COASTAL PROCESSES SPECIALIST
WOODS HOLE SEA GRANT | CAPE COD COOPERATIVE EXTENSION
gberman@whoi.edu | gberman@barnstablecounty.org
508-289-3046 | 193 Oyster Pond Road, MS #2, Woods Hole, MA 02543-1525

February 26, 2014

TO: Chuck Hodgkinson (Conservation Agent, Town of Chilmark Conservation Commission)

CC:

FROM: Greg Berman, Coastal Processes Specialist (WHSG & CCCE)

RE: Town of Chilmark Squibnocket Beach and Parking Area Project

Background: Since the inception of the coastal processes position established within WHSG & CCCE, on-site and remote technical assistance on coastal processes has been and continues to be an on-going, effective technical information communication and dissemination tool. Technical assistance relating to coastal processes, shoreline change, erosion control alternatives, coastal landform delineation, potential effects of various human activities on coastal landforms, coastal floodplains, coastal hazards and hazard mitigation analyses, and dune restoration techniques provided in the field and remotely will continue to be provided on an as-needed basis. Site visits generally address site-specific coastal processes or coastal hazards related issues. Follow-up unbiased, written technical analyses are generally provided.

Introduction: Due to recent erosion at Chilmark's Squibnocket Beach and Parking Area, Selectmen are proposing a project for voter consideration at the April 2014 annual town meeting. Mr. Hodgkinson (the town conservation agent) got in touch with the coastal processes specialist (working for both the CCCE and WHSG), requesting an evaluation of the available historical erosion data, FEMA data, land surveys and other materials to assess the impacts of current and projected future conditions on what's being proposed by the town. A site visit was performed on 01/16/2014.

The fragile nature of the coastal resource areas adjacent to the existing and proposed Squibnocket Beach and parking areas, in addition to the potential changes in tides, currents, erosion, and water quality warrant a high level of study. Below I attempt to briefly answer specific questions in order to lessen some of the uncertainty with this project and with the system as a whole. However this does not take the place of a more rigorous study that may be needed before such an undertaking. Neither WHSG nor CCCE are regulatory agencies and everything presented in this document is provided at the request, and for the consideration, of the Town Of Chilmark.

Site Details: This report focuses on the property and land immediately surrounding the Squibnocket Beach and parking area (Figure 1). The project that is being considered by the Town of Chilmark is leasing an additional parcel of land and moving the beach parking area further to the south (Figure 2). The existing parking lot as well as the revetment protecting the parking lot might then be removed and converted into a more natural coastal landform.

Squibnocket Beach is located on the Atlantic Ocean in the town of Chilmark (Figure 1). Waves reaching this coastline are influenced by meteorological conditions offshore in the Atlantic Ocean and may not represent local conditions. The ocean wave climate is important because it is among the dominant forces shaping the beach. The direction and intensity of ocean wave energy can be depicted by a wave rose. A wave rose graphically summarizes wave height, frequency, and direction. The United States Army Core of Engineers (USACE) Wave Information Studies (WIS) uses historical meteorological data to calculate hourly wave conditions, which are then verified against measurements from wave buoys. The resultant data set is comprised of twenty years (1980-1999) of wave information, including significant wave height, peak period, and direction once each hour. The wave rose in Figure 3 illustrates the percentage of waves that arrive from a given directional band and the distribution of wave height within that direction band. An open stretch of barrier beach is not very sensitive to small changes in the angle of wave attack when compared to an area, such as Squibnocket, with headlands and other geographic features that can interrupt wind and waves. The location of Squibnocket Beach affords it protection from much of the winds and waves from the north and west. It should be noted that these roses are for an area greater than ten miles offshore of the site, therefore this data is presented to illustrate the general wave patterns for this portion of the coast exposed to ocean waves.

The wave rose of the offshore WIS wave hindcast station shows relatively weak and infrequent waves from the north (Figure 3). The station shows the trend of a higher quantity of waves from the SSW, likely due to the protection of the island of Martha's Vineyard to the north. Therefore a hurricane, with a landfall just west of the Vineyard, would be able to more directly impact Squibnocket Beach than comparable strength nor'easter. The most frequent wave energy direction is narrowly distributed from the south to the south-southwest, however the largest significant wave heights (>15') come from the east. This may indicate that, although the most frequent waves at Squibnocket Beach occur from the south, it may be that the swell from the east (generated during nor'easters) results in the most significant erosion.

Local wind data was collected from a nearby site in Aquinnah by the UMASS-Renewable Energy Research Laboratory from 07/11/2008 to 08/13/2009 (Figure 4). The annual average wind speed, at 160' off the ground, was 15 mph and the prevailing wind direction was West-Southwest, however seasonal trends are apparent in the data. The summer is characterized by lower wind speed and a more southerly wind direction. Winter is characterized by prevailing north and west winds as well as higher wind speeds. It should be noted that the peak winds recorded (53 mph) occurred during December from a northwest direction, October and January had similar peak speeds and direction.

There are multiple natural resource areas at this location that have been delineated by DEP (Figure 5). To the north of the revetment there are coastal banks, although they are not shown on the

DEP datalayer. The land that has been classified as Barrier Beach-Coastal Dune extends to the road at the site of the proposed parking area, although this is not the case further south.

Site Photographs: A series of photographs (Appendix A) was collected the site on 01/16/2014. Each of the photographs called out in this section have been selected to highlight potential issues or conditions that might be associated to the erosion at these sites. Photograph 1 shows the erosion of the coastal bank north of the parking lot revetment. The bank is currently too steep to support a vegetated slope and will likely experience more erosion soon. The most recent high tide reached the toe of the bank and there was likely no dry beach in front of the revetment. Photograph 2 shows the narrow access road leading from the parking lot southward towards the proposed parcel to lease. The beach extends from the ocean to the revetment, and on the other side (to the right on the photograph) is a low elevation marsh with some sand and cobbles that have likely been washed over the revetment. During storms, it is only this revetment that prevents a direct hydrologic connection with the pond at this location. Photograph 3 shows an area of erosion south of the existing revetment, some disorganized boulders are located seaward of the eroding coastal bank. Photograph 4 shows the intertidal cobbles of the "Mussel Bed" area. This area appears to have a much higher elevation beach than anywhere up to some distance north of the parking lot. Photograph 5 shows the approximate area of the proposed parking lot, looking towards the ocean from the road. The area between the ocean and road has low dunes and is vegetated by grasses, shrubs, and trees.

The sections below are organized by the specific questions that were a part of the requested assessment. Some of the questions are grouped together for ease of explanation.

Q1: What are the estimated annual rate of beach erosion and projected FEMA flood line for the shoreline that is south of the proposed location for the new parking area? **Q2:** If the new parking area is installed at the currently proposed location, will it be protected from severe storm activity and how long will it take for the shoreline to reach the south border (ocean side edge) of the parking area? **Q3:** Is there a better location on the south side of Squibnocket Farm Road on the 10.5 acres of newly leased land for this parking area? One that is more protected from erosion and storm activity. If so, please explain the reason for suggesting a different location.

A1-3: Erosion is not linear. Storm impacts and other short term, high intensity events make it difficult, if not impossible to predict erosion on a short time frame. The best known erosion data available for this site is the CZM shoreline change project, which, at the best of times, has a significant amount of uncertainty associated with the dataset. The recent (2013) update now quantifies this uncertainty and allows the user to understand the true range that contains the actual rate, in addition to the "best guess" of the erosion rates at this site. Additionally, project shorelines are delineated at the wet/dry line and not at the top of the bank. While the erosion rates at these two locations are certainly linked there is a somewhat convoluted correlation between them (e.g., 2' of erosion at MHW does not immediately equal 2' of loss at the top of the bank).

Shoreline change transects for Squibnocket, called out in Figure 6 and Table 1, indicate both the long-term (1845-2007) and short-term (1979-2007) rates of change as well as the associated uncertainty. The estimated long-term rate is variable along this section of shoreline. The transects closest to the parking lot (MV-1658 and MV-1659) are in a rapidly eroding section of this shoreline at approximately 1.4' of erosion per year (the actual erosion range is between 1.0' and 1.8' of erosion per year) while the transect at the Mussel Bed area (MV-1665) shows an erosion rate of approximately 0' (the actual range is between 0.2' and -0.6' per year). Short-term erosion rates are more variable but still show similar patterns, that there is a decrease in erosion to the south. The parking area short-term erosion rate (1.7' per year) is consistent with the long term rates. The Mussel Bed area indicates accretion, however the high levels of uncertainly associated with the short-term make it difficult to confidently determine if the shoreline is eroding (negative values in table) or accreting (positive values in table). For example, while the "best guess" at MV-1665 is accretion of 1.4'/yr it actually could be anywhere between erosion of 2.3'/yr or accretion of 5.0'/yr. It may be reasonable to use the long-term erosion estimate (~0'/yr) until such a time that additional site specific data is collected that indicates that a different erosion rate is more appropriate.

