Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 3 – Notice of Intent

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:

MassDEP File Number

Document Transaction Number

City/Town

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

Note: Before completing this form consult your local Conservation Commission regarding any municipal bylaw or ordinance.

A. General Information

1. Project Location (**Note:** electronic filers will click on button to locate project site):

85-107A Baxter Road	Nantucket	02554
a. Street Address	b. City/Town	c. Zip Code

Latitude and Longitude: 41°16'36.748"N (d. Latitude) 69°57'40.559"W (e. Longitude)

48	8,14,14.1,15,17,18,19,21,22,35
f. Assessors Map/Plat Number	g. Parcel /Lot Number

2. Applicant:

Kara Buzanoski	Steven Cohen (for SBPF)
a. First Name	b. Last Name

Nantucket DPW and Siasconset Beach Preservation Fund, Inc
c. Organization

188 Madaket Road &
d. Street Address

Nantucket	MA	02554
e. City/Town	f. State	g. Zip Code

508-228-7244	508-228-7289	kbuzanoski@nantucket-ma.gov / slc@readelaw.com
h. Phone Number	i. Fax Number	j. Email Address

3. Property owner (required if different from applicant): ☒ Check if more than one owner

multiple owners list attached	
a. First Name	b. Last Name

Town of Nantucket
c. Organization

16 Broad Street
d. Street Address

Nantucket	MA	02554
e. City/Town	f. State	g. Zip Code

508-228-7255		lgibson@nantucket-ma.gov
h. Phone Number	i. Fax Number	j. Email address

4. Representative (if any):

a. First Name
b. Last Name

c. Company

d. Street Address

e. City/Town
f. State
g. Zip Code

h. Phone Number
i. Fax Number
j. Email address

5. Total WPA Fee Paid (from NOI Wetland Fee Transmittal Form):

0.00	0.00	0.00
a. Total Fee Paid	b. State Fee Paid	c. City/Town Fee Paid

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A. General Information (continued)

6. General Project Description:

Stabilization of roadway and utilities in the public layout of Baxter Road.

7a. Project Type Checklist:

1. ☐ Single Family Home
2. ☐ Residential Subdivision
3. ☐ Limited Project Driveway Crossing
4. ☐ Commercial/Industrial
5. ☐ Dock/Pier
6. ☒ Utilities
7. ☐ Coastal Engineering Structure
8. ☐ Agriculture (e.g., cranberries, forestry)
9. ☐ Transportation
10. ☐ Other

7b. Is any portion of the proposed activity eligible to be treated as a limited project subject to 310 CMR 10.24 (coastal) or 310 CMR 10.53 (inland)?

1. ☒ Yes ☐ No If yes, describe which limited project applies to this project:

Maintenance of public roadway and public utilities.
2. Limited Project

8. Property recorded at the Registry of Deeds for:

Nantucket
a. County

b. Certificate # (if registered land)

c. Book

d. Page Number

B. Buffer Zone & Resource Area Impacts (temporary & permanent)

1. ☐ Buffer Zone Only – Check if the project is located only in the Buffer Zone of a Bordering Vegetated Wetland, Inland Bank, or Coastal Resource Area.
2. ☐ Inland Resource Areas (see 310 CMR 10.54-10.58; if not applicable, go to Section B.3, Coastal Resource Areas).

Check all that apply below. Attach narrative and any supporting documentation describing how the project will meet all performance standards for each of the resource areas altered, including standards requiring consideration of alternative project design or location.

For all projects affecting other Resource Areas, please attach a narrative explaining how the resource area was delineated.

Resource Area	Size of Proposed Alteration	Proposed Replacement (if any)
a. ☐ Bank	1. linear feet	2. linear feet
b. ☐ Bordering Vegetated Wetland	1. square feet	2. square feet
c. ☐ Land Under Waterbodies and Waterways	1. square feet	2. square feet
	3. cubic yards dredged	

B. Buffer Zone & Resource Area Impacts (temporary & permanent) (cont'd)

Resource Area	Size of Proposed Alteration	Proposed Replacement (if any)
d. ☐ Bordering Land Subject to Flooding	1. square feet	2. square feet
	3. cubic feet of flood storage lost	4. cubic feet replaced
e. ☐ Isolated Land Subject to Flooding	1. square feet	
	2. cubic feet of flood storage lost	3. cubic feet replaced
f. ☐ Riverfront Area	1. Name of Waterway (if available)	

2. Width of Riverfront Area (check one):

☐ 25 ft. - Designated Densely Developed Areas only

☐ 100 ft. - New agricultural projects only

☐ 200 ft. - All other projects

3. Total area of Riverfront Area on the site of the proposed project: ______ square feet

4. Proposed alteration of the Riverfront Area:

______ a. total square feet ______ b. square feet within 100 ft. ______ c. square feet between 100 ft. and 200 ft.

5. Has an alternatives analysis been done and is it attached to this NOI? ☐ Yes ☐ No

6. Was the lot where the activity is proposed created prior to August 1, 1996? ☐ Yes ☐ No

3. ☒ Coastal Resource Areas: (See 310 CMR 10.25-10.35)

Check all that apply below. Attach narrative and supporting documentation describing how the project will meet all performance standards for each of the resource areas altered, including standards requiring consideration of alternative project design or location.

Online Users: Include your document transaction number (provided on your receipt page) with all supplementary information you submit to the Department.

Resource Area	Size of Proposed Alteration	Proposed Replacement (if any)
a. ☐ Designated Port Areas	Indicate size under Land Under the Ocean, below	
b. ☐ Land Under the Ocean	1. square feet	
	2. cubic yards dredged	
c. ☐ Barrier Beach	Indicate size under Coastal Beaches and/or Coastal Dunes below	
d. ☒ Coastal Beaches	69,900 1. square feet	24,560(16cy/lf) 2. cubic yards beach nourishment
e. ☐ Coastal Dunes	1. square feet	2. cubic yards dune nourishment

B. Buffer Zone & Resource Area Impacts (temporary & permanent) (cont'd)

		Size of Proposed Alteration	Proposed Replacement (if any)
f. ☒	Coastal Banks	**1535 feet** 1. linear feet	
g. ☐	Rocky Intertidal Shores	1. square feet	
h. ☐	Salt Marshes	1. square feet	2. sq ft restoration, rehab., creation
i. ☐	Land Under Salt Ponds	1. square feet 2. cubic yards dredged	
j. ☐	Land Containing Shellfish	1. square feet	
k. ☐	Fish Runs	Indicate size under Coastal Banks, inland Bank, Land Under the Ocean, and/or inland Land Under Waterbodies and Waterways, above 1. cubic yards dredged	
l. ☐	Land Subject to Coastal Storm Flowage	1. square feet	

4. ☐ Restoration/Enhancement
If the project is for the purpose of restoring or enhancing a wetland resource area in addition to the square footage that has been entered in Section B.2.b or B.3.h above, please enter the additional amount here.

a. square feet of BVW ______ b. square feet of Salt Marsh ______

5. ☐ Project Involves Stream Crossings

a. number of new stream crossings ______ b. number of replacement stream crossings ______

C. Other Applicable Standards and Requirements

Streamlined Massachusetts Endangered Species Act/Wetlands Protection Act Review

1. Is any portion of the proposed project located in **Estimated Habitat of Rare Wildlife** as indicated on the most recent Estimated Habitat Map of State-Listed Rare Wetland Wildlife published by the Natural Heritage and Endangered Species Program (NHESP)? To view habitat maps, see the *Massachusetts Natural Heritage Atlas* or go to http://www.mass.gov/dfwele/dfw/nhesp/regulatory_review/priority_habitat/online_viewer.htm.

a. ☐ Yes ☒ No **If yes, include proof of mailing or hand delivery of NOI to:**

Natural Heritage and Endangered Species Program
Division of Fisheries and Wildlife
100 Hartwell Street, Suite 230
West Boylston, MA 01583

October 1, 2008
b. Date of map

C. Other Applicable Standards and Requirements (cont'd)

If *yes*, the project is also subject to Massachusetts Endangered Species Act (MESA) review (321 CMR 10.18). To qualify for a streamlined, 30-day, MESA/Wetlands Protection Act review, please complete Section C.1.C, and include requested materials with this Notice of Intent (NOI); *OR* complete Section C.1.d, if applicable. *If MESA supplemental information is not included with the NOI, by completing Section 1 of this form, the NHESP will require a separate MESA filing which may take up to 90 days to review (unless noted exceptions in Section 2 apply, see below).*

1. c. Submit Supplemental Information for Endangered Species Review*

   1. ☐ Percentage/acreage of property to be altered:

      (a) within wetland Resource Area ____________ percentage/acreage

      (b) outside Resource Area ____________ percentage/acreage

   2. ☐ Assessor's Map or right-of-way plan of site

   3. ☐ Project plans for entire project site, including wetland resource areas and areas outside of wetlands jurisdiction, showing existing and proposed conditions, existing and proposed tree/vegetation clearing line, and clearly demarcated limits of work ****

      (a) ☐ Project description (including description of impacts outside of wetland resource area & buffer zone)

      (b) ☐ Photographs representative of the site

      (c) ☐ MESA filing fee (fee information available at: http://www.mass.gov/dfwele/dfw/nhesp/regulatory_review/mesa/mesa_fee_schedule.htm). Make check payable to "Commonwealth of Massachusetts - NHESP" and ***mail to NHESP*** at above address

      *Projects altering **10 or more acres** of land, also submit:*

      (d) ☐ Vegetation cover type map of site

      (e) ☐ Project plans showing Priority & Estimated Habitat boundaries

   d. OR Check One of the Following

   1. ☐ Project is exempt from MESA review.
      Attach applicant letter indicating which MESA exemption applies. (See 321 CMR 10.14, http://www.mass.gov/dfwele/dfw/nhesp/regulatory_review/mesa/mesa_exemptions.htm; the NOI must still be sent to NHESP if the project is within estimated habitat pursuant to 310 CMR 10.37 and 10.59.)

