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MEMO

TITLE	Sconset Coastal Analysis Summary
DATE	6 December 2013
TO	SBPF
COPY	Epsilon Associates
FROM	Azure Dee Sleicher, P.E.
PROJECT NO	210019.1

Ocean and Coastal Consultants, Inc. (OCC) performed coastal analyses to determine design conditions and proposed geometry for the emergency stabilization project along Sconset Bluff. This memo provides a brief summary of methodologies, calculations and results which demonstrate that the proposed 4-tiered, stacked geotextile tube design with toe at 0.0 ft MLW and crest at +26.0 ft MLW is appropriate as a means to protect the pre-1978 homes along the landward and seaward sides of Baxter Road and Baxter Road based on standard coastal engineering practices of the U.S. Army Corps of Engineers (USACE) and FEMA.

Design Recurrence Interval:

The 1-percent-chance-annual storm, also referred to as a "100-year" storm has a 1% chance of being equaled or exceeded in any given year. This recurrence interval is the standard of measure by FEMA for flood mapping and mitigation as well as the USACE for their Hurricane and Storm Damage Risk Reduction System. Wave data for 1982-2008 from NOAA buoy 44008 (54 NM SE Nantucket) indicate numerous occasions when the significant wave height exceeded 10 meters (exceeding the "100-year" design wave height of 28.8') and numerous occasions when the dominant wave period exceeded the "100-year" design value of 15 seconds. These data suggest that 100-year storm conditions are experienced at the site on a much more frequent basis than once every 100 years. The project must be designed for the coastal environment at Sconset. Designing to anything less than the "100-year" storm conditions risks a chance of failure during major storms or even lower magnitude storms that occur in rapid succession when protection is most needed. For these reasons, the "100-year" storm is an appropriate level of design for this project and is the minimum design level required to abate the emergency.

Stillwater Level (SWL):

"100-year" SWL = 10.2 ft MLW per FEMA Flood Insurance Study dated November 6, 1996. This value is likely underestimated at this point in time based on sea level rise and other factors but is being used as best available data for this project.

Deepwater Significant Wave Height and Peak Period:

28.8 ft and 15.2 seconds: Determined from statistical analysis of USACE WIS Hindcast data.

Toe of Bluff:

+8.0 ft MLW (average elevation along bank toe in study area) per LIDAR survey conducted in July 2013.

Wave Setup:

Wave setup is the increase in mean water level due to the presence of waves. Wave setup was calculated according to the direct integration method (DIM) prescribed by FEMA. Setup = 3.9 ft.

Design Water Depth:

100-year design water depth at the toe of the bluff equals stillwater level plus setup minus the mudline at the toe of the bluff: 10.2 ft + 3.9 ft – 8.0 ft = 6.1 ft.

Wave Height:

The deepwater significant wave height will break as it approaches shore. The wave impacting the bluff and geotube structure will be limited by the depth at the toe calculated above. Standard breaker index of 0.78 (per USACE) times the water depth provides a maximum breaking wave height of 4.8 ft, which is rounded to 5 feet.

Wave Crest Elevation:

Breaking wave crest elevation is equal to the stillwater level + setup + 0.7(H):

10.2 ft + 3.9 ft + (0.7*4.8 ft) = 17.5 ft MLW

Wave Runup:

Wave runup on the stacked geotube system was calculated in accordance with USACE Coastal Engineering Manual (CEM) methodology for berm configuration based on the proposed geometry (Equation VI-5-7). Wave runup was calculated to be 10.1 ft.

Crest Elevation:

Minimum required crest elevation is SWL + Setup + Runup: 10.2 ft + 3.9 ft + 10.1 ft = 24.2 ft MLW. Standard geotube dimensions put the top elevation at +26 ft MLW.

Scour:

The beach at the toe of the coastal bank varies in elevation over the course of an average year. The beach level at the toe of the coastal bank on the 2013 LIDAR survey was at +8 ft MLW and during an average winter; Northeaster storms can lower the beach level up to 3 to 5 ft below that level. It is critical that the geotube system be designed for potential scour. As confirmed by J. Richard Weggel, Ph.D., P.E., D.CE, Professor Emeritus Department of Civil, Architectural & Environmental Engineering at Drexel University below, wave-induced scour is the leading cause of geotube failure:

"Wave forces also act on the tube, but they generally act to push the tube shoreward while gravity acts to displace the tube seaward. While much attention is paid to wave forces, direct wave action rarely results in failure, rather it is wave-induced scour that leads to failure. Observations suggest that tube displacement is most often seaward indicating that are not wave forces, per se, that displace the tubes. Rather, the tubes are undermined when the beach in front scours and the scour hole propagates landward under the tube generating its failure. That is, the beach slope steepens locally as scour progresses beneath the tube until the tube falls seaward into the scour hole." J. Richard Weggel

USACE recommends that a scour depth of 1.5 times the wave height be considered for areas with moderate to severe scour potential such as the case with Sconset Beach. The 100-year breaking wave height at the structure toe is approximately 5 ft so a scour depth of at least 7.5 ft should be considered. Rounding this to 8 feet brings the bottom of the geotube to the 0.0 ft MLW elevation.