While it may be reasonable to use the long-term erosion estimate (~1.4'/yr at the existing parking lot, ~0'/yr at the Mussel Bed) for the area, this assumes there are no major (or even medium) storm events within the next few years. This is a MAJOR assumption and one of the failings of using a long-term rate to attempt to predict short-term erosion. Also, changing location conditions (ex. wind/wave regime, bank composition, etc.) as well as global conditions (ex. Sea level rise) can have impacts on the longevity at this site. Short-term rate erosional range extremes along this section of shoreline were up to 3.7'/yr but cannot be considered a "worst-case-scenario", as these rates could definitely be experienced during one day in a storm event.

Table 1. The spreadsheet below contains data extracted from individual transect data downloaded from MORIS. Transects highlighted in yellow are closest to the parking lot with transects above located north, and below being south, of the parking lot.

LABEL	Longterm Rate (feet/year) "Best Guess"	Longterm Rate (feet/year) Range			Shortterm Rate (feet/year) "Best Guess"	Shortterm Rate (feet/year) Range		
MV-1652	-1.8	-2.5	to	-1.2	-1.3	-2.9	to	0.3
MV-1653	-1.8	-2.4	to	-1.3	-0.7	-2.7	to	1.3
MV-1654	-1.5	-2.0	to	-0.9	-0.5	-2.8	to	1.9
MV-1655	-1.5	-2.1	to	-0.9	-1.0	-3.3	to	1.3
MV-1656	-1.4	-1.9	to	-0.9	-1.3	-3.2	to	0.6
MV-1657	-1.4	-1.8	to	-0.9	-1.9	-2.9	to	-1.0
MV-1658	-1.4	-1.8	to	-1.0	-1.6	-2.5	to	-0.8
MV-1659	-1.4	-1.8	to	-0.9	-1.8	-3.1	to	-0.5
MV-1660	-0.9	-1.3	to	-0.5	-1.7	-3.7	to	0.2
MV-1661	-1.0	-1.3	to	-0.6	-2.0	-3.6	to	-0.5
MV-1662	-0.9	-1.1	to	-0.7	-0.8	-2.3	to	0.8
MV-1663	-0.9	-1.0	to	-0.7	-0.3	-1.1	to	0.5
MV-1664	-0.8	-1.0	to	-0.5	0.0	-0.4	to	0.4
MV-1665	-0.2	-0.6	to	0.2	1.4	-2.3	to	5.0

The USACE finalized the Southern Massachusetts Hurricane Evacuation Study in 1997, to provide the Massachusetts Emergency Management Agency and the coastal communities in southern Massachusetts with realistic data quantifying the major factors in hurricane evacuation decision-making. The map (Figure 7) provides information on the extent and severity of potential flooding from hurricanes, the associated vulnerable population, and impacts to evacuation roadways. According to the inundation matrix, any category 1 (or greater) hurricane will flood the entirety of the proposed land to be leased (as Inundation Area A). Due to its higher elevation the current parking lot is Inundation Area B, and would only flood during a fast moving category 3 (or greater) hurricane.

The FEMA NFIP FIRM for the area shows a similar delineation. Significant changes have been made to the Special Flood Hazard Area (SFHA) boundaries from the 2010 effective map to the 2013 preliminary map (Figure 8). Some of the existing parking lot has been removed from the SFHA that has at least a 1% annual chance of flooding (the blue line with blue dots on Figure 8), however now instead of being in an AO zone that could flood to a depth of about 2’ due to overwash, portions of the existing parking lot are now in a VE zone which can experience waves of >3’. Additionally, in the 2010 map the upland portion of the proposed lease area was either an AO zone or AE (EL 7), now this area is VE (EL 15). Consistent between the two maps is the Coastal Barrier Resources System (CBRS) area (black dotted line on Figure 8) boundary. The existing parking lot is not in the CBRS, however the entire proposed lease area is CBRS. This designation does not forbid privately financed development; however it does not allow federal financial assistance (ex. NFIP flood insurance, FEMA post disaster assistance funding, etc.) within the CBRS.

Collecting topographic surveys were outside the scope of this assessment; however there is freely assessable 2012 Post Sandy USACE LiDAR data. LiDAR is an optical remote sensing technology that uses lasers to detect the distance to an object or surface, thereby obtaining detailed elevation data. This data was downloaded from NOAA Digital Coast and three topographic profiles were extracted to represent the existing parking lot (red line on Figure 9), the proposed parking area (blue line on Figure 9), and an alternative site at the southern extreme of the proposed leased land (green line on Figure 9). Each of these topographic profiles have been graphed (bottom of Figure 9) in order to show their relative elevation and distance from the Atlantic Ocean shoreline (which would be on the right side of the graph). It is clear that the existing parking lot would be the closest to the water and at the highest elevation of the three transects. The alternative southern location would be the furthest from the water the lowest elevation; however it would have high dunes for wave protection and to add volume to the beach during storms. The originally proposed location is in the middle for both of these parameters.

There is a significantly higher dune system, a wider beach, and a slower erosion rate (near zero) at the southern extent of the proposed lease area. For these reasons it is likely that the southern site should be considered as a potential location of the parking area. While the originally proposed parking area (blue on Figure 9) is slightly higher than the southern location (green on Figure 9) it is likely that both sites would be flooded during a major storm event, and therefore erosion and not temporary flooding should be one of the key characteristics when determining the new parking location. Additionally, the currently proposed parking area is located in an area that has been classified as Barrier Beach-Coastal Dune, further to the south the land is classified more generally as a Barrier Beach System, which might make it easier to permit (Figure 5).

Q4: How vulnerable is the existing understory vegetation to storm erosion and ocean wash over south of the proposed new parking area and how long will it remain healthy?

A4: The vegetation observed during the site visit appeared to be healthy and robust (Picture 5). This type of salt-tolerant vegetation with extensive root systems helps hold sediment in place, helping to stabilize the area. Also, reducing runoff erosion and trapping windblown sand, these plants are increasing the ability of the coastal resource area to buffer inland areas from storm waves, erosion, and flooding. The vegetation will likely remain healthy unless impacted by human activity or coastal erosion during a storm event. Erosion rates were presented in the previous section.

Bare, low areas can be created by walking over the coastal resource area to access the beach. These areas are weak spots that can allow waves to flow over the dune and cause loss of the sediment and subsequently allow waves and water further inland, increasing the potential for a breach through the system to Squibnocket Pond. The town may want to consider a path with a zigzag pattern (as the distance between the proposed lot and beach is great enough) so the water does not have a straight path towards the proposed parking lot. Stairways or seasonal walkways might also reduce erosion; however they are much more expensive alternatives.

Q5: What impact has the current revetment and parking lot had on beach erosion in front (south) of the parking area, and up and down tide of the structure?

A5: The existing revetment has provided the benefit of maintaining the position of the upland (parking lot). This has allowed the shoreline in this area to artificially stay further seaward than the rest of the shoreline. If the site had contained a coastal bank or dunes, instead of a revetment, the current position of the shoreline would likely be much more in line with the rest of the coast, likely between the red and yellow lines on the top of Figure 10. The red line indicates where the shoreline might be if the shoreline connected the toe of bank north of the parking lot (Photograph 1) and the toe of the bank south of the parking lot (Photograph 3). The yellow line indicates a potential shoreline position if the toe of bank north of the parking lot connected to another probable shoreline position to the south if the bank adjacent the southern end of the revetment is not stabilized.

Revetments have the potential to alter wave, tidal or sediment transport processes while protecting upland structures. General negative effects include: exacerbating beach erosion, damaging neighboring properties, impacting marine habitats, and diminishing the capacity of landforms to protect inland areas from storm damage. Reflected waves can erode the fronting beach, potentially undermining the revetment while lowering the height of the beach. This erosion may also result in a loss of dry beach at high tide, reducing the beach's value for storm damage protection, recreation, and wildlife habitat. Specific to this site, it is difficult to determine if these negative effects are occurring as the sand appears to be highly mobile in this section of shoreline. Typical evidence of reflection of wave energy includes; a lower beach than adjacent areas, and/or a larger grain size (cobble) lag left behind after erosion of the small grain size. During the site visit, and in other pictures I've examined, sand was present up to the toe of the revetment. The revetment has not moved, and as the adjacent banks have retreated, it now sticks out and has lost its dry beach during some high tides. The adjacent banks are eroding but appear to be in line with the rest of the shoreline (Figure 1, 2, and 6) making it unlikely that significant scour at the end of the revetment is occurring. It is likely that the revetment is having some effect (denying the sediment that would have been eroded if nothing else), but site conditions preclude a definitive observation of negative effects.