   2. ☐ Separate MESA review ongoing. ____________ a. NHESP Tracking # ____________ b. Date submitted to NHESP

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* Some projects **not** in Estimated Habitat may be located in Priority Habitat, and require NHESP review (see http://www.mass.gov/dfwele/dfw/nhesp/nhesp.htm, regulatory review tab). Priority Habitat includes habitat for state-listed plants and strictly upland species not protected by the Wetlands Protection Act.

** MESA projects may not be segmented (321 CMR 10.16). The applicant must disclose full development plans even if such plans are not required as part of the Notice of Intent process.

C. Other Applicable Standards and Requirements (cont'd)

3. ☐ Separate MESA review completed.
Include copy of NHESP "no Take" determination or valid Conservation & Management Permit with approved plan.

2. For coastal projects only, is any portion of the proposed project located below the mean high water line or in a fish run?

a. ☐ Not applicable – project is in inland resource area only

b. ☐ Yes ☒ No If yes, include proof of mailing or hand delivery of NOI to either:

South Shore - Cohasset to Rhode Island, and the Cape & Islands:	North Shore - Hull to New Hampshire:
Division of Marine Fisheries - Southeast Marine Fisheries Station Attn: Environmental Reviewer 1213 Purchase Street – 3rd Floor New Bedford, MA 02740-6694	Division of Marine Fisheries - North Shore Office Attn: Environmental Reviewer 30 Emerson Avenue Gloucester, MA 01930

Also if yes, the project may require a Chapter 91 license. For coastal towns in the Northeast Region, please contact MassDEP's Boston Office. For coastal towns in the Southeast Region, please contact MassDEP's Southeast Regional Office.

3. Is any portion of the proposed project within an Area of Critical Environmental Concern (ACEC)?

Online Users: Include your document transaction number (provided on your receipt page) with all supplementary information you submit to the Department.

a. ☐ Yes ☒ No If yes, provide name of ACEC (see instructions to WPA Form 3 or MassDEP Website for ACEC locations). **Note:** electronic filers click on Website.

b. ACEC

4. Is any portion of the proposed project within an area designated as an Outstanding Resource Water (ORW) as designated in the Massachusetts Surface Water Quality Standards, 314 CMR 4.00?

a. ☐ Yes ☒ No

5. Is any portion of the site subject to a Wetlands Restriction Order under the Inland Wetlands Restriction Act (M.G.L. c. 131, § 40A) or the Coastal Wetlands Restriction Act (M.G.L. c. 130, § 105)?

a. ☐ Yes ☒ No

6. Is this project subject to provisions of the MassDEP Stormwater Management Standards?

a. ☐ Yes. Attach a copy of the Stormwater Report as required by the Stormwater Management Standards per 310 CMR 10.05(6)(k)-(q) and check if:

1. ☐ Applying for Low Impact Development (LID) site design credits (as described in Stormwater Management Handbook Vol. 2, Chapter 3)

2. ☐ A portion of the site constitutes redevelopment

3. ☐ Proprietary BMPs are included in the Stormwater Management System.

b. ☒ No. Check why the project is exempt:

1. ☐ Single-family house

C. Other Applicable Standards and Requirements (cont'd)

2. ☒ Emergency road repair
3. ☐ Small Residential Subdivision (less than or equal to 4 single-family houses or less than or equal to 4 units in multi-family housing project) with no discharge to Critical Areas.

D. Additional Information

Applicants must include the following with this Notice of Intent (NOI). See instructions for details.

Online Users: Attach the document transaction number (provided on your receipt page) for any of the following information you submit to the Department.

1. ☒ USGS or other map of the area (along with a narrative description, if necessary) containing sufficient information for the Conservation Commission and the Department to locate the site. (Electronic filers may omit this item.)
2. ☒ Plans identifying the location of proposed activities (including activities proposed to serve as a Bordering Vegetated Wetland [BVW] replication area or other mitigating measure) relative to the boundaries of each affected resource area.
3. ☒ Identify the method for BVW and other resource area boundary delineations (MassDEP BVW Field Data Form(s), Determination of Applicability, Order of Resource Area Delineation, etc.), and attach documentation of the methodology.
4. ☐ List the titles and dates for all plans and other materials submitted with this NOI.

a. Plan Title

b. Prepared By

c. Signed and Stamped by

d. Final Revision Date

e. Scale

f. Additional Plan or Document Title

g. Date

5. ☒ If there is more than one property owner, please attach a list of these property owners not listed on this form.
6. ☐ Attach proof of mailing for Natural Heritage and Endangered Species Program, if needed.
7. ☐ Attach proof of mailing for Massachusetts Division of Marine Fisheries, if needed.
8. ☐ Attach NOI Wetland Fee Transmittal Form
9. ☐ Attach Stormwater Report, if needed.

E. Fees

1. ☒ Fee Exempt: No filing fee shall be assessed for projects of any city, town, county, or district of the Commonwealth, federally recognized Indian tribe housing authority, municipal housing authority, or the Massachusetts Bay Transportation Authority.

Applicants must submit the following information (in addition to pages 1 and 2 of the NOI Wetland Fee Transmittal Form) to confirm fee payment:

2. Municipal Check Number ____ 3. Check date ____

4. State Check Number ____ 5. Check date ____

6. Payor name on check: First Name ____ 7. Payor name on check: Last Name ____

F. Signatures and Submittal Requirements

I hereby certify under the penalties of perjury that the foregoing Notice of Intent and accompanying plans, documents, and supporting data are true and complete to the best of my knowledge. I understand that the Conservation Commission will place notification of this Notice in a local newspaper at the expense of the applicant in accordance with the wetlands regulations, 310 CMR 10.05(5)(a).

I further certify under penalties of perjury that all abutters were notified of this application, pursuant to the requirements of M.G.L. c. 131, § 40. Notice must be made by Certificate of Mailing or in writing by hand delivery or certified mail (return receipt requested) to all abutters within 100 feet of the property line of the project location.

Steven Cohen for SBPF

Steven Cohen — 10/23/13
1. Signature of Applicant — 2. Date

Kane Ba — 10/23/13
3. Signature of Property Owner (if different) — 4. Date

5. Signature of Representative (if any) — 6. Date

For Conservation Commission:
Two copies of the completed Notice of Intent (Form 3), including supporting plans and documents, two copies of the NOI Wetland Fee Transmittal Form, and the city/town fee payment, to the Conservation Commission by certified mail or hand delivery.

For MassDEP:
One copy of the completed Notice of Intent (Form 3), including supporting plans and documents, one copy of the NOI Wetland Fee Transmittal Form, and a **copy** of the state fee payment to the MassDEP Regional Office (see Instructions) by certified mail or hand delivery.

Other:
If the applicant has checked the "yes" box in any part of Section C, Item 3, above, refer to that section and the Instructions for additional submittal requirements.

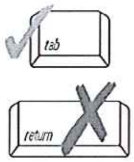
The original and copies must be sent simultaneously. Failure by the applicant to send copies in a timely manner may result in dismissal of the Notice of Intent.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

NOI Wetland Fee Transmittal Form

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A. Applicant Information

1. Location of Project:

a. Street Address ____ b. City/Town ____

c. Check number ____ d. Fee amount ____

2. Applicant Mailing Address:

a. First Name ____ b. Last Name ____

c. Organization ____

d. Mailing Address ____

e. City/Town ____ f. State ____ g. Zip Code ____

h. Phone Number ____ i. Fax Number ____ j. Email Address ____

3. Property Owner (if different):

a. First Name ____ b. Last Name ____

c. Organization ____

d. Mailing Address ____

e. City/Town ____ f. State ____ g. Zip Code ____

h. Phone Number ____ i. Fax Number ____ j. Email Address ____

B. Fees

To calculate filing fees, refer to the category fee list and examples in the instructions for filling out WPA Form 3 (Notice of Intent).

Fee should be calculated using the following process & worksheet. ***Please see Instructions before filling out worksheet.***

Step 1/Type of Activity: Describe each type of activity that will occur in wetland resource area and buffer zone.

Step 2/Number of Activities: Identify the number of each type of activity.

Step 3/Individual Activity Fee: Identify each activity fee from the six project categories listed in the instructions.

Step 4/Subtotal Activity Fee: Multiply the number of activities (identified in Step 2) times the fee per category (identified in Step 3) to reach a subtotal fee amount. Note: If any of these activities are in a Riverfront Area in addition to another Resource Area or the Buffer Zone, the fee per activity should be multiplied by 1.5 and then added to the subtotal amount.

Step 5/Total Project Fee: Determine the total project fee by adding the subtotal amounts from Step 4.

Step 6/Fee Payments: To calculate the state share of the fee, divide the total fee in half and subtract $12.50. To calculate the city/town share of the fee, divide the total fee in half and add $12.50.

Engineering, Planning
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

October 25, 2013

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

RE: Baxter Road Temporary Stabilization Application
Town of Nantucket
Nantucket, Massachusetts
MMI #2967-11-4

Dear Chairman Steinauer and Members of the Conservation Commission:

As you may know, in addition to performing engineering review of the Sconset Beach Stabilization Project on behalf of the Conservation Commission, Milone & MacBroom, Inc. (MMI) has been assisting the Nantucket Public Works Department in evaluating measures to protect and relocate Baxter Road. At this time, it is apparent that any viable option for permanently stabilizing the road and infrastructure cannot be completed before this coming winter season. In light of this, the town is seeking to temporarily protect the existing Baxter Road in the areas where it is in imminent danger of failure. It is this protection that is the subject of this current application.

