Presentation to Squibnocket Committee
Friends of Squibnocket
September 16, 2014

From the Friends of Squibnocket:
Thank You To Our Partners!

LEC

LEC Environmental Consultants, Inc. (LEC) is a multidisciplinary ecology-based environmental consulting firm dedicated to providing an interface between the natural sciences and land-use management.

Applied COASTAL

Applied Coastal Research and Engineering, Inc.
766 Falmouth Road
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Mashpee, MA 02649

Applied Coastal Research and Engineering, Inc. (Applied Coastal) focuses on developing and implementing scientifically defensible solutions to problems in the marine environment. Our specialty areas include coastal process analyses, coastal engineering, coastal change assessment, coastal data collection and analyses, estuarine circulation water quality modeling, sediment transport modeling, on-line information management, computer mapping and geographic information system (GIS) applications, coastal and marine geology, and coastal zone management. Applied Coastal's staff is composed of a diverse group of specialists, most with advanced degrees in coastal science or engineering.

Atlantic
Civil Engineers, Environmental Scientists and Land Surveyors

Friends of Squibnocket Recommendations:

The major elements of our strategy for the Squibnocket area :

- **Managed retreat and adaptation**: The guiding principle of our strategy is managed retreat, which recognizes the natural processes of erosion, sea level rise, and the landward migration of barrier beaches and coastal dunes.
- **Barrier beach and coastal dune:** The area delineated by the Commonwealth as barrier beach and coastal dune should be protected consistent with the provisions of the Wetlands Protection Act. Vegetation on the coastal dune should not be disturbed. (See Appendix B.)
- **Revetments and beach:** The second major component of the strategy is the removal of all revetment structures. This will result in the naturalization of the shoreline from the east end of the parking lot to the west end of Money Hill by allowing natural sediment deposition and regeneration of a 60' beach area between the high water mark and the top edge of the naturalized shoreline.
- **Rural character of the area:** The third component to our strategy is to maintain the rural character of the area. A bridge structure is inconsistent with the existing environment.
- **Restoration of the dune ridge:** The area between Squibnocket Road and Money Hill should be restored with a reconstructed dune ridge that will serve three key purposes: prevention of frequent overwash into the pond, nourishment of the beach, and vehicular access to Squibnocket Farm via a roadway on the back of the dune.
- **Access to Squibnocket Farm:** Maintenance that allows the roadway to migrate landward should continue. Utility access should be separate from the roadway.
- **Parking:** Parking facilities should be moved to a location along Squibnocket Road at the east end of the pond (location TBD).

Erosion: Historical and Projected

The projected erosion rate for the next 50 years was determined by Applied Coastal Research and Engineering, using data from the last 56 years. From 1955-2011 the erosion rate for the target area in front of the revetments was 2.3' per year and this is the rate that has been forecasted by Applied Coastal for the next 50 years. (See Appendix A)

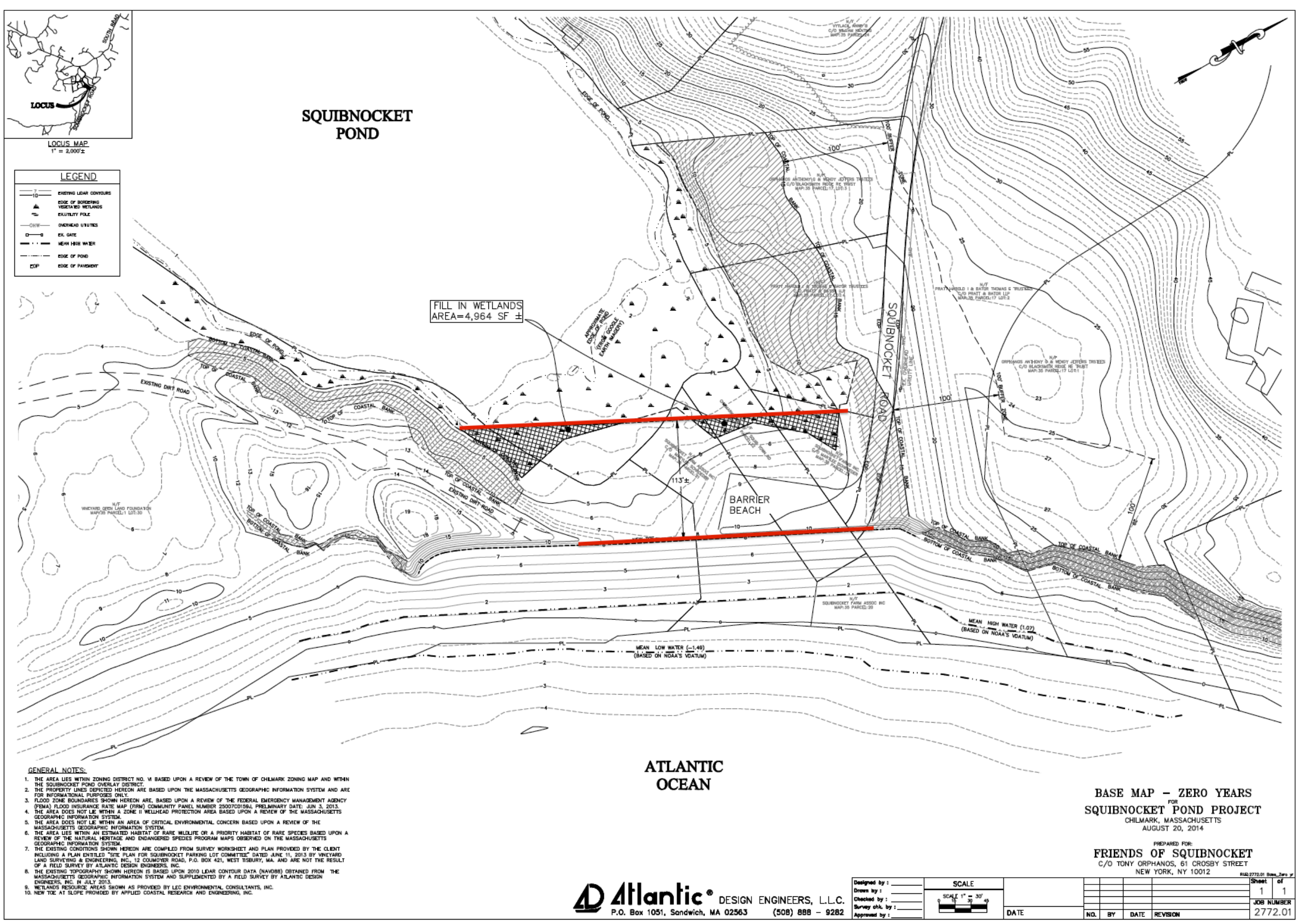
Dune Ridge

The Friends of Squibnocket is recommending a reconstructed dune ridge for the 400' area between Squibnocket Road and Money Hill. This area included a dune in the past and our recommendation is to reconstruct that landform to protect the roadway and the east end of the pond from storm damage.