Q6: What section(s) of the existing revetment that is located south of the current parking area should be removed – if any and why? **Q7:** What section(s) of this same revetment should remain in place or be re-organized (if any) to protect any existing roadway or other planned structural features? **Q8:** What is the best land, vegetation and beach restoration plan for the removed revetment and existing raised parking area? **Q9:** What are the projected changes to the re-nourished section of barrier beach will take place after the revetment is removed and the land and beach re-nourished?

A6-9: Careful consideration should be made before removing this revetment, as it will likely be impossible to replace a revetment at this location. Much of what is asked in these questions would need to be examined in a later design phase than at present. The configuration of the project that would replace the revetment has a significant impact on the potential projected changes or a restoration/maintenance plan.

Generally, by removing the revetment, more frequent washover will likely occur during storms, potentially migrating the landforms landward. Inlets may form in this area (as they have in the past), likely temporary in nature, but could have more significant impacts if they are longer-lived features. If the revetment is removed and an artificial dune placed in the same location (i.e. further seaward than adjacent shorelines), then the site will likely experience rapid erosion at the protruding area until it aligns with coastal banks to north and south, then erosion rates should become more consistent (not accounting for coastal management techniques). The longer attempts are made to keep the shoreline in this exact position the harder it will be to maintain this location as the rest of the shoreline retreats.

A potential alternative to complete revetment removal is leaving some of the revetment in place and/or realign the stones. Figure 11 shows two potential restoration conceptual designs. These should not be considered preferred designs, simply examples to consider when designing the restoration of the existing parking lot. Both designs show approximately 0.5 acres of restored area with different habitats on each side of a potential revetment. The revetment in these designs could be covered with dune material such that it would only be exposed after a storm, which could be a trigger for renourishment. The top elevation is not indicated, and would need to be considered. This structure could be a revetment matching the height of the current revetment, or it could be a low sill. The left image shows a realigned contiguous revetment. This type of configuration would protect the habitats behind the revetment, and may prevent new inlet formation while still allowing overwash. The right image shows a realigned revetment with a gap. This type of configuration would protect some of the habitat behind the revetment, and would allow new inlet formation and overwash. The connection points to a potential new raised roadway would be protected, while the restored dune/beach in front of the revetment would likely be lost, in either configuration. A third configuration could be if all the revetment stones were removed, which would still provide the 0.5 acres of habitat restoration, but might eventually endanger access to the road. While these are examples of what might be considered at the site, the town will likely need a more robust (engineering) analysis of all feasible alternatives in order to weigh its options.

Q10: What impact will normal tidal action and storm surge activity have on the re-nourished barrier beach, Squibnocket Pond water quality, and the level to the north and abutting properties up and down tide of the of the current revetment? **Q11:** What do you estimate will be needed to maintain the re-nourished beach on an annual basis? Will this re-nourished section of barrier beach eventually stabilize and if so, where will the shoreline be located and what will the beach become?

A10-11: Storm surge and tidal effects on Squibnocket Pond are discussed under **A12**. The coastal banks that are adjacent to the revetment are experiencing erosion (Photographs 1 and 3, Figure 6 and Table 1). Already the toe of the revetment, and the adjacent coastal banks, get wet during many high tides. As the revetment currently extends further seaward than the coastal bank to the east it is highly likely that any shoreline stabilization, by way of placing sediment, will experience erosion equal to or greater than what is being experienced by the adjacent coastal bank (-1.4'/yr from Figure 6 and Table 1). If an inlet were to form, for any significant length of time, it would certainly affect longshore sediment transport and could generate eddies and other flow phenomena that will have an impact on the beach and coastline. As much of the re-nourishment sediment will be transported along the shoreline adjacent properties may see some minor storm protection from this project.

Beach nourishment is the process of adding sand to an eroding beach to restore its width and elevation to specified, engineered dimensions. Without knowing those dimensions it will be impossible to provide a specific quantitative volume. It could be approximated by multiplying the erosion rate, by the existing landform height and length to get a very rough volume (example below).

<u>Example:</u>

Erosion Rate	X	Length of Landform	X	Height of Landform	=	Volume
1.4'/yr	**X**	**300' long**	**X**	**6' high**	**=**	**2,520 ft3/yr (≈93 cy/yr)**

Beach nourishment does not prevent erosion or stop the movement of sand along a beach. It is an alternative that reestablishes the buffer of sand between the ocean and structures. To be effective over the long term, beach nourishment projects must be periodically maintained by adding more sand. There is currently no dry beach during higher tides seaward of the revetment (Photograph 1). You would actually have to put enough sand on the beach to raise the entire system above the intertidal zone. This sediment would form a "bump" out into the ocean (similar to the mussel bed area, but without the cobbles that maintain that formation) and the material would be transported along the beach relatively quickly. The volume that would be required would vary depending on if the designed dune/bank was to follow the existing bank, or stay out were the revetment is currently located. Two lines are drawn (very roughly) in Figure 10 in order to show the potential location of the shoreline if the toe of the landform were to match with the toe of the coastal banks to the east and west. The red line indicates a position that might occur if the westernmost boulders (Photograph 3) are not removed, the yellow indicates a more conservative line if all of the boulders are removed. These lines are very crudely drawn in that they only match up the geometry of the shoreline and do not take the sediment composition, elevation, and other important factors into consideration. Access to the beach for machinery to dump and move sediment for nourishment should be included in the final design.

Q12: If there is a water exchange with the Pond how will this affect the water level of the pond – during normal tidal actions and during significant storm events?

A12: The southwest barrier beach shoreline of Squibnocket Pond is a permeable geologic deposit and a pathway for discharge from Squibnocket Pond as seepage through the beach face when the ocean is lower. Additionally, Squibnocket Pond is connected to Menemsha Pond by way of Herring Creek. At about 10ppt salinity Squibnocket Pond is much less salty than Menemsha Pond, which has a direct connection to Nantucket Sound. While some exchange and flooding may enter through Herring Creek it is certainly restricted and less than would occur through an inlet at the location of the existing parking lot. In the 18th century the pond was connected to the Atlantic via an inlet through the southwest barrier beach. Later maps and the remains of a sluiceway indicate an inlet at the southeast corner of the Pond during the early 1900's. For a more in depth description of the hydrogeology of Squibnocket Pond the reader is referred to *Chilmark, Menemsha and Squibnocket Ponds: Nutrient Loading & Recommended Management Program*, by the Martha's Vineyard Commission (2001). Much of the background presented above is from this document.

As has been described in previous sections of this report, if the existing revetment is removed it is likely that Squibnocket Pond will have a new hydrologic connection with the Atlantic Ocean, either as overwash during storms or more frequently if an occasional inlet were to form after a storm. Inlets have formed at this location in the past (1992) but were closed again within days (pers. comm.. Reid Silva). Additionally, there is evidence for overwash along the western shoreline of the pond (bottom of Figure 10). There is currently relatively little water exchange between Squibnocket Pond and the Atlantic Ocean (compared to other ponds such as Menemsha). If the existing parking lot area becomes a point for flow between the pond and the Atlantic Ocean, the pond would likely experience an increase in salinity level and a reduction in nitrogen content. However there may be temporary negative impacts associated with such flow. The more efficient connection may lower the water level and/or allow greater water into the system during storms. Any freshwater wetland plant communities within the pond may not be able to tolerate seawater and would experience rapid die offs, however salt-tolerant plants would over time become established. There also may be a concern for flooding of low-lying properties and potentially salt intrusion into domestic wells (if applicable).

Regulatory agencies may require a more detailed analysis of potential changes to the local coastal dynamics and flooding potential. For many years the shorelines inside Squibnocket Pond have not experienced both wave and tidal conditions that are similar to what may occur after the proposed project. Permitting this project may require numerical modeling assessment of the potential alterations to tidal hydrodynamics, associated with a new area of greatly increased overwash and/or a potential inlet, as well as the influence of these tidal current changes on coastal erosion potential on the pond and ocean shorelines.

Q13: Will the paved Squibnocket Road that leads to the current parking area be exposed to excessive erosion or storm surge impacts if the revetment is removed and the land and barrier beach re-nourished? **Q14:** What protective measures should be taken (if any) for Squibnocket Road after the revetment is removed?

A13-14: Estimates of short-term shoreline position (red/yellow lines on Figure 10) are over 60' away from the paved Squibnocket Road. If erosion continues at 1.4' per year there would still be over 40 years until the paved road was threatened. This is a VERY rough estimate as the exact position of the road may be part of another project design, and the town's plan for maintenance (and the budget of said maintenance) of the proposed new landforms is still uncertain. As shown in Figure 11, some of the revetment could be re-aligned in order to protect the road connection points to the proposed raised roadway.

