Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Designs

Napeague Harbor Water Circulation Enhancement
Napeague, Town of East Hampton

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Table of Contents

List of Figures

1 Executive Summary

Napeague Harbor is one of the most significant coastal habitats within the Peconic Estuary for finfish populations, shellfish, and eelgrass, due to its high water quality and undeveloped watershed. The Peconic Estuary Program (PEP), the Town of East Hampton (Town), and other stakeholders determined that restoration of the east inlet, which closed in 2007, should be evaluated as a means to restore historical circulation patterns in the harbor and, as a result, 1) improve water quality and habitat for shellfish, finfish, and eelgrass 2) reduce water flow through the west inlet and, potentially, 3) reduce shoreline erosion on the north side of Lazy Point and in Promised Land. The conclusion that restoration of tidal flow through the east inlet would provide ecological benefits was based on observations by the Town's Natural Resources Department indicating increased shellfish production at the Town's shellfish grow-out facility and increased eelgrass abundance in years immediately following the excavation of a small channel near the historic east inlet location compared to years when the east inlet was entirely closed.

The PEP and Town's rationale is broadly supported by scientific literature. For example, it is probable that increased inlet size will be beneficial to eelgrass productivity in Napeague Harbor as the cross-sectional area of an inlet is positively correlated with the volume of water entering and exiting the inlet during flood and ebb tides (O'Brien, 1931; O'Brien, 1969). Large flood and ebb flows will maintain high water turnover with Napeague Harbor and high water clarity conditions typical of Gardiners and Napeague Bays. Eelgrass growth productivity has been found to be dependent on water clarity and light availability (Hauxwell et al., 2003; Ochieng et al., 2010). Maintenance of healthy eelgrass beds in Napeague Harbor will benefit shellfish and finfish populations, as eelgrass beds are important developmental habitats for bay scallop (Heck et al., 1995) and winter flounder (Goldberg et al., 2002). In addition, it is likely that the narrowing and eventual closure of the east inlet was correlated with increased flow volumes within the west inlet and erosion along that inlet's shoreline. This is supported by the results of scientific studies in estuaries with multiple inlets, which observe that some inlets will either capture flow or lose flow in response to changes in the flow volumes of other inlets within the same estuary (Batten et al., 2007).

The original scope of this project was to evaluate historical changes in inlet configuration through analysis of historical aerial imagery and document the existing bathymetric and topographic conditions of northern Napeague Harbor in order to provide a conceptual plan for restoration of the east inlet including estimated dredge sediment volume, potential sediment deposition sites, environmental impacts and benefits of east inlet restoration, and approximate project costs for the restoration of the east inlet. The original scope of work assumed that the west inlet would remain open during and after the restoration of the east inlet, as Napeague Harbor had two inlets during the late 1800's and early 1900s and between 1967 and 2007.

Field data collection for bathymetric and topographic mapping and review of the historical shoreline changes from 1954 to the present was conducted in late spring 2012. Bathymetric mapping indicated that the minimum cross-sectional area of the west inlet at Napeague Harbor in 2012 was 1,720 square feet. Hydrodynamic analysis of Napeague Harbor indicates that the predicted cross-sectional area for a single inlet in the harbor is 1,740 square feet. This suggests that the existing west inlet is in equilibrium with the surface area and tidal range of the harbor. Accordingly, Napeague Harbor can likely support only one stable inlet and any efforts to greatly increase the size of the west inlet to increase water circulation into Napeague Harbor are not likely to be effective in the long term. In addition, any effort to relocate and enlarge Napeague Harbor's inlet from its existing location to the historic eastern location is not likely to result in any significant increase in the actual volume of water exchanged between Napeague Harbor and Napeague Bay.

Restoration of the east inlet via hydraulic dredging would require the removal of approximately 60,600 cubic yards of sediment. This report provides a conceptual plan for the restoration of the east inlet including inlet dimensions (*i.e.* minimum cross-sectional area, minimum width, channel length and depth). A restored east inlet constructed through the removal of 60,600 cubic yards of sediment would be sufficiently large to capture a significant fraction of the Napeague Harbor's tidal flow. Preliminary estimates indicate that a dredging project to restore Napeague Harbor's east inlet through the removal of approximately 60,600 cubic yards of sediment and placement of dredged sediment in the west inlet and on the beaches of Promised Land would cost between $500,000 and $1,200,000.

Considering that Napeague Harbor can only support one stable inlet, east inlet restoration would either require or cause the closure of the west inlet. In light of this concern, the PEP and Town requested that the conceptual analysis of this project be expanded to include a summary of the hydrodynamic and water circulation studies necessary for policy makers to evaluate if the east inlet would provide sufficient improvements in water circulation and ecological conditions to justify the significant design, permitting, and construction costs associated with restoring the east inlet. A preliminary cost for this hydrodynamic study and the associated field measurements necessary for this evaluation and support the development of construction plans for a dredging project is approximately $250,000.

The PEP and Town also requested that a decision matrix be developed as a planning tool to facilitate 1) the evaluation of the results of future hydrodynamic studies and water chemistry modeling and 2) the potential selection of a preferred alternative for the restoration of Napeague Harbor by considering the relative ecological benefits of the inlets, the construction costs of an east inlet restoration project, the frequency of maintenance dredging for both inlets, and the effects of the inlets on coastal erosion at Lazy Point and Promised Land. This decision matrix is provided in Section 6 of this report.

2 Field Investigations and Literature Research on Existing Conditions at Napeague Harbor

2.1 Existing Topographic and Bathymetric Conditions

A topographic map of Hicks Island, Goff Point, and Lazy Point and a bathymetric map of the northern portion of Napeague Harbor and nearshore waters of Napeague Bay were developed to inform estimates of dredged sand volumes required for the restoration of the east inlet to its historic location and dimensions. The bathymetry and elevation map, shown in Figure 1, was based on profiles collected by Land Use Ecological Services in May 2012. Bathymetric and elevation data were collected in accordance with the Quality Assurance Project Plan (last revised December 11, 2011), approved by the US EPA and the Suffolk County Department of Health Services (Appendix A). Approximately 594 bathymetric and elevation data points were collected for the development of the bathymetry and elevation map. All depth soundings were corrected for variation in tidal stage, as required in the QAPP. The spatial distribution of the bathymetry and elevation data points is presented in Figure 2.

Notable topographic and bathymetric features of northern Napeague Harbor, Hicks Island, and the nearshore waters of Napeague Bay include:

- Hicks Island consists of a narrow plateau with elevations ranging between 10.0 and 17.9 feet (NGVD 1929) and steep slopes on the eastern and western sides. The height and steep slopes are not consistent with the natural geomorphological and ecological conditions of Napeague. Hicks Island should naturally feature low elevation maritime beach and dune habitats, rather than the perched backdune habitat present. The conditions at Hicks Island have resulted from its repeated use as a dredge spoil deposition site for east and west inlet dredging projects in 1967, 1987, 1989, and 2004. The 2004 dredging project removed 37,000 cubic yards of sediment from the west inlet and increased the elevation of Hicks Island by approximately 6 feet.

- The northern portion of Napeague Harbor largely consists of shallow (less than 4 feet deep) sandy shoals and bars. The notable exception to these shallow shoals is a 15-acre area of deeper water (up to -18 feet NGVD 1929) immediately south of Goff Point, known as Skunk Hole. The deep waters of Skunk Hole are remnants of the inlet gorge for the historic east inlet that connected Napeague Bay to the backwaters of Napeague Harbor through a narrow channel of deep water located on the eastern side of Napeague Harbor.

- The west inlet features a 2,200 foot long and 180 foot wide channel of deep water (up to 8 feet in depth) extending from north of Lazy Point to the offshore waters of Napeague Bay. This large and well-established channel is the result of the persistent effects of inlet hydrodynamic processes and repeated maintenance dredging since the inlet's construction in 1967.

- A shallow shoal (less than 6 feet deep) is present offshore of the historic location of the east inlet between the northern end of Hicks Island and Goff Point. There are no areas of deep water offshore remaining from the ebb channel of the historic east inlet.

2.2 Natural Resources of Northern Napeague Harbor

Napeague Harbor is one of the least developed coastal bays on eastern Long Island and, in conjunction with the adjacent upland habitats in Hither Hills State Park and Napeague State Park, provides a regionally-important habitat complex consisting of pristine beaches and dunes, dune heath, shallow shoals and littoral waters, tidal wetlands, shrub thickets, and oak and pine forests. Napeague Harbor is one of two tidal embayments in the Town of East Hampton with eelgrass beds (*Zostera marina*).

Eelgrass beds benefit shellfish and finfish populations by providing important developmental habitats for bay scallop, *Argopecten irradians* (Heck et al., 1995) and winter flounder, *Pseudopleuronectes americanus* (Goldberg et al., 2002). Historical maps from 1930 indicate that eelgrass beds were located throughout Napeague Harbor (Peconic Estuary Program, 2009). The existing Napeague eelgrass beds are located on the harbor's eastern shoreline and on the southern side of the flood shoal remaining from the historic east inlet, as shown in Figure 3 (data provided by the Town of East Hampton Shellfish Hatchery). In addition to the significant reduction in eelgrass bed area, surveys have indicated that portions of Napeague's eelgrass beds in waters less than 1m in depth have converted to *Codium* and/or *Gracilaria* (EEA, 1999). In 2008, the Town of East Hampton Trustees designated Napeague Harbor an eelgrass sanctuary to protect these habitats from physical disturbance by shellfishing activities (Peconic Estuary Program Natural Resources Subcommittee, 2010). Anecdotal reports indicate that the existing eelgrass beds have expanded after dredging or excavation projects to temporarily re-open the east inlet (L. Penny, 2000).

Napaegue Harbor is one of the most important shellfish habitats in the Town of East Hampton and the Peconic Estuary. The high shellfish productivity in Napeague Harbor is attributed to high water quality resulting from low development density in the Harbor's watershed. The Town of East Hampton Shellfish Hatchery has seeded hard clams, oysters, and bay scallops throughout the harbor (Figure 3). Many of these seeding activities have been located on the shoals to the north and south of Skunk Hole and shoals adjacent to flood channels associated with the west inlet. The Town Hatchery maintains rafts for growing out hatchery-cultured hard clam (*Mercenaria mercenaria*) and oyster (*Crasostrea virginica*) seed in Skunk Hole.

The maritime beaches of Goff Point, Hicks Island, and Lazy Point provide important nesting habitat for piping plover (*Charadrius melodus*) and least terns (*Sternula antillarum*). Along with the nearby beaches of Hither Hills and Napeague State Parks, this area serves as a large complex of contiguous maritime habitats of regional importance to shore-nesting birds. Accordingly, this area has been designated as a bird conservation area of state-wide importance (Napeague Bird Conservation Area). Between 2000 and 2011, five to twenty two piping plover nests were observed annually on Hicks Island and Goff Point beaches. Between 2005 and 2011, twenty three to sixty five least tern nests have been observed annually on these beaches. Plover and tern nests have typically been located in the sparsely vegetated beaches from Goff Point south through the sand spit located in the area of the historic east inlet and the dredge spoil deposition areas on the southern end of Hicks Island, as shown in Figure 3. Piping plovers have also nested on at Lazy Point on the southern shoreline of the west inlet. The preceding plover and tern nesting data was provided by the Town of East Hampton Natural Resources Department and New York State Office of Parks, Recreation, and Historic Preservation.

Prior to 2006, Hicks Island supported a large common tern nesting colony (averaging 106 pairs/nests). This colony was destroyed by red foxes when the closure of the east inlet allowed access to Hicks Island from Goff Point (Evans et al., 2000). Roseate tern and black skimmer have historically nested at Hicks Island (New York State Department of State, 2002), but not in recent years. The closure of the east inlet and, perhaps, the use of Hicks Island as a dredge deposition site have increased predator exposure and altered the beach topography resulting in decreased abundance and diversity of nesting shorebirds.

3 Hydrodynamic Analysis of Napeague Harbor and the West Inlet

3.1 Tides and Tidal Datum

The nearest NOAA tide station to Napeague Harbor is the Montauk tide station located in Fort Pond Bay (approximately 5.5 miles to the east of Napeague Harbor). The mean tidal range at the Montauk tide station is 2.07 feet with an average spring tidal range of 2.53 feet (NOAA, 2005).

3.2 Tidal Prism for Napeague Harbor

Due to the proximity of the Montauk tide station, tide data can be reliably used to perform a preliminary hydrodynamic analysis of the existing, single-inlet conditions at Napeague Harbor. However, water circulation modeling under multiple inlet configurations requires a more robust hydrodynamic study that should include measurements of water surface elevation, wave height, wave direction, and current using acoustic doppler current profilers (ADCP) positioned in Napeague Harbor and in the west inlet along with a wave gauge in the nearshore waters of Napeague Bay.

The spring tidal prism of an inlet channel (*i.e.* the total volume of water entering or leaving through an inlet during a spring flood or ebb tide, respectively) is positively related to the cross-sectional area of the inlet (O'Brien, 1969; Jarrett, 1976). The tidal prism of an inlet can be calculated as:

$P = a_b A_b$ (Seabergh, 2006)

where P = Spring Tidal Prism (ft^3)
a_b = Spring tidal range (ft)
A_b = Surface area of bay (ft^2)

The tidal prism of Napeague Harbor is estimated to be 100.3×10^5 cubic feet based on a bay surface area of 3.54×10^6 square feet (81.4 acres) and a spring tidal range of 2.53 feet.

Jarrett (1976) analyzed tidal prism and inlet cross-sectional area parameters for inlets in the Atlantic Ocean, Pacific Ocean, and Gulf of Mexico and found the following relationship in Atlantic Coast inlets without jetties:

$A_c = 7.75 \times 10^{-6} P^{1.05}$ (Jarrett, 1976)

where A_c = Minimum Cross-Sectional Area (ft^2)
P = Spring Tidal Prism (ft^3)

The cross-sectional area for a single inlet in Napeague Harbor predicted from the above equation is 1,740 square feet. The minimum cross-sectional area of the west inlet at Napeague Harbor calculated from the bathymetric map performed by Land Use Ecological Services was 1,720 square feet.

Inlet cross-sectional area is variable and can change by ±10 percent over short time frames in response to variation in tidal current and wave energy caused by storms or changing astronomical or meteorological conditions (Byrne et al., 1974). Despite the natural variability of tidal inlets, our preliminary analysis shows very good agreement between the measured cross-sectional area of the existing west inlet and the predicted dimensions based on the surface area and tidal range of Napeague Harbor.

