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November 1, 2013

Mr. Ernest Steinauer, Chairman
Nantucket Conservation Commission
2 Bathing Beach Road
Nantucket, MA 02554

RE: Response to Issues Raised at Conservation Commission Meeting of October 30, 2013
Baxter Road Temporary Stabilization Application
Town of Nantucket
Nantucket, Massachusetts
MMI #2967-11-4

Dear Chairman Steinauer and Members of the Conservation Commission:

Thank you for your consideration of the above-referenced application at your October 30, 2013 meeting. At that meeting, we heard a number of concerns from commission members and other interested parties. This letter is intended as a response to those comments and concerns. Information regarding waiver requirements and regulatory compliance will be submitted under a separate cover from the town's attorney.

The technical comments and concerns expressed on October 30 fell into four broad categories as follows:

1. Roadway maintenance and limited projects
2. Retreat and nourishment rates, littoral drift, and project monitoring
3. Geotextile tubes versus jute versus coir logs
4. Construction protocols for geotextile (e.g., water volumes, etc.)

This letter addresses these broad categories rather than attempting to go point by point through each comment that was made. This was done in the interest of time and efforts to move the project forward as quickly as possible. As presented at the hearing, ***time is of the essence in this application, and it is critical to us that we make every effort to address the concerns expressed while continuing to move the project forward as quickly as possible.***

1.0 Roadway Maintenance and Limited Projects

As mentioned in the NOI narrative, the town is seeking to complete the repair work in question as a "limited project" under 310 CMR 10.24(c) 2. Baxter Road is in need of maintenance through the project reach to ensure that public access to the north of 85 Baxter Road is maintained. We recognize that some members of the public may be confused about roadway maintenance being performed at the base of a slope some 60 feet below the road, and we understand that on most roads maintenance is only required along and within the paved area itself. However, in the case of Baxter Road, the road base is reliant on the bluff for structural support. If the bluff is gone, then the road is no longer structurally supported. Therefore, in this specific case, stabilization of the bluff is a roadway maintenance item.

In Attachment C of the NOI Narrative, we included a memorandum from Haley & Aldrich that clearly explains why stabilizing Baxter Road in a more traditional location along the edge of pavement is not technically feasible. We also note that Haley & Aldrich is recommending that construction staging must be completed a minimum of 25 feet from the top of the bank, suggesting that placing large loads too close to the edge of bank could result in failure. Based on that, it is logical to suggest that the loss of just a few more feet of bank in the project area will prevent fire trucks from using this road, limiting the town's ability to provide critical public services to the residences at the north end.

2.0 Retreat and Nourishment Rates, Littoral Drift, and Project Monitoring

This is the most complicated issue associated with this application. While there are many opinions on this topic and a long history of back and forth, we are making an effort here to clearly quantify the issue. To facilitate the discussion, we have broken this discussion into subcategories and tackled each topic independently.

Retreat and Nourishment Rates

As the commission is aware, a number of consultants have had a hand in this area of the island over the past decade. Our application materials rely and build upon that previous work. To that end, we have included as Attachment A to this letter a memorandum from Epsilon Associates that defines the previously used retreat rates, how these rates were calculated, and the backup data and computations that support the calculations.

In short, the retreat rates have varied by application because they have been calculated for each specific application. Past applications for work on the bluff have covered areas as far south as 63 Baxter Road to as far north as 119 Baxter Road. The current application is 1,500 feet in length and includes the area from 85-107A Baxter Road. The 14.3 cubic yards per linear foot was calculated for the specific 1,500-foot section that is the subject of this application.

The application materials suggested initial nourishment at the rate of 14.3 CY/LF, with an adaptive approach taken in subsequent years. Some concern was expressed about this approach, and we understand those concerns. In an effort to assuage those concerns, we suggest that the nourishment protocols be more clearly defined as placing a minimum of 14.3 CY/LF annually with the need for additional nourishment evaluated annually based on beach transects. We hope that the annual placement of 14.3 CY/LF will allay concerns that the project will result in an undernourished beach.