If the revetment to the parking lot is totally removed it may be difficult to permit another revetment to protect Squibnocket Road. While pre-1978 dwellings are grandfathered under the state Wetlands Protection Act, the access roads to such dwellings are not explicitly covered, but primary access may be allowed similar status as the dwelling it serves. Nourishment of the landform and beach may be the primary methods in the future by which to protect the road in the short to mid-term. Over the long term plans for continued managed retreat, such as the one being proposed in this project, should be considered.

Summary: I have attempted to address all of the questions asked by the Town of Chilmark regarding this beach and parking project. Complete answers to some of the questions will require a more robust analysis than I was able to provide for this assessment. There will likely be several regulatory and permitting agencies that will need to weigh-in before this project can break ground. If this project were to cause unintended negative consequences similar proposals for other areas might be harder to permit. However, if this project is successfully implemented and maintained, it has the chance to serve as an example of the effectiveness of un-armoring (removing revetments) for other sites along southeast Massachusetts.

Figure 1. Overview map illustrating the location of Town of Chilmark Squibnocket Beach and Parking Area in relation to Martha's Vineyard and Squibnocket Pond.

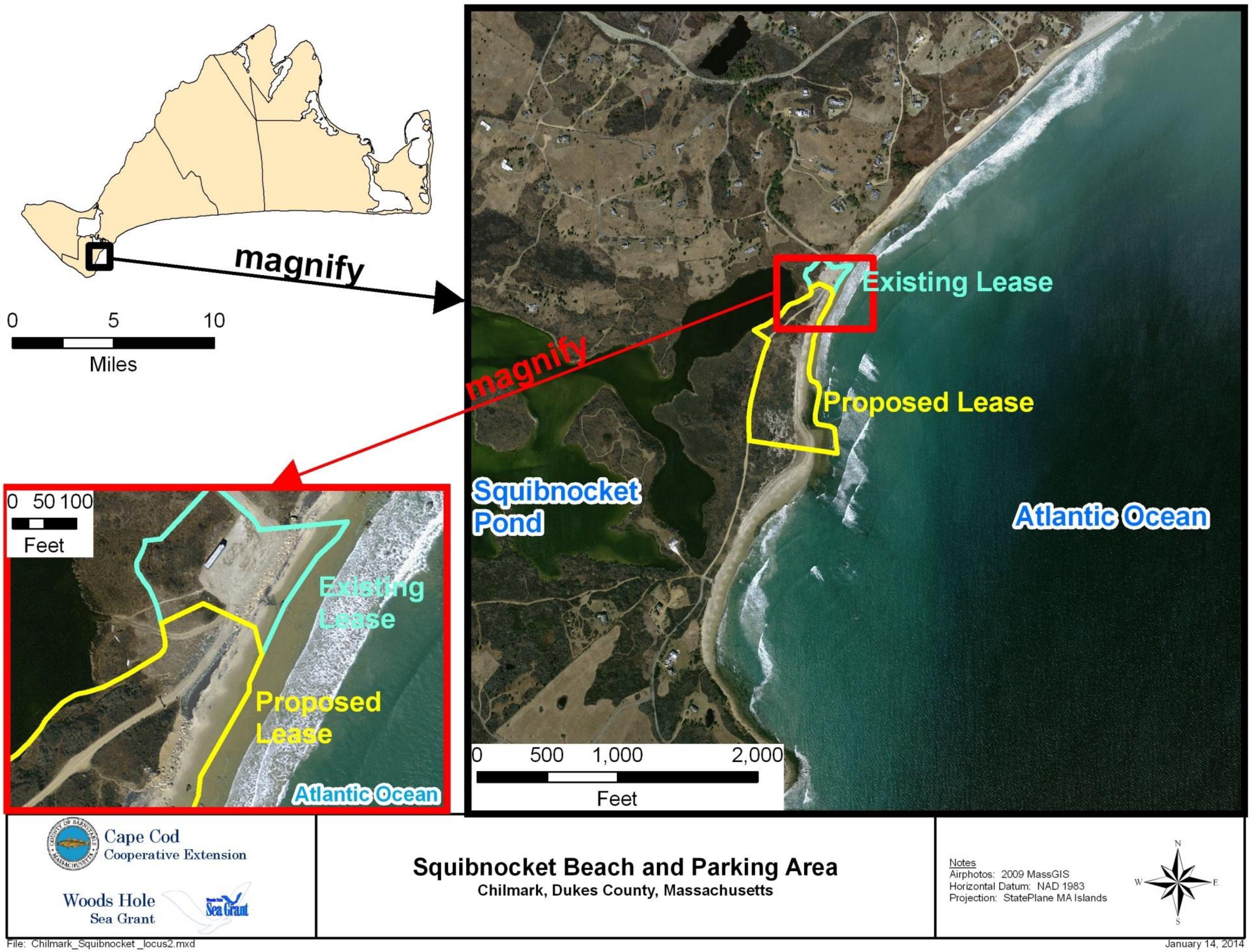


Figure 2. Map location of the currently leased land, along with the land that is proposed to be leased. The approximate locations of the proposed new parking lot and re-alignment of the road is also indicated.