This letter is intended to provide one document that describes the project goals, construction methods, potential impacts, and mitigation and is intended to supersede and replace previous supporting materials for this application. The following information is presented:

1. Project Background
2. Project Purpose and Goal
3. Regulatory Framework for Application Request
4. Alternatives Analysis
5. Description of Proposed Activity (including sand volumes and flanking)
6. Construction Methodology
7. Monitoring and Maintenance
8. Failure Criteria and Removal

1. Project Background

The town has been advised by Town Counsel that it is legally obligated to provide access to the properties on Baxter Road. During the winter storms of 2013, significant retreat of the Sconset Bluff occurred, leaving the top of bank as close as 30 to 40 feet to the edge of Baxter Road in several areas and 60 to 70 feet in many others. While erosion rates can vary substantially from year to year, another storm season similar to 2013 could render the road impassable and/or public water supply breached, leaving the residences at the north end landlocked and the town unable to provide fire protection and safe drinking water. If this were to occur, the town would not be able to provide emergency services to these properties.

The Sconset Beach Preservation Fund, Inc. (SBPF) has proposed various stabilization measures at the toe of the slope, with the most recent application requesting authorization for hard armoring. There had been some hope that construction of the SBPF project would occur in fall 2013, which would mitigate the town's concerns regarding the roadway and utilities; however, in August it became clear that the SBPF construction project would not occur this year. At that point, the town's Public Works Department began aggressively seeking methods to protect those sections of Baxter Road that appear in imminent danger of failing during this winter season.

2. ***Project Purpose and Goal***
The goal of the project is to maintain vehicular access and utility service to the residential properties on Baxter Road from Bayberry Lane north to the Sankaty Head Lighthouse property. Work is limited to those areas where Baxter Road appears in imminent danger of failure from bank failure. Specifically, these areas are 85 to 107a Baxter Road. Work under this application is specifically proposed as temporary and intended to provide a minimum but adequate level of protection for the short term while long term solutions are explored and implemented. The town requests that the measures proposed consider a design life of about five years.

3. ***Regulatory Framework for Application Request***
The town is seeking to complete the repair work in question as a "limited project" under 310 CMR 10.24(c) 2. The project is needed to protect the health, safety, and welfare of the residents of Baxter Road north of Bayberry Lane and consists of the protection, maintenance, and improvement of an existing public roadway and public utilities.

4. ***Alternatives Analysis***
Baxter Road Protection - MMI completed an alternatives analysis specific to protecting Baxter Road, and this is included as Attachment A to this letter. Given the town's project goal of protecting Baxter Road, we sought methods of stabilizing the roadway from the top of the slope (by driving sheet piling along the right-of-way) rather than at the toe; however, this was ultimately deemed infeasible due to the geology of this bluff. We made this determination using data and information provided by Haley & Aldrich (a Boston-based geotechnical and structural engineering firm with an excellent reputation throughout New England for the quality of their work) that indicates the bluff consists of a glacial till and clay material above a lens of loose poorly graded sand that is structurally unstable. This is evident in the boring logs that are presented in Attachment B.

The information provided by Haley & Aldrich makes two critical points. The first point is that the presence of poorly graded sand at the base of the bluff suggests there is little to no cohesion and, therefore, little to no structural stability in this layer of material. The second point is that the glacial till and clay deposits present in the upper bank indicate that driving sheeting would be difficult if not impossible to do without risk of causing a failure of the bank. This is detailed in a Haley & Aldrich memo included in Attachment C.

Soft protection, such as drift fence, snow fence, and similar measures, was not considered appropriate for this area because, although it can work, it does not provide the type of protection needed in the lengthy or successive storm events that can occur in this location.

Hard armoring such as the revetment proposed by SBPF was not considered appropriate for the temporary stabilization. While stone armoring, seawalls, and similar hard armoring may be valid and appropriate long-term stabilization mechanisms, hard armoring would be more difficult to implement in the short period of time afforded before the winter storm season begins, and most raise concerns about removability. Further, simply moving the road and utilities is not an option. There is no room within the existing town right-of-way that would allow for moving them any meaningful amount, and any long-term solution will require relocating them. Although the water is being moved from the east to the west side of the road, this is not considered a solution to the problem.

Geotube Alternatives - Ultimately, the alternatives analysis led to the conclusion that geotubes are the only viable means of temporary protection of the bluff. Within the geotube option, there are three potential methods as described below:

– Geotube Alternative 1 – Jute Fiber Logs: The use of jute to create the logs was considered for this application since this has been used in the past on Sconset Beach with some moderate success. As we have observed in recent years, once the jute rips, as it is designed to do, the failure can be difficult to control. As sand is lost, the logs fail, which results in loss of the toe and collapse in the bank above the logs. The geotextile material is not as susceptible to ripping as the jute and, if torn, the geotextile can be repaired more readily. Ultimately, we have requested to use geotextile to create the logs because this material offers greater stability and ease of repair; therefore, it should reduce the possibility of the failures that have occurred in the past during multiday or quick-succession storms.

  Advantages of Jute: Natural material that degrades over time
  Disadvantages of Jute: Degradation of material weakens the entire system resulting in continued bank failure; degradation of material makes repair difficult.

– Geotube Alternative 2 – Three-Geotextile-Tube Configuration: The first plan called for three geotubes with the lowest tube set essentially on the existing beach and the top tube extending to elevation 26.0 Mean Low Water (MLW). The three-tube design was put forth in an effort to reduce the project footprint and impact for the temporary installation. However, the reduced impact would also result in a less robust system that would be more susceptible to failure due to toe scour. Consideration was given to compensating for the lack of stability with an enhanced monitoring and repair program but, ultimately, this design was rejected by the project team due to the lack of scour protection afforded at the toe of the geotube.

  Advantages of Three-Tube Design: Less overall impact to beach from construction and maintenance while providing some protection for the short term
  Disadvantages of Three-Tube Design: Less robust design may lead to premature failure of the system due to toe scour.

– Geotube Alternative 3 – Four-Geotextile-Tube Configuration: The preferred alternative for toe stabilization and proposed in this request is the placement of four 45-foot diameter geotubes, with the bottom tube buried in the beach to elevation 0.0 MLW and the top tube set at elevation 26.0 MLW. The bottom tube and scour apron are buried to mitigate for localized toe scour that will inevitably occur at the base of the structure. The U.S. Army Corps of Engineers (USACE) recommends designing for a scour depth of 1.5 times wave height. The 1% annual chance breaking wave height at the structure toe is estimated at five feet. Using the USACE guidelines, the predicted scour depth may be up to 7.5 feet. This is approximately equal to the 0.0 MLW elevation selected for the base.

The Federal Emergency Management Agency has set the 1% annual chance wave elevation to 26.0 MLW in the project area. The geotubes are set to this elevation to reduce the potential for overtopping during a major storm event.

The preferred design calls for the tubes to overlap, providing an effective slope of 2 horizontal:1 vertical to mitigate wave reflection with a scour apron and four-foot-diameter anchor tube extending five feet seaward of the lowest log at elevation 0.0 MLW. This results in encroachment of the geotubes of approximately 40 feet seaward of the toe of the slope, plus five feet for the scour apron and anchor tube. An estimated 20 feet of the encroachment will occur above the summer beach profile, with the remaining 25 feet below grade. Efforts have been made to reduce the encroachment onto the beach to the extent possible. This includes reducing the width of the scour apron from 10 feet to five feet and steepening the geotube logs slightly to further limit encroachment on the beach. The design as presented attempts to balance the wave reflection caused by a steeper shoreline system with minimizing encroachment onto the beach.

Advantages of Four-Tube Design: More robust than three-tube system and less susceptible to toe scour
Disadvantages of Four-Tube Design: Requires excavation on beach; encroaches further into beach (horizontally and vertically) than the three-tube design

5. ***Description of the Proposed Activity***
The application consists of placing approximately 1,500 linear feet of geotubes extending from 85 Baxter Road to 107a Baxter Road. While initial application materials proposed two distinct sections of tubes only at the locations where roadway failure appears imminent and where no structures currently exist, the issue of flanking cannot be resolved in the gap area between the two systems. Therefore, the application materials request a continuous run of geotube from 85 Baxter Road to 107a Baxter Road.

The proposed plan is a geotextile tube configuration that was developed in coordination with geotextile tube manufacturer Maccaferri, Inc. The MacTube® geotextile tube containers (geotubes) are made from a woven polypropylene (PP) geotextile. Manufactured in a sand color, the geotextile fabric is woven in a rip-resistant weave pattern for maximum resistance to mechanical damage. The system will consist of four tubes, each with a 45-foot circumference (approximately 19 feet wide and 6.5 feet tall). The tubes will be 100 or 200 feet long through the project area, with returns set at a 45-degree angle constructed with 50-foot-long tubes. Following construction of the tubes (see below for construction methodology), sand cover will be provided, and nourishment will be performed to protect the tubes and mitigate for loss of the bank as a sediment source. Aside from providing adequate nourishment, maintaining cover over the tubes is critical to maintaining their life expectancy since the geotextile is prone to degradation from ultraviolet light. Sand fill will be secured from on-island sources of compatible sand.

The embankment above the toe shows evidence of rill erosion from rainfall and runoff from the grass areas along the top. The town is working with the property owners to reduce runoff that discharges over the top of the slope and will provide a low berm along the easterly side of the roadway to direct water toward Baxter Road. This will only be completed in areas where the roadway contributes to flow of water over the bluff. In addition to redirecting runoff, jute netting will be placed on the bank face to protect the exposed soil. Netting will be placed this fall immediately upon receipt of approval to proceed. In the spring, native plantings (e.g., beach grass and woodier species) will be added to the slope to further reduce erosion.

Sand Nourishment Criteria: Sand for nourishment will be provided from on-island sources. Attachment D is sieve analysis data from the on-island sources in comparison to existing bank and beach material as taken from applications submitted to the commission by SBPF. Immediately following placement of the tubes, a minimum of two feet of sand cover will be provided over the top of the geotube, creating a bench that extends approximately 20 feet from the bank and slopes down the beach at 2.5 horizontal:1 vertical. This results in a sand application rate of approximately 14.3 cubic yards per linear foot for the 1,500-linear-foot installation.