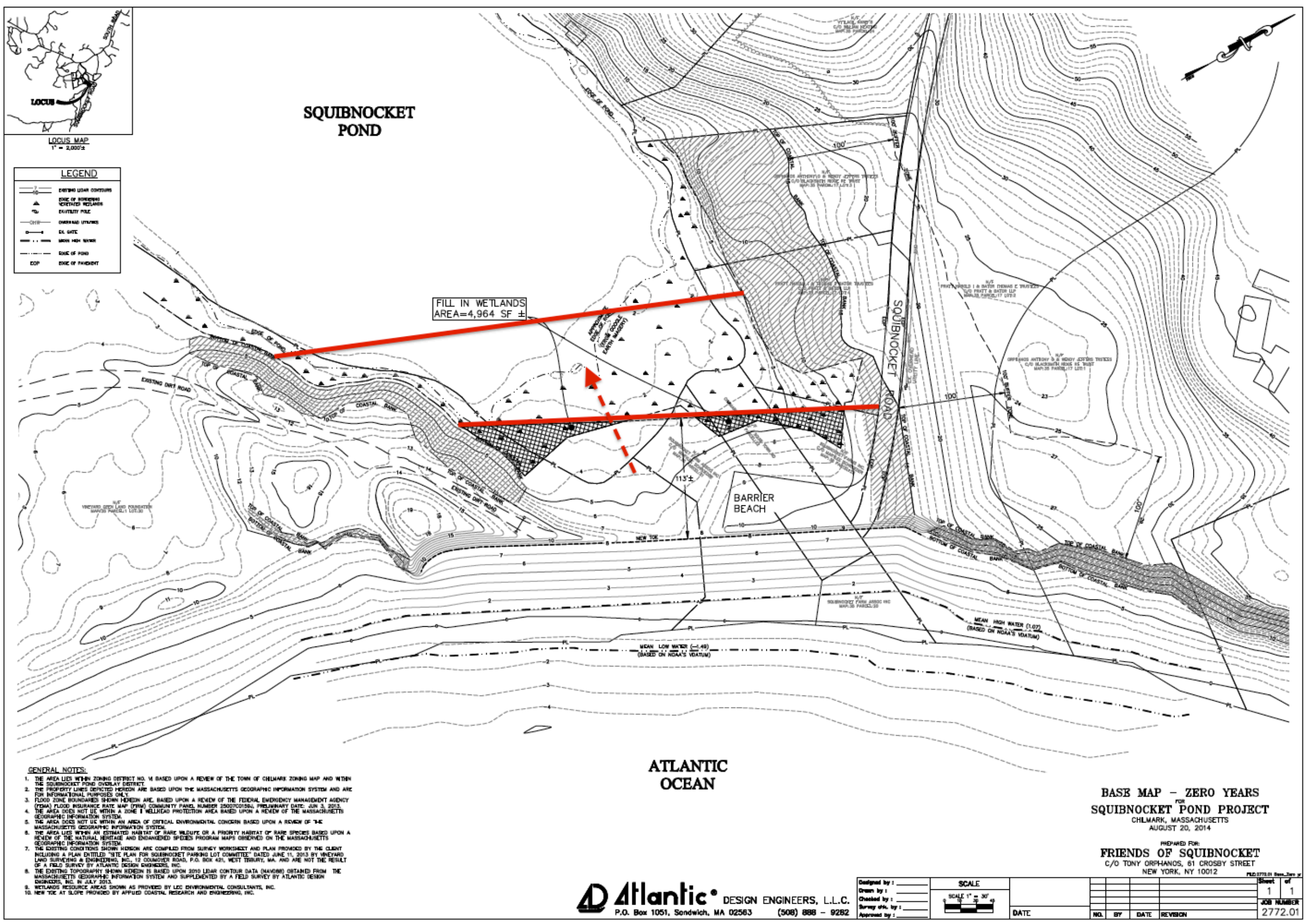
The footprint of the dune was determined using a model that maximized its width while minimizing its impact on the wetlands. The dimensions and shape of the dune ridge were developed by Applied Coastal Research and Engineering, using industry-recognized methodology and best practices (see Appendix A).

- 400’ length; 113’ width
- 16.8’ crest height; 30’ crest width
- 12’ roadway width; 10’ roadway height

The footprint of the dune ridge is depicted below in the topographical map. The shaded area in the rear of the dune ridge shows the segments of the wetlands that we proposed to fill. The filled wetlands are on the northern edge of the dune ridge, just below the upper red line. Filling a portion of the wetlands is allowed under the Wetlands Protection Act. The initial position of the dune after construction is as follows:

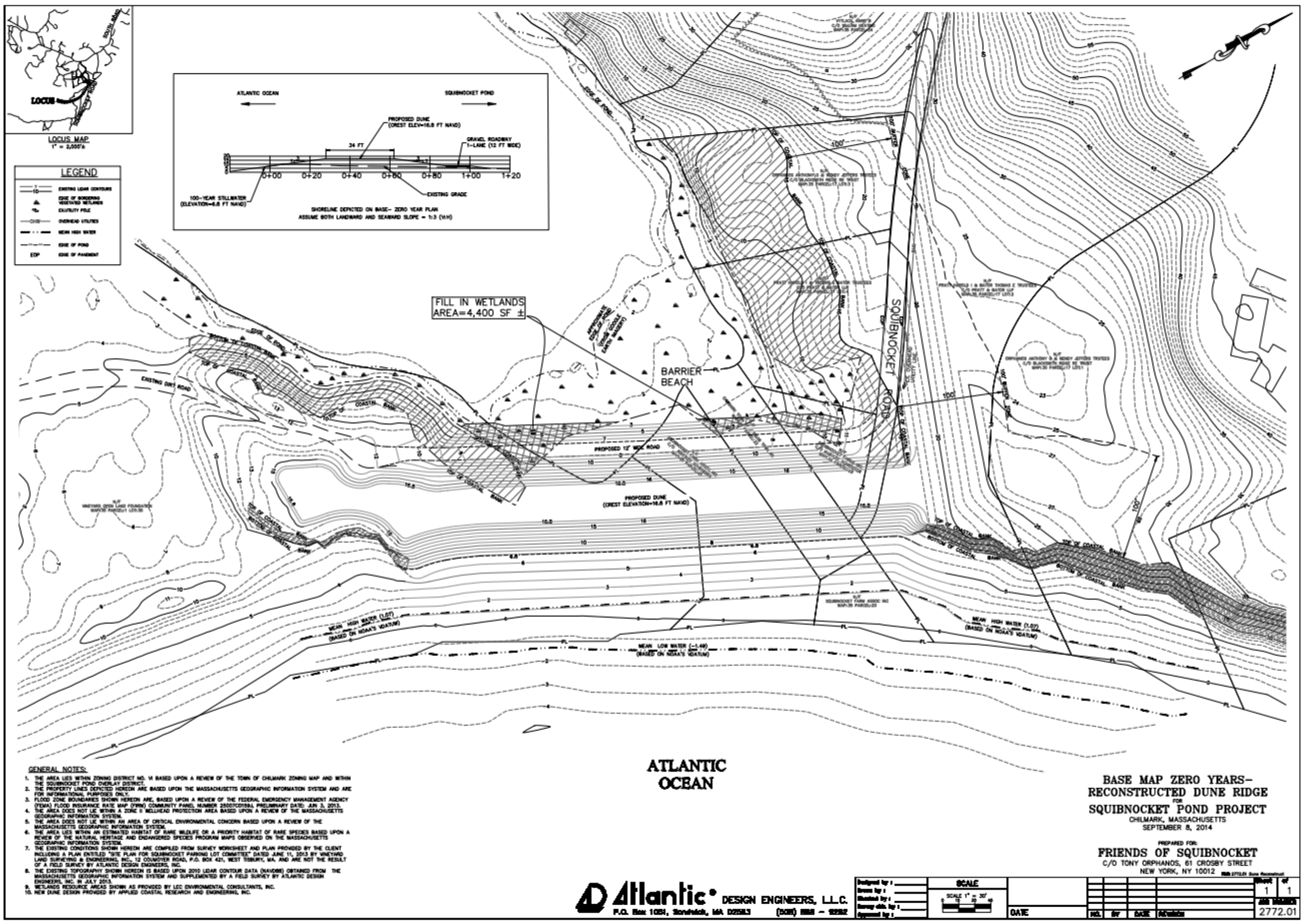


Consistent with managed retreat, the reconstructed dune ridge has been designed to migrate to the north at rate to similar to existing barrier beach. In the illustration (below), we are showing dune ridge migrating to the north of its original location. Assuming an erosion (or migration) rate of 2.3' per year, the entire dune form and the Squibnocket Farm road will move from its present location to the new location 113 feet landward over 50 years. The following shows the position of the migrated dune after 50 years. The areas to the east and west of the migrated dune ridge will have moved but these changes are not shown in this diagram:



The concept of a dune ridge, as opposed to a hard structure such as a bridge or a revetment, can be difficult to absorb. Traditional questions such as duration or permanence are less relevant when considering a solution that is designed for managed retreat and adaptation. A dune ridge necessitates a different approach to design and focuses more on attributes of a dynamically changing environment. The challenge is to establish a process that accommodates adjustments to the dune and the road over time and embraces the natural migration that will occur because of storms and the advancing tides. The Chilmark Conservation Commission has the authority to grant a three year, renewable maintenance permit which would provide the discretion to make the necessary incremental and gradual changes to the underlying natural resources to allow migration of the road to occur.

The map below provides a more detailed view of the design of the dune ridge, including topographical detail on the dune and the location of the roadway.



Resiliency and Dune Maintenance

As discussed above, the shoreline erosion rate is approximately 2.3’ per year. While the dune is designed to prevent overwash from a 50-year storm event, this strategy foresees major maintenance activity only once every 10 years. Throughout the 10-year period, however, the dune should be maintained and any significant damage addressed. As time progresses, the front of the dune will be degraded and the likelihood of overwash will increase until the dune receives its scheduled major maintenance at which time it could be migrated as much as 11'. This maintenance cycle can be interrupted by major storm events, which are recognized as state disasters. Repairs after a severe storm will likely require full maintenance and would reset the 10-year maintenance cycle.

Squibnocket Farm Homeowner Association Proposed Elevated Roadway

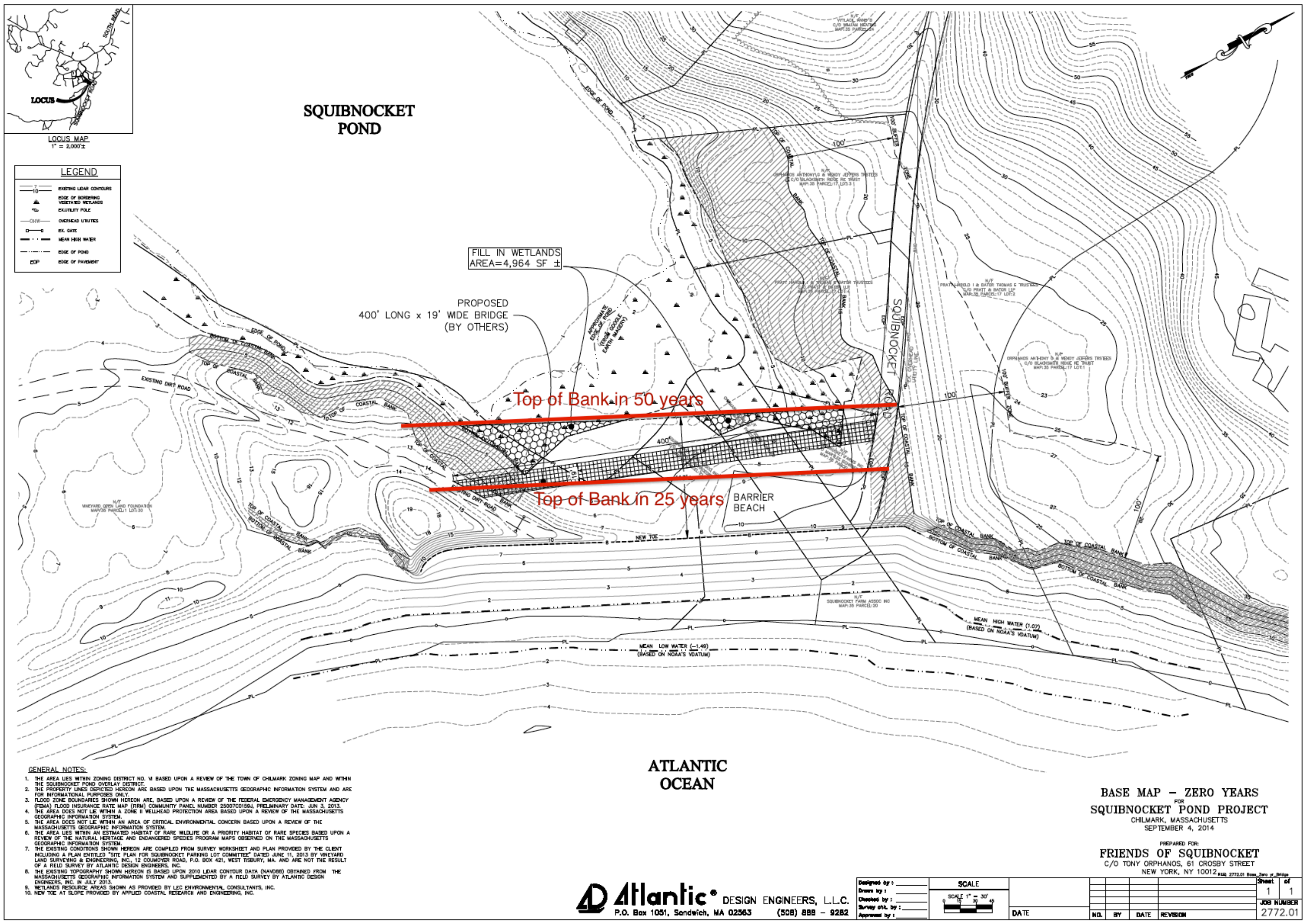
We have positioned the elevated roadway (bridge) on the topographical map using the latest presentation material from Haley and Aldrich:

- East end-point: 5' south of the corner of Peter Weldon's ½ acre lot
- West end-point: 400' from the east end-point, intersecting the gravel road beyond the gate near Money Hill
- Two lane configuration

These are significant issues to consider:

- Except for the areas close to the end-points of the bridge at the banks on either end, most of the span of the bridge is over terrain behind the causeway or the current parking lot, which is at an elevation of 4' – 5'.
- The roadway surface of the bridge is 15' above mean sea level. This means the roadway is 10' – 11' above the level of the terrain under the bridge for much of its span.
- The railing adds 4' and puts the elevation at 14' – 15' above the terrain.
- The southwest corner of the bridge near Money Hill is only 45' from the edge of the shoreline at the west end.
- The southeast corner of the bridge is 75' from shoreline at the east end.
- The bridge bisects the area between the ocean and the pond. This becomes a significant issue as the shoreline moves landward. In 20- 25 years, at the rate of 2.3' of erosion per year, the top dune behind the swimming beach will be at or under the bridge on the western end with the remainder of the top dune close to much of the bridge on the eastern end.
- The plan to fortify the end-points of the bridge has not been communicated. If required, abutments (or new revetments) at the bridge end-points will further distort the shoreline and leave us in a similar quandary to where we find ourselves today.
- Future adjustments required to keep the bridge end-points accessible are unclear. Impacts could be significant, given the 2.3' of erosion per year.
- The plan for the bridge does not show any adjustments to the underlying terrain after the revetments are removed to mitigate the effects of overwash into the pond.
- As a fixed structure, the bridge cannot adapt as the shoreline erodes and therefore, the useful life of the bridge is far less than the dune ridge road alternative.

Location of the bridge vs. top of dune after 25 and 50 years:



Our conclusion is that the introduction of a hard structure into a dynamically changing environment like this one with erosion rates of nearly 2 1/2 feet per year should be avoided.

Parking

The Selectman’s plan for parking on the barrier beach faces significant permitting issues:

- Access to the area will necessitate an enhanced roadway system with the requisite removal of vegetation.
- Removal of 12,000 square feet of vegetation for the parking lot will be required. There is no provision in the Wetlands Protection Act for the removal of any vegetation from a barrier beach or coastal dune.

- Placing parking in at an area that is close to or below sea level will enhance the possibility of overwash and/or breeches. The Selectmen's proposed location is one of the most vulnerable on the barrier beach to overwash and flooding.
- The barrier beach and the coast dune need to be protected in a way that is consistent with the Wetland Protection to prevent storm damage, to provide flood, and protection for wildlife habitat, as well as to protect the existing coastal roadway in this are.
- The inland, or Squibnocket side of the barrier beach is a designated area of Rare Species habitat

Friends of Squibnocket recommend a plan for parking along the Squibnocket Road, at the east end of the pond. There are currently two ½ acre unbuildable lots without extensive wetlands that could be employed for this purpose. In addition, the Vytlacil property above these lots is currently for sale and could be incorporated into the town's Squibnocket strategy for the future.

Appendix A

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TECHNICAL MEMORANDUM

Date: **September 9, 2014**

To: **Charles Parker, Friends of Squibnocket, LLC**

From: **John S. Ramsey, P.E.**

Subject: **Squibnocket Dune Design**

According to the Office of Massachusetts Coastal Zone Management (MCZM) "Storm Smart Coast Fact Sheet 1: Artificial Dunes and Dune Nourishment", an artificial dune is a method of shore protection where a mound of compatible sediment (material similar or slightly coarser than the native sediments) is built along the back of the beach and seaward of the infrastructure to be protected. In the case of constructed dunes, the "soft" shoreline stabilization technique dissipates wave energy and, if designed properly, can withstand the impacts from major storm events. MCZM states that "dune projects are appropriate for almost any area with dry beach at high tide and sufficient space to maintain some dry beach even after new dune sediments are added to the site." Countless dune nourishment projects for storm protection have been performed along the East Coast of the U.S., with Massachusetts examples including Revere Beach, Sandwich Beach, Duxbury Beach, Dead Neck (Barnstable), and Winthrop Beach.

For Squibnocket Beach, the barrier beach width landward of the dune toe is approximately 115 feet, which is sufficient space to construct a shore protection dune and one-lane roadway. Moreover, the existing coastal banks both east and west of the barrier beach area in the vicinity of the parking lot allow the constructed dune to "tie-in" to these higher elevation features to form a contiguous shore protection regime.

Design of the dune system required (a) prediction of the shoreline position after revetment removal, (b) determination of dune volume above predicted flood elevations, and (c) determination of expected wave run-up during storms. In addition, it is understood that this portion of the Martha's Vineyard south shoreline has a 'natural' retreat rate of approximately 2.3

feet per year and this long-term rate of shoreline retreat can be expected to continue over the life of any project constructed at this location.
The predicted shoreline shape subsequent to revetment removal was based on the work of Gonzalez and Medina (2000) for Development of equilibrium bay plan shape, as described in ERDC/CHL CHETN-IV-36 (2001) entitled "Chronic Beach Erosion Adjacent to Inlets and Remediation by Composite (T-Head) Groins" (Hanson and Kraus). Although the wave angle defining the bay shape could not be determined without a substantial numerical modeling effort, an approximation was developed based on the observed shape of adjacent shorelines controlled by updrift "headlands" (e.g. the beach east of Mussel Shoal, approximately 900 feet west of the site). Based on this information, the wave angle relative to the bay shape was determined to be between 3° and 5° relative to the shoreline. The shoreline shape following revetment removal is shown on the 'Base Map – Zero Years - After Revetment Removal', where the model predicts the shoreline position of high water including typical wave uprush which is the approximate location of the dune toe. It should be understood that this shoreline will retreat landward at the rate of 2.3 feet per year.

Design of coastal dunes for shore protection requires both sufficient elevation and volume to resist the impacts of coastal storms. FEMA developed guidelines regarding the required cross-sectional area of a dune needed to survive a 100-year storm and determined that approximately 540 ft^2 is required based upon erosion data related to 46 historical storm events. Figure 1 illustrates the cross-sectional area of dune required above the 100-year still water elevation necessary to withstand various return-period events. The initial dune design developed for Squibnocket Beach consists of approximately 490 ft^2 above the 100-year storm level and 555 ft^2 above the 50-year storm level. Based on Figure 1, the initial dune volume can withstand a storm less than ~75-year return frequency event.