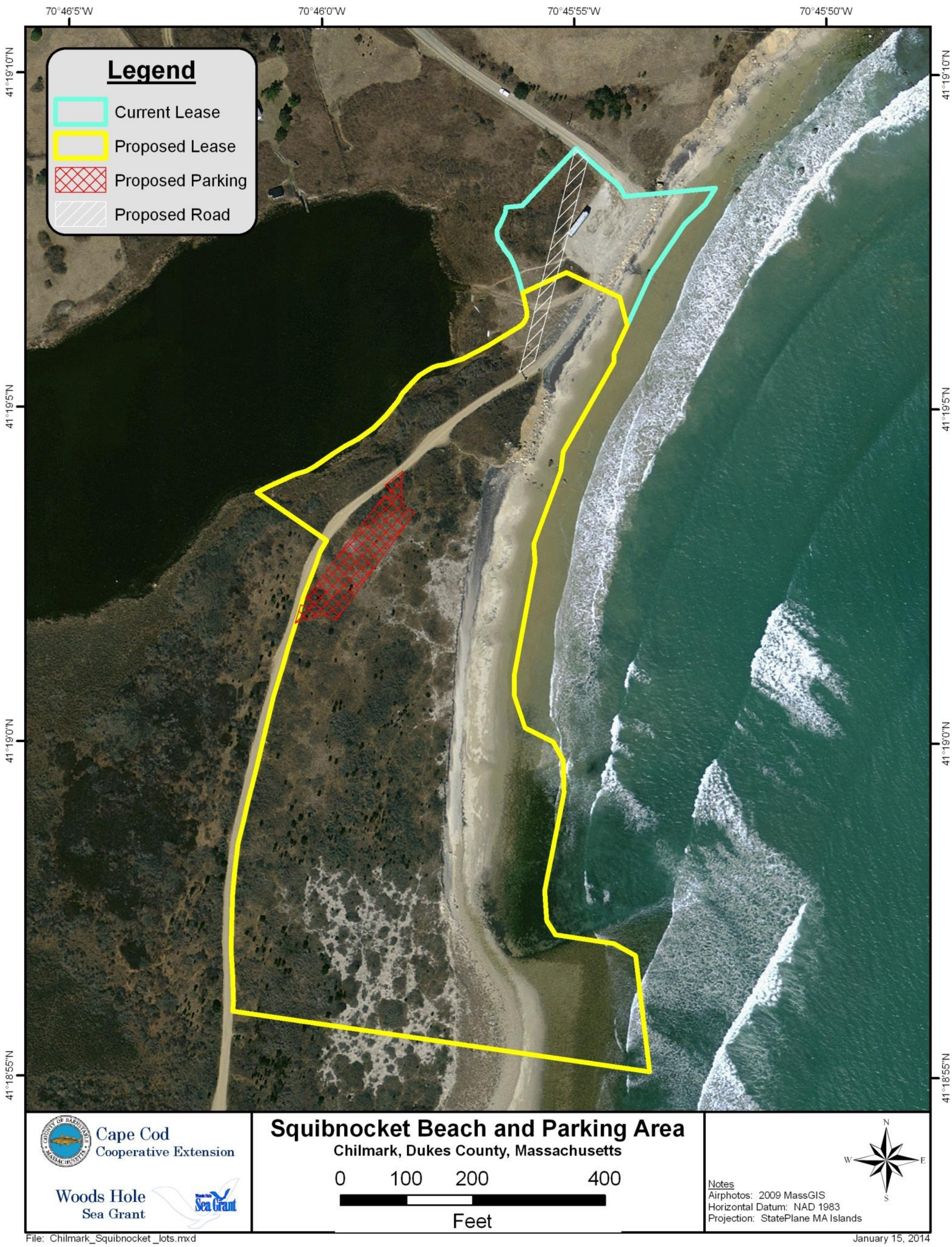
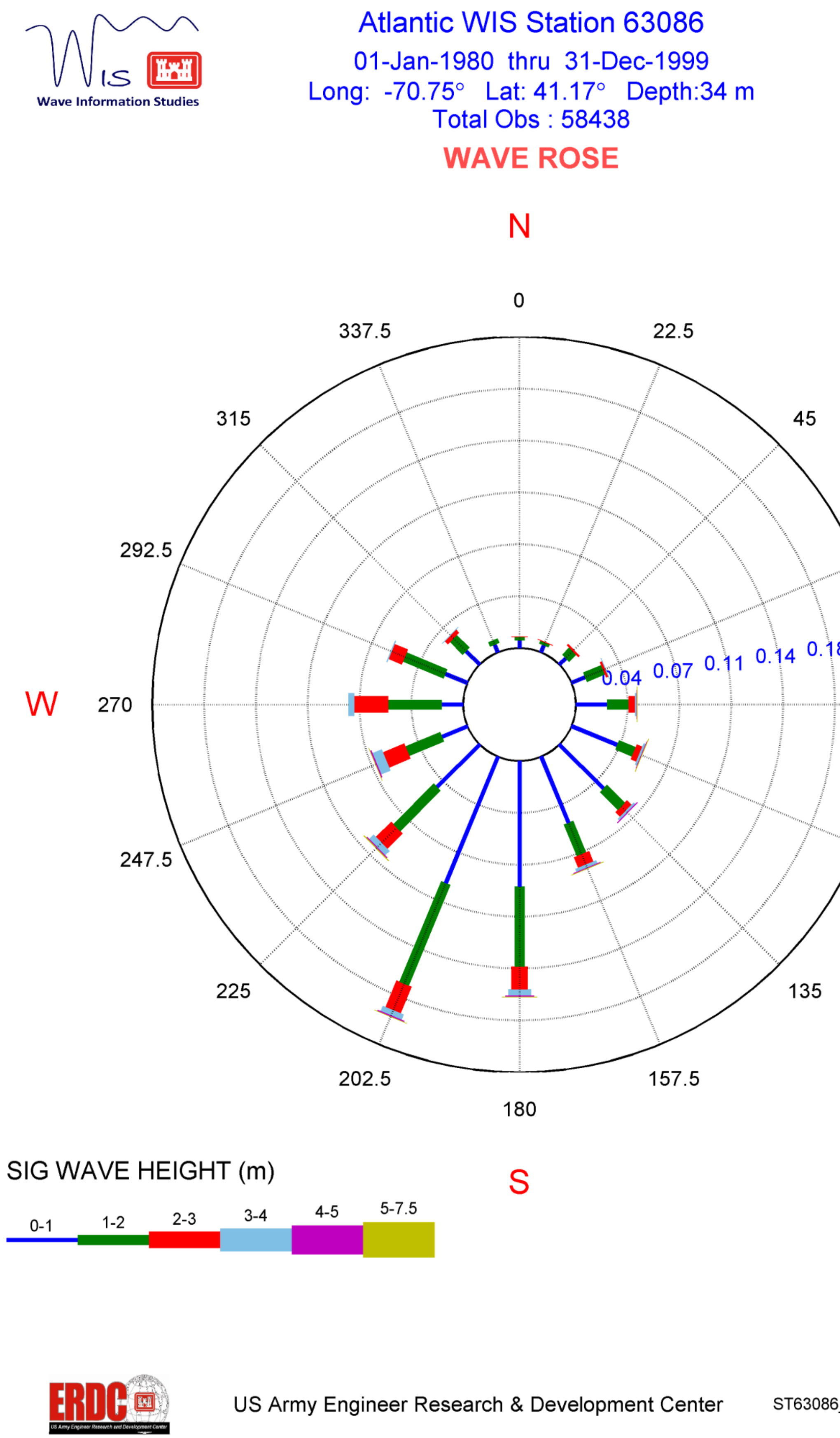


Figure 3. Map showing a wave rose of the nearest WIS (Wave Information Studies) station #63086 to the site. The USACE produces wave climate information for U.S. coastal waters. WIS information is generated by numerical simulation of past wind and wave conditions, a process called hindcasting. (images adapted from http://wis.usace.army.mil/)



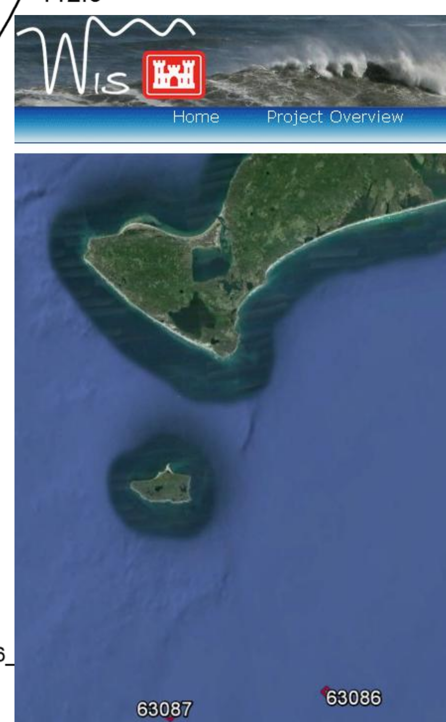


Figure 4. Wind data collected from a site in Aquinnah by the Renewable Energy Research Laboratory, UMASS. The table and graph below are adapted from their Wind Data Report (07/11/2008 – 08/13/2009).

Date	Mean Wind Speed	Max Wind Speed	Prevailing Wind Direction	Mean Wind Speed	Max Wind Speed	Prevailing Wind Direction	Mean Wind Speed	Max Wind Speed
Height Units	49 m [m/s]	49 m [m/s]	49 m	35 m [m/s]	35 m [m/s]	35 m	25 m [m/s]	25 m [m/s]
Aug 08	4.5	10.8	WSW	3.82	9.4	WSW	3.18	7.7
Sep 08	5.51	15.5	SSW	4.55	13.3	ENE	3.71	11.1
Oct 08	7.12	21.2	W	6.04	18.2	WSW	4.88	15
Nov 08	7.22	18	WNW	6.11	15	NW	5.02	12.7
Dec 08	9.11	23.7	NW	7.64	20.3	NW	6.2	16.5
Jan 09	7.56	21.2	NW	6.62	18.1	NW	5.62	15.3
Feb 09	8.14	18.4	W	6.96	15.8	WNW	5.73	13.2
Mar 09	6.62	18.2	N	5.59	15.5	NNE	4.64	13.4
Apr 09	7.21	15.8	W	6.02	13.2	WSW	4.86	11
May 09	5.62	14.1	WSW	4.54	11.5	WSW	3.66	9.4
Jun 09	5.07	14.6	NE	4.21	12.5	NNE	3.46	11
Jul 09	5.48	13.1	SW	4.37	11.3	SW	3.55	10
Aug 2008 - Jul 2009	6.59	23.7	WSW	5.52	20.3	WSW	4.53	16.5