Littoral Drift

There has been much discussion of impacts to the beach systems located to the north and south of the project site that may result from the placement of the temporary geotube system and the associated sand nourishment. The nourishment sand is intended to provide a sufficient quantity of material to the beach and backshore areas and to make that material available to the natural shoreline processes at the site. The intent is to place on the face of the geotextile tube system a minimum quantity of sand equivalent to the average amount of in-situ material that is annually eroded from the bluff and thus mitigate for changes in the coastal regime updrift and downdrift of the project site. It is unlikely that all of the naturally eroded material enters into the littoral regime and is transported as alongshore drift to the neighboring beaches. But it is certain that at least a portion, and possibly a significant portion, of the eroding bluff materials does contribute to the natural littoral system. The other contributing sources of littoral material to this system are the offshore and nearshore shoals that extend along the beach and the beach itself. The quantity and direction of the nearshore transport of these materials is directly dependent upon the wave climatology of the site.

The full characterization of the littoral regime at this or any similar site is a challenging task, requiring extensive field data gathering, sophisticated modeling, and real-world verification (i.e., long-term monitoring). The emergency nature of the proposed activities requires immediate action and provides no luxury for such studies. Further, such studies may be of limited use in a dynamic and complex environment like Sconset, where the available monitoring data suggest that the volume and/or direction of sediment transport may vary significantly over time.

The town proposes to provide, at a minimum, the volume of sand equivalent in quantity to the average historic bluff erosion to an area of the beach that will be exposed to storm waves. This will provide the opportunity for natural processes to mobilize and distribute that artificially introduced sand within the littoral zone and to transport it to adjacent beaches or offshore areas. The replenishment protocol is also designed to be adaptive, so that if more sand is eroded than the planned nourishment amount of 14.3 CY/LF a volume of additional sand will be placed at the site (for a description of the sand renourishment trigger and replenishment protocol, see our October 25, 2013 letter to the commission). In our opinion, this is a reasonable means to compensate for the potential littoral drift contribution from the eroding bluff while allowing for the stabilization of the bluff and thus the Baxter Road infrastructure. Following this adaptive approach, there is no reason to expect adverse impacts to downdrift beaches.

<u>*Project Monitoring*</u>

Monitoring of the Sconset Bluff has been routinely conducted by Woods Hole Group (WHG) and submitted without analysis. Transect survey would continue following implementation of the project. Some concern has been expressed over the qualifications of WHG to perform this task in a legitimate manner and the fact that analysis of the data has not been completed.

We are not interested in debating the qualifications of WHG with the commission. They are a well-respected consulting group with an excellent reputation. The measurements completed have been scientifically based and performed by professional hydrographers and coastal scientists. Changing to a new survey firm at this point may well render all previous data inconsistent with future information, making meaningful comparisons difficult, if not impossible. At this point, in our opinion it is best to maintain WHG as the consultant for transect survey to ensure consistency of the measurement methods.

We do understand the need for meaningful interpretation of the data from WHG, and the town will commit through this application to providing analysis and interpretation of the data collected during the life of the project.

3.0 Geotextile VersusJute Versus Coir Geotubes

As proposed, the project consists of construction of four geotextile geotubes set at elevation 0.0 mean low water (MLW) in a staggered formation. A number of questions were asked regarding the design, and these are addressed below.

Coir Geotubes

It is our understanding that both jute and coir fiber logs have been used in select locations of Sconset Beach in the past. In 2004, coir mats were installed on portions of the slope at Sconset, and in 2005 coir bags were placed in front of the matting as a means of toe protection. Ultimately the use of coir fiber was abandoned because the material degraded, resulting in debris distribution along the beach.

In evaluating coir fiber geotextile matting for this application, this alternative was rejected by the design team for its lack of durability. While of similar durability than jute fiber, coir is naturally biodegradable and is considered by manufacturers of the material to last up to three years. This material has practical application in riverine or low-velocity environments to provide stability while vegetation is established. As observed in past applications along Sconset, it is not a material well suited to withstanding wave impacts associated with the Atlantic Ocean. Therefore, this material was not considered for this application.

Jute Geotubes

As noted in the NOI narrative and discussed at the hearing of October 30, 2013, jute was considered and dismissed for this application. It was dismissed due to its limited design life and required ongoing maintenance. Questions were asked regarding the performance of jute logs at 79 Baxter Road, where approximately 100 linear feet of jute was installed at a cost of $1,410 per linear foot. Ongoing installation and repair in this area have reduced the costs to less than $1,000 per linear foot. The property owner at 79 Baxter Road has indicated that tubes have been replaced completely one to three times each year (at the costs noted above) since they were installed. In the winter of 2012-2013, successive storms prevented reconstruction of failed jute logs, and approximately 30 feet of the bank at the north end of the property was lost, suggesting that jute is not an adequate material to withstand the extreme forces and successive storms that occur at the project site.

