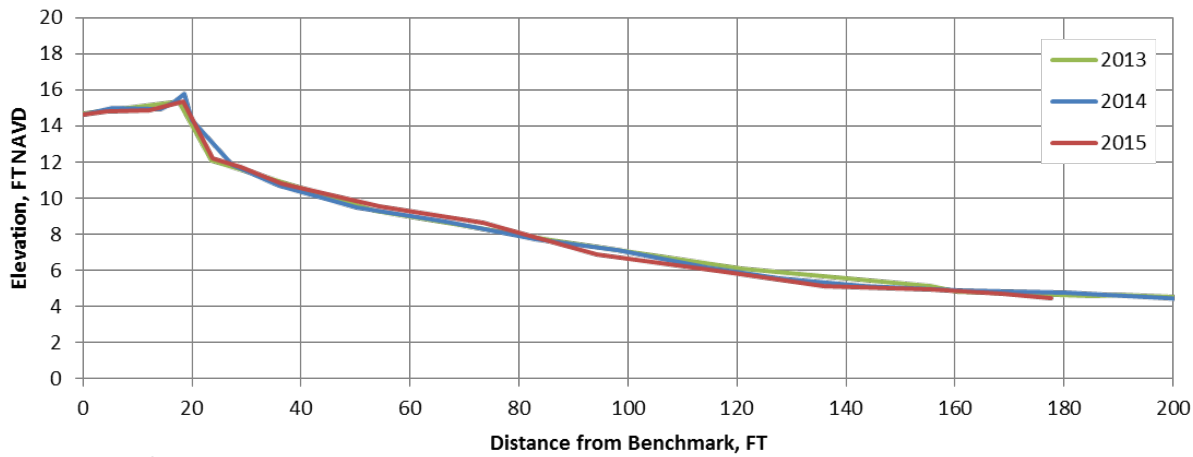



Transect 12

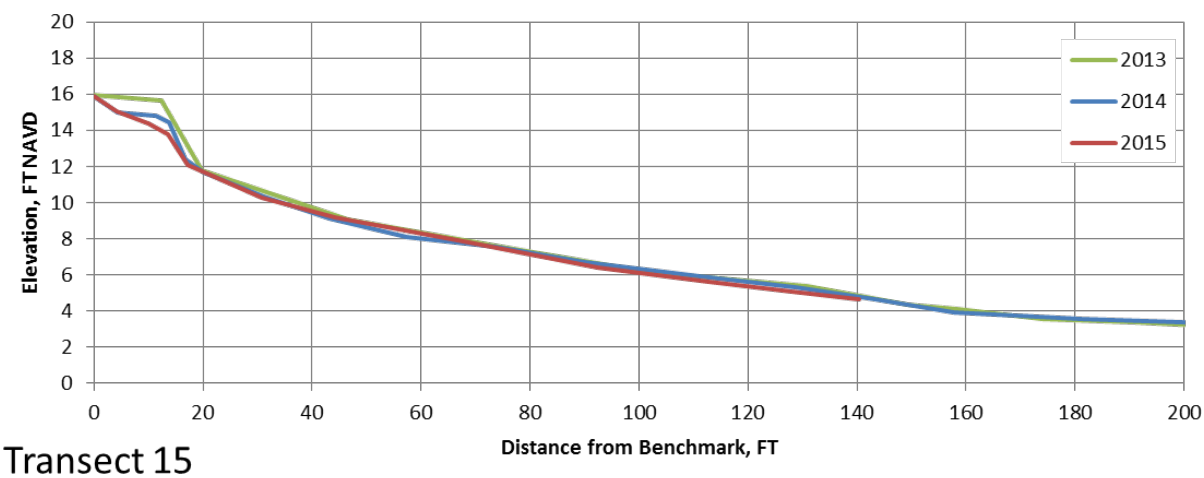
**Figure D.6 Cross-sectional plots of the survey transects, Transects 10 though 12**