Aquinnah Wind Speed Time Series, 49 m

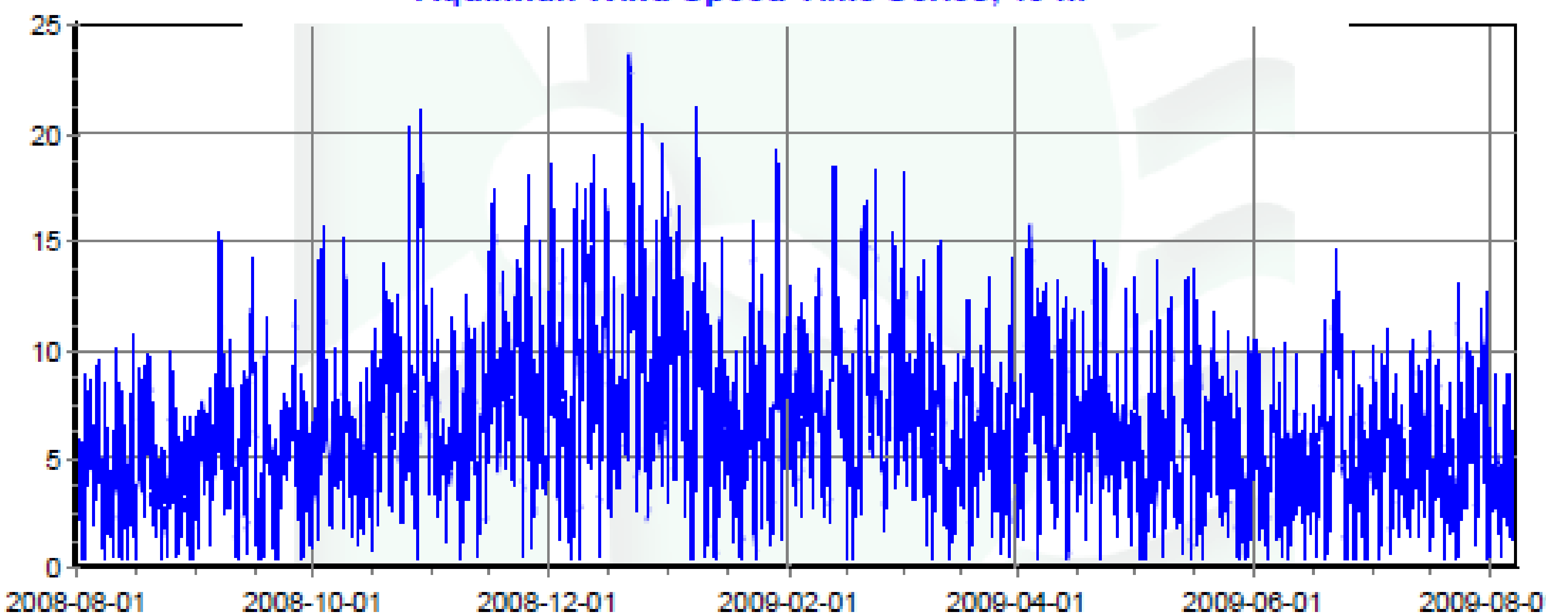


Figure 5. The image below is a screen shot from MORIS focused on the Squibnocket project area. The polygons presented are the 2009 DEP Wetlands (1:12,000) datalayer, indicating coastal resource areas.

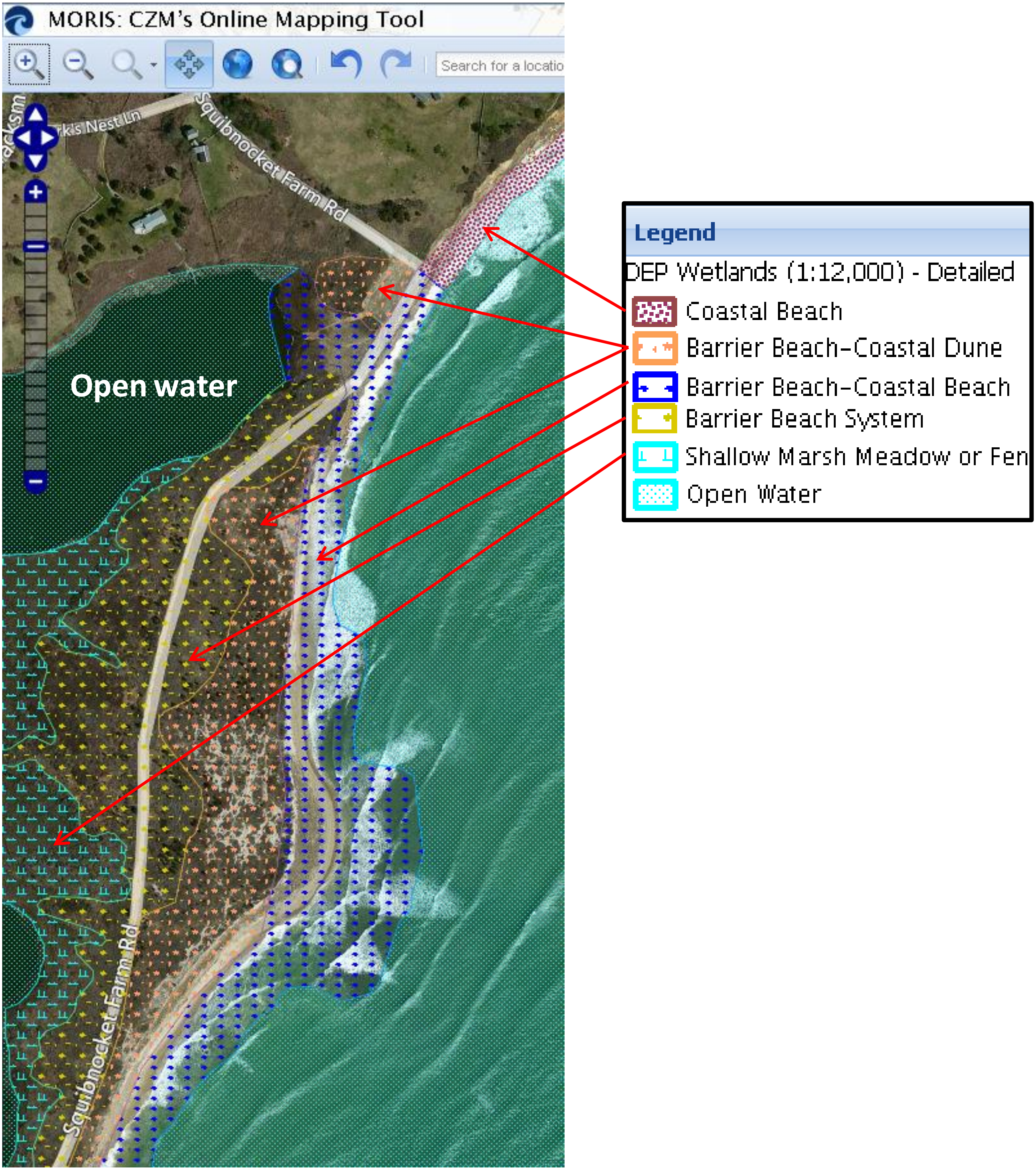


Figure 6. The image is from the Massachusetts Shoreline Change Project on the Massachusetts Ocean Resource Information System (MORIS) with the existing **Squibnocket** parking area called out.