Sand replenishment will occur periodically through the project life as needed. Winter replenishment will occur at a rate of one cubic yard per linear foot when 50% of the height of the bottom tube is exposed. Each spring (before April 30), the two feet of sand cover will be re-established over the geotubes.

The overall sand volume to be used in the project is as follows:

Placement Location	Rate of Placement (CY/LF)	Length of Placement (Feet)	Total Volume (CY)
Inside Geotubes	4.22 (each tube)	1,500	25,320
Leveling Sand	2.3	1,500	3,450
Nourishment Sand	14.3	1,500	21,450
		TOTAL VOLUME	50,220

Structure Flanking: As with any coastal structure that retards beach erosion, flanking of the geotubes is a critical concern. Ideally, the tubes would be excavated into the banks at each end but, given the temporary nature of the proposed project and the invasiveness of such excavation, we are not currently proposing this. As noted in the inspection protocols (below), observations for flanking will be made regularly. To minimize the possibility of flanking, additional nourishment sand will be placed at the ends of the tubes. If substantial retreat of the adjacent bank occurs and nourishment is no longer an appropriate response, then additional geotubes will be considered to fill any gapping that develops. If geotubes are considered the most appropriate response, then an application to the Conservation Commission will be made prior to implementation.

6. *Construction Methodology*

As previously mentioned, construction of the geotube system will be completed at the toe of the existing Sconset Bluff between 85 and 107a Baxter Road, with installation starting at the most endangered sections (based on distance of the edge of the bluff to the road) in case weather or other factors prevent full installation this season. The geotubes will be filled in place with sand to the proper volume. Compacted sand backfill will be used behind each geotube layer to provide a flat stable bench for the next subsequent layer of geotube. The total system will be four geotubes high and will be covered with a sacrificial sand layer to a top elevation not to exceed +28.0 feet MLW and extending down the foreshore slope on a 1 vertical:2.5 horizontal slope to meet existing grade. Frequency of renourishment of the sacrificial sand layer will depend on the duration that the temporary protection is left in place and the severity/occurrence of storms.

The construction period will extend an estimated eight weeks, with one week of setup and installation of approximately 800 linear feet of tube per week on average. For example, it would take slightly less than two weeks to construct the 1,500-foot-long bottom tier. The following construction sequence is proposed for the work under this application:

1. The existing beach within the footprint of the bottom geotube and scour apron layer will be graded to elevation 0.0 MLW and to achieve a maximum 1.5% slope in any direction. Given the variations in the beach profile, this will require varying amounts of excavation along the beach as noted in the cross sections shown on the project plans.
2. Approximately five feet to the seaward side of the bottom geotube layer will be excavated to an elevation of 0.0 feet MLW for installation of the four-foot circumference anchor tube and attached scour apron. This section will then be backfilled to the original beach elevation.
3. The scour apron will be rolled out toward the bluff and the bottom geotube placed on top of the apron at the appropriate distance from the slope. The scour apron is delivered in 60-foot-wide rolls and will be overlapped by 10 feet at the vertical seams.
4. Sand will be supplied by on-island sand pits, trucked to Baxter Road and placed in a slurry mixer at the top of the slope. Water to create the slurry will be obtained from an existing fire hydrant in the project area. Details on the slurry delivery are provided below.
5. The slurry will be pumped from the top of the bank through a six-inch-diameter hose and into the geotubes on the beach. Sand will remain in the tubes, and clean water will filter through the membrane. The water will infiltrate through the beach.
6. The bottom geotube will be filled with the sand slurry mixture until the tube achieves the required volume and exterior dimensions.
7. The scour apron will then be pulled seaward over the top of the recently filled geotube. The area behind the geotube, between the tube and the bluff, will be backfilled and compacted with 12-inch lifts of clean sand fill. The fill will be installed to an elevation matching the top of the filled geotube.
8. The scour apron will then be pulled landward over the newly backfilled section, and the next geotube layer will be placed upon the scour apron. This next geotube layer shall be staggered so as to provide an effective slope of 2 horizontal:1 vertical with the upper layer overlapping the previously placed geotube layer.
9. Steps 5 – 8 are repeated for the remaining geotube layers.
10. Once all geotubes are filled, the entire structure will be covered with a clean sand fill. The sand cover will be a minimum of two feet in depth at a 1 vertical: 2.5 horizontal slope to meet the existing beach profile along the front of the geotube structure.
11. Following construction, the beach will be restored to its current elevation (if construction impacts necessitate repair) using beach sand from the site. No material from the on-island sand pits is expected to be used for postconstruction beach repair.

<u>Construction Access</u>: Equipment will access the beach from Hoicks Hollow. A long-armed excavator will be used along with a skid steer on the beach. Any fueling of these machines will happen in the Hoicks Hollow parking lot area. All other equipment will operate out of the staging area located at 99 and 101 Baxter Road.

<u>Staging Area for Slurry Production</u>: The lots at 99 and 101 Baxter Road including portions of the Baxter Road right-of-way (not travel way) will be used as a staging area for the construction. Vegetation will be removed from these lots in those areas where slurry sand will be delivered.

This is necessary to ensure that no grass or woody debris is mixed with the sand, which will result in clogging the slurry pumps. A 30- or 40-cubic-yard roll-off dumpster will be used to mix the slurry, which will be approximately 80% water and 20% sand. Water will be pumped from the fire hydrant located in front of 97 Baxter Road into this dumpster. The flow will be regulated by a valve at the dumpster. An excavator will constantly feed sand into the gate end of the dumpster. Inside the dumpster will be an agitating pump that will create the slurry as it pumps the water at the same rate it is being delivered to the dumpster, down into the geotubes via a six-inch hose.

The sand will be delivered to the staging area via standard 20-cubic-yard dump trucks. They will dump just along the seaward side of the roadway creating a windrow, or continuous series of piles. A small bucket dozer will push the sand down to the excavator, which will constantly feed the slurry production. The roadway will be swept clean daily, and a police detail will be hired to manage any traffic impacts.

Haley & Aldrich has been consulted relative to the weight of the dumpster and the sand stockpiling that is proposed for this area and, as long as a minimum distance of 25 feet is maintained from the top of the bank, it has been determined a safe staging area.

The slurry will be delivered down the face of the bluff via a slurry hose, which will pump directly into the ports of the geotubes. The water will leach from the geotubes as they fill with sand. A small berm will be constructed on the beach on the waterward side of the geotubes to prevent water from discharging down the beach unmitigated.

<u>Template Sand Delivery</u>

The staging area that was used for the slurry will later be used for the delivery of the sand template. For this phase of the work, the sand will be pushed over the top of the bluff with a dingo (a small hand-operated, walk-behind dozer style piece of equipment) or by a conveyor. Once the face of the bank is vegetated in spring 2014, future sand delivery will be accomplished through the use of three-foot-diameter polyethylene pipes.

Once the sand is delivered to the geotubes below, a skid steer and/or a bucket dozer will work to spread the sand evenly over the entire system. These machines will not drive directly on top of the geotubes until they have a sufficient sand cover, requiring the machines to work their way further outward from the central delivery point(s).

For future maintenance and nourishment sand deliveries, material will be delivered directly to the two end points as well as to some central locations. By delivering a volume of sand to the end points, a skid steer or bucket dozer will be able to build a ramp, similar to how the existing terraces are accessed. The sand would then be pushed inward from the end points until it gets to more central delivery locations, at which point it will continue to push sand toward the middle. The bench on the top of the geotube system will be a minimum of 20 feet wide, easily facilitating this activity.

As part of the annual nourishment in the spring, sand will similarly be pushed down the face of the system with a grading technique until the system is again fully covered and the template is back to a 1 vertical: 2.5 horizontal slope.

Truck Traffic

Dump trucks with a 20-cubic-yard capacity will deliver compatible sand to the site from a local pit(s). Given the volume of sand required and the capacity of the trucks, approximately 2,500 truck trips will be required to complete the project. Over the eight-week construction cycle, this will average 63 trucks per day, or six trucks making 10 round trips to the site. Following construction, ongoing deliveries for nourishment will require fewer truck loads.

7. ***Monitoring and Maintenance Requirements***

The geotube installation will be visually inspected monthly and following significant storm events throughout its life. The inspection will consist of:

1. Photodocumention of the condition of the geotube and nourishment sand
2. Observation of the sacrificial sand layer to determine if replenishment is needed
3. Identification of the location of any exposed geotextile
4. Identification of any repair required to the geotextile
5. Visual observation of the ends of the tubes to determine if flanking is occurring

Results of the inspection will be submitted in writing to the Town of Nantucket Public Works Director. If inspection reveals that repair work is needed, the Public Works Director will coordinate having this completed as soon as possible. The schedule of repair will be determined based upon the severity of the work required. For example, repair of torn geotextile will be completed as soon as the beach is accessible for such activity. Sand replenishment will be completed as soon as appropriate based on weather conditions and time of year.

If the commission would like to have updrift and downdrift impacts monitored, the town would be amenable to modifying the monitoring plan to include the following:

- Year 1 transect surveys in locations previously performed by Woods Hole Group in April and August
- Year 2 through 5 transect surveys in locations previously performed by Woods Hole Group in April

The monitoring data will be used to estimate the volume of nourishment sand remaining on the geotubes as well as the accretion of sand on downdrift beaches. Results of the monitoring will be compiled into an annual report in April of each year documenting the data collection and analysis and recommending a nourishment protocol. The frequency and volume of nourishment will be determined annually based on observed site conditions. Following determination of the proposed nourishment volume, a written report will be submitted to the Conservation Commission documenting performance of the nourishment layer over the past year and outlining the additional sand volume to be provided in that nourishment cycle.