This suggests that the existing west inlet is in equilibrium with the surface area and tidal range of the harbor. Accordingly, any efforts to greatly increase the size of the west inlet to increase water circulation into Napeague Harbor are not likely to be effective in the long term. The increased inlet cross-sectional area would result in decreased velocity of the inlet's ebb and flood currents allowing sediments to accumulate in the inlet and return it to its equilibrium dimensions. In addition, any effort to relocate and enlarge Napeague Harbor's inlet from its existing location to the historic eastern location is not likely to result in any significant increase in the actual volume of water exchanged between Napeague Harbor and Napeague Bay.

3.3 Littoral Transport

The predominant direction of littoral sediment transport in Napeague Bay in the vicinity of Napeague Harbor is from east to west. The westward oriented prograding sediment ridges located offshore of the northern end of Hicks Island (Figure 4) and the sand accretion on the east side of the Promised Land groins (Figure 5) provide visual indications of predominant littoral sediment transport direction.

4 Geomorphic Analysis and Interpretation of Coastal Processes

4.1 Methods of Analysis of Historical Aerial Imagery

Changes in the Napeague Harbor inlets and the shorelines of Goff Point, Hicks Island, Lazy Point, and Promised Land were determined through analysis of a chronosequence of historical aerial images. Nine sets of aerial images dating from 1954 to 2012 were obtained from the Town of East Hampton Planning Department, New York State Office of Cyber Security (NYSOCS), and the United State Geological Survey (USGS). Aerial photographs obtained before 1994 were manually orthorectified utilizing multiple reference locations at Lazy Point and Goff Point. Orthorectification methods and meta-data are provided in Appendix B. The shorelines were digitized (along the seaward limit of the visibly dry beach) and shoreline change was calculated by measuring shoreline location relative to five baselines oriented perpendicular to the shoreline. The five baselines are shown in Figure 6 and provide estimates of the changes in the width of the sand spit at Goff Point, the length of the attachment bar at the northern end of Hicks Island, the width of Hicks Island, and estimates of shoreline change at two locations on Lazy Point. In addition, the minimum width of the east and west inlets were measured for each of the nine aerial images.

4.2 Interpretation of Shoreline and Inlet Configuration Change in Napeague Harbor

The shoreline and inlet configuration of Napeague Harbor has undergone significant changes in the latter half of the 20th century due to coastal storms and anthropogenic manipulation. In 1954, Napeague Harbor had one inlet, the east inlet, located south of Goff Point. At this time, Hicks Island was connected to Lazy Point by a narrow sand spit approximately 150 feet in width. The east inlet consisted of a well-defined channel, 162 feet in width, connected to the relatively deep waters of Skunk Hole (Figure 7, Aerial Photo dated February 20, 1954). The main channel of the east inlet clearly turned to the northwest on the ebb side of the inlet. A 1951 United States Geological Services/Coast Guard navigational chart (Figure 8) indicates that the ebb channel of the east inlet was at least 8 feet deep (below mean low water) and Skunk Hole was up to 19 feet deep. The navigational chart also shows the ebb channel extending to the northwest, where it meets with a steep shelf and the deeper waters of Napeague Bay approximately 1,600 feet offshore. This navigational chart should be interpreted cautiously, as the chart does not show the main inlet channel connecting Napaeague Harbor and Napaeague Bay and instead shows a shallow shoal (approximately 2 feet deep) within the inlet.

At this time, there was also a small shoal and sandbar, approximately 120 feet in width, to the southwest of the east inlet on the eastward extending arm of Hicks Island. This sandbar and shoal appear as if they were overtopped during spring and storm tides. This overwash zone, hereafter referred to as the central inlet, was wide (approximately 248 feet in width), but shallow and does not appear to have conveyed a large proportion of the harbor’s tidal prism. The 1954 aerial image also shows a narrow spit (approximately 405 feet in length and 165 feet in width) extending to the northwest from the northwest corner of Hicks Island. This shoal is an attachment bar formed by the accumulation of sediment 1) flushed from the inlet channel and subsequently deposited on the downdrift side of the inlet and/or 2) by-passing the inlet. The 1954 aerial image also shows an area of deeper water (up to 7 feet deep according to the 1951 navigation chart) located to the north of Lazy Point. This deeper water has a distinct southwest-northeast orientation and is likely relic of the historical west inlet from the early 1900's when Hicks Island was isolated and not connected to either Goff Point or Lazy Point. While remnants of the west inlet's flood channel remain in 1954, there is no visible evidence of the ebb channel connecting to deep water of Napeague Bay offshore of the west inlet. This nearshore zone appears uniform and shallow in depth on both the aerial imagery and the 1951 navigation chart.

Hurricane Carol made landfall at Montauk Point on August 31, 1954 causing profound changes to the inlet configuration at Napeague Harbor. The 1962 aerial photograph (Figure 9) shows the significant effects of this storm. This storm resulted in an overwash and breach of the northeastern arm of Hicks Island, which expanded the small shoal to an inlet ('central inlet') with a width of 502 feet. In 1962, the central inlet appears to have been sufficiently wide and deep to have captured a substantial fraction of the harbor's flood and ebb waters leading to the maintenance of the inlet for nearly a decade after Hurricane Carol. At this time, the west inlet is closed, but the spit connecting Hicks Island to Lazy Point had narrowed slightly to approximately 105 feet in width.

A dredging project conducted by Suffolk County in 1967 aimed to both reverse the effects of Hurricane Carol and re-open the west inlet, which closed between 1933 and 1947. Suffolk County dredged approximately 342,000 cubic yards of sediment from the sand spits and shoals of Hicks Island to create two navigation channels for Napeague Harbor and deposited the sediments on Hicks Island (Town of East Hampton, 1999). Aerial imagery from 1970 shows the configuration of Hicks Island and the Napeague inlets after this large project (Figure 10). Figure 10 shows a deep, straight channel from the east inlet extending approximately 1,500 feet to the deep waters of Napeague Bay. The west inlet was constructed through the narrow sand spit and connected to the deep waters of Napeague Bay by a 1,600 foot ebb channel. In 1970, the west inlet was 64 feet wide at its narrowest point. A 1974 navigation chart (Figure 11) confirms that the new navigation channels at the east and west inlet were constructed in 1967 and indicates that the depth of the east and west inlets were 14 feet and 5 feet, respectively. The central inlet is not present in 1970 and the eastern arm of Hicks Island has increased dramatically in area. This indicates that a large proportion of the dredged sediments from this project was placed on the eastern arm of Hicks Island to close the central inlet created by Hurricane Carol.

The opening of the west inlet has had profound impacts on Napeague Harbor since its opening in 1967. These impacts can be observed in the sequence of aerial photographs from 1970 to 2010 (Figures 10 through 15). During this forty year interval, the west inlet increased in width from 64 feet to 180 feet. In contrast, the east inlet dwindled from a width of 240 in 1970 to 51 feet in 2010. The gradual shift in the ebb and flood of Napeague Harbor's tidal prism from the east inlet to the west inlet can be observed as early as 1978. Aerial imagery from 1978 (Figure 12) shows that the west inlet increased in width to 108 feet and the east inlet decreased in width to 135 feet. As described in Section 4 (*Hydrodynamic Analysis*), there is a limited volume of water, *i.e.* the tidal prism, that can be exchanged between Napeague Harbor and Napeague Bay during flood and ebb tides. The introduction of water flow through the west inlet decreased the water volume available to east inlet and reduced flood and ebb flow velocities in the east inlet. This is known as tidal prism capture. The decreased flow volume and velocity in the east inlet reduced the capacity of the inlet's ebb current to flush out sediments deposited in the inlet channel by littoral currents. The reduced sediment flushing capacity of the east inlet caused the accumulation of sediments in the east inlet channel and the gradual narrowing of the channel. In addition to tidal prism capture by the west inlet, the narrowing and eventual closure of the east inlet was likely facilitated by Suffolk County's maintenance dredging of the west inlet in 1987, 1989, and 2005 without concurrent dredging of the east inlet.

Tidal prism capture by the west inlet initiated several other observable changes in the shoreline morphology of Napeague Harbor. For example, the large attachment bar at the northwestern corner of Hicks Island decreased in length and width until it eroded completely by 2010. Erosion of the attachment bar was caused by decreased sediment supply to the attachment bar due to decreased velocity of the east inlet's ebb current. The littoral sediments were deposited and accumulated in the east inlet channel rather than being flushed out to the attachment bar.

The pronounced ebb channel of the east inlet created by the 1967 dredging project gradually filled with sediments and is barely visible in the 2010 aerial photograph (Figure 4) and the 2012 bathymetric mapping (Figure 1). Similarly, the gradual prism capture and maintenance dredging of the west inlet resulted in the development of a pronounced ebb channel extending more than 2,200 feet offshore. Sediments eroded from the northern and southern shorelines of the west inlet, associated with its widening and prism capture, were transported inshore and created a large flood shoal. This flood shoal is first apparent in the 1978 aerial photograph (Figure 12), but by 2010 extends more than 2,000 feet northeast of the west inlet and is more than 2.54 acres in area.

The southern shoreline of the west inlet eroded significantly as the inlet increased in size and flow volume. The northern shoreline of Lazy Point to the north of the intersection of Shore Road and Lazy Point Road (to the west of the existing boat ramp) has receded by 165 feet between 1970 and 2010 (Figure 6). This erosion has been abated somewhat by the installation of rip-rap and the presence of the Town boat ramp. The increased flow volume at the west inlet has resulted in a convergence of flood and ebb waters from Napeague Bay (during the flood tide) or Napeague Harbor (during the ebb tide). This convergence of flows creates currents that flow parallel to the adjacent shorelines toward the inlet. The convergence of waters toward the west inlet on the ebb tide has eroded the eastern tip of Lazy Point. As shown in Figures 6 and 10 through 15, the beach at the tip of Lazy Point has receded by 95 feet since 1970 and the outer roadway loop has been lost.

These shoreline convergence currents have likely contributed to the relatively static position and width of Hicks Island. Despite the deposition of large volumes of sand from repeated dredging and excavation projects (1987, 1989, 2004, 2007, and 2008), the width of Hicks Island and the position of its eastern and western shorelines have remained relatively constant. This is likely due to 1) the planting of American beach grass on the dredge spoils (after at least some of the dredging events) to reduce aeolian transport of the sediments and 2) currents flowing along the eastern shoreline during ebb tides preventing eastward expansion of Hicks Island.

The east inlet closed completely in 2007 after an April nor'easter and was artificially re-opened several times, most recently in 2010. These small projects used land-based excavators to create a new channel with a maximum depth of 6 feet below mean low water. The new inlets created by these projects had insufficient water volume (due to the small size) and velocity (due to friction with the channel substrate) to efficiently convey tidal waters. Accordingly, these new inlets rapidly filled with sediments.

Since the closure of the east inlet in 2007, the large littoral sediment transport flux has produced substantial sand accretion on the spit between Goff Point and Hicks Island despite the periodic attempts to temporarily re-open the east inlet. For example, recent field investigations indicate areas of beach with elevations greater than 8.0 feet (NGVD 1929) and upland vegetation such as beach plum (*Prunus* *maritima*), poison ivy (*Toxicodendron radicans*), and rugosa rose (*Rosa rugosa*). In addition, the width of the sand spit at Goff Point has increased to 185 feet in 2012; the spit has not been wider since before 1994.

5 Conceptual Plan for Restoration of the East Inlet

The following section provides a conceptual plan for restoration of the east inlet through hydraulic dredging, including the location and dimensions of a new east inlet and a preliminary sediment dredge volume.

The Town of East Hampton re-opened the east inlet three times between April 2007 and the spring of 2010 (L. Penny, pers. comm.). These projects used a land-based excavator to dig a small channel in the location of the historic east inlet. The excavated channel was 40 feet in width, with a maximum depth of -6 feet (NGVD 1929), and did not extend seaward of mean low water on either the western or eastern shorelines of the spit (i.e. only the dry beach was excavated). Re-opening the east inlet in this manner required the removal of approximately 3,000 cubic yards of sand, which was deposited on the eastern arm of Hicks Island. Anecdotal reports indicate that re-opening the east inlet provided localized improvements in water clarity and eelgrass and shellfish production in the northern portion of Napeague Harbor.

Due to the small size of the constructed opening, these channels were destined to be closed quickly by sediments deposited by the littoral current from the east. The cross-sectional area of these excavated channels was only 204 square feet. These channels were too small to capture a significant fraction of the tidal prism from the larger west inlet with its cross-sectional area of 1,720 square feet. The frictional forces imposed on flood and ebb waters while flowing over the sandy substrate of the bottom and sides of these small east inlet channels reduced the velocity of the currents and their capacity to flush or remove sediments from the channel (Seabergh, 2006). As littoral sediments accreted in the re-opened channel, the frictional forces increased, and flood and ebb velocities decreased, yielding additional sediment accretion and the eventual closure of the re-opened channel.

Any future project aimed at restoring the east inlet must excavate or dredge significantly more sediments from the sand spit in order to create an inlet capable of capturing a significant fraction of the harbor’s tidal prism. A conceptual plan and profile for the restoration of the east inlet is provided in Figures 16 and 17. These figures provide both plan and section views for the east inlet restoration. The proposed location, inlet dimensions, and bathymetric contours reflect the following considerations:

- The minimum cross-sectional area of the proposed inlet channel is 2,400 sq ft. This proposed inlet channel would be sufficiently large to accommodate the tidal prism of Napeague Harbor and is consistent with the relationship between tidal prism and inlet cross-sectional area put forth by Jarrett (1976).
- The minimum width of the proposed inlet configuration is 325 feet. Our review of historical aerial photographs indicates that the east inlet was 162 feet wide in 1954. The minimum width of the existing west inlet is 223 feet.
- The proposed depth of the inlet channel shown in Figure 16 is -8.0 feet (NGVD 1929). The average depth of the inlet channel in the existing west inlet is -8 to -9.99 feet. Insufficient bathymetric data exists on the inlet channel depth for the historical east inlet prior to the opening of the west inlet in 1967 to provide reliable guidance for this conceptual design analysis.

However, the 1951 historical navigation charts indicates that depth of the east inlet was at least -8 below mean low water in the inlet gorge just offshore of the inlet.

- The proposed inlet is located adjacent to the deep waters of Skunk Hole to 1) minimize the volume of sediment necessary for removal 2) maximize the effective length of the channel, and 3) maximize the impact of the inlet on water turnover in Skunk Hole.
- Flood and ebb currents through tidal inlets do not converge solely in the narrow channel between the ends of the opposing sand spits. Instead tidal inlets typically have a defined channel that extends some distance both offshore and into the bay. The historic channel of the east inlet can be observed in the 1954 aerial imagery (Figure 7) heading to the northwest from the inlet. The historic channel is also represented on the 1951 USCS navigation chart which shows a defined channel (7 to 8 feet in depth) through the shallow nearshore shoal. In order to effectively re-open the east inlet, the constructed channel must similarly extend offshore. The offshore extension of the inlet channel allows the ebb current to remain consolidated and capable of transporting sediment offshore from the inlet gorge. The conceptual channel profile extends approximately 1,050 feet offshore to a depth of –8.0 feet.
- A similar inshore extension of the inlet channel into Napeague Harbor is not necessary as the proposed inlet is adjacent to Skunk Hole. The deep waters of the Skunk Hole will then serve as the inshore portion of the inlet's channel.
- The side slopes of natural inlet channels typically have slopes between 3-5º or 5.24-8.75% (Buonaiuto and Kraus, 2003). The proposed inlet configuration has a side slope of 4º or 7%.