Despite their limited durability, the jute logs have been somewhat effective (prior to their failure). Attachment B to this letter presents erosion rates for 79 Baxter Road and the nearby properties. Transect data comparing 2003, 2012, and 2013 aerial photographs and summarized in table form suggests that 79 Baxter Road had a significantly lower erosion rate over the period from 2003 to 2013 with an average of 0.38 feet per year lost while bordering lots lost up to four feet per year. During the 2012-2013 season, Lot 79 lost more material than neighboring properties, even with the jute logs contributing sand. Based on this, it is our opinion that while the jute logs contribute sand during storm events that contribution does not necessarily translate into the required protection of the property on which they are installed.

Proposed Design

As the design team developed its plans, discussions focused on risk, the risk associated with the number of and intensity of storms that may occur. A 100-year storm has a one percent chance of occurring in any one given year, translating to a five percent chance of occurrence over the life of the proposed structure. Although it can be said that a five percent risk is minimal, it is not a risk that as design engineers we are comfortable in taking. The unpredictability of coastal storms necessitates a robust approach as has been presented in this application.

The proposed plan calls for placement of four geotextile geotubes. During design development, a great deal of discussion focused on the effective slope of the tubes, with a number of flatter (i.e., more beach coverage) and steeper cross sections considered. Ultimately, the design submitted to the commission balances the overall project footprint while minimizing wave reflection.

The design of any coastal structure that is subject to wave impacts and potential scour of the foundation soils must consider measures to minimize the risk of damage to the structure. In this case, the risk is greatly amplified in light of the imminent exposure of the public infrastructure at Baxter Road. The failure of any coastal structure is often linked to scour of the soils and ultimate sloughing or displacement of the foundation. In the case of the proposed geotube system, potential scour at the toe of the placed tubes is the most significant potential risk.

The design approach proposes to position a scour apron, composed of a woven polypropylene geotextile mat on the prepared beach and lower bluff sand. This will require excavation of a trench to a depth equivalent to the El. 0.0 (MLW), which is approximately five to seven feet below the typical elevation of the winter season beach profile and backshore area.

The proposed depth of the bottom geotube and scour apron was determined based upon an assessment of potential scour depths at the toe of the assembly. Using the empirically derived computational methods provided in the Coastal Engineering Manual (CEM Version 2.01 as modified by Veri-Tech, Inc.) originally prepared by the U.S. Army Engineer Research and Development Center, potential scour depths were quantified. Noting that the design wave at the structure will be depth limited to a height of approximately 4.7feet and can be characterized by wave periods ranging from 8.0 to 15.2 seconds, potential scour depths resulting from irregular waves at the toe of the assembly were computed to potentially range from 2.5 feet ($\pm$) to 6.2 feet ($\pm$). This was based on the relatively conservative assumption that the face of the lowest geotube could be assumed to present a near vertical face to the impacting wave. Conservatively, the U.S. Army Corps of Engineers' Engineering Manual, EM 110-2-1614, "Design of Coastal Revetments, Seawalls, and Bulkheads," 30 June 1995, recommends that the anticipated scour depth at the toe of revetment structure could run as much as 1.5 times the wave height at the toe of the structure. This equates to (1.5 x 4.7 feet), or approximately seven feet. Based upon these relatively conservative criteria, the applicant proposes to maintain scour protection to a depth of approximately five to seven feet below the typical elevation of the winter beach profile.

This approach includes the excavation of a trench at the toe of the bluff into which the foundation scour apron and the bottom geotube will be placed. The trench excavation will include the temporary removal of approximately 18 CY/ lf of material. This sand will be utilized in the installation of the geotube assembly as part of the leveling pads and in the sand cover to be placed over the geotubes following their installation. No sand will be removed from the beach.

The design of the proposed geotube assembly further required the determination for the effective slope at which the tubes will be placed. In an attempt to minimize and preferably eliminate any required excavation into the sensitive face of the bluff,and to present a nonvertical effective slope to the incoming waves, as well as to minimize waterward encroachment onto the beach, a series of alternative slopes were evaluated. These ranged broadly and included: 1 Vertical:2 Horizontal (26.5°); 1V:1.5 H (33.5°); 1 V:1 H (45°); Vertical Face (90°). The relative effects of the effective slope of the structure are manifested in the quantification of the Reflection Coefficient, C_R, computed based upon the methodology described in the CEM version 2.01. The results, assuming that the face of the exposed geotube assembly is smooth and impermeable are, summarized in Table 1.