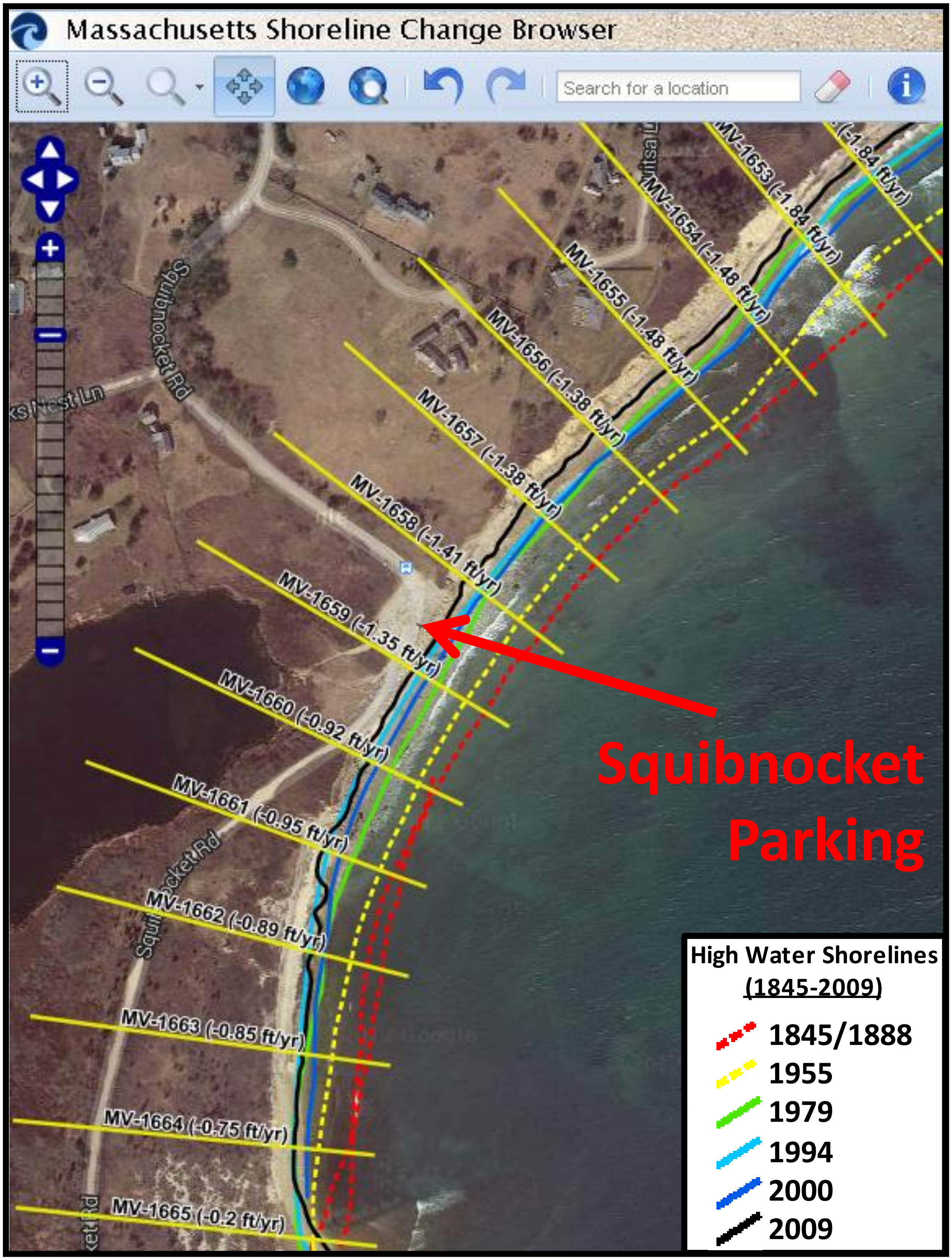
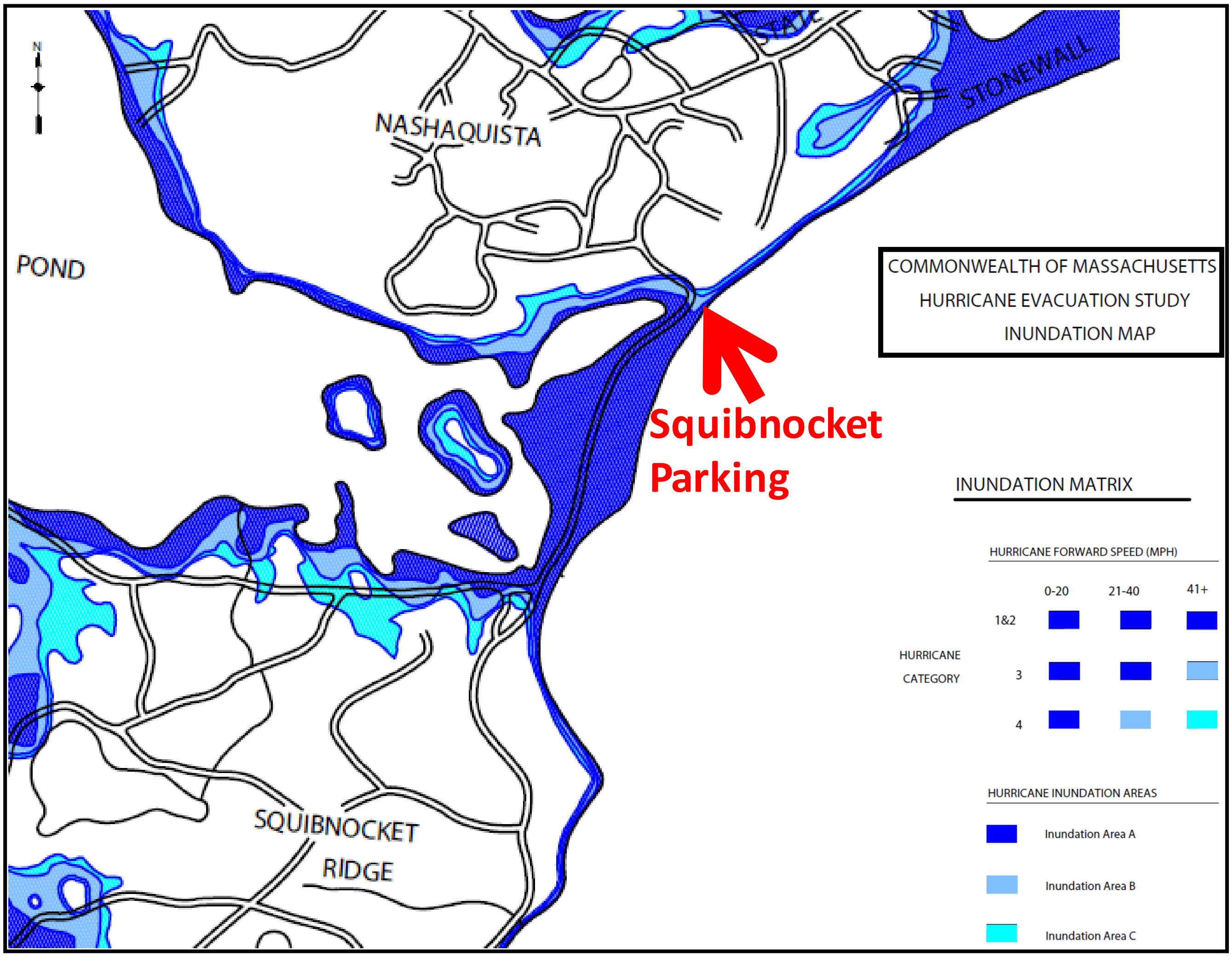


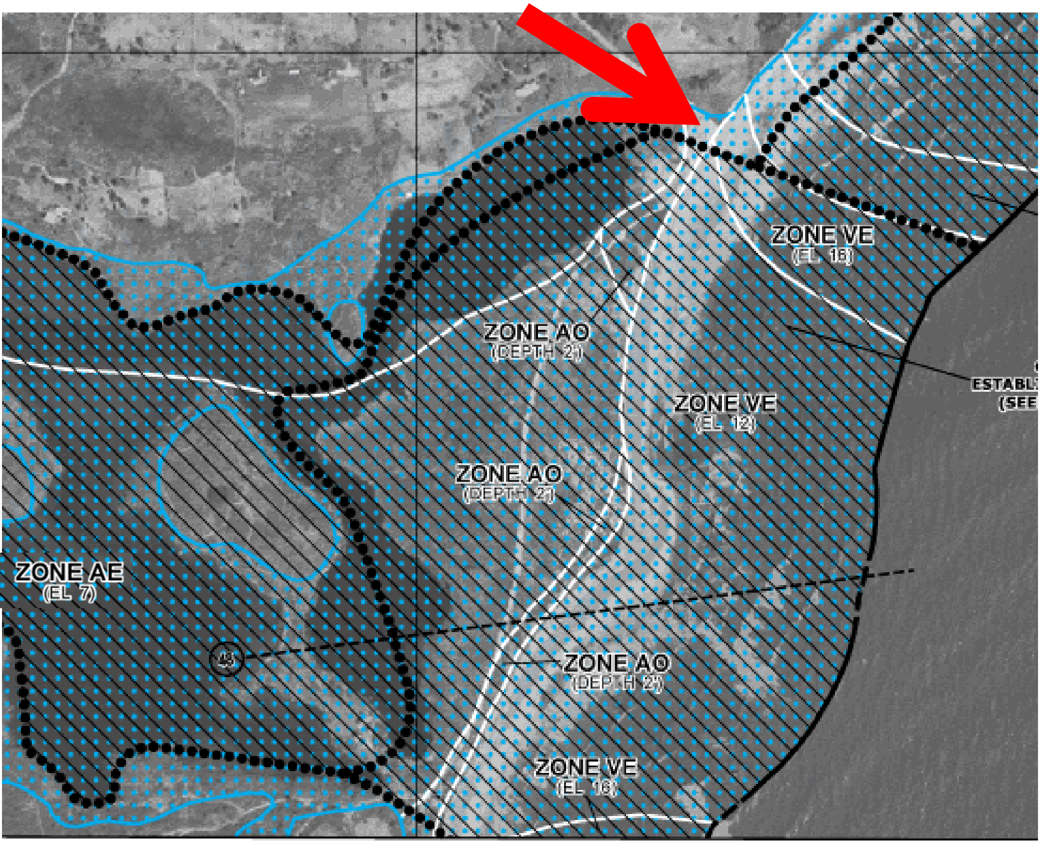
Figure 7. The image below has been adapted (and existing Squibnocket parking area called out) from the Commonwealth of Massachusetts Hurricane Evacuation Study Inundation Map for the town of Chilmark. The original map was prepared by the U.S. Army Corps of Engineers, New England Division in cooperation with the Federal Emergency Management Agency, Region I for the Massachusetts Emergency Management Agency.



Notes from original map: 1. Inundation areas were derived from the National Hurricane Center's application of the SLOSH (Sea, Lake and Overland Surges from Hurricanes) model. Inundation areas reflect "WORST CASE" combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. 2. Hurricane categories 1 through 4 refer to the Saffir-Simpson scale of hurricane intensity. 3. Shaded land areas represent areas with coastal flooding potential from hurricanes of the categories and forward speeds referenced by the inundation matrix shown above. Inland areas that may only be subjected to freshwater flooding are not identified. 4. "WORST CASE" hurricane surge elevations delineated for each inundation area are given in the surge tide profiles provided on Plate iii.

Figure 8. The images below were extracted from the NFIP Flood Insurance Rate Maps for Dukes County. Map # 25007C0159H, Effective Date July 6, 2010 is on the left, Map # 25007C0159J, Preliminary Date June 3, 2013 is on the right. The existing Squibnocket parking area is called by the red arrow.