Transect 13

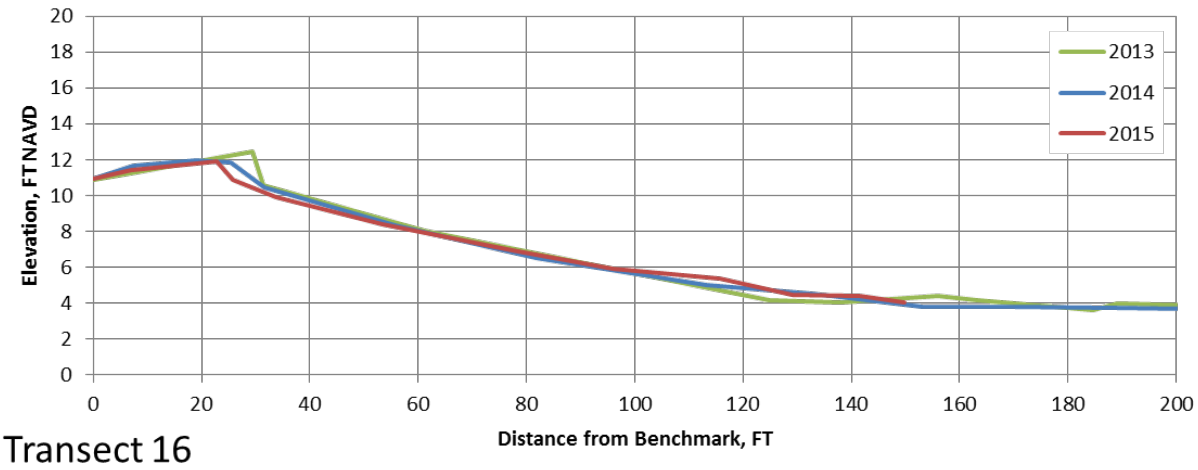



Transect 14

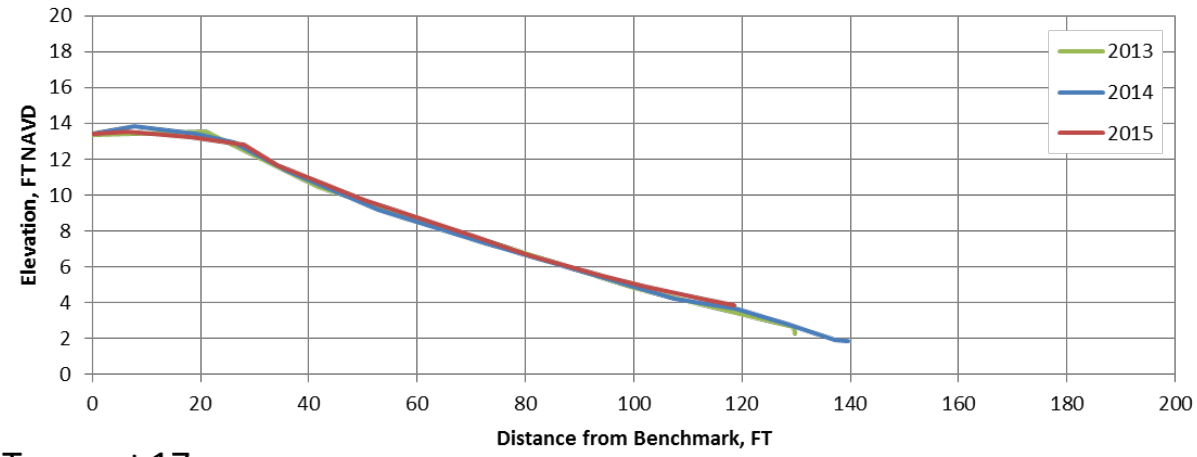



Transect 15

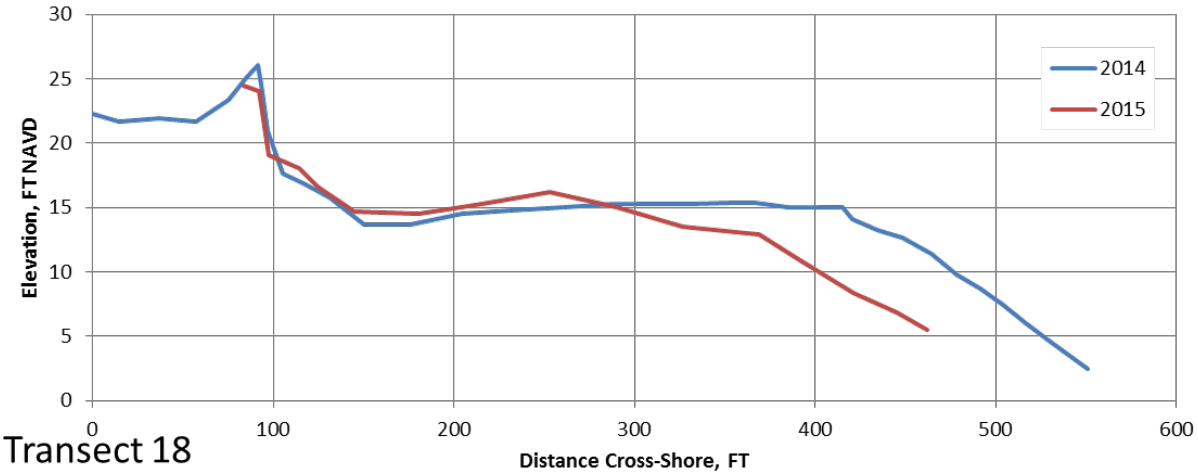
**Figure D.7 Cross-sectional plots of the survey transects, Transects 13 though 18**