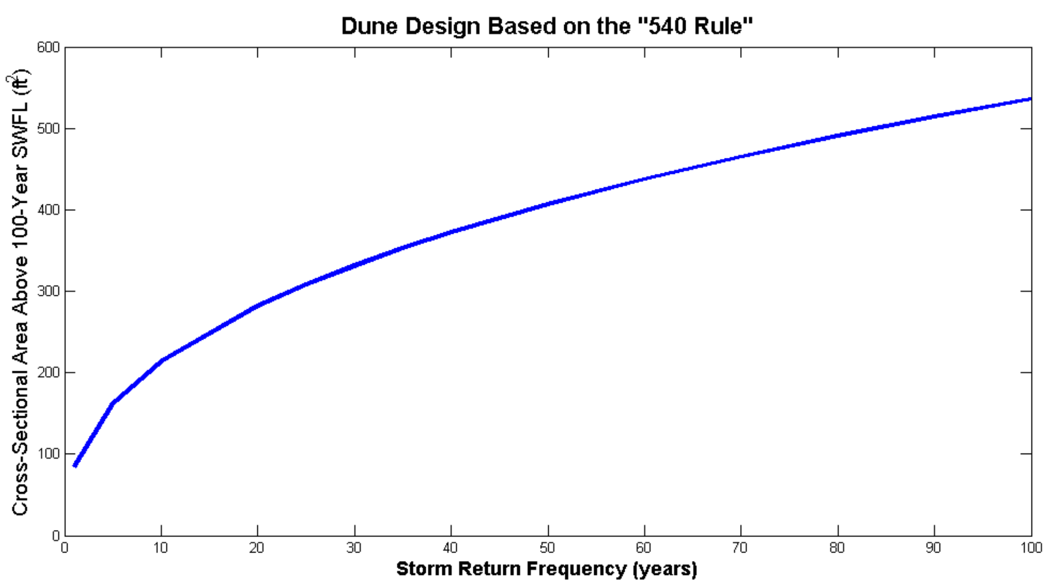


Figure 1: Dune cross-sectional area required above the 100-year still water flood level (SWFL) to protect against various return period storm events.

An independent method for determining the influence of wave setup and runup on a shoreline can be utilized to determine whether the dune will be overtopped during a severe storm event.

Similar to the analysis above, the 100-year SWFL was used as the baseline water level for the computation technique developed by Stockdon, *et al.* (2006). Based on the storm wave information derived from the most recent USACE Wave Information System (WIS) hindcast data set, the 100-year offshore wave height south of this area is 34.4 feet, where the two largest wave events in the 33-year record are Hurricane Bob (1991) and Hurricane Sandy (2012). The WIS data indicates that the wave runup will reach 9.7 above the 100-year SWFL, which is below the 10-ft height of the dune above the 100-year SWFL (or 16.8 feet NAVD).

It should be noted that the design calculations are based upon the initial volume and height of beach compatible material placed. As ongoing erosion reduces the volume of the dune, its ability to withstand storm events is reduced (as shown in Figure 1). It is anticipated that dune repair/replenishment will be required approximately every 10 years to (a) allow the shoreline to migrate landward naturally by periodically 'repositioning' the dune and roadway, and (b) replenishing the eroded dune volume to ensure it provides the level of protection desired.

Based on the design criteria described above, the plan and section provided by Atlantic Design represents the proposed dune reconstruction and at-grade roadway connecting Squibnocket Road with Money Hill.

References

González, M., and Medina, R., 2000. On the application of static equilibrium bay formulations to natural and man-made beaches, *Coastal Engineering*.

Hanson, H. and Kraus, N. C., 2001: Chronic Beach Erosion Adjacent to Inlets and Remediation by Composite (T-Head) Groins. ERDC/CHL CHETN-IV-36, U.S. Army Corps of Engineers, Vicksburg, MS.

MacArthur, B., 2005: Event-Based Erosion. FEMA Coastal Flood Hazard Analysis and Mapping Guidelines Focused Study Report, 84 pp.

Stockdon, H.F., Holman, R.A., Howd, P.A., and Sallenger, A.H., 2006: Empirical parameterization of setup, swash, and runup. *Coastal Eng*ineering 53, 573-588.

United States Army Corps of Engineers (USACE), 2002: *Coastal Engineering Manual*. Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, D.C.

Appendix B
MA Wetlands Protection Act (WPA)
Coastal Dunes and Barrier Beaches

10.28: Coastal Dunes

(1) Preamble. All coastal dunes are likely to be significant to storm damage prevention and flood control, and all coastal dunes on barrier beaches and the coastal dune closest to the coastal beach in any area are per se significant to storm damage prevention and flood control. Coastal dunes are also often significant to the protection of wildlife habitat.

Coastal dunes aid in storm damage prevention and flood control by supplying sand to coastal beaches. Coastal dunes protect inland coastal areas from storm damage and flooding by storm waves and storm elevated sea levels because such dunes are higher than the coastal beaches which they border. In order to protect this function, coastal dune volume must be maintained while allowing the coastal dune shape to conform to natural wind and water flow patterns.

Vegetation cover contributes to the growth and stability of coastal dunes by providing conditions favorable to sand deposition.

On retreating shorelines, the ability of the coastal dunes bordering the coastal beach to moves landward at the rate of shoreline retreat allows these dunes to maintain their form and volume, which in turn promotes their function of protecting against storm damage or flooding.

A number of birds, most commonly terns and gulls, nest at the base or sides of dunes. In some dune systems other birds also nest in the interdunal area, the species being determined by the plant community structure, topography, and hydrologic regime of the area. In a few dune systems, wet meadows or vernal pool habitats occur, which serve as important feeding areas for a wide variety of bird species.

When a proposed project involves the dredging, filling, removal or alteration of a coastal dune, the issuing authority shall presume that the area is significant to the interests of storm damage prevention, flood control and the protection of wildlife habitat. This presumption may be overcome only upon a clear showing that a coastal dune does not play a role in storm damage prevention, flood control or the protection of wildlife habitat, and if the issuing authority makes a written determination to that effect.

When a coastal dune is significant to storm damage prevention, flood control or the protection of wildlife habitat, the following characteristics are critical to the protection of those interest(s):

(a) the ability of the dune to erode in response to coastal beach conditions;
(b) dune volume;
(c) dune form, which must be allowed to be changed by wind and natural water flow;
(d) vegetative cover;
(e) the ability of the dune to move landward or laterally; or
(f) the ability of the dune to continue serving as bird nesting habitat.