Restoration of the east inlet according to the conceptual plans in Figures 16 and 17 would require the removal of approximately 60,600 cubic yards of sediment. By comparison, the 2004 maintenance dredging of the west inlet removed 37,000 cubic yards of sediment. The 2004 dredged sediments were deposited on Hicks Island and raised the elevation of Hicks Island by approximately 6 feet. With the maximum elevation of Hicks Island now at nearly 18 feet, further elevation increases through dredge spoil deposition would be inconsistent with its historical condition as a maritime beach spit and dune complex. Perhaps more importantly, the deposition of dredge sediments on Hicks Island does not alleviate the impacts of the Napeague inlets on littoral sediment transport to Promised Land communities to the west. Sediments dredged from either a restored east inlet or maintenance dredging of the west inlet should be deposited downdrift of the inlet to mitigate for the disruption of littoral sediment transport by the inlets.

Closure of the east inlet after the construction of the west inlet in 1967 strongly suggests that if the west inlet were left open after the re-construction of the east inlet, the re-constructed east inlet would close again. Therefore, a fraction of the 60,600 cu yards of sediment dredged to restore is needed to close the west inlet. Preliminary calculations indicate that closing the west inlet by creating a 100 foot wide sand spit would require approximately 18,000 cubic yards of sand. However, a larger sand spit could be constructed. This spit should be sufficiently high in elevation to provide piping plover habitat and not be overwashed during normal spring high tides. An elevation of 4 ft (NGVD 1929) was selected for preliminary volume calculations.

Approximately 42,600 cubic yards of dredged sand would remain. Beach nourishment at the beaches to the west of the Napeague inlets is the most appropriate beneficial use of the remaining sand. Downdrift beach nourishment is a logical deposition option 1) due to the close proximity of the downdrift eroded areas and 2) this beach nourishment would replicate the littoral sediment transport interrupted by the Napeague inlets. Approximately 3,600 linear feet of shoreline along Shore Road west to Bay View Avenue have been subject to coastal erosion over the past several decades. The 42,600 cubic yards of available sand could certainly provide significant benefits to downdrift property owners. However, it is beyond the scope of this project to determine how this sand volume could be best utilized to protect private property.

Preliminary estimates indicate that a dredging project to restore Napeague Harbor's east inlet through the removal of approximately 60,600 cubic yards of sediment and placement of dredged sediment in the west inlet and on the beaches of Promised Land would cost between $500,000 and $1,200,000.

6 Introduction to Decision Matrix for Policy Makers and Stakeholders

In light of the findings of the analysis of historical shoreline changes from 1954 to the present, it has become apparent that Napeague Harbor can likely support only one stable inlet. Consequently, east inlet restoration would either require or cause the closure of the west inlet. In light of this concern, the PEP and Town have requested that the conceptual analysis of this project be expanded to include a decision matrix for use as a planning tool. This decision matrix shall facilitate 1) the evaluation of the results of any future hydrodynamic studies and water chemistry modeling and 2) the selection of a preferred alternative for the restoration of Napeague Harbor by considering the relative ecological benefits of the inlets, the construction costs of an east inlet restoration project, the frequency of maintenance dredging for both inlets, and the effects of the inlets on coastal erosion at Lazy Point and Promised Land. The decision matrix is based upon a series of questions whose answers are necessary for policy makers and stakeholders at the Town, State, and Federal levels to determine the optimal resolution of these water quality, ecological, and erosion issues. To the maximum extent practical, the decision matrix estimates costs for engineering studies and water circulation/quality modeling and project construction costs.

The questions addressed in the decision matrix are:

- *Question 1: Can Napeague Harbor Support Two Inlets?*
- *Question 2: Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?*
- *Question 3: Is the East Inlet more stable than (or as stable as) the West Inlet? Therefore, would be East Inlet require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?*
- *Question 4: Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet is closed?*

A detailed hydrodynamic study including the following field investigations and modeling are required to adequately address these questions and inform decisions by the Town and other stakeholders. More detailed information regarding the necessity and objectives of these investigations is provided in the following discussion. A preliminary cost for this hydrodynamic study and associated field measurements is approximately $250,000.

1. Bathymetry of the entire harbor and the nearshore waters of Promised Land
2. Installation of acoustic doppler current profilers (ADCPs) at the west inlet and inside the Harbor adjacent to the east inlet's past locations
3. Installation of a wave gauge in nearshore waters of Napeague Bay
4. Sediment sampling and grain size analysis to calibrate littoral sediment transport modeling
5. Hydrodynamic modeling of Napeague Inlet using DELFT 3D or an equivalent model
6. Modeling of water chemistry parameters under different inlet hydrodynamic scenarios using DELFT3D WAQ numeric water quality model or equivalent model

7. Additional water chemistry sampling may be necessary to support numerical modeling using the DELFT 3D WAQ model. The Peconic Estuary Program currently has one water quality monitoring location in Napeague Harbor (Station #134). This monthly water testing provides data on dissolved oxygen, temperature, total suspended solids, light attenuation, nutrient concentration, and other water chemistry parameters since 2010. Water chemistry data for some parameters have been collected since the mid-1980s under the BTCAMP program. If the available water chemistry data is insufficient to support the water quality model, then additional water chemistry sampling will need to be conducted.

Question 1: Can Napeague Harbor Support Two Inlets?

Closure of the east inlet after the anthropogenic opening of the west inlet, the large littoral sediment transport inferred by the extensive flood shoals, and the small tidal prism of Napeague Harbor strongly suggest that Napeague Harbor cannot support two stable inlets. However, this question is the fundamental issue for the evaluation of project alternatives and should be conclusively answered before commencing with a strategy for evaluating single inlet configurations for Napeague Harbor.

The following field studies and modeling will be needed to confirm that a multiple inlet system in Napeague is not stable and that subsequent studies should focus on assessing the optimal single inlet configuration for Napeague Harbor.

1. Bathymetry of the entire Harbor.
2. Installation of acoustic doppler current profilers (ADCP) at the west inlet and inside the Harbor adjacent to the east inlet's past locations.
3. Installation of a wave gauge in nearshore waters of Napeague Bay.
4. Sediment sampling and grain size analysis to calibrate littoral sediment transport modeling.
5. Hydrodynamic modeling of Napeague Inlet using DELFT 3D or an equivalent model.

In the unlikely event that these analyses indicate that a multiple inlet state in Napeague Harbor is stable, the hydrodynamic model should be used to evaluate or answer the following questions:

- What are the optimal locations/sizes for the two inlets in Napeague Harbor?
- Does a two-inlet scenario provide for a greater proportion of the harbor's tidal prism to be exchanged during ebb and flood tides? If so, it would be expected that water quality and ecological conditions would be improved under a two inlet scenario.
- What is the anticipated frequency of maintenance dredging for both the east and west inlet in a two inlet scenario? Under a two inlet scenario, there shall be less tidal flow in each inlet to flush out sediments accumulated by littoral transport. Therefore, a two inlet scenario may require more frequent maintenance dredging than a one inlet scenario, obligating the Town and/or County to greater maintenance costs.

As described previously, it is likely that hydrodynamic modeling will indicate that the tidal prism of Napaeague Harbor is too small and the littoral sediment transport is too great to support two inlets. The hydrodynamic modeling should then be used to evaluate the optimal single inlet configuration in Napeague Harbor, along with other considerations related to water chemistry and circulation modeling, maintenance dredging frequency, and impacts to shorelines to the west of Napeague Harbor. The following questions would then to be addressed by the Town and other policy makers to determine the optimal single inlet configuration for Napeague Harbor.

Question 2: Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?

As described in Section 4 (*Hydrodynamic Analysis)*, the maximum amount of water exchange between Napeague Harbor and Napeague Bay is a function of the surface area of Napeague Harbor and the tidal range, not the size or location of the inlets. Therefore, an inlet of a given size will allow the same volume of water exchange whether located in the vicinity of the existing west inlet or the historic east inlet. As described previously, the size of the existing west inlet is consistent with the tidal prism of Napeague Harbor and, as a result, it is not likely to be feasible to increase water exchange over the long term by increasing the size of the inlet.

For that reason, if the water chemistry and resulting conditions for ecological resources in Napeague Harbor are solely dependent on the absolute volume of water exchange then inlet location should have no effect on water quality and, accordingly, there would be no benefit realized from restoring the east inlet. However, it is possible that the proximity of the east inlet to the significant ecological resources in the northern portion of the harbor may have localized affects on the water chemistry in the north and, therefore, may better support these ecological resources. If this is the case, localized water quality and ecological benefits may be achieved by restoration of the east inlet.

The significant marine resources in Napeague Harbor, *i.e.* eelgrass stands, shellfish beds, and Town of East Hampton mariculture grow-out rafts, are concentrated in the northern portion of the harbor. Under existing conditions, flood waters from the west inlet likely warm substantially while flowing over the large shallow sand flats, typically less than 4 feet in water depth, before reaching than northern harbor. Oxygen (and all gases) is more soluble in cold waters relative to warm waters (if atmospheric pressure is held constant). Therefore, dissolved oxygen concentrations are likely to decrease, perhaps substantially, as waters flow over the shallow shoals of Napeague Harbor. In contrast, direct and continuous exchange of water from Napeague Bay to the deep waters of Skunk Hole through a restored east inlet would avoid the warming shoals and may result in cooler, more oxygen-rich waters in and near Skunk Hole.

An evaluation of whether modeled improvements in water chemistry parameters would enhance eelgrass or shellfish productivity requires adequate information on the water chemistry needs of these biological resources. For example, eelgrass requires sustained water temperatures of less than 25°C (Zimmerman et al., 1989), light extinction coefficients of less than or equal to 0.46, and water column nitrogen and phosphorus concentrations of less than 0.05 mg/L and 0.08 mg/L, respectively (Peconic Estuary Program, 2009). Eelgrass is resistant to a variety of conditions common in estuaries (*i.e.* variance in salinity, water temperature, oxygen concentrations), but the effects of one of these stressors is compounded by the others. For instance, if dissolved oxygen is low and temperatures are at the higher end of the survivable range (28-30° C), photosynthetic performance and survivorship are lowered (Moore et al., 2012). Habitat requirements related to salinity, temperature, phytoplankton abundance, suspended solids, and nutrient concentrations would need to be developed for bay scallop, hard clam, and Eastern oyster. Bay scallops utilize eelgrass beds as a necessary substrate for settlement, feeding and shelter. Therefore, environmental conditions favorable to eelgrass are preferable to bay scallop reproduction and growth (Tettelbach and Smith, 2009). The optimal temperature for growth and survival of bay scallop larvae lies between 68°and 86°F (20°–30°C), and the optimal salinity lies between 20‰ and 30‰. Scallops grow well at constant temperatures between 59°F and 90°F (15°C and 30°C). The findings of these and similar studies of the water chemistry and ecological conditions required for eelgrass and shellfish would need to be compared to modeled water quality conditions to determine if restoration of the east inlet would improve eelgrass and shellfish productivity in Napeague Harbor.

As described above, there is a plausible mechanism that suggests localized improvements in water chemistry and ecological conditions may occur in the northern harbor after relocation of the inlet to the east. This mechanism is supported by anecdotal evidence of enhanced shellfish and eelgrass productivity in years when the east inlet was artificially opened in 2007 and 2008 (L. Penny, pers. comm..) and Town of East Hampton Shellfish Hatchery data which suggests increased oyster growth rates and production in years when the east inlet was open (J. Dunne, unpublished data). However, due to the substantial financial expense of restoring the Napeague inlet to its historic eastern location, it is imperative that this hypothesized mechanism is supported by numerical hydrodynamic and water chemistry modeling.

The following studies would be needed to confirm that the east inlet location in Napeague Harbor provides higher water quality *(i.e.* higher dissolved oxygen, cooler temperatures, lower turbidity, lower nutrient concentrations, etc.) in the northern harbor.

- Review of existing water chemistry data from Peconic Estuary Marine and Estuarine Monitoring Program to determine if existing data is sufficient for numerical water quality modeling.
- Collection of additional water chemistry data may be necessary to support numerical modeling. For example, the Peconic Estaury Program currently has one sampling location in Napeague Harbor (Station #134). Water chemistry data from one location within Napeague Harbor may not be sufficient to support a water quality model aimed at discriminating spatial variation in water chemistry parameters throughout the harbor.
- Modeling of water chemistry parameters under different inlet hydrodynamic scenarios using DELFT3D WAQ numeric water quality model or equivalent model.

Water quality modeling would need to demonstrate significant, and biologically relevant, improvements in water chemistry parameters under an east inlet scenario relative to the west inlet. It is expected that comparison of water chemistry modeling results to quantifiable habitat suitability criteria for the target biological resources would allow for reasonable inferences on the potential improvements in ecological habitat quality. It is recommended that this modeling take an approach to determine how much suitable habitat for eelgrass or shellfish would exist under modeled west and east inlet configurations. This shall provide an answer to the question *"Does the East Inlet provide improved ecological conditions in northern Napeague Harbor relative to the West Inlet"* and provide tangible, quantified benefits for evaluating ecological benefits under east or west inlet configurations.

Note that this modeling approach would not result in predicted increases in biological productivity of the target resources. This sort of modeling would be more complex and, accordingly, would require more data for accurate prediction (perhaps including long-term data on eelgrass or shellfish productivity in relation to various environmental parameters). It is unlikely that the necessary data for this type of modeling is available. As a result, it is recommended that a more simplistic modeling assessment be prepared to provide cost efficiency while still generating a quantitative assessment for use by Town and other policy makers.

Question 3: Is the East Inlet more stable than (or as stable as) the West Inlet? Therefore, would the East Inlet require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?

Large quantities of littoral sediment are transported to Napeague Harbor from east of Goff Point. This sediment flux has 1) filled the eastern inlet despite dredging or excavation projects to maintain the inlet in 1967, 1975, 2007, 2008, and 2010; and 2) created a substantial flood shoal interior to the west inlet after its construction in 1967. Independent of any potential water quality and ecological benefits resulting from re-location of the inlet, potential differences in sediment deposition between the east and west inlet configurations should be considered by the Town and other stakeholders. Due to the close proximity of the two inlet locations, it is possible that the littoral sediment entering the east or west inlet from the east will be similar. However, there is geomorphological evidence that indicates that the east inlet is subject to greater littoral sediment transport than the west inlet. The prograding sediment beds found to the north of Hicks Island terminate abruptly where the bathymetric grade drops steeply from less than 5 feet of water to more than 20 feet of water (Figure 4). This suggests that some fraction of the littoral sediments drifting westward from Goff Point may settle in the deep waters of Napeague Bay rather than being transported around Hicks Island to the west inlet. If the east inlet is exposed to greater littoral sediment transport and sediment accumulation in the inlet, it may be more prone to closure and may require more frequent maintenance dredging to allow for navigation and provide water exchange and ecological benefits.