Transect 16




Transect 17




Transect 18

**Figure D.8 Cross-sectional plots of the survey transects, Transects 16 though 18**

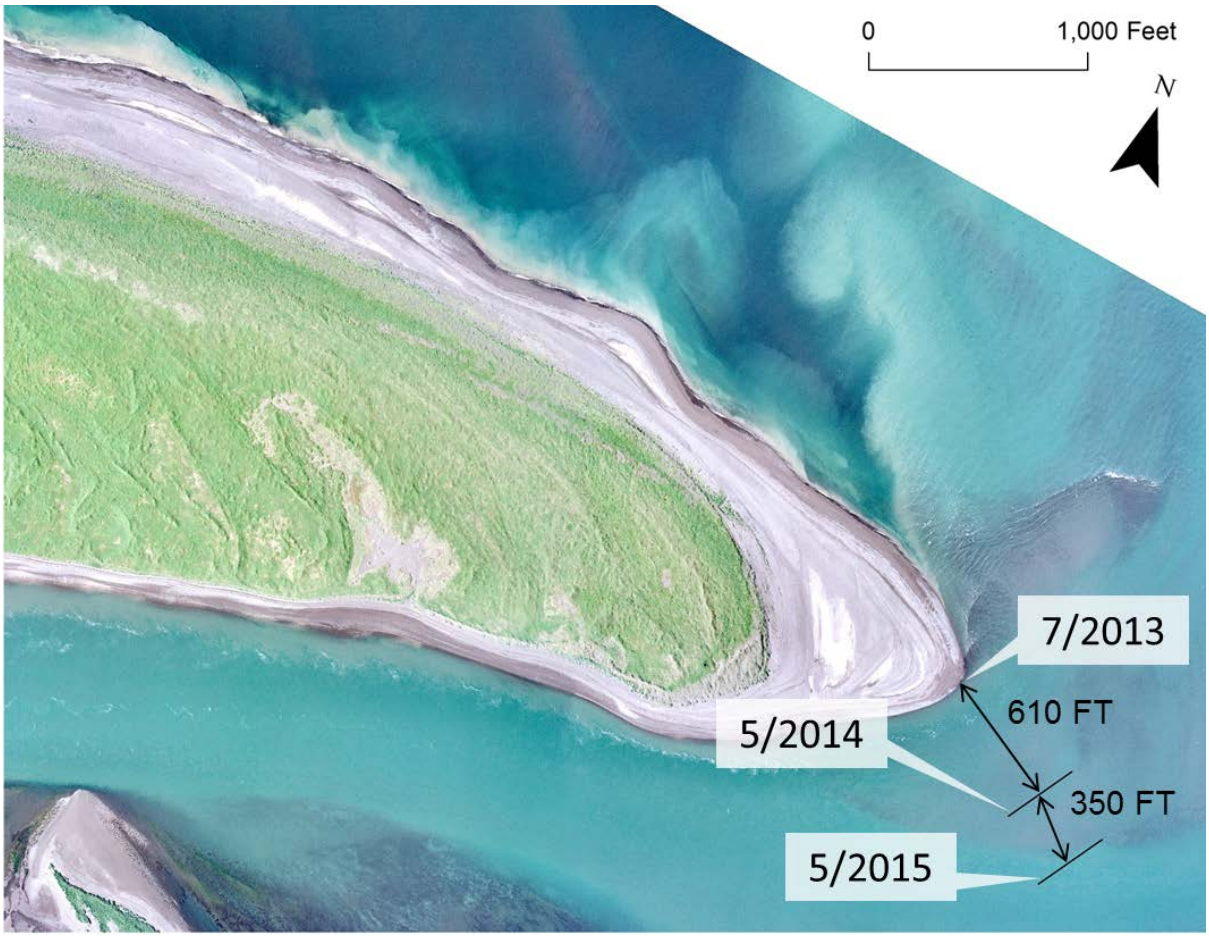



**Figure D.9 Location of the end of the spit (2014 and 2015) in reference to the 2013 aerial**