(2) Definition. Coastal Dune means any natural hill, mound or ridge of sediment landward of a coastal beach deposited by wind action or storm overwash. Coastal dune also means sediment deposited by artificial means and serving the purpose of storm damage prevention or flood control.

WHEN A COASTAL DUNE IS DETERMINED TO BE SIGNIFICANT TO STORM DAMAGE PREVENTION, FLOOD CONTROL OR THE PROTECTION OF WILDLIFE HABITAT, 310 10.28(3) through (6) SHALL APPLY:

(3) Any alteration of, or structure on, a coastal dune or within 100 feet of a coastal dune shall not have an adverse effect on the coastal dune by:

(a) affecting the ability of waves to remove sand from the dune;
(b) disturbing the vegetative cover so as to destabilize the dune;
(c) causing any modification of the dune form that would increase the potential for storm
or flood damage;
(d) interfering with the landward or lateral movement of the dune;
(e) causing removal of sand from the dune artificially; or
(f) interfering with mapped or otherwise identified bird nesting habitat.

(4) Notwithstanding the provisions of 310 CMR 10.28(3), when a building already exists upon a coastal dune, a project accessory to the existing building may be permitted, provided that such work, using the best commercially available measures, minimizes the adverse effect on the coastal dune caused by the impacts listed in 310 CMR 10.28 (3)(b) through 10.28(3)(e). Such an accessory project may include, but is not limited to, a small shed or a small parking area for residences. It shall not include coastal engineering structures.

(5): The following projects may be permitted, provided that they adhere to the provisions of
310 CMR 10.28(3):

(a) pedestrian walkways, designed to minimize the disturbance to the vegetative cover and
traditional bird nesting habitat;
(b) fencing and other devices designed to increase dune development; and
(c) plantings compatible with the natural vegetative cover.
(6) Notwithstanding the provisions of 310 CMR 10.28(3) through (5), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

10.29: Barrier Beaches

(1) Preamble. Barrier beaches are significant to storm damage prevention and flood control and are likely to be significant to the protection of marine fisheries and wildlife habitat and, where there are shellfish, the protection of land containing shellfish.

Barrier beaches protect landward areas because they provide a buffer to storm waves and to sea levels elevated by storms. Barrier beaches protect from wave action such highly productive wetlands as salt marshes, estuaries, lagoons, salt ponds and fresh water marshes and ponds, which are in turn important to marine fisheries and protection of wildlife habitat. Barrier beaches and the dunes thereon are also important to the protection of wildlife habitat in the ways described in 310 CMR 10.27(1) (coastal beaches) and 10.28(1) (coastal dunes).

Barrier beaches are maintained by the alongshore movement of beach sediment caused by wave action. The coastal dunes and tidal flats on a barrier beach consist of sediment supplied by wind action, storm wave overwash and tidal inlet deposition. Barrier beaches in Massachusetts undergo a landward migration caused by the landward movement of sediment by wind, storm wave overwash and tidal current processes. The continuation of these processes maintains the volume of the landform which is necessary to carry out the storm and flood buffer function.

When a proposed project involves removal, filling, dredging or altering of a barrier beach, the issuing authority shall presume that the barrier beach, including all of its coastal dunes, is significant to the interest(s) specified above. This presumption may be overcome only upon a clear showing that a barrier beach, including all of its coastal dunes, does not play a role in storm damage prevention, flood control, or the protection of marine fisheries, wildlife habitat, or land containing shellfish, and if the issuing authority makes a written determination to such effect.

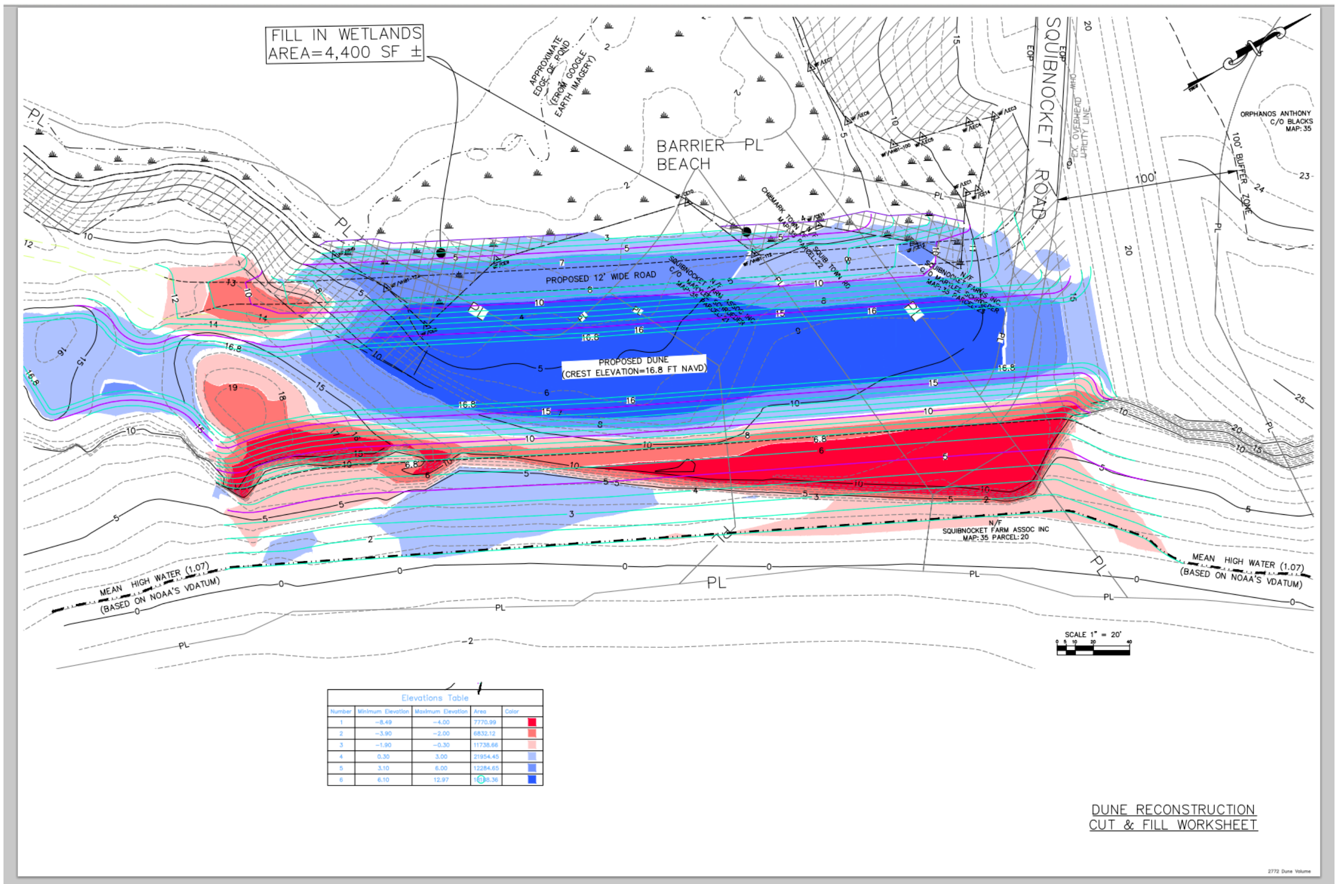
When a barrier beach is significant to storm damage prevention and flood control, the characteristics of coastal beaches, tidal flats and coastal dunes listed in 310 CMR 10.27(1) and 10.28(1) and their ability to respond to wave action, including storm overwash sediment transport, are critical to the protection of the interests specified in 310 CMR 10.29

(2) Definition. Barrier Beach means a narrow low-lying strip of land generally consisting of coastal beaches and coastal dunes extending roughly parallel to the trend of the coast. It is separated from the mainland by a narrow body of fresh, brackish or saline water or a marsh system. A barrier beach may be joined to the mainland at one or both ends.