Due to the significant cost of maintenance dredging, any potential increase in the frequency of maintenance dredging should be assessed and considered prior to relocating the inlet to its historic eastern location. The detailed hydrodynamic study described previously would be needed to determine the littoral transport rates in the location of the historical east inlet and the existing west inlet and determine if sediment loading (and therefore maintenance dredging) would differ in these locations.

Question 4: Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet is closed?

Waterfront properties in Promised Land on Shore Road, Old Lazy Point Road, and Mulford Lane have experienced substantial coastal erosion in recent years. The shoreline has receded by 117 feet since 1994 just east of Mulford Lane and the shoreline has receded by 41 feet near the western end of Shore Road. Many residents of Promised Land have blamed erosion problems on the maintenance of the west inlet through dredging and the disposal of dredged sediments on Hicks Island. During public review and comment of any potential inlet relocation or modification project, these residents will (rightfully) ask about the potential impacts to sediment supply to the beaches downdrift of the west inlet. Therefore, during the evaluation of the littoral sediment transport rates at the east and west inlet sites, it is recommended that analyses be extended downdrift to Promised Land to address this critical issue for the residential community. Similar to Question 3, evaluation of the effects of the west and east inlets on Promised Land properties shall require the detailed hydrodynamic study along with bathymetry collected immediately offshore of Promised Land.

7 Decision Matrix for Policy Makers and Stakeholders

Assuming that hydrodynamic modeling indicates that a two inlet configuration is not stable, the Town of East Hampton and other stakeholders would need to need to evaluate the results of the hydrodynamic and water circulation modeling, weigh the environmental benefits of the east and west inlet configurations and the financial costs of an east inlet restoration project, and select the optimal single inlet configuration for Napeague Harbor. The following decision matrix has been provided to facilitate the evaluation of the single inlet alternatives by summarizing the potential conclusions of the hydrodynamic and water circulation studies and providing recommendations for a subsequent course of action. A recommended course of action is provided for each of the eight combinations of answers to the three scientific questions posed above.

Outcome A:

Question	*Answer*
i. Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?	NO
ii. Is the East Inlet more stable than (or as stable as) the West Inlet? Therefore, would the East Inlet require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?	NO
iii. Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet closed?	NO

If the hydrodynamic and water circulation studies indicate that the answer to each of these questions is "NO", then restoration of the east inlet would not result in any benefits regarding environmental conditions or coastal erosion and, therefore, is not a logical alternative. Under this scenario, ecological and water chemistry improvements are not realized because relocating the inlet does not increase the volume of water exchanged between Napeague Harbor and Napeague Bay and because the harbor cannot support a larger inlet due to its size and tidal range. However, long term solutions would be needed for the adverse impacts of the west inlet (*i.e.* shoreline recession in Promised Land due to the west inlet's disruption of littoral sediment transport and scouring at the end of Lazy Point Road and the Town boat ramp). The Town of East Hampton and other stakeholders should investigate various options for mitigating these remaining impacts.

The pronounced bend in the west inlet channel increases the channel length travelled by flood and ebb waters and may increase sediment accumulation in the channel through increased frictional forces. The channel bend also causes greater water velocity for flood and ebb waters on the outer (*i.e.* southern) edge of the channel due to the increased path length, this higher water velocity on the outer edge of the channel exacerbates erosion for the residences at the end of Lazy Point Road and the Town boat ramp. An engineering and hydrodynamic study could be conducted to determine if straightening of the west inlet channel, by sacrificing the southern tip of Hicks Island, would reduce erosion at the end of Lazy Point Road and reduce the frequency of maintenance dredging in the west inlet. This analysis could be performed concurrent with the hydrodynamic analysis of the east and west inlet configurations.

Less costly options of adapting to the current location west inlet should also be considered. The Town boat ramp could be removed, as the existing concrete surface is not functional, and relocated to the southern side of Lazy Point where it would be sheltered from the inlet's flood and ebb currents. Alternatively, a new boat ramp could be constructed on the southern side of Lazy Point to provide formal access for recreational and commercial uses, while maintaining the non-functional ramp in its current location. The non-functional ramp appears to be reducing shoreline erosion to the east of the ramp. A large rip-rap revetment or bulkhead could also be constructed to protect the residences at the end of Lazy Point Road. While hard shoreline structures are rightly discouraged due to their impacts on nearshore habitats and adjacent properties, a hard structure could be considered at this location because 1) it is considerably less expensive than re-configuring the inlet and 2) it would prevent further threats to these residences and Lazy Point Road. In conjunction with the existing concrete boat ramp, this shoreline hardening would stabilize the shoreline recession along the outer edge of the inlet channel.

Site plans and permit applications for future maintenance dredging of the west inlet by Suffolk County or the Town of East Hampton should consider the use of dredged sediments for dune construction and beach nourishment in Promised Land. Promised Land beaches are the closest potential disposal location, considering that Hicks Island is no longer a viable location, and sand placement on these beaches would compensate for the interruption of littoral sediment transport posed by the west inlet. The NYSDEC currently authorizes sand placement on eroded beaches landward of the mean high water line and has approved sand placement landward of the mean low water line in pilot projects in the South Shore Estuary. The NYSDEC does not authorize the placement of sand fill below the mean low water line, as it is classified as a "presumptively incompatible" use under 6NYCRR Part 661, to prevent the burial of nearshore invertebrates and submerged aquatic algae and vegetation. Sand placement below mean low water is only authorized in the case of beach nourishment projects on the Atlantic Ocean coast. Repeated sand placement on the upper beach between the groins at the west end of Shore Road and the west inlet would provide an updrift source of littoral sediment that will be transport westward to eroded shorelines.

Outcome B:

Question	*Answer*
i. Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?	YES
ii. Is the East Inlet more stable than (or as stable as) the West Inlet? Therefore, would the East Inlet require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?	YES
iii. Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet is closed?	YES

Under this outcome scenario, restoration of the east inlet would improve water quality and ecological conditions in northern Napeague Harbor, would reduce coastal erosion in Promised Land, and would require less frequent maintenance dredging by the Town or Suffolk County. Under this outcome scenario, the Town and other project stakeholders could proceed with procuring funding and the development of construction drawings and specifications for an east inlet restoration project. A dredging project to restore the east inlet is expected to cost between $500,000 and $1,200,000. At least 30% of the dredged sediments would be needed to close the west inlet and the remaining sand volume could be utilized for beach nourishment of the Promised Land beaches downdrift of the west inlet. The use of dredged sediments to close the west inlet is necessary as 1) it ensures that the east inlet will remain open by forcing all tidal prism flow through it, 2) it is the closest available (and therefore the most inexpensive deposition site), and 3) by creating approximately 0.6 acres of upper beach habitat, the closed west inlet would replace some of the plover nesting habitat lost by the dredging of the east inlet.

It is expected that State Environmental Quality Review (SEQR) of an east inlet restoration project would necessitate the preparation of an Environmental Impact Statement (EIS). It may be argued that there is no potential for "significant adverse impact" as the project is restoring historic conditions. However, it is likely that an EIS would be required under SEQR as the project would be considered a Type I action as it 1) involves the physical alteration of more than 2.5 acres (25% of the 10 acre threshold) of publicly-owned parkland (§617.4(b)(10)) and 2) would impact known habitat of a federally-protected species (*i.e.* piping plover). The hydrodynamic and water circulation modeling completed to evaluate the benefits and feasibility of restoring the east inlet would provide a large majority of the necessary information for the evaluation of potential environmental impacts required in the EIS. After the completion of the environmental impact assessment process, and presumed issuance of a negative declaration, environmental permits and authorizations would need to be obtained from the NYSDEC, US Army Corps of Engineers, New York State Department of State, New York State Office of General Services, New York State Parks Department, Town of East Hampton, and Town of East Hampton Trustees. The construction of the east inlet would need to be completed between October 1 and January 30 to comply with dredging windows to protect finfish spawning (June 1 to September 30) and winter flounder (February 1 to May 31).

Outcome C:

Question	*Answer*
i. Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?	YES
ii. Is the East Inlet more stable than (or as stable as) the West Inlet? Therefore, would the East Inlet require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?	NO
iii. Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet is closed?	NO

Under this outcome scenario, restoration of the east inlet would improve water quality and ecological conditions by enhancing water circulation to the northern harbor. However, the hydrodynamic modeling also indicates that higher rates of sediment accumulation in the east inlet, relative to the west inlet, are expected to result in more frequent maintenance dredging to support water exchange and navigation. Therefore, the Town and other stakeholders would need to evaluate if the benefits of ecological and water quality improvements justify both the construction cost of east inlet restoration and the increased maintenance costs relative to the existing west inlet. If the costs are justified relative to the environmental benefits, the Town could proceed with inlet construction design and permitting as described in Outcome B. Under this outcome scenario, the construction of the east inlet is not expected to alleviate shoreline erosion in Promised Land. As a result, it will be particularly important to pursue regulatory approval to use the dredged sediments from east inlet restoration, and subsequent maintenance dredging, for beach nourishment and dune construction downdrift of the west inlet.

Outcome D:

Question	*Answer*
i. Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?	NO
ii. Is the East Inlet more stable than (or as stable as) the West Inlet? Therefore, would the East Inlet require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?	YES
iii. Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet is closed?	NO

Under this outcome scenario, the hydrodynamic and water circulation studies indicate that the restoration of the east inlet would not provide any ecological or water quality benefits. Similarly, the restoration of the east inlet is not expected to alleviate the shoreline erosion for residents in Promised Land. However, the hydrodynamic modeling does indicate that at a new east inlet could be designed and constructed that has less predicted maintenance dredging requirements (and reduced maintenance dredging costs over the long term) than the existing west inlet. While reduced maintenance dredging frequency may provide some long term cost savings to Suffolk County and the Town, these savings are not likely to outweigh the substantial design, permitting, and construction costs of restoring the east inlet. Therefore, Town and other stakeholders could investigate if reconfiguration of the west inlet (*i.e.* straightening the inlet as described in Outcome A) could accomplish similar reduced maintenance dredging benefits for less construction costs than relocating the inlet to the east. If re-configuration of the west inlet does not also reduce erosion at the end of Lazy Point Road and the Town boat ramp, relocation of the boat ramp and construction of a revetment or bulkhead at Lazy Point Road could be considered as described in Outcome A. Similar to Outcome A, regulatory approval for deposition of sediments from the maintenance dredging of the west inlet on the upper beach in Promised Land should incorporated into future maintenance dredging projects.

Outcome E:

Question	*Answer*
i. Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?	NO
ii. Is the East Inlet more stable than (or as stable as) the West Inlet? Therefore, would the East Inlet require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?	NO
iii. Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet is closed?	YES

Under this outcome scenario, the restoration of the east inlet would not provide any ecological or water quality benefits to northern Napeague Harbor. Furthermore, in this scenario, relocating of the inlet to the east does not provide reduced maintenance costs to the Town, likely because the littoral sediment transport to either east or west inlet locations are similar or greater for the east inlet location. The only potential benefit would be reduced shoreline erosion for the residential properties in Promised Land. Without ecological benefits for Napeague Harbor, the financial cost of east inlet restoration cannot be justified. Similar to other outcome scenarios resulting in selection of the west inlet, the Town and other stakeholders could potentially address the erosion at Lazy Point Road and the Town boat ramp by re-configuring the west inlet or relocating the boat ramp and hardening the Lazy Point Road shoreline. Under Outcome E, the hydrodynamic modeling indicates that the west inlet may be exacerbating the shoreline erosion in Promised Land. Restoration of the east inlet would clearly be a costly and inefficient method of addressing this problem. The erosion in Promised Land could be addressed more cost effectively by a beach nourishment and dune construction project using an upland sand source or sediments from west inlet maintenance dredging sediments. As described previously, the NYSDEC currently authorizes sand placement on eroded beaches landward of the mean high water line and has approved sand placement landward of the mean low water line in pilot projects in the South Shore Estuary. Sand placement on the upper beach east of the jetties at the west end of Shore Road after maintenance dredging project(s) would provide an updrift source of littoral sediment that would then be transported westward to eroded shorelines.

Outcome F:

Question	*Answer*
i. Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?	NO
ii. Is East Inlet more stable than (or as stable as) the West Inlet and, therefore, require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?	YES
iii. Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet is closed?	YES

Under this outcome scenario, the restoration of the east inlet would not provide any ecological or water quality benefits. However, the restored east inlet would provide reduced maintenance costs to Suffolk County and the Town and would reduce shoreline erosion for the residential properties at Promised Land. Similar to Outcome D, the design, permitting, and construction costs of the restored east inlet would need to be compared to the long term cost savings provided by reduced maintenance dredging and the costs of correcting the adverse impacts of the west inlet (*i.e.* the erosion at the end of Lazy Point Road, the degradation of the Town boat ramp, and the shoreline erosion in Promised Land). Due to the high costs of east inlet restoration and absence of ecological benefits, it is likely that relocation of the boat ramp, hardening the Lazy Point Road shoreline, and beach nourishment in Promised Land using either a west inlet or upland sand source would be more cost effective alternatives. However, this would need to be borne out by budgetary analysis.

Outcome G:

Question	*Answer*
i. Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?	YES
ii. Is East Inlet more stable than (or as stable as) the West Inlet and, therefore, require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?	YES
iii. Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet is closed?	NO

Under this outcome scenario, the restoration of the east inlet would provide ecological and water quality benefits and would result in less frequent maintenance dredging by Suffolk County and/or the Town. As described in Outcome B, the Town and other stakeholders could proceed with procuring funding, development of construction drawings and specifications, and initiation of environmental impact statement preparation for an east inlet restoration project. Under this outcome scenario, the restoration of the east inlet is not expected to alleviate shoreline erosion in Promised Land. As a result, it will be particularly important to pursue procurement of regulatory approval to use the dredged sediments from east inlet restoration, and subsequent maintenance dredging, for beach nourishment and dune construction in Promised Land.