8. ***Failure Criteria and Removal***

As with any coastal structure, there is potential this system will fail. We define failure as the following:

- Complete loss of one or more tubes
- Greater than 50% section loss of one or more tubes. Tearing of a log would not be considered failure unless more than 50% of the fill material is lost.
- Flanking that leaves greater than 10% of the tube length exposed at each end and that is not mitigated by nourishment
- Excessive change in updrift or downdrift beach cross section. Quantitative failure for updrift and downdrift impacts is difficult to develop with certainty at this time. If annual transects suggest changes are occurring as compared to historic data collected by SBPF over the past 15+ years, the Department of Public Works will meet with Conservation Commission staff and determine if they believe the changes are a result of the project, and an appropriate course of action will be determined.

In the event of failure, the following will occur:

1. The Conservation Commission will be immediately notified through its staff.
2. Following mutual agreement by the Department of Public Works and the Conservation Commission staff, the logs will be cut and removed. Removal will require use of an excavator or similar equipment on the beach to pull the geotextile up, leaving the sand in place.
3. Following removal of the geotextile, the sand will be spread along the toe of the slope and left in place.

This protocol will also be followed to remove the structures at the end of the permit life.

It should be noted that if a large section of geotextile is lost (which is extremely unlikely given the durability of the material) it would sink to the ocean floor rather than float. In the event this does occur, the town will notify the Conservation Commission to determine if retrieval is necessary and, if retrieval is required, an appropriate course of action.

We appreciate the Conservations Commission's consideration of this application and look forward to discussing this with you in more detail on October 30, 2013.

Very truly yours,

MILONE & MACBROOM, INC.

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

Enclosures:
Attachment A – Baxter Road Stabilization Alternatives Analysis
Attachment B – Boring Logs
Attachment C – Haley and Aldrich Memorandum Regarding Sheet Pile Installation (DRAFT)
Attachment D – Sand Source Data and Analysis

cc: Kara Buzanoski, Public Works Director

2967-11-4-o2513-ltr.docx

BAXTER ROAD TEMPORARY STABILIZATION
NOI SUBMISSION

BAXTER ROAD
NANTUCKET, MASSACHUSETTS

October 25, 2013

LOCATION MAP:

0' 1000' 2000'
0 1/4" 1/2"
SCALE 1" = 2000'

PROJECT SITE VICINITY MAP:

0' 125' 250'
0 1/4" 1/2"
SCALE 1" = 500'

PREPARED FOR:

TOWN OF NANTUCKET
NANTUCKET, MASSACHUSETTS

LIST OF DRAWINGS

SHEET NO.	TITLE
1	TITLE SHEET
2	EXISTING CONDITIONS
3	GENERAL PLAN
4	TYPICAL CROSS SECTION
5-9	CROSS SECTIONS

PREPARED BY:

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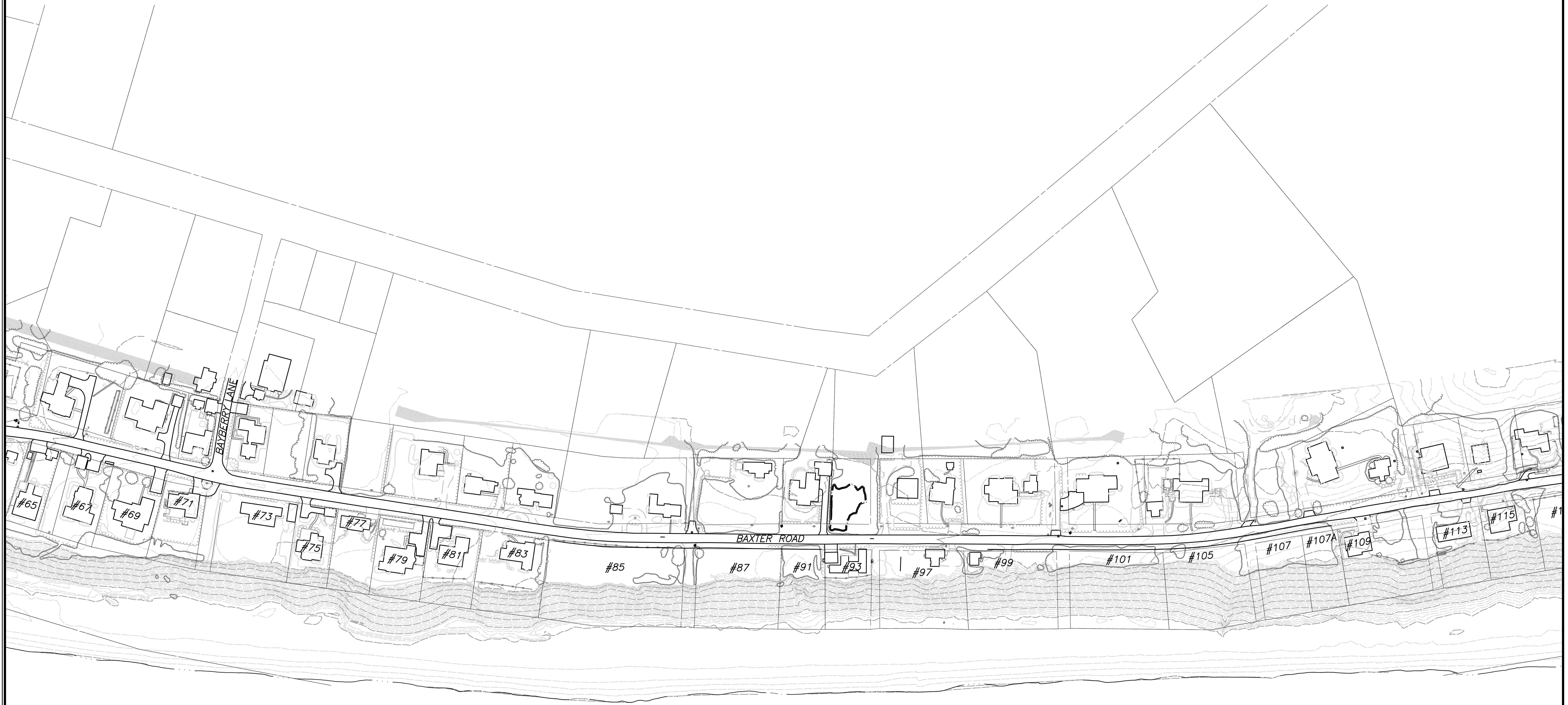
DESIGNER: MILONE & MACBROOM, INC.
BY: James Macbroom
DATE: October 25, 2013
P.E. NO.: 43052

DRAFT



GENERAL NOTES

1. ALL ELEVATIONS ARE BASED ON MEAN LOW WATER DATUM (M.L.W.=0.0').
2. CONTOURS SHOWN IN 2 FOOT INTERVALS.
3. EXISTING TOPOGRAHIC SURVEY INFORMATION SHOWN ON THIS PLAN TAKEN FROM A LIDAR SURVEY PROVIDED BY COL-EAST AND BLACKWELL & ASSOCIATES, INC. PERFORMED ON JULY 15, 2013, AND CAN ONLY REFLECT CONDITIONS AS THEY EXISTED AT THE TIME OF THE SURVEY.

FOR PERMITTING PURPOSES ONLY

0' 50' 100'
0 1/4" 1/2"

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EXISTIN□ CONDITIONS - TEMPORARY SLOPE STABILIZATION

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

DESIGNED	DRAWN	CHECKED
RSD	SMW	---

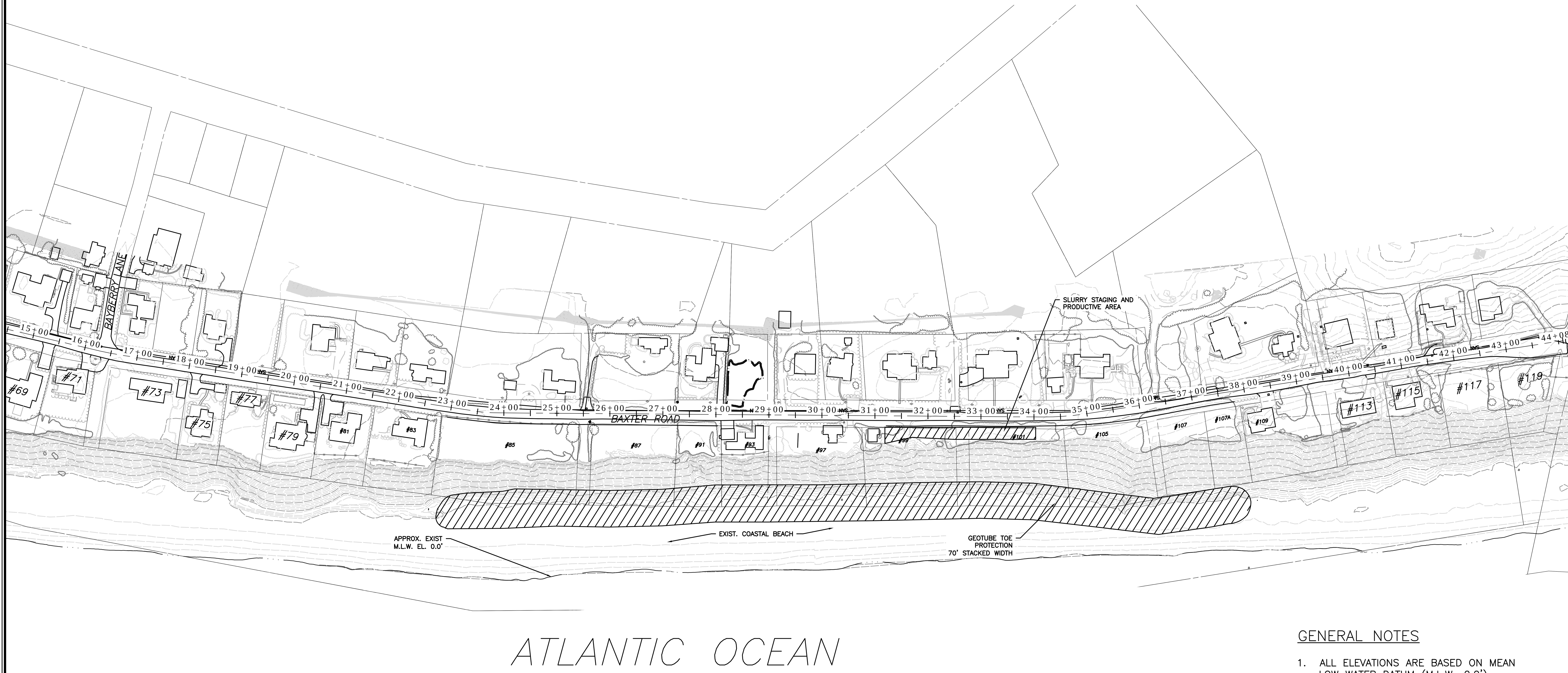
SCALE: 1" = 200'

DATE: OCT. 25, 2013

PROJECT NO.: 2967-11

SHEET NO.: 2 OF 9

SHEET NAME: EXIST.