(3) When a Barrier Beach is Determined to be Significant to Storm Damage Prevention, Flood Control, Marine Fisheries or Protection of Wildlife Habitat. 310 CMR 10.27(3) through 10.27(6) (coastal beaches) and 10.28(3) through 10.28(5) (coastal dunes) shall apply to the coastal beaches and to all coastal dunes which make up a barrier beach.

(4) Notwithstanding the provisions of 310 CMR 10.29(3), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

Appendix C
Fill Requirements for Dune Ridge



Elevations Table

Number	Minimum Elevation	Maximum Elevation	Area	Color
1	−8.49	−4.00	7770.99	
2	−3.90	−2.00	6832.12	
3	−1.90	−0.30	11738.66	
4	0.30	3.00	21954.45	
5	3.10	6.00	12284.65	
6	6.10	12.97	[illegible]	

Cut/Fill Report

Generated: 2014-09-08 16:08:48

By user: miro

Drawing: X:\2501 - 3000\2772.00-Squibnocket Beach-Chilmark\CAD\dwg\C3D2013 \X:\2501 - 3000\2772.00-Squibnocket Beach-Chilmark\CAD\dwg\C3D2013 \2772 Dune Volume.dwg

Volume Summary							
Name	**Type**	**Cut Factor**	**Fill Factor**	**2d Area** (Sq. Ft.)	**Cut** (Cu. Yd.)	**Fill** (Cu. Yd.)	**Net** (Cu. Yd.)
Volume Surface.1	bounded	1.000	1.000	95678.54	2844.94	9365.87	6520.93<Fill>

Totals				
	2d Area (Sq. Ft.)	**Cut** (Cu. Yd.)	**Fill** (Cu. Yd.)	**Net** (Cu. Yd.)
Total	95678.54	2844.94	9365.87	6520.93<Fill>

* Value adjusted by cut or fill factor other than 1.0

Appendix D
Case Studies

D R A F T

C O N F I D E N T I A L   M E M O R A N D U M

DATE: September 8, 2014

TO: Friends of Squibnocket

CC: Town Committee on Squibnocket

FROM: Stan Humphries

RE: Case Study Research

PROJECT #: OrpA\14-006.01

Limited research has been conducted to identify examples of projects in the coastal zone that involve revetment removal, parking lot relocation, roadway clearing/maintenance, dune replication or a combination of these projects. Projects such as these are no longer the simple "fix it and protect it where it is". With increasing erosion rates, more frequent coastal storms and sea level rise, managed retreat or adaptive management, such projects involve a complex set of evaluations and assessments to determine longer term sustainability. Barrier beach environments are particularly difficult to work in because they are narrow and low-lying landforms. Since barrier beaches separate two water bodies, they often have two, actively eroding shorelines. The barrier beach located at Squibnocket Pond only has one actively eroding shoreline.

A list of project areas or case studies is provided below to show that adaptive measures are being used in various locations similar to that which may be proposed at Squibnocket Beach. In addition, there is a matrix which compares several physical characteristics of nine other barrier beaches along the south coast of the Vineyard (Table 1). Finally, Duxbury Beach in Duxbury, Massachusetts is discussed as a model because of the management success that has occurred over the last seven years. Implications from these case studies are discussed in support of projects for Squibnocket that include revetment removal, dune reconstruction, at-grade roads and relocated parking lots.

Herring Cove Beach, Provincetown, MA

http://parkplanning.nps.gov/projectHome.cfm?projectID=44437 and
http://www.nps.gov/caco/parkmgmt/index.htm

The Herring Cove Beach in Provincetown, MA is one of six life-guarded, improved beaches managed by Cape Cod National Seashore. The Commonwealth of Massachusetts developed the Herring Cove Beach facilities in the 1950's and includes: a one-mile macadam revetment (seawall); two parking lots; and, a bath house and concession stand. The NPS proposes a plan for management of the deteriorating north parking lot that considers the potential for erosion, sea level rise, coastal flooding during storm events, and long-term sustainability; restores natural systems to the greatest extent possible. The NPS would replace the existing north parking lot and revetment with a new asphalt parking lot 125 feet inland from the current parking lot proposed at the 15-foot elevation, one foot above the highest projected base flood elevation. A setback of 125 feet is intended to keep this facility beyond the reach of erosion of the natural beach for a 50-year life span. The sand that has accumulated east of the existing parking lot would be redistributed to provide a low-crested protective berm just to the west of the new parking lot, and recreational access and views to the beach would be preserved.

Much of this project is similar to Squibnocket because of the revetment removal and road relocation. The implication is that the National Seashore is pursuing a very expensive project through the proper permitting channels based on a plan that is designed for sea level rise and coastal erosion processes over the next 50 years.

Westport Harbor, Westport, MA
http://www.savebuzzardsbay.org/WestportHarborBarrierBeach
The Westport Harbor barrier beach is a half-mile strip of sandy dunes and shoreline overlooking Buzzards Bay. The beach leads out to the dramatic Point of Rocks, or "the Knubble," as well as more than five acres of protected land owned by the Westport Land Conservation Trust and the town of Westport. The proposed restoration project includes the removal of a paved road, providing dune nourishment and constructing at-grade boardwalks. It is designed to meet four goals: 1) Provide access to the beach, the Knubble, and more than five acres of protected land for all Westport residents, including people with disabilities: 2) Prevent environmental degradation that paving Beach Avenue would cause; 3) Restore and protect the barrier beach, a sensitive habitat where many different types of wildlife live; and, 4) Strengthen the beach's resilience against erosion, damage from coastal storms, and sea level rise.

Much of this project is similar to Squibnocket because of the dune ridge restoration and beach access issues. The implication is that a town and other stakeholders are taking steps to reconstruct a deteriorated dune system on a barrier beach for the purpose of improving the natural protective functions and public access to a beautiful area of the town.