Outcome H

Question	*Answer*
i. Does the East Inlet provide improved water circulation, water quality, and ecological conditions in northern Napeague Harbor relative to the West Inlet?	YES
ii. Is East Inlet more stable than (or as stable as) the West Inlet and, therefore, require similar or reduced maintenance dredging to support water exchange and navigation over the long-term?	NO
iii. Is coastal erosion at Promised Land likely to decrease if the East Inlet is opened and the West Inlet is closed?	YES

Under this outcome scenario, the restoration of the east inlet would provide ecological and water quality benefits and would alleviate shoreline erosion in Promised Land. However, the restored east inlet would require more frequent maintenance dredging than the existing west inlet. In this case, the Town and other stakeholders should evaluate the anticipated frequency and costs of maintenance of the east inlet. Very short intervals between maintenance dredge projects may be prohibitively expensive for the County and Town. Due to its elevation, Hicks Island is no longer a suitable disposal site. Therefore, sand from these repeated dredge projects would need to be placed on the created spit at the west inlet and the upper beaches in Promised Land, or used for other projects. Assuming that the anticipated dredging frequency to maintain the east inlet is acceptable to the Town and Suffolk County, stakeholders could proceed with the course of action to procure funding, develop construction drawings and specifications, and prepare an environmental impact statement for an east inlet restoration project, as fully described in Outcome B.

8 Literature Cited

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9 List of Preparers

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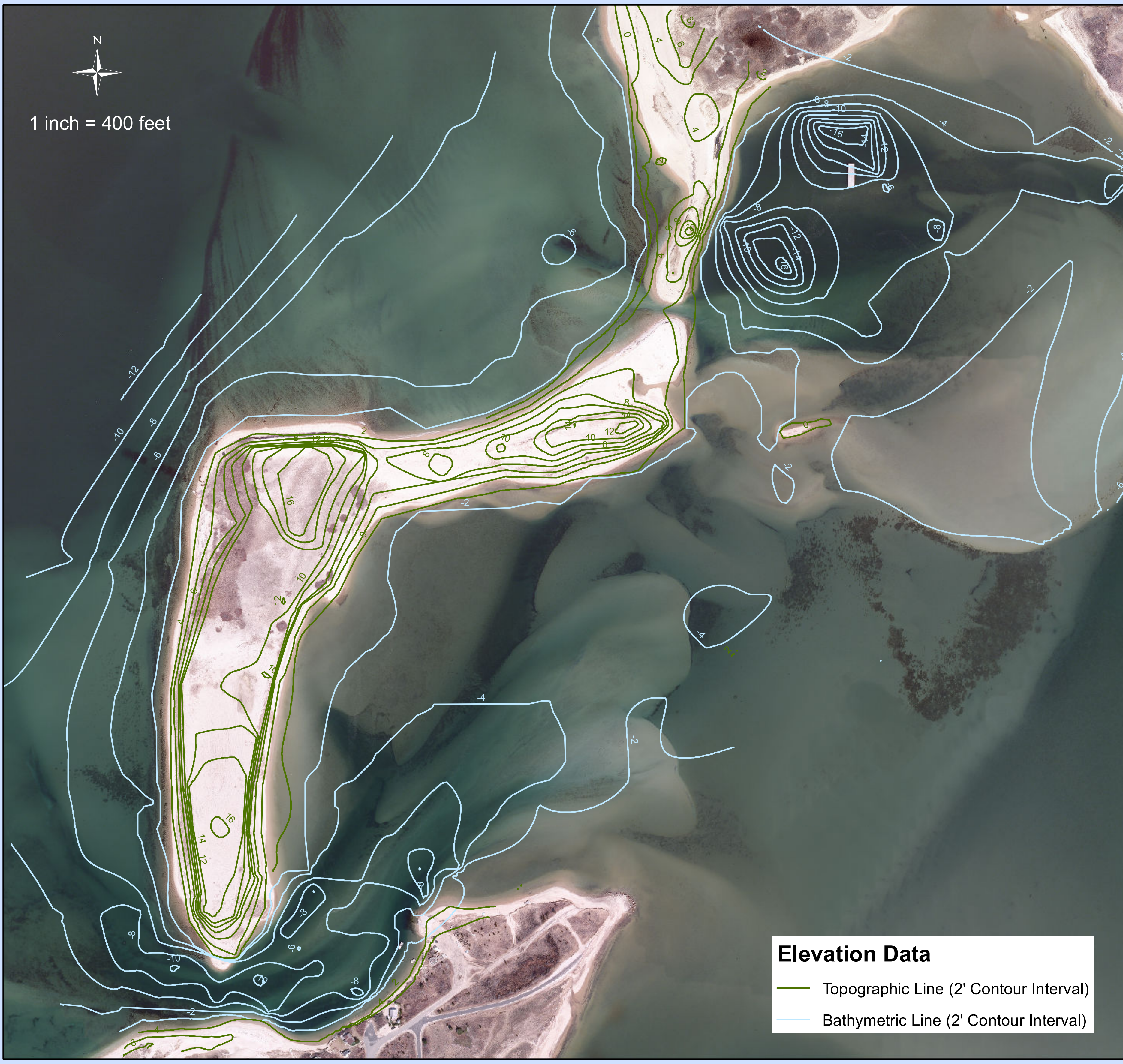
Kelly Risotto, Land Use Ecological Services, Inc.
Quin Robertson, PhD, Coastal Planning and Engineering, Inc. (Boca Raton, FL)

Figure 1. Topography & Bathymetry

Northern Napeague Harbor, Town of East Hampton



NOTES:

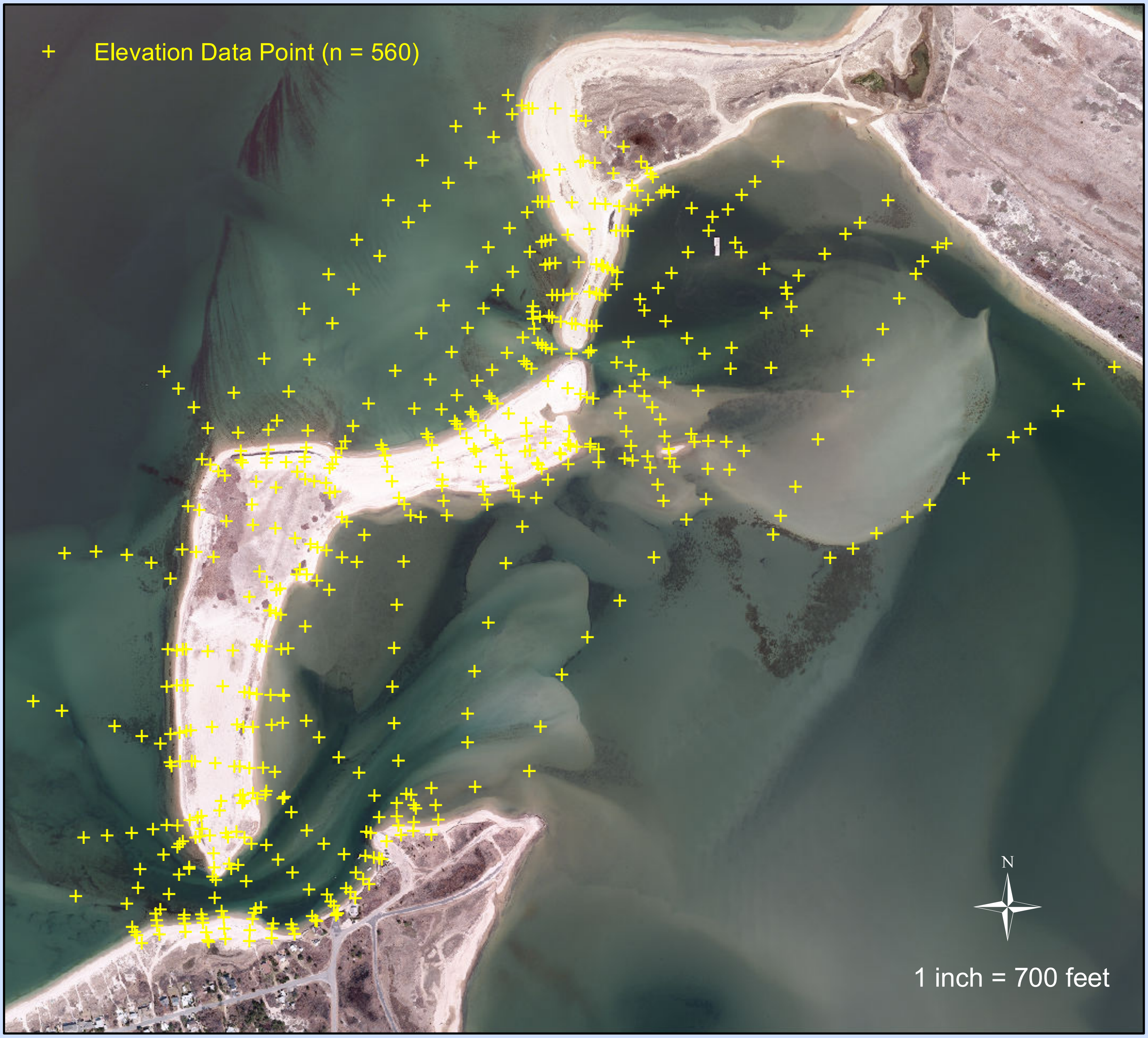
1. Elevation data collected by Land Use Ecological Services, Inc. in May 2012 in accordance with the Quality Assurance Plan approved by USEPA and Suffolk County Dept. of Health Services.
2. Topography (dry) and bathymetry (underwater) separated for interpolation at elevation -1' NGVD. Contours created using Nearest Neighbor Interpolation with manual correction for "bubble" errors and missing contours.
2. Elevations referenced to NGVD 1929.
3. Base Map: 2010 Orthoimage (NYSOCS)
4. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc.

Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project: For:	Napeague Harbor Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Drawn By:	K. Risotto	Scale:	As Noted
Date:	12/19/2012	Revisions:	

Figure 2. Data Point Distribution: Topography & Bathymetry

Northern Napeague Harbor, Town of East Hampton



NOTES:

1. Elevation data collected by Land Use Ecological Services, Inc. in May 2012 in accordance with the Quality Assurance Plan approved by USEPA and Suffolk County Dept. of Health Services.
2. Base Map: 2010 Orthoimage (NYSOCS)
3. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: K. Risotto Date: 12/17/2012	Project: Napeague Harbor For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: As Noted Revisions:

Figure 3. Natural Resources

Northern Napeague Harbor, Town of East Hampton

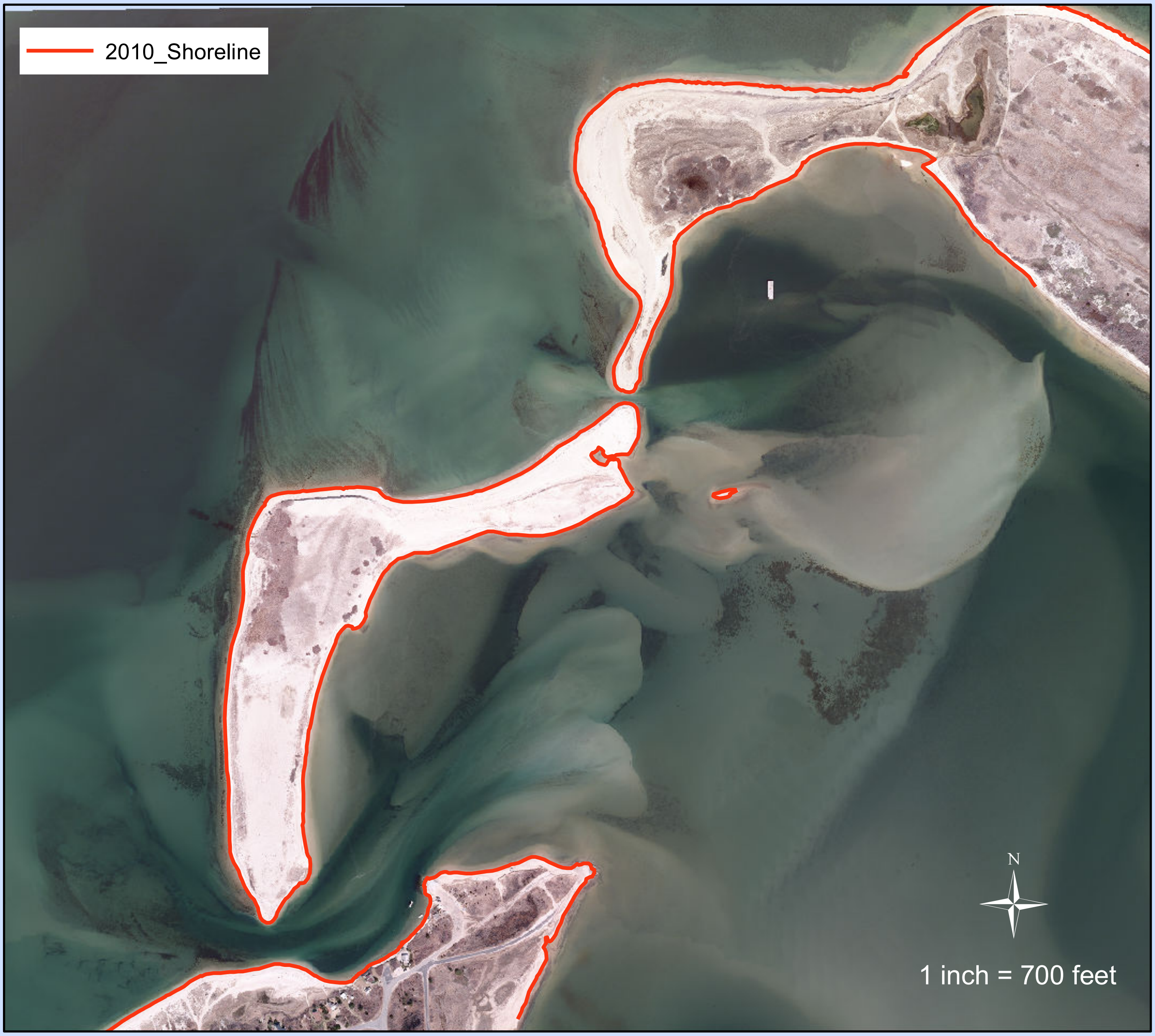
NOTES:

1. Data Sources (Natural Resources): Town of East Hampton, East Hampton Shellfish Hatchery and Ron Pirelli, NYSDEC
2. Base Map: 2010 Orthoimage NYSOCS

Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project: For:	Napeague Harbor Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Drawn By: Date:	K. Risotto 12/17/2012	Scale: Revisions:	As Noted

Figure 4. 2010 Aerial Image

Northern Napeague Harbor, Town of East Hampton



NOTES:

1. Seaward edge of dry shoreline digitized to 2010 Shoreline.
2. Base Map: 2010 Orthoimage (NYSOCS)
3. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: K. Risotto Date: 12/17/2012	Project: Napeague Harbor For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: As Noted Revisions:

Figure 5. Promised Land Shoreline Change: 1994 - 2010

Town of East Hampton

Seaward Edge of Dry Shoreline

1994 (green) 2001 (yellow) 2010 (red)

Year	1 Midway Between Mulford Lane and Merrills Road (FT)	2 Northwest Curve of Shore Road (FT)	3 Midway Between Shore Road Curve and West Inlet (FT)
1994-2001	-29'	-1'	+10
2001-2010	-88'	-40	-17

NOTES:

1. 1994, 2001, and 2010 seaward edge of dry shoreline digitized from orthoimagery (NYSOCS) to measure change.
2. Base Map: 2010 orthoimage (NYSOCS)
3. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc.