NOTE:

LENGTH =1,500 LF
AREA OF IMPACT = 105,320 SF

GENERAL NOTES

1. ALL ELEVATIONS ARE BASED ON MEAN LOW WATER DATUM (M.L.W.=0.0').
2. CONTOURS SHOWN IN 2 FOOT INTERVALS.
3. EXISTING TOPOGRAHIC SURVEY INFORMATION SHOWN ON THIS PLAN TAKEN FROM A LIDAR SURVEY PROVIDED BY COL-EAST AND BLACKWELL & ASSOCIATES, INC. PERFORMED ON JULY 15, 2013, AND CAN ONLY REFLECT CONDITIONS AS THEY EXISTED AT THE TIME OF THE SURVEY.
4. LIMITS OF SAND COVER OVER THE GEOTEXTILE TUBES NOT SHOWN FOR CLARITY. FOR LIMITS SEE TYPICAL SECTION ON SHEET 4 AND CROSS SECTIONS SHEETS 5 THRU 9.
5. GEOTUBE LIMITS, ELEVATIONS AND SLOPE IS BASED ON DESIGN PROVIDED BY MACAFFERI AND OCEAN & COASTAL CONSULTANTS.

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DESCRIPTION	DATE	BY

GENERAL PLAN - TEMPORARY SLOPE STABILIZATION

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

RSD	SMW	---
DESIGNED	DRAWN	CHECKED

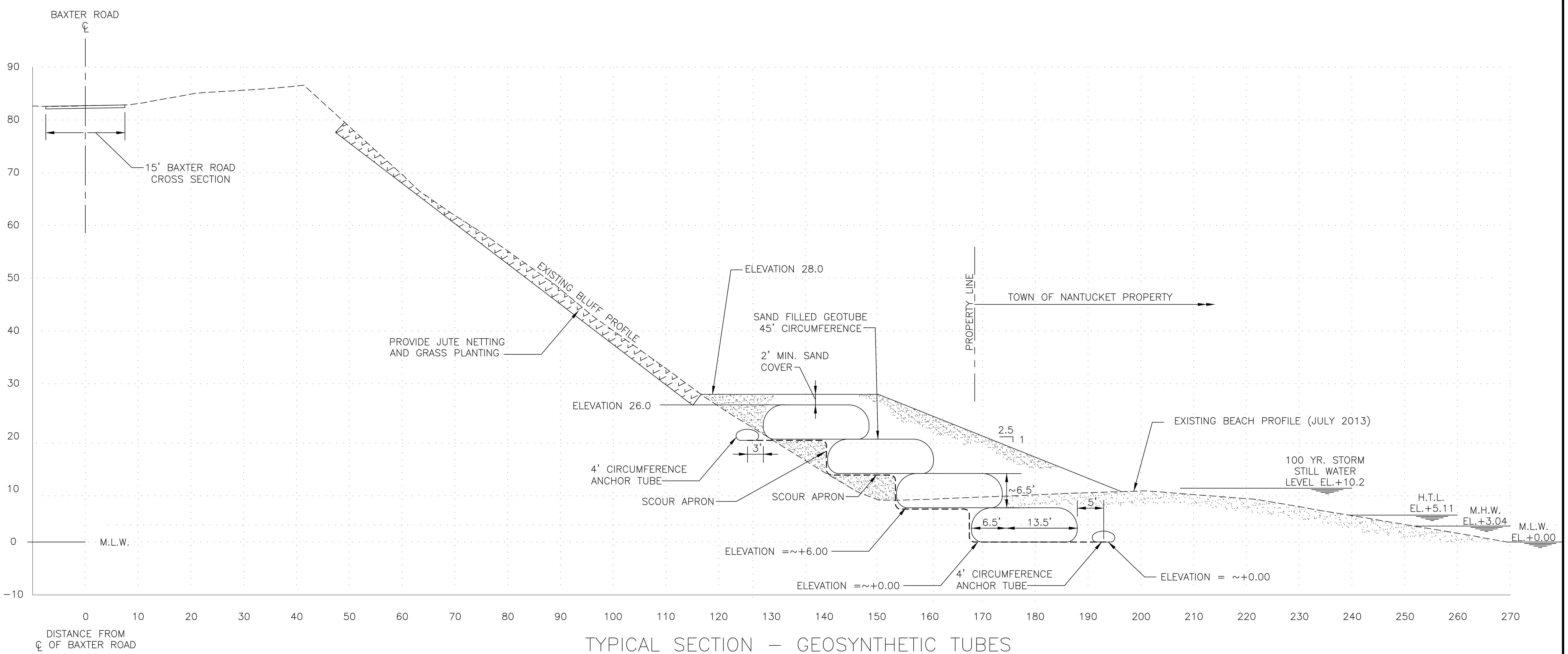
SCALE: 1" = 200'

DATE: OCT. 25, 2013

PROJECT NO. 2967-11

SHEET NO. 3 OF 9

SHEET NAME: GEN



TYPICAL SECTION – GEOSYNTHETIC TUBES

GENERAL NOTES

1. THIS GEOTEXTILE TUBE SLOPE PROTECTION IS SUBMITTED FOR TEMPORARY SHORT–TERM STABILIZATION OF THE BLUFF ENVIRONMENT AND IS NOT INTENDED TO BE INSTALLED AS A PERMANENT STRUCTURE.
2. ALL ELEVATIONS ARE BASED ON MEAN LOW WATER DATUM (M.L.W.=0.0').
3. GEOTEXTILE TUBES SHALL OVERLAP IN STEPPED LAYERS WITH THE WIDTH OVERLAPPED TO PROVIDE AN EFFECTIVE SLOPE OF 2:1.
4. SLOPE OF GEOTEXTILE TUBE STACK SHALL NOT BE STEEPER THAN 1:2.
5. GEOTEXTILE TUBE FABRIC SHALL BE MACCAFERRI MACTUBE OS 500, OR APPROVED EQUAL, WITH EITHER A COMPOSITE OR SHROUD ATTACHED TO THE TOP OF THE GEOTEXTILE TUBE WHERE EXPOSED TO ELEMENTS.
6. SCOUR APRON SHALL BE APPROXIMATELY 60' WIDE SO AS TO EXTEND ALONG THE BOTTOM CONTOUR OF STACKED GEOTEXTILE TUBE CONFIGURATION.
7. SAND BACKFILL SHALL BE PLACED IN 12" LIFTS AND COMPACTED PRIOR TO PLACEMENT OF UPPER GEOTEXTILE TUBE LAYER, SO AS TO PROVIDE A FLAT STABLE BENCH FOUNDATION FOR THE GEOTEXTILE TUBE INSTALLATION.
8. CONTRACTOR SHALL UTILIZE CONSTRUCTION TECHNIQUES WHICH ELIMINATE THE POSSIBILITY OF RIPPING/PUNCTURING GEOTEXTILE TUBE SYSTEM.

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TYPICAL CROSS SECTION - TEMPORARY SLOPE STABILIZATION

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

DESIGNED	DRAWN	CHECKED
RSD	SMW	---

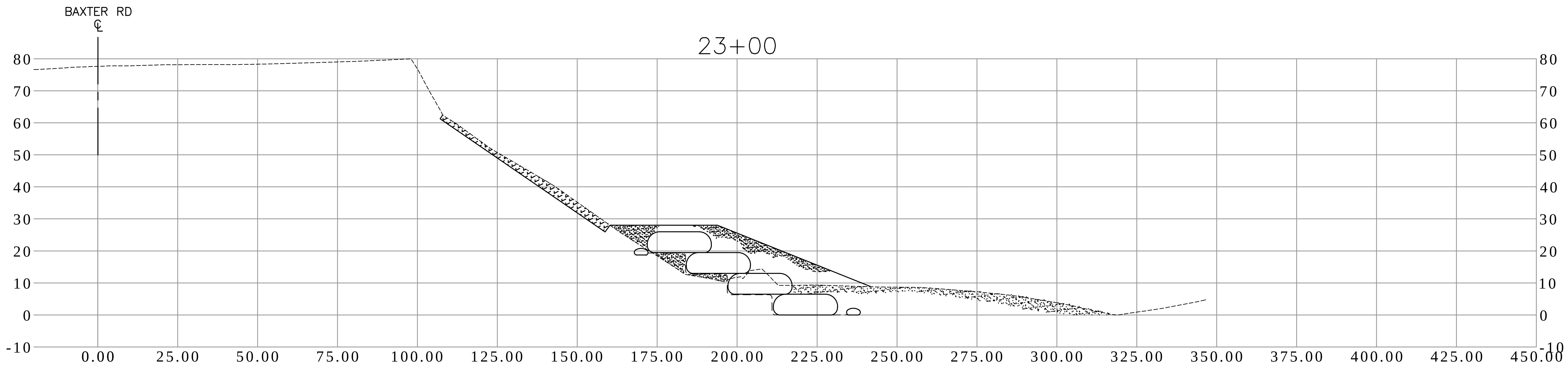
SCALE: HOR: 1" = 20' VERT: 1" = 20'