US DOT Federal Highway Administration Publication
http://www.fhwa.dot.gov/engineering/hydraulics/pubs/07096/8.cfm
Damages to roads that are located in dunes and on barrier beaches can occur from storm overwash. The two primary damages resulting from the forces of breaking waves and strong currents can be undermining of the road and burying of the road with sediments and debris. Four strategies for minimizing roadway damage due to overwash have been successful for coast-parallel roads on barrier islands. They can be used in combination with each other:

1. relocating the road to a portion of the barrier island where sand will likely bury the road, rather than undermine it, during overwash;
2. lowering the elevation of the road to be at or below much of the existing grade to encourage burial by sand during overwash;
3. constructing a sand dune seaward of the road to reduce the likelihood of overwashing and to provide a reservoir of sand to bury the road when overwashing occurs; or,
4. armoring of the shoulders of the road to resist erosion during overwashing.

Many of these guidelines will be useful to Squibnocket because of the road design and protection issues. The implication is that a Federal agency is gaining a better understanding of coastal processes relative to the damage of at-grade roads in dune environments. New methods of road reconstruction and protection are being proposed that are somewhat counterintuitive to those of the past. Now, perhaps, overwash should be allowed to occur and maintenance may be less expensive than reconstructing or structurally protecting these roads.

Peggotty Beach, Scituate, MA

Annual overwash of dune material (from town land) onto a privately owned access road serving six dwellings has plagued a 400 foot long section of this barrier dune over the last five years. A project was approved by the Conservation Commission to remove overwash material from the road and place it back into the frontal dune as continual maintenance activities. Beach grass plantings and snow fencing were also included in the maintenance conditions. The attached LEC project summary shows a photo taken during a post-storm high tide that had minor overwash impacts.

Much of this project is similar to Squibnocket because of the need to prepare for the maintenance of overwash. The implication is that certain conditions can be predicted and that solutions can be proposed and permitted in advance to eliminate the bureaucratic delays in the post-storm recovery process.

Ten Barrier Beach Segments, Martha's Vineyard, MA

Numerous barrier beaches separate salt ponds from the Atlantic Ocean along the south shores of Edgartown, West Tisbury and Chilmark. With elevation data provided by Google Earth 2013, several physical characteristics were evaluated and compared for the purposes of developing an appropriate design for a reconstructed dune ridge that would offer a reasonable amount of protection against coastal storm overwash (Table 1). The following bullets summarize the evaluation and comparisons:

- The beach at Squibnocket is narrower than others primarily because of the revetments that exist there;
- The dune width at Squibnocket is one of the largest of those evaluated, while the shoreline length is one of the smallest;
- Problematic overwash sections of the dunes (i.e., unvegetated) are low-lying, ranging from 4-11 feet in height along the dune crest; whereas,
- Protective vegetated sections of the dunes area higher, ranging from 9-17 feet in height along the dune crest or ridge; and,
- All the barrier dunes are mapped by FEMA as Velocity Erosion Zones with elevations from 13-16 feet.

As a result of this evaluation, appropriate design characteristics for a reconstructed dune ridge at Squibnocket would include: artificially nourishing the dune above high tide to an elevation of 13-16 feet; providing a dune ridge width as wide as possible to reduce overwash; and, vegetating the dune ridge for more protection from storm overwash.

Duxbury Beach Reservation, Duxbury, MA

Duxbury Beach is a four and a half mile long barrier beach, which is to say it is a narrow, low-lying strip of land consisting of coastal beaches and coastal dunes that extend roughly parallel to the trend of the coast. There is also a narrow, gravel road (el. 9 feet) located along the backside of the barrier beach which provides vehicular access to Gurnet Point and Saquish Neck that is developed with over 200 homes. Sections of the barrier are as narrow as 60-90 feet wide and as low as 12 feet high. The 100-year flood zone and elevation is VE Zone (el. 14) as mapped in 2012. As a consequence of storm damages and the necessity to manage plover habitat, a Beach Management Plan was written and approved as an Order of Conditions so that a number of maintenance and restoration activities could be undertaken in a timely manner with bureaucratic delays.

The primary management and restoration activities used at Duxbury include artificial dune nourishment, fencing, vegetation and road relocation in an effort to sustain the ecological health of the barrier beach while protecting the vital access for homeowners and recreational users of the beach. To summarize the most recent history, two sacrificial dunes have been constructed and maintained on Duxbury Beach. The first was constructed in 1992 as a result of beach/dune alterations caused by the October 1991 "No-name" northeast storm. FEMA concluded that the very low post-storm elevation of the beach and dune posed a significant public safety concern and urged the Duxbury Beach Reservation to take immediate action to restore the storm damage prevention value of the beach and dune system. After consultation with USACE, FEMA recommended that the beach and dune be restored by construction of a "sacrificial dune." The design called for approximately 80,000 cubic yards of sand to raise the dune to a consistent elevation of 16 feet National Geodetic Vertical Datum (NGVD) to prevent storm wave overtopping coincident with a 5-year storm. Snow fencing was replaced and approximately 500,000 culms of grass were planted on the dune.

Dune heights, widths and hazard vulnerability are nearly identical for some sections of Duxbury and Squibnocket. The need for access along the barrier beach and the use of a gravel road is also identical for these two sites. Because of the environmental and land use similarities between Duxbury and Squibnocket, the implication is that the *Duxbury Beach Management and Conservation Habitat Plan* can be used as a model for the dune ridge restoration and road relocation alternative at Squibnocket. Storms have historically, severely eroded the dune and covered a vital access road by overwash, so action was taken to identify the maintenance requirements, the management techniques and the necessary permitting process to protect the barrier beach into the future.

Examples of MV Dune Ridges Cited in LEC Memorandum Above

Table 1. Barrier Beach Evaluation and Comparisons of 10 Areas along the south shore of the Vineyard

LOCATION	Widths (ft) Beach	Widths (ft) Dune	Length (ft)	Dune Ridge Elevations (ft) Overwash Beach to Bay	Dune Ridge Elevations (ft) Vegetated Dunes	2003 Preliminary FIRM
East of Jobs Neck Pond*	96	171	525	6 - 11	10 - 15	VE 15/13 AE 12 Pond
Jobs Neck Pond*	120	190	1200	7 - 10	not present	VE 15/13
East of Paqua Pond	100	215	288	9 - 10	10 - 17	VE 15/13
Paqua Pond	115	130	660	7 - 10	10 - 14 East End	VE 15/13 AE 10 Pond
Ripley Cove	100	133	1600	4 - 9	9 - 13	VE 15/14/13
Horner Pond	136	176	650	7 - 9	10 - 14	VE 15/13
Long Cove*	100	170	958	7 - 10	10 - 16	VE 16/15/13
Black Point Pond	90	155	3000	not present	10 - 16	VE 16/14/13
Quenamer Cove	125	125	777	not present	10 - 13	VE 16/15/13
Squibnocket Pond	20	210	270	Causeway & Parking Revetments 9 - 10		VE 16/15