TABLE 1
Reflection Coefficients
for Various Effective Slopes of the Geotube Assembly

Effective Slope	Wave Period (sec)	Reflection Coefficient
1:2 (26.5°)	8	0.75
	15.2	0.89
1:1.5 (33.5°)	8	0.83
	15.2	0.92
1:1 (45°)	8	0.89
	15.2	0.94
Vertical (90°)	8	0.96
	15.2	0.96

The Reflection Coefficient represents that part of the incident wave that can be reflected from the structure. In this case, it was determined for waves approaching normal to the face of the geotube assembly. The reflected wave energy contributes significantly to the potential for scour at the toe of the assembly. The tabulated values demonstrate the wave reflection, and this scour can be reduced by making the effective slope of the placed tubes to be as shallow as possible. Based on this assessment and the geometric constraints of the natural system (i.e., the applicant's preference to not cut into the bluff), it was recommended that the geotube assembly be installed at an effective slope of 1Vertical:2 Horizontal.

An assessment of the potential compromise of the geotube material that could occur as a result of the design wave impacting the assembly was performed as a part of the design review process. Noting that the design wave condition includes the impact of a broken, depth-limited wave on the face of an exposed geotube, the anticipated wave loading at the assumed near-vertical face was determined utilizing the Goda formula for irregular waves (Equations VI-5-147 to 5-151) in the CEM Version 2.01. The peak loading of the tube would occur at the stillwater line and was computed to be approximately 416 pounds per square foot (psf) for the eight-second wave and 420 psf for the 15-second wave. This loading is relatively low and does not pose a threat to a stable, filled tube.

The more critical design condition for the geotube material is the potential for tearing or puncturing as a result of impact from debris. Employing the debris impact analogy recommended by FEMA (Coastal Construction Manual, FEMA 55 4th Ed, August 2011, Section 8.5.10, the assessment included the quantification of loads that could be imposed by wave-carried debris onto the face of the tube(s). The design conditions included debris of up to 1,000 pounds (FEMA recommendation), typical of floating logs, portions of floating docks, timber piles, etc. The load imposed by such an object will be on the order of 14,000 pounds. The shape of the object or, more specifically, the impact area is critical. For example: a 1,000-pound timber pile with a nominal cross section of one square foot (144 square inches) impacting the tube normally would impose a load of 14,000 pounds per square foot or 97.2 pounds per square inch. The puncture strength of the geotextile material was estimated to be 666 pounds per square inch. This would indicate that puncturing of the tube fabric is unlikely. However, if the floating log were to impact the tube at an angle, the impact area would be significantly reduced. If that impact area is along the edge of the log, estimated to be on the order of six square inches in area, the loading to the face of the tube would be more than 2,300 pounds per square inch, significantly greater than the puncture strength of the material. The point is that the geotubes are exposed to potential puncturing and will require periodic repairs. Such repairs are readily completed by sewing a patch over the damaged section. It is anticipated that any such damage will be noted during the proposed regular and poststorm event monitoring of the installation.

4.0 Construction Protocols and Impacts

While a great deal of discussion was had regarding construction of the geotubes, the issue of water usage remained in question. Using the ratio of 20% sand to 80% water, the estimated water demand for the project is 20,454,509 gallons, or 511,363 gallons (68,364 cubic feet) per day assuming eight weeks of construction with crews working five days per week. The work area consists of 105,320 square feet of surface area over which the water would infiltrate. The result is an average discharge of 7.8 inches of water per day into the beach, or approximately equal to the rainfall associated with the 2% annual chance rainfall event.

This is a simplification of what is clearly a dynamic process. In reality, the work day will not be 24 hours, so the loading rate will be higher. However, on the other hand, wave run-up and tide cycles will produce some flushing in the system that will reduce the impact of the freshwater loading. The most important point is that the impact will be temporary, and we expect the natural system to rebound within a short period of time following construction. This is not intended to minimize the concerns expressed but rather to point out the complexity and robust value of this dynamic system.

We appreciate the Conservation Commission's continued consideration of this application and look forward to discussing this with you in more detail on November 6, 2013.

Very truly yours,

MILONE & MACBROOM, INC.

Nicolle E. Burnham, P.E., CFM
Principal

Enclosures
Attachment A – Epsilon Memorandum Regarding Retreat and Nourishment Calculations
Attachment B – Comparison of Retreat Rates at 79 Baxter Road and Nearby Properties

cc: Kara Buzanoski, Public Works Director

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