Effective 7/6/2010, Map # 25007C0159H



Preliminary 6/3/2013, Map # 25007C0159J

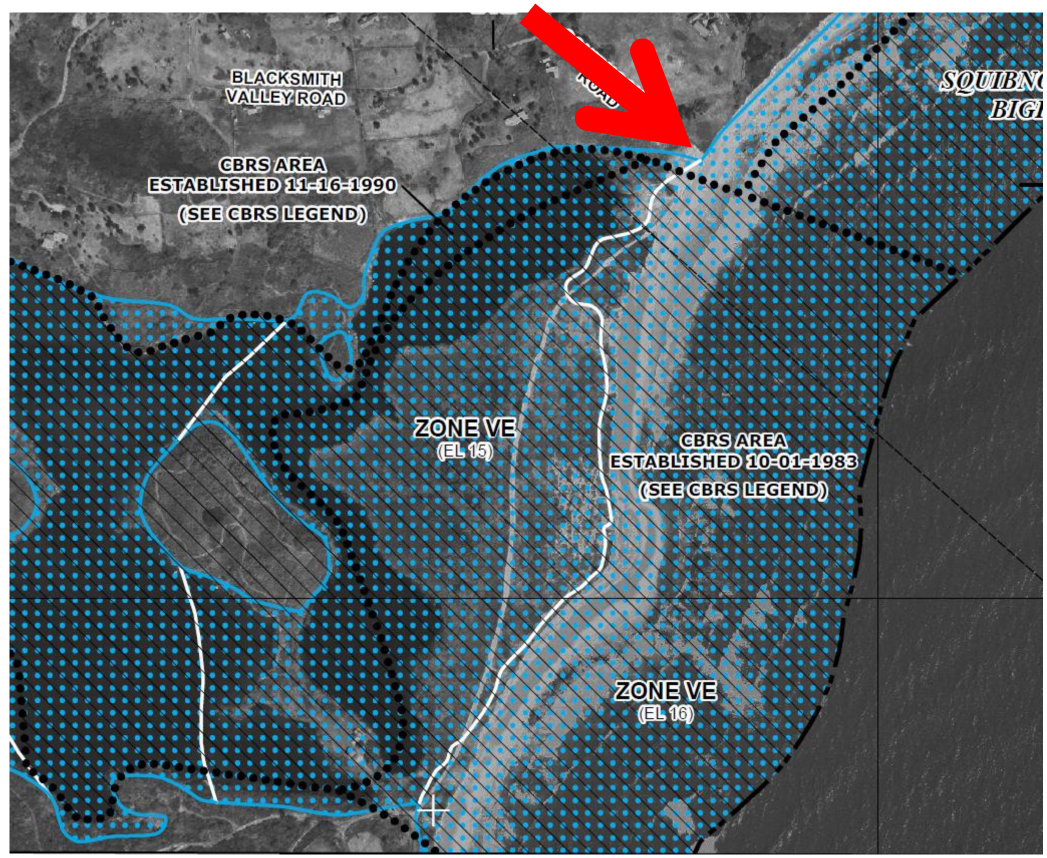


Figure 9. Three topographic profiles were extracted from 2012 Post Sandy USACE LiDAR data (downloaded from NOAA Digital Coast) along transects, represented by colored lines in the figure below. The topographic profile for the existing parking lot (red in both the map and graph), the originally proposed parking lot (blue in both the map and graph), and the alternative parking lot location (green in both the map and graph), all intersect at the elevation 2' NAVD88. The topographic profiles have also been smoothed along the existing or proposed parking lots to help identify these areas.

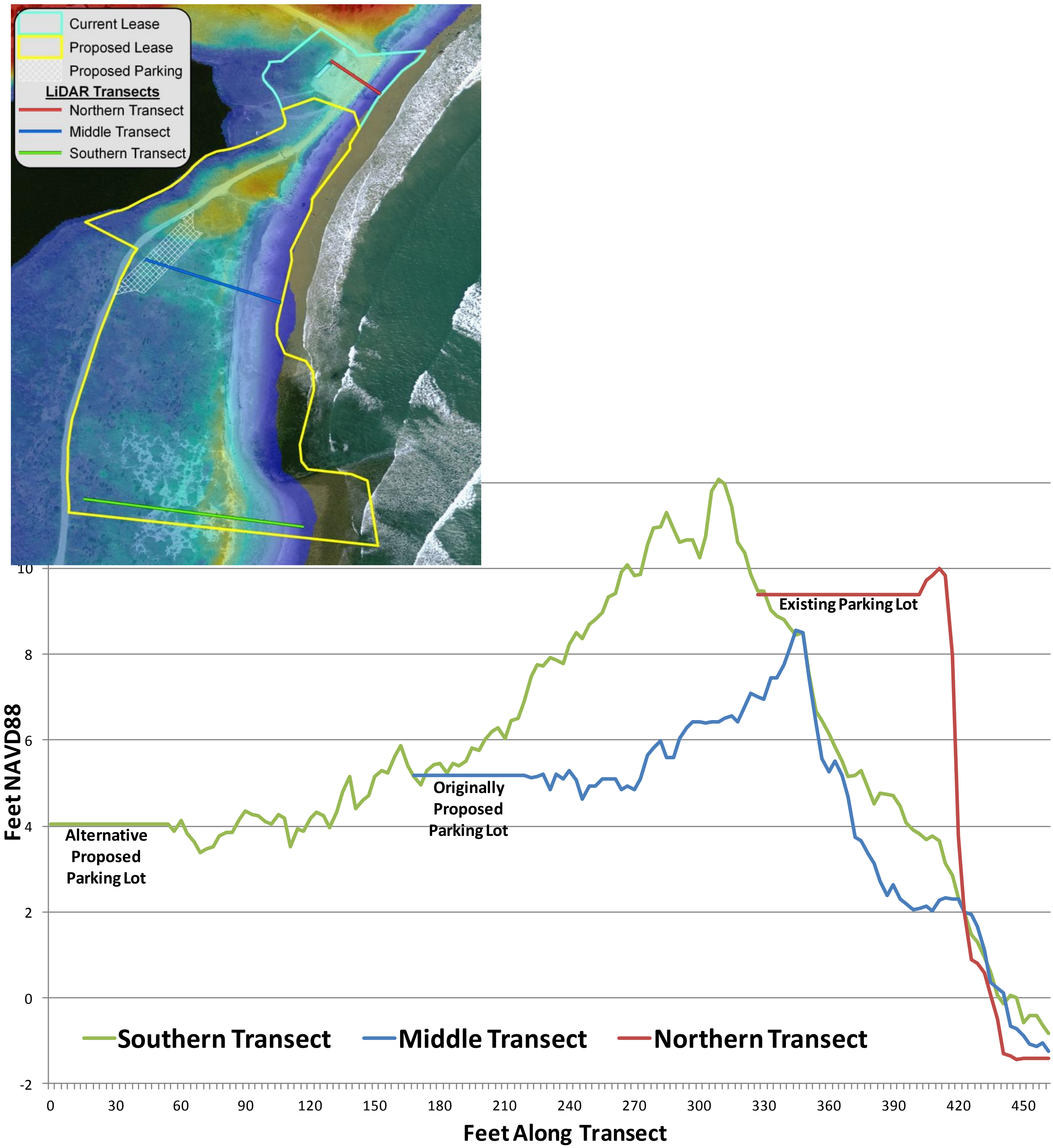


Figure 10. The top image shows a shoreline position, in line with the rest of the coast, after removing just the revetment (red line) or the revetment and the boulders to the south (yellow line) that are shown in Photograph 3. The bottom image shows areas of overwash along the western barrier beach of the pond.

Figure 11. The map below shows two potential restoration conceptual designs. These should not be considered preferred designs, simply examples to consider when designing the restoration of the existing parking lot. The left image shows a re-aligned contiguous revetment, while on the right there is a gap in the revetment. The rough estimate of restored resource area in this example is about 0.5 acres.

Appendix A. Site Photographs

Photograph 1. The photograph below shows the erosion north of the parking lot revetment. The image to the right indicates the location and direction of the photograph below (red arrow) as well as the other photographs in the series (green arrows).

Photograph 2. The photograph below shows the narrow roadway from the parking lot to the south. The image to the right indicates the location and direction of the photograph below (red arrow) as well as the other photographs in the series (green arrows).

Photograph 3. The photograph below shows the erosion south of the revetment. The image to the right indicates the location and direction of the photograph below (red arrow) as well as the other photographs in the series (green arrows).

Photograph 4. The photograph below shows the “mussel bed” headland area looking towards the upland areas. The image to the right indicates the location and direction of the photograph below (red arrow) as well as the other photographs in the series (green arrows).

Photograph 5. The photograph below shows the approximate area of the proposed parking lot, looking towards the ocean from the road. The image to the right indicates the location and direction of the photograph below (red arrow) as well as the other photographs in the series (green arrows).