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570 Expressway Drive South, Suite 2F
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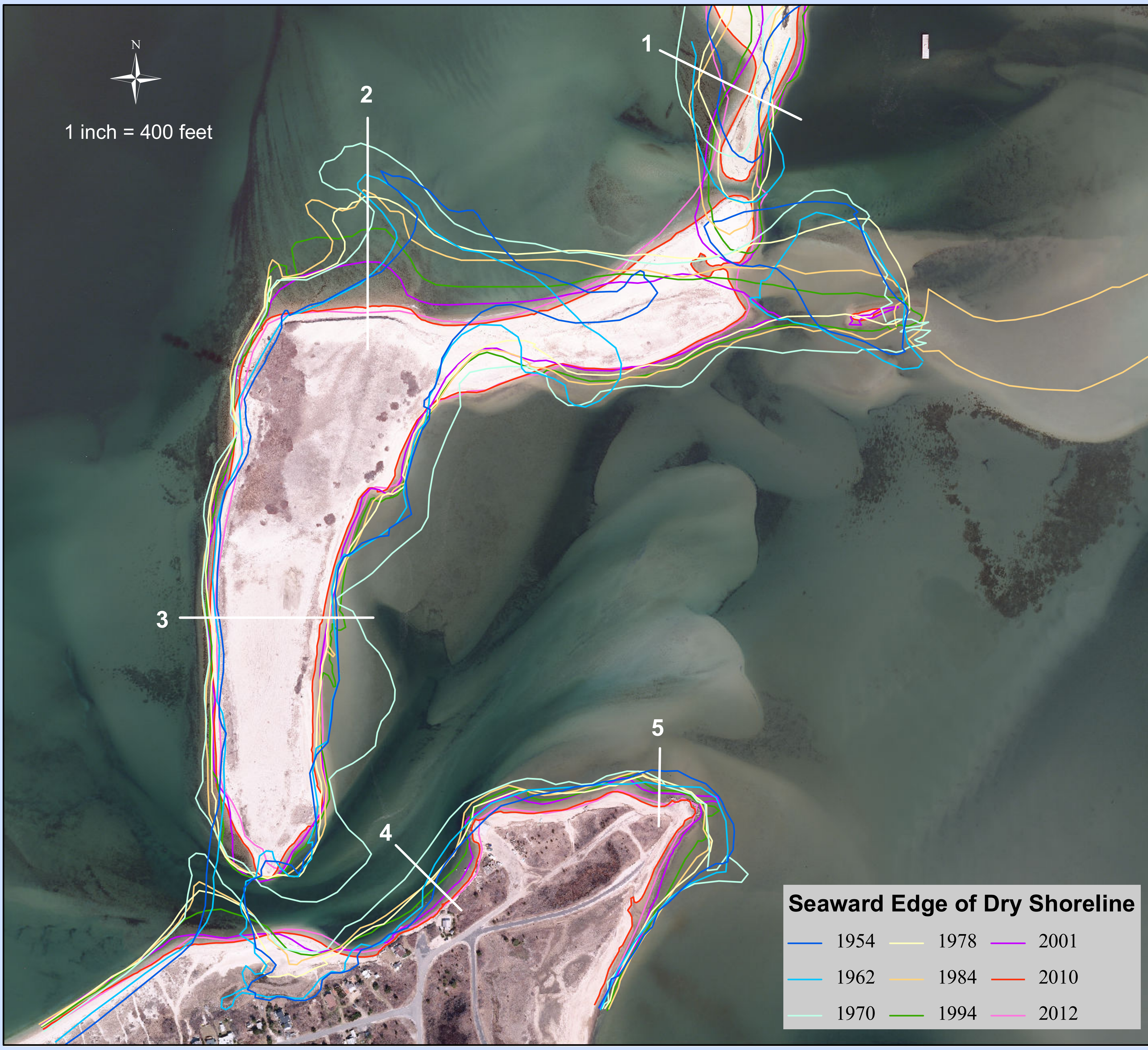
Drawn By: K. Risotto
Date: 12/17/2012

Project: Napeague Harbor
For: Suffolk County Peconic Estuary Program
Conceptual Habitat Restoration Project
Scale: As Noted
Revisions:

Figure 6. Shoreline Change 1954 - 2010

Northern Napeague Harbor, Town of East Hampton



Year	1 Width of Goff Point (North of East Inlet) (feet)	2 Hicks Island: Migration of North Spit Year - 2010* (feet)	3 Hicks Island: Main Island Width (feet)	4 Lazy Point: Intersection Shore Rd/Lazy Point Rd Year - 2010 (feet)	5 Lazy Point: East Point Year - 2010 (feet)
1954	143	-104	394	-75	-119
1962	269	-428	392	-106	-75
1970	273	-523	446	-165	-95
1978	258	-361	408	-95	-88
1984	196	-367	438	-89	-81
1994	174	-258	445	-65	-55
2001	169	-146	416	-24	-44
2010	83	0	384	0	0
2012	185	21	388	3	-14

** Northernmost point taken in 1962.*

NOTES:

1. Seaward edge of dry shoreline digitized using historic aerial photographs georeferenced to 2010 orthoimage using fixed structures.
2. Data Sources: Town of East Hampton, NYSOCS, USGS
3. Base Map: 2010 Orthoimage (NYSOCS)
4. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc.

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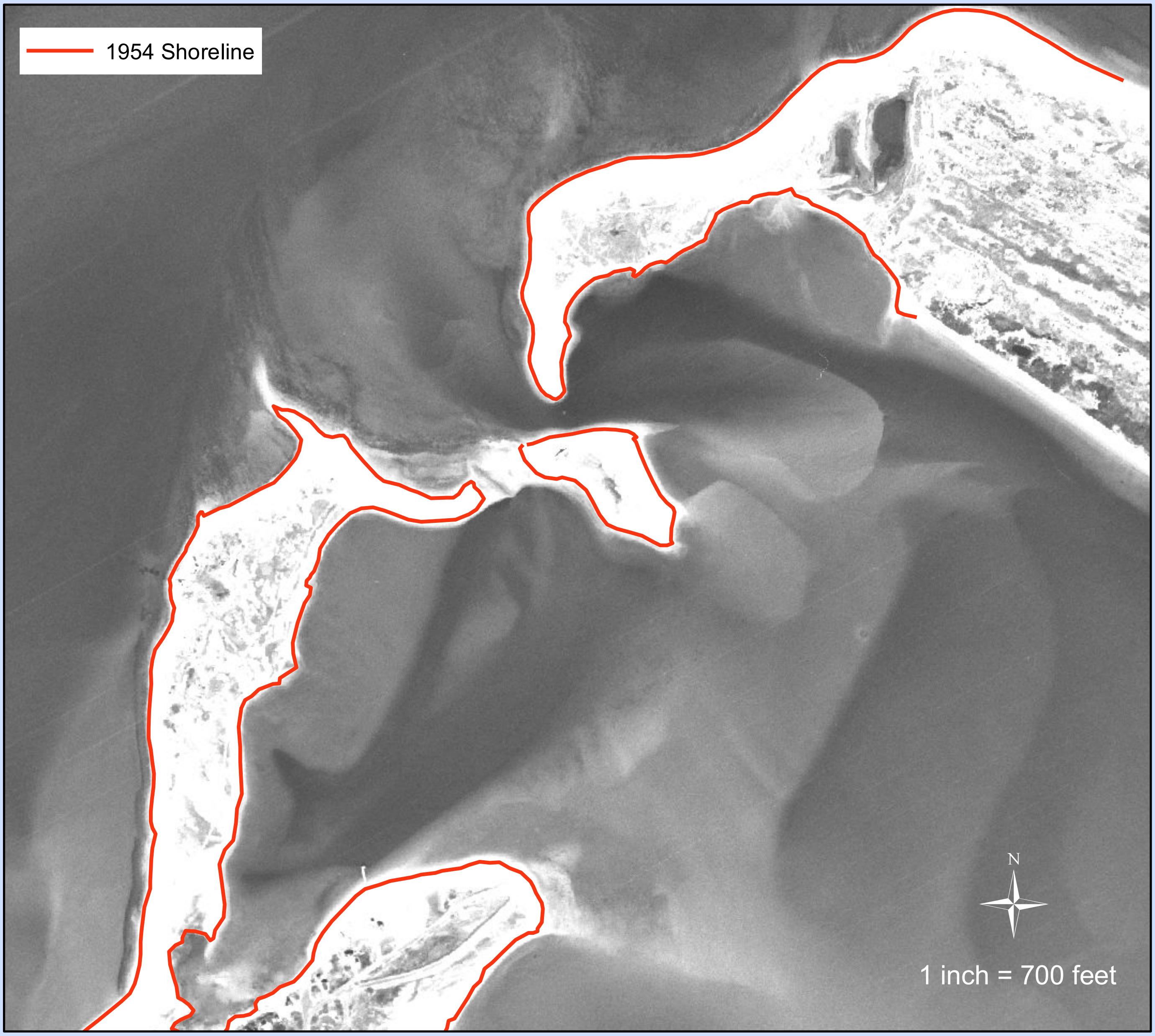
Drawn By: K. Risotto
Date: 12/17/2012

Project: Napeague Harbor
For: Suffolk County Peconic Estuary Program
Conceptual Habitat Restoration Project
Scale: As Noted
Revisions:

Figure 7. 1954 Aerial Image

Northern Napeague Harbor, Town of East Hampton



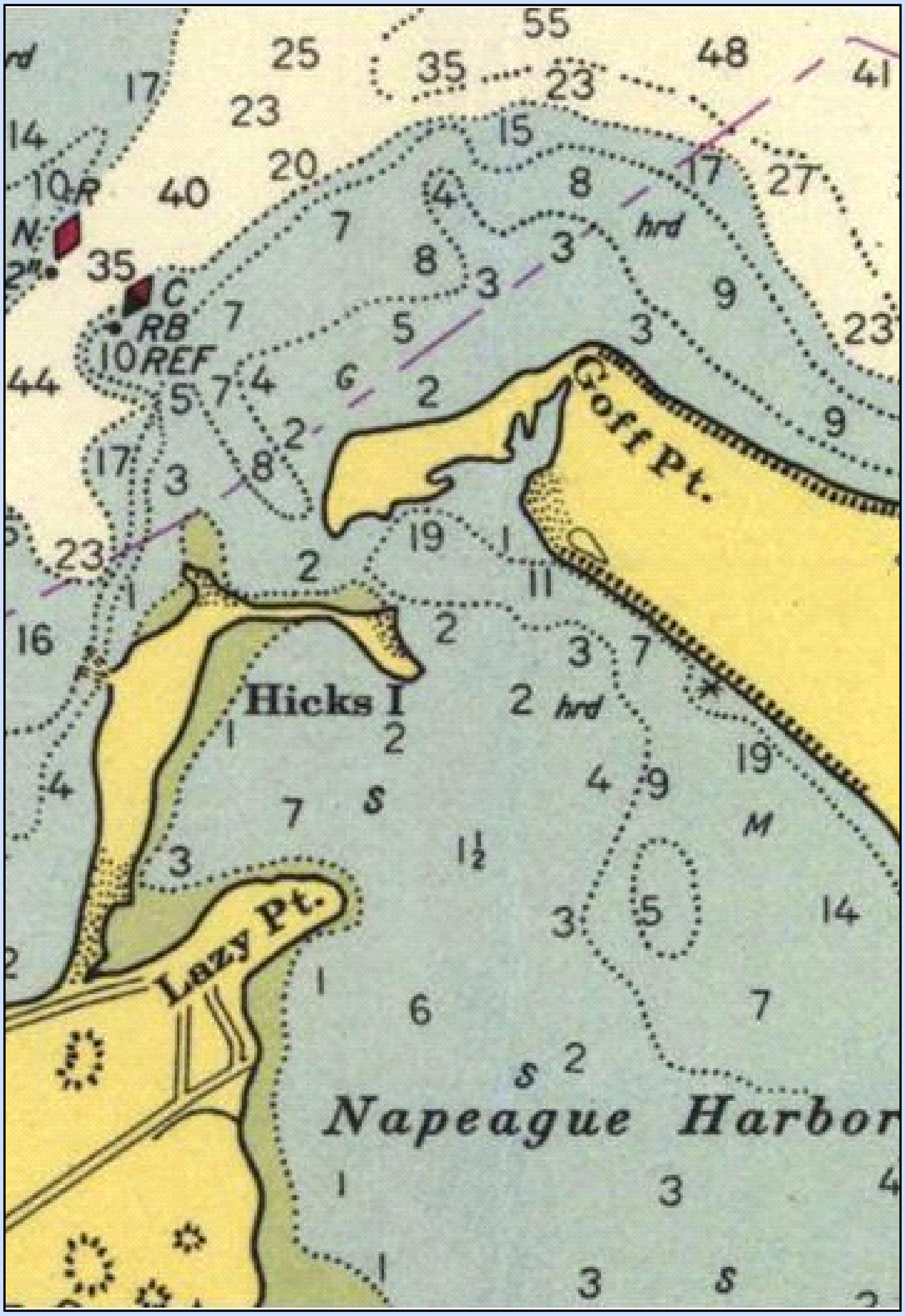
NOTES:

1. Data Source: USGS
2. 1954 aerial image georefereneced to 2010 orthoimage using structures and roadways.
3. Seaward edge of dry shoreilne digitized for 1954 shoreline.
4. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project:	Napeague Harbor
		For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Drawn By:	K. Risotto	Scale:	As Noted
Date:	12/17/2012	Revisions:	

Figure 8. 1951 Navigation Chart

Napeague Harbor, Town of East Hampton



NOTES:

1. Navigation chart obtained from United States Coast and Geodetic Survey.

Land Use Ecological Services, Inc

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Drawn By: K. Risotto
Date: 12/17/2012

Project: Napeague Harbor
For: Suffolk County Peconic Estuary Program
Conceptual Habitat Restoration Project
Scale: NTS
Revisions:

Figure 9. 1962 Aerial Image

Northern Napeague Harbor, Town of East Hampton

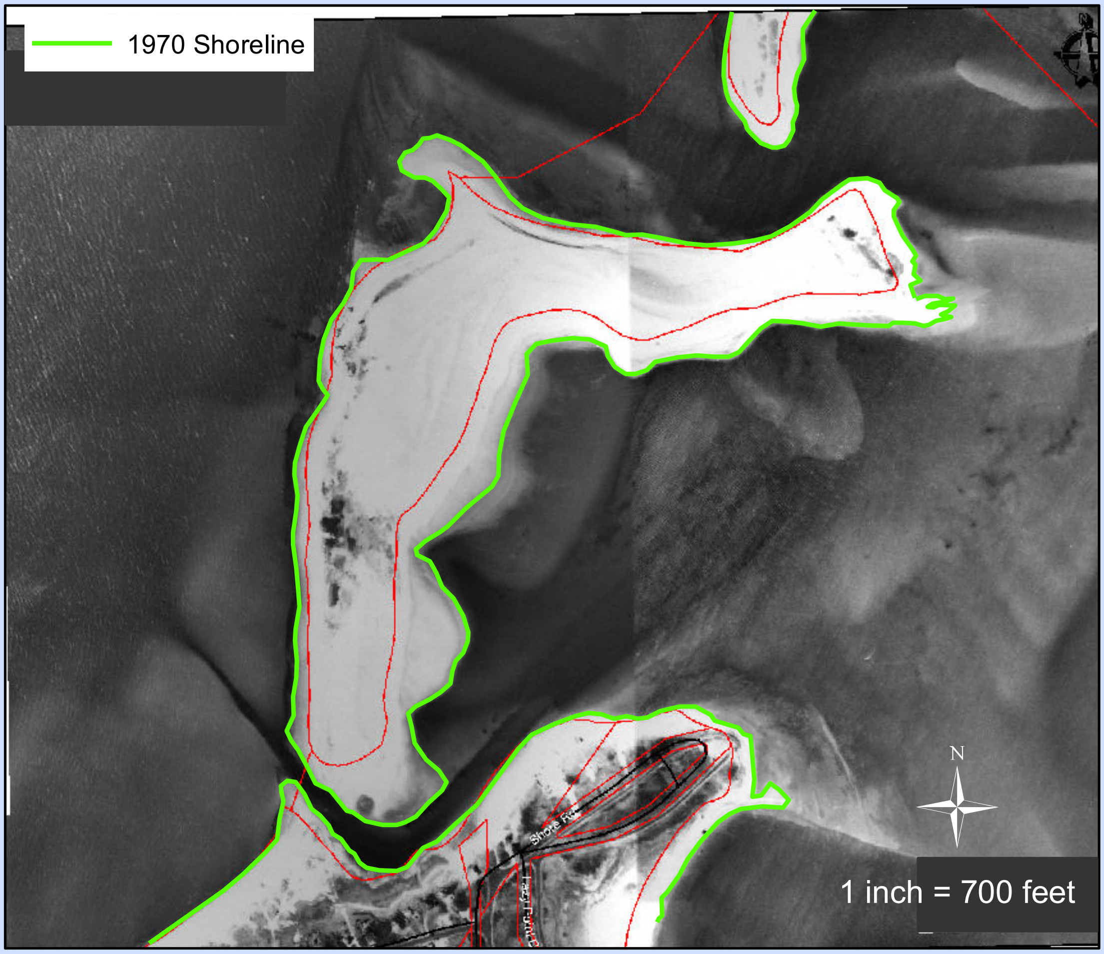
NOTES:

1. Data Source: Town of East Hampton
2. 1962 aerial image georeferenced to 2010 orthoimage using structures and roadways.
3. Seaward edge of dry shoreline digitized to 1962 shoreline.
4. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: K. Risotto Date: 12/17/2012	Project: Napeague Harbor For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: As Noted Revisions:

Figure 10. 1970 Aerial Image

Northern Napeague Harbor, Town of East Hampton



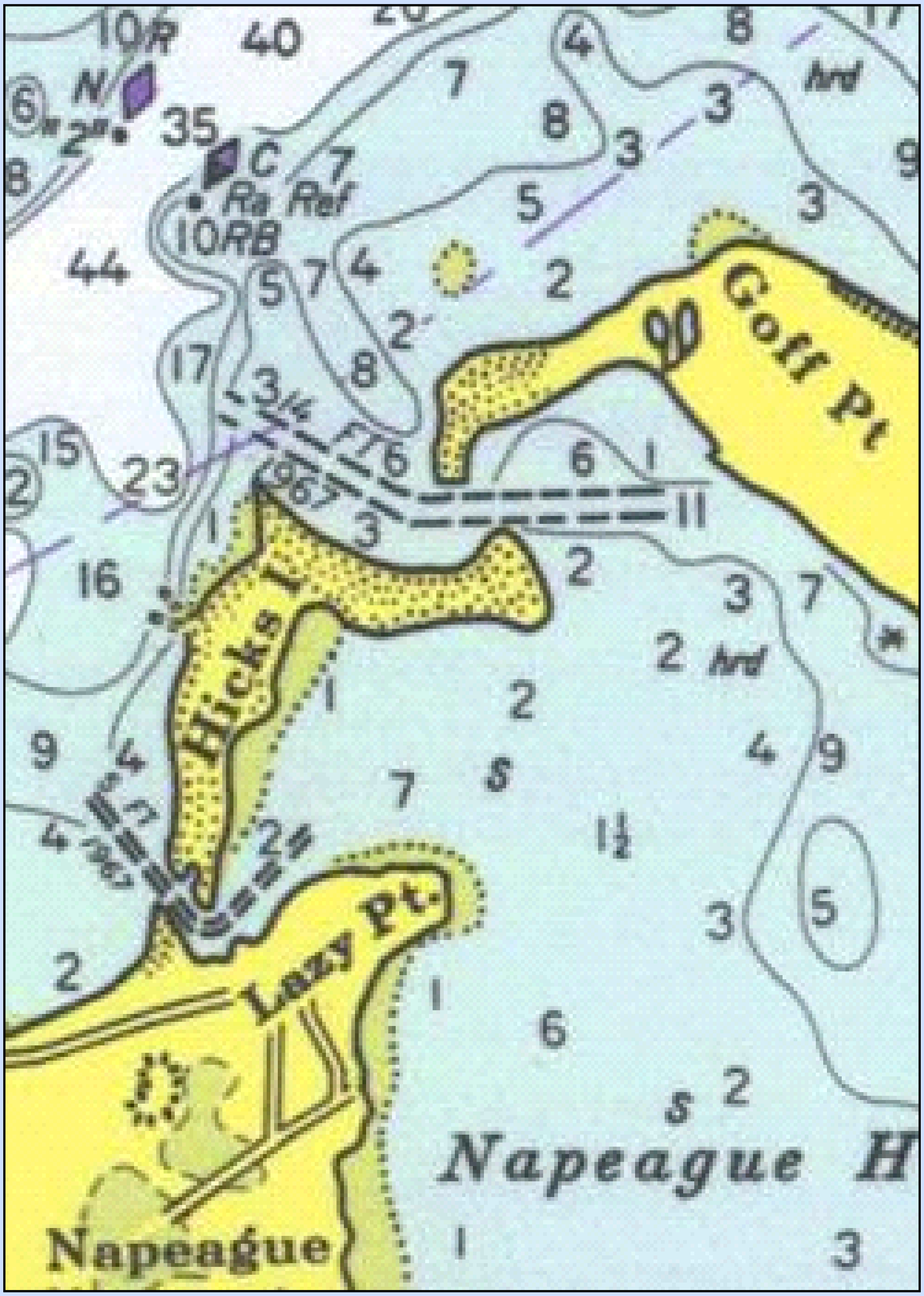
NOTES:

1. Data Source: Town of East Hampton
2. 1970 aerial image georeferenced to 2010 orthoimage using structures and roadways.
3. Seaward edge of dry shoreline digitized for 1970 shoreline.
4. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: K. Risotto Date: 12/17/2012	Project: Napeague Harbor For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: As Noted Revisions:

Figure 11. 1974 Navigation Chart

Napeague Harbor, Town of East Hampton



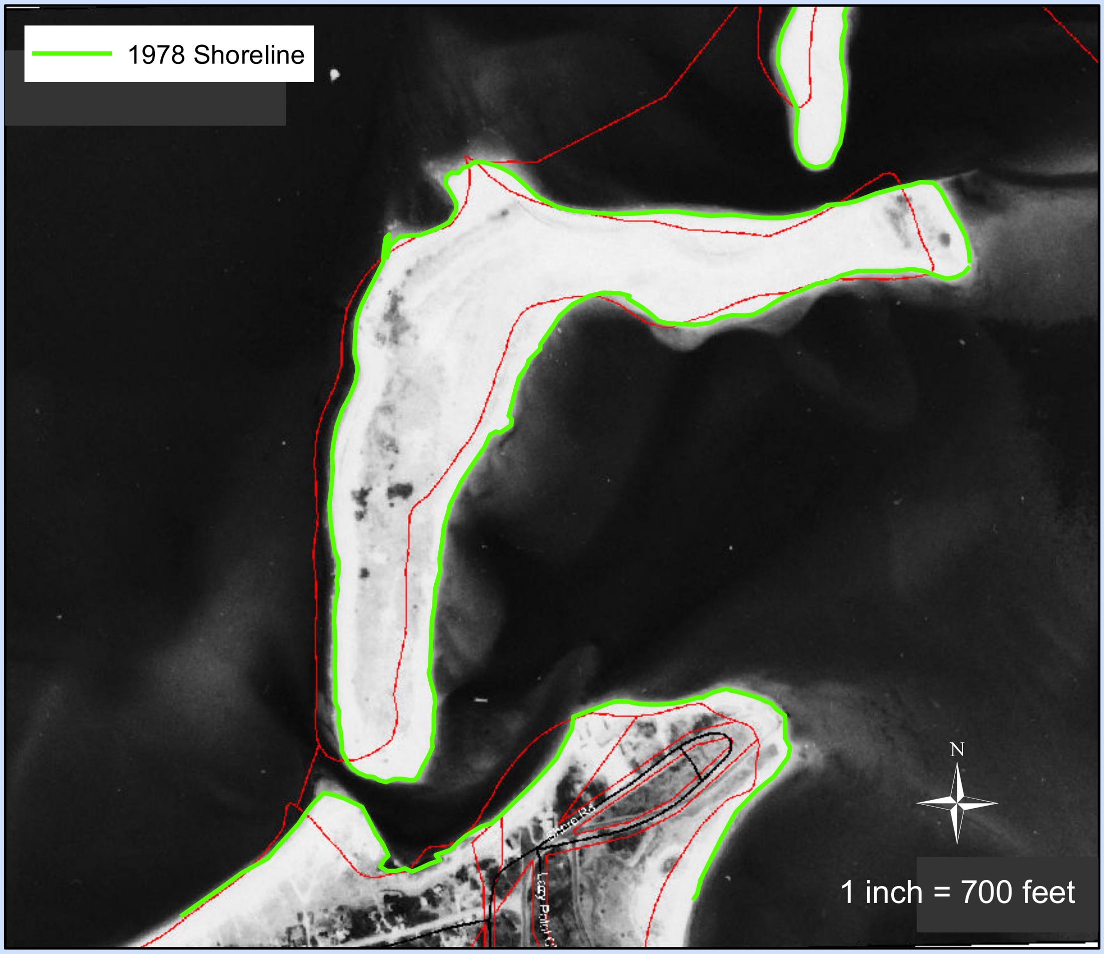
NOTES:

1. Navigation chart obtained from National Oceanic and Atmospheric Administration, National Ocean Survey.

Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project: For:	Napeague Harbor Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Drawn By:	K. Risotto	Scale:	NTS
Date:	12/17/2012	Revisions:	

Figure 12. 1978 Aerial Image

Northern Napeague Harbor, Town of East Hampton



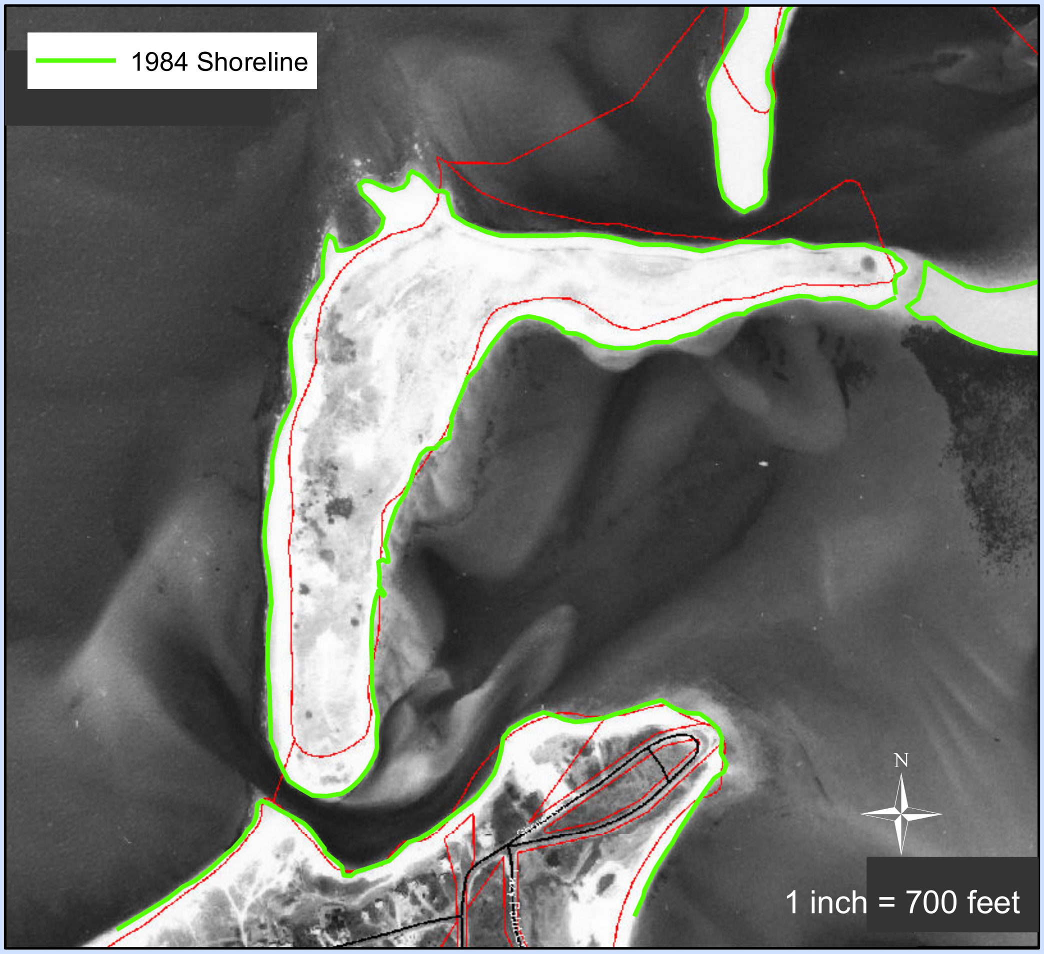
NOTES:

1. Data Source: Town of East Hampton
2. 1978 aerial image georeferenced to 2010 orthoimage using structures and roadways.
3. Seaward edge of dry shoreline digitized for 1978 shoreline.
4. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: K. Risotto Date: 12/17/2012	Project: Napeague Harbor For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: As Noted Revisions:

Figure 13. 1984 Aerial Image

Northern Napeague Harbor, Town of East Hampton



NOTES:

1. Data Source: Town of East Hampton
2. 1984 aerial image georeferenced to 2010 orthoimage using structures and roadways.
3. Seaward edge of dry shoreline digitized for 1984 shoreline.
4. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: K. Risotto Date: 12/17/2012	Project: Napeague Harbor For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: As Noted Revisions:

Figure 14. 1994 Aerial Image

Northern Napeague Harbor, Town of East Hampton

NOTES:

1. Data Source: NYSOCS
2. Seaward edge of dry shoreline digitized for 1994 shoreline.
3. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763 Drawn By: K. Risotto Date: 12/17/2012	Project: Napeague Harbor For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project Scale: As Noted Revisions:

Figure 15. 2001 Aerial Image

Northern Napeague Harbor, Town of East Hampton

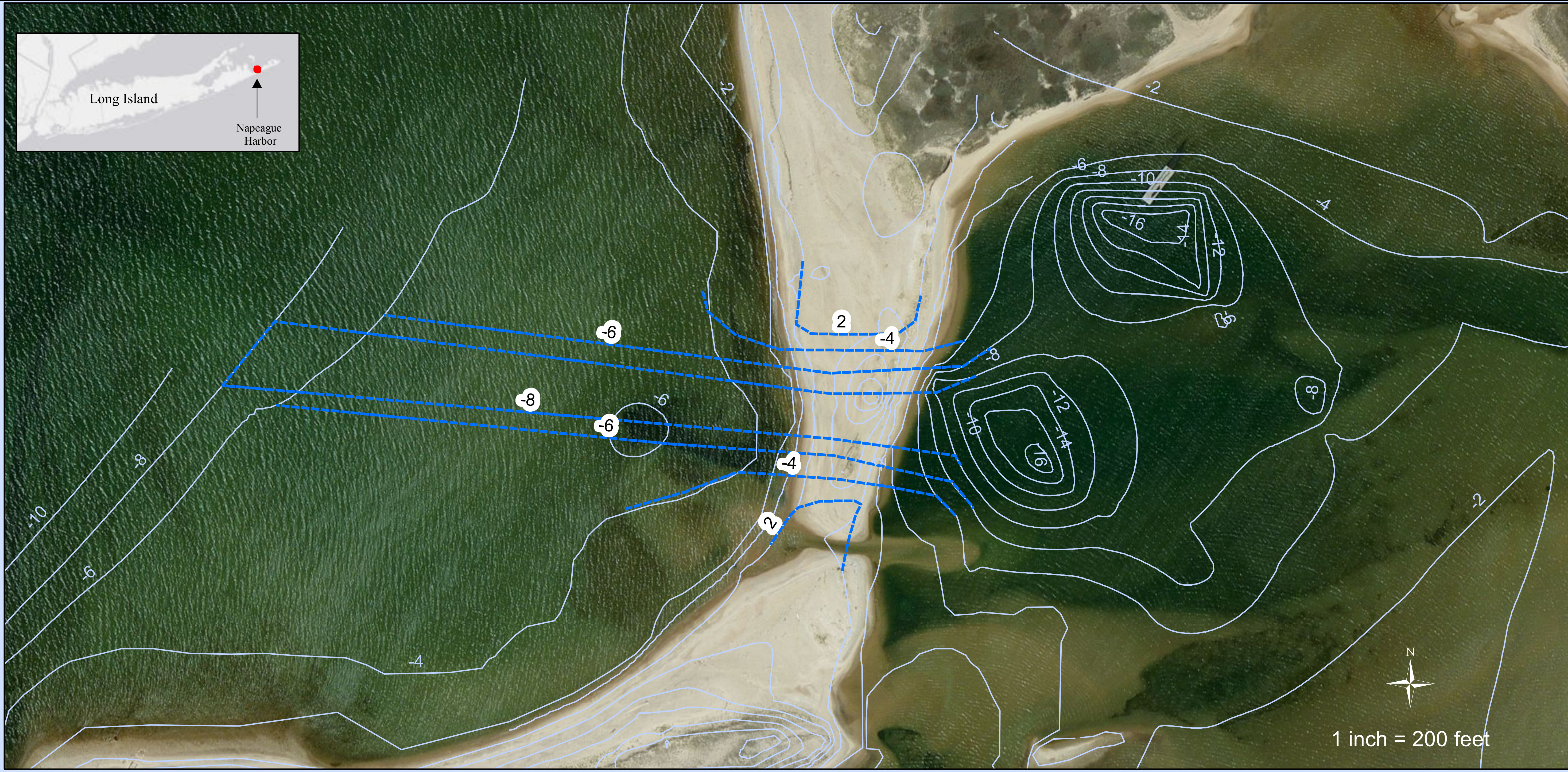
NOTES:

1. Data Source: NYSOCS
2. Seaward edge of dry shoreline digitized for 2001 shoreline.
3. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

Land Use Ecological Services, Inc	Prepared By: Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project: Napeague Harbor
		For: Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
	Drawn By: K. Risotto	Scale: As Noted
	Date: 12/17/2012	Revisions:

Figure 16. Conceptual Plan for a Proposed East Inlet

Napeague Harbor, Town of East Hampton



Proposed East Inlet Contour — Existing Contour

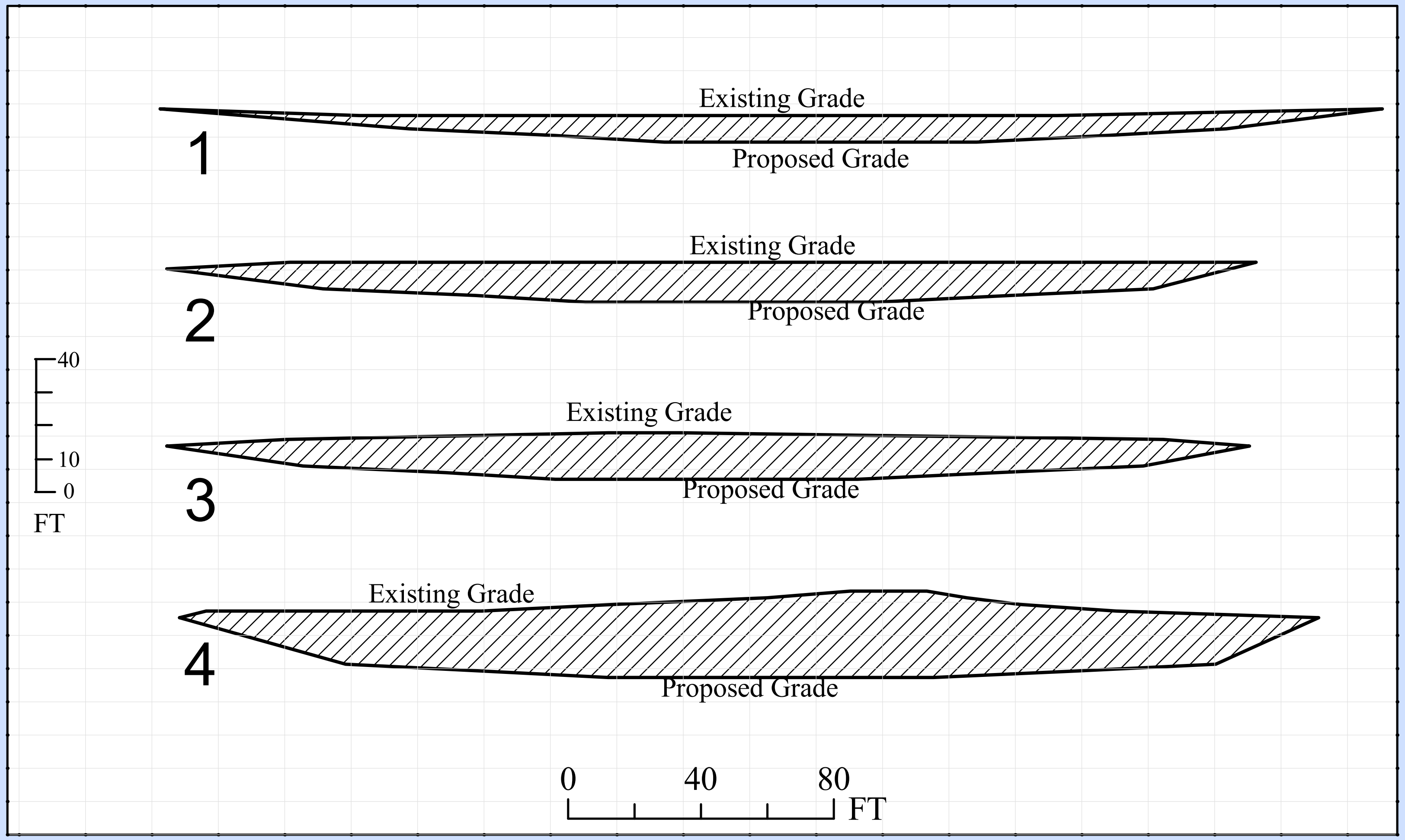
NOTES:

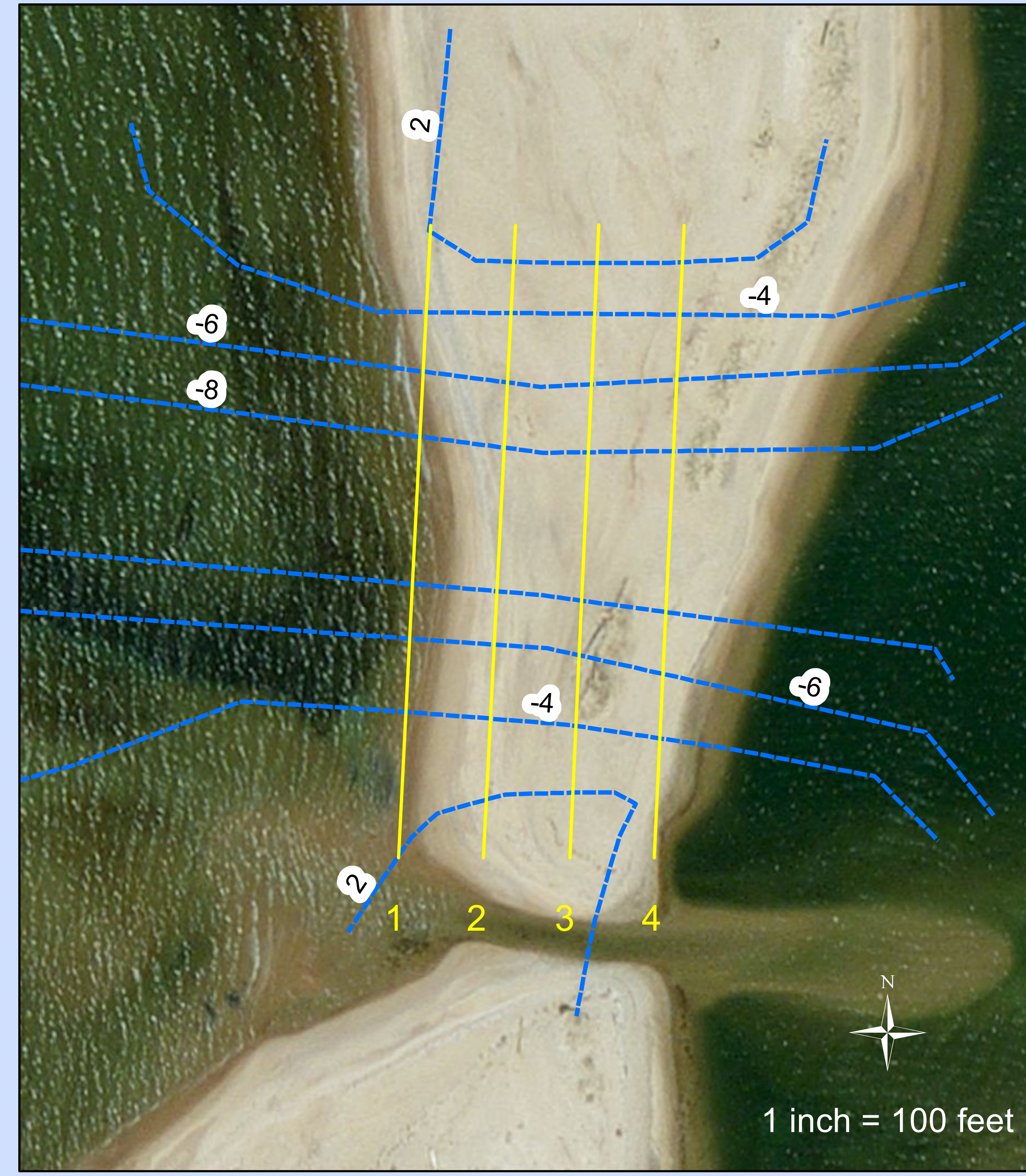
1. Elevation data collected by Land Use Ecological Services, Inc. in May 2012 in accordance with the Quality Assurance Plan adopted by USEPA and Suffolk County Dept. of Health Services.
2. Total estimated dredge and excavation volume is 60,600 cubic yards.
3. Elevations referenced to NGVD 1929.
4. Base Map: 2010 Orthoimage (NYSOCS)
5. Coordinate System: NAD 83 UTM Zone 18N (equivalent to Long Island State Plane coordinate system).

Prepared By:	Land Use Ecological Services, Inc. 570 Expressway Drive South, Suite 2F Medford, NY 11763	Project:	Napeague Harbor
		For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Drawn By:	K. Risotto	Scale:	As Noted
Date:	12/17/2012	Revisions:	2/22/2013

Figure 17. Conceptual Profile for a Proposed East Inlet

Napeague Harbor, Town of East Hampton





Proposed East Inlet Contour

NOTES:

1. Elevation data collected by Land Use Ecological Services, Inc. in May 2012 in accordance with the Quality Assurance Plan adopted by USEPA and Suffolk County Dept. of Health Services.
2. Total estimated dredge and excavation volume is 60,600 cubic yards.
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5. Coordinate System: NAD 1983 UTM Zone 18N (equivalent to Long Island State Plane coordinate system)

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Date:	12/17/2012
Project:	Napeague Harbor
For:	Suffolk County Peconic Estuary Program Conceptual Habitat Restoration Project
Scale:	As Noted
Revisions:	2/22/2013