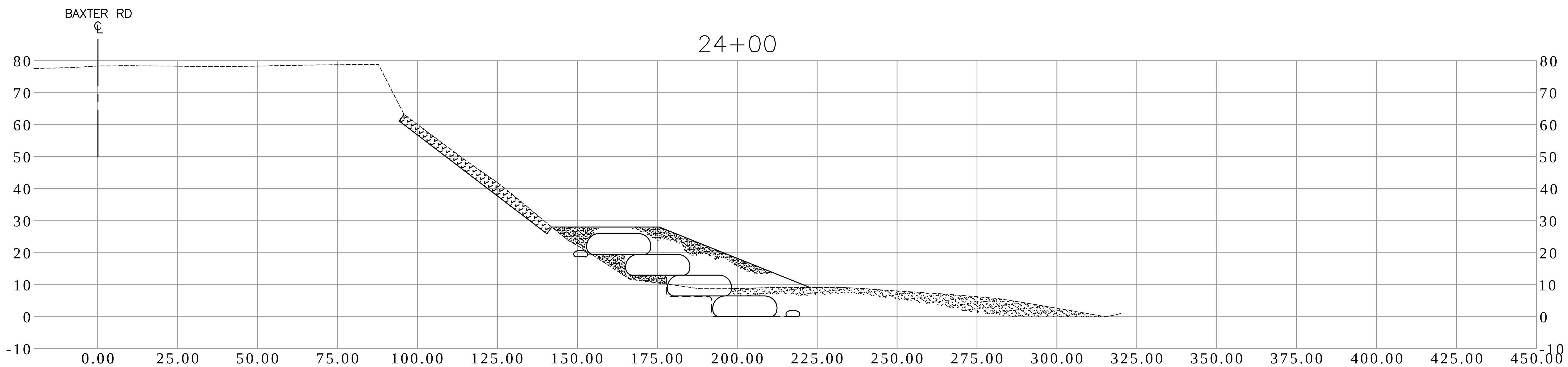
DATE: OCT. 25, 2013

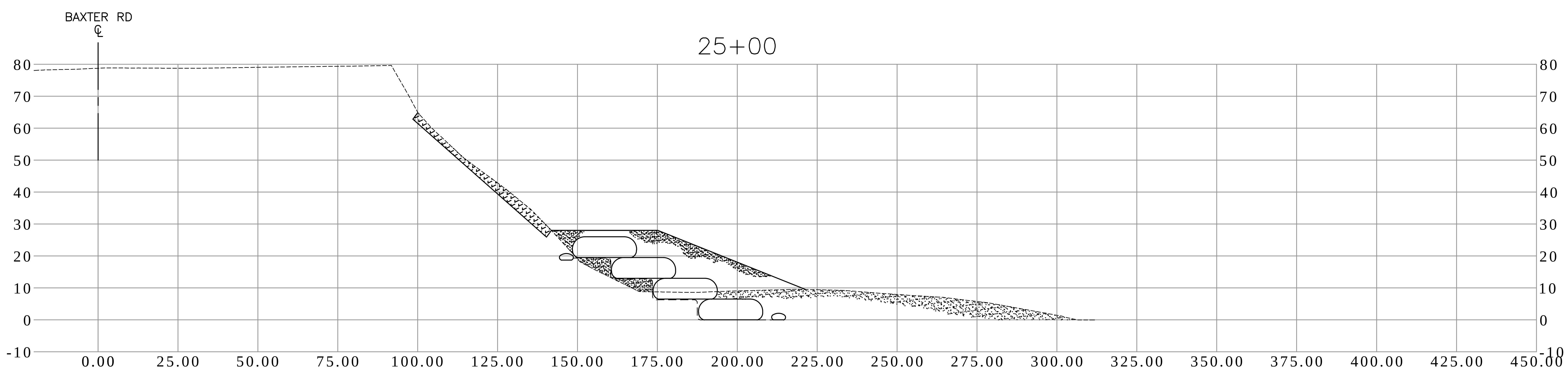
PROJECT NO.: 2967-11

SHEET NO.: 4 OF 9

SHEET NAME: TYP







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DESCRIPTION	DATE	BY

CROSS SECTIONS - TEMPORARY SLOPE STABILIZATION

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

RSD (DESIGNED)	SMW (DRAWN)	--- (CHECKED)

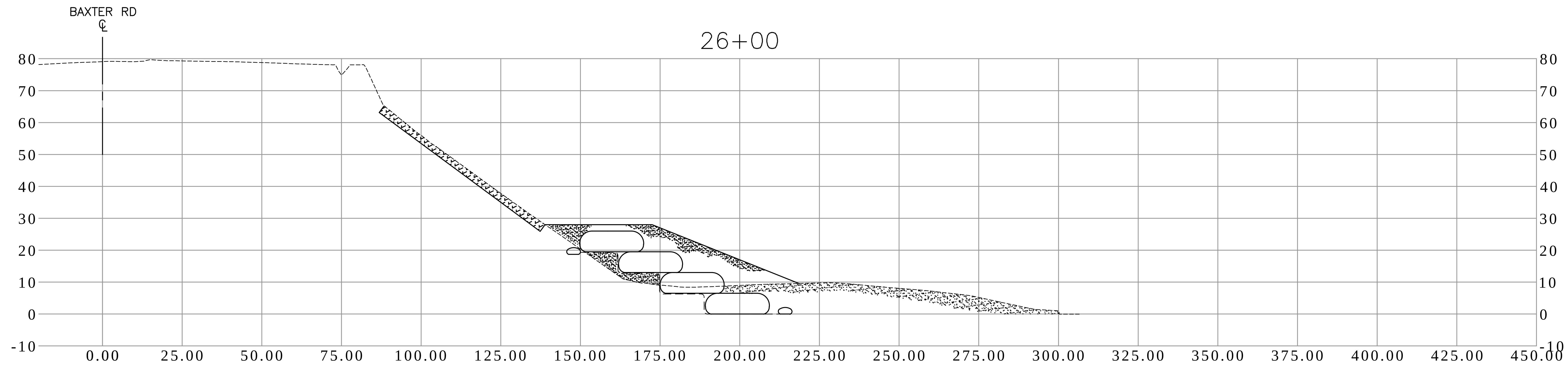
SCALE: HOR: 1" = 40' VERT: 1" = 40'

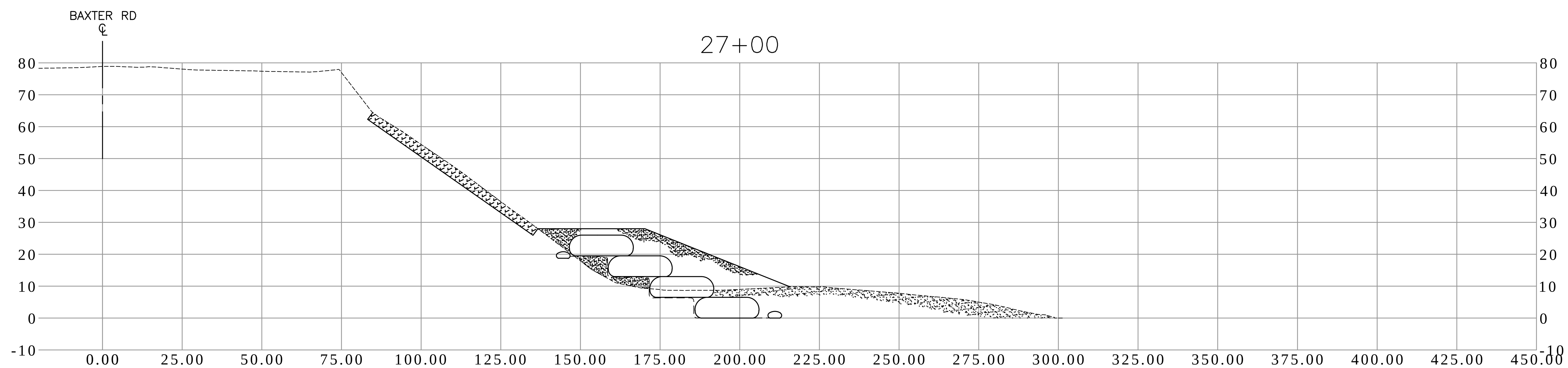
DATE: OCT. 25, 2013

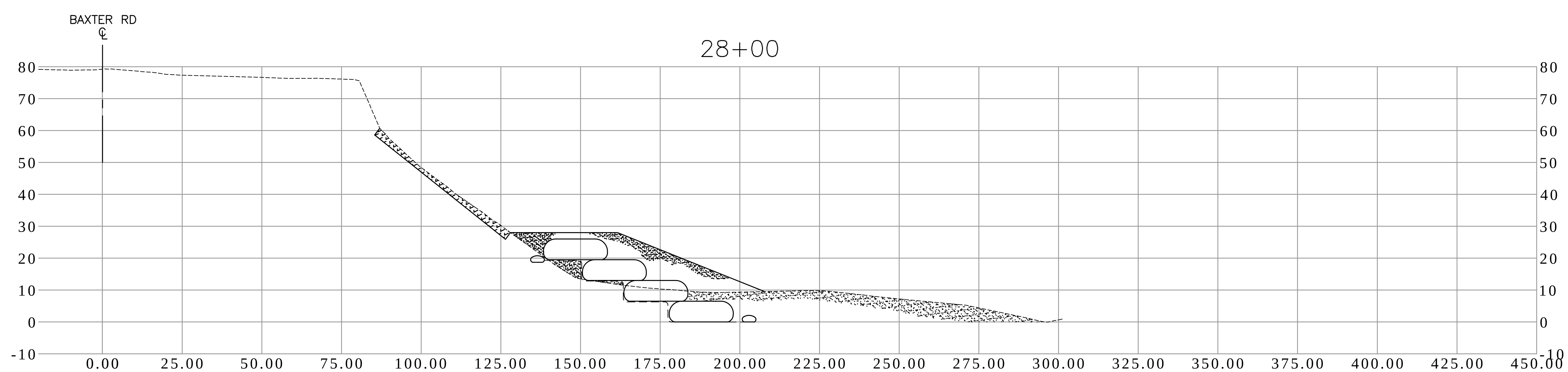
PROJECT NO. 2967-11

SHEET NO. 5 OF 9

SHEET NAME: X-SECTION







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CROSS SECTIONS - TEMPORARY SLOPE STABILIZATION

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

RSD	SMW	---
DESIGNED	DRAWN	CHECKED

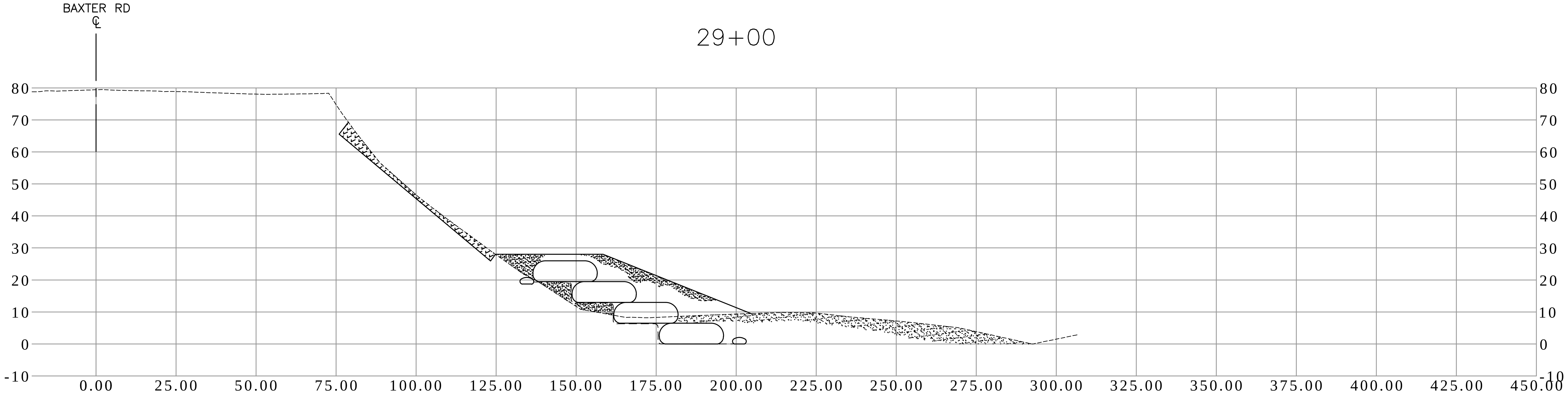
SCALE: HOR: 1" = 40' VERT: 1" = 40'

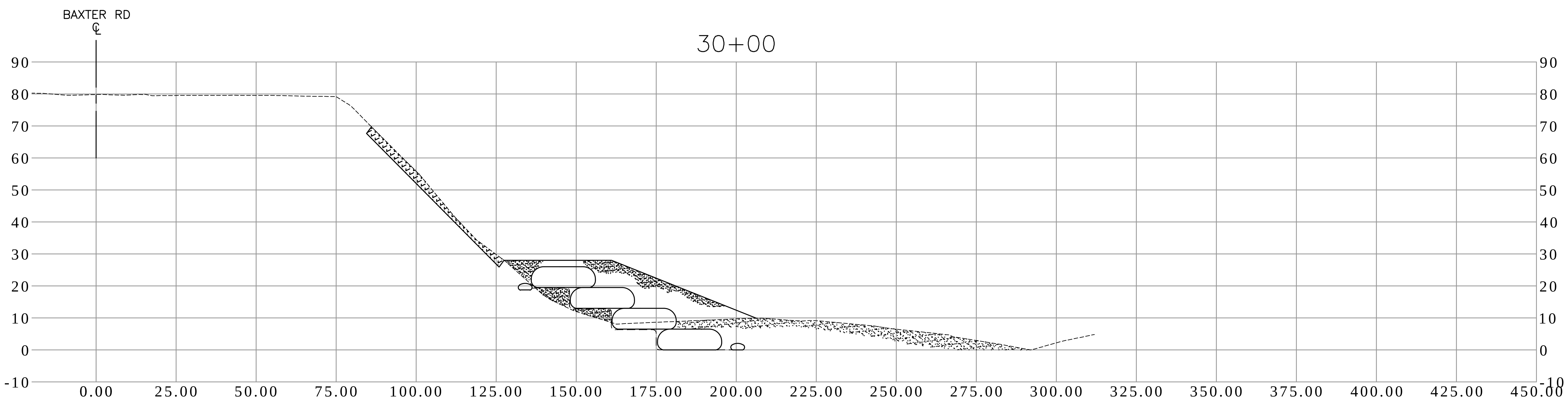
DATE: OCT. 25, 2013

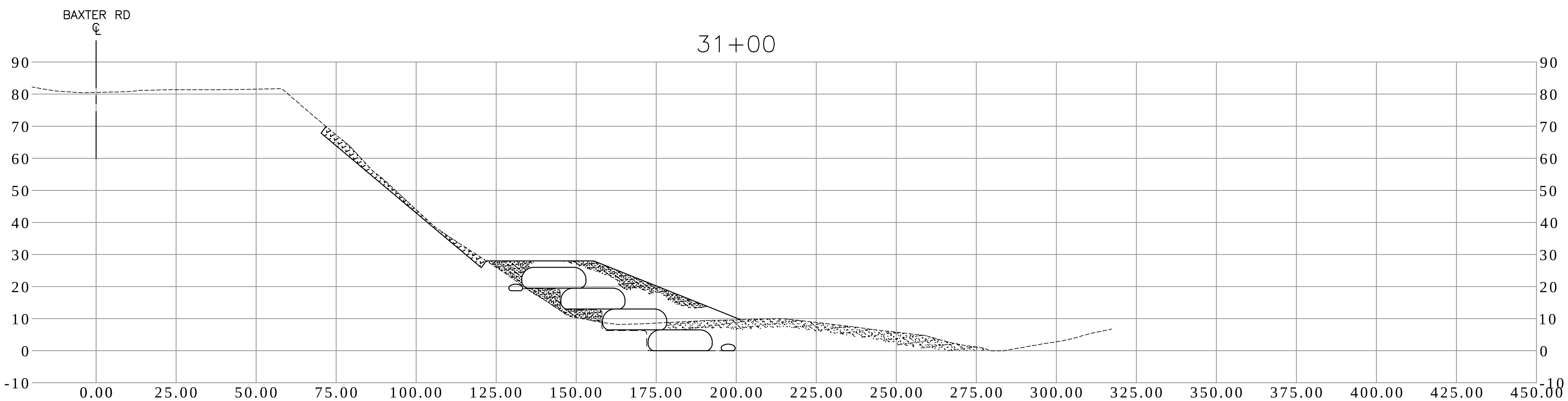
PROJECT NO.: 2967-11

SHEET NO.: 6 OF 9

SHEET NAME: X-SECTION







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CROSS SECTIONS - TEMPORARY SLOPE STABILIZATION

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

DESIGNED	DRAWN	CHECKED
RSD	SMW	---

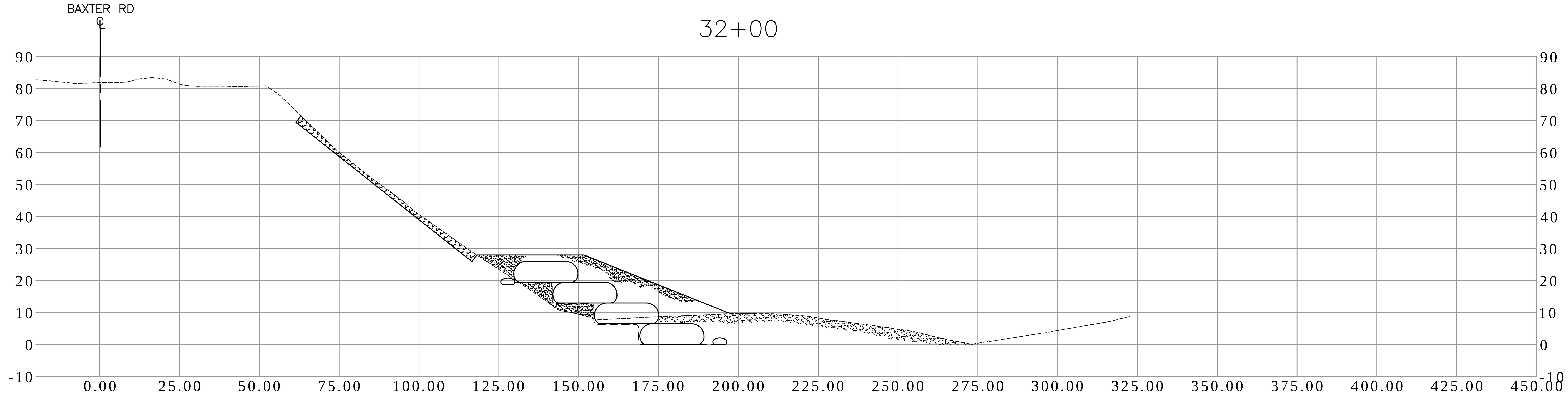
SCALE: HOR: 1" = 40' VERT: 1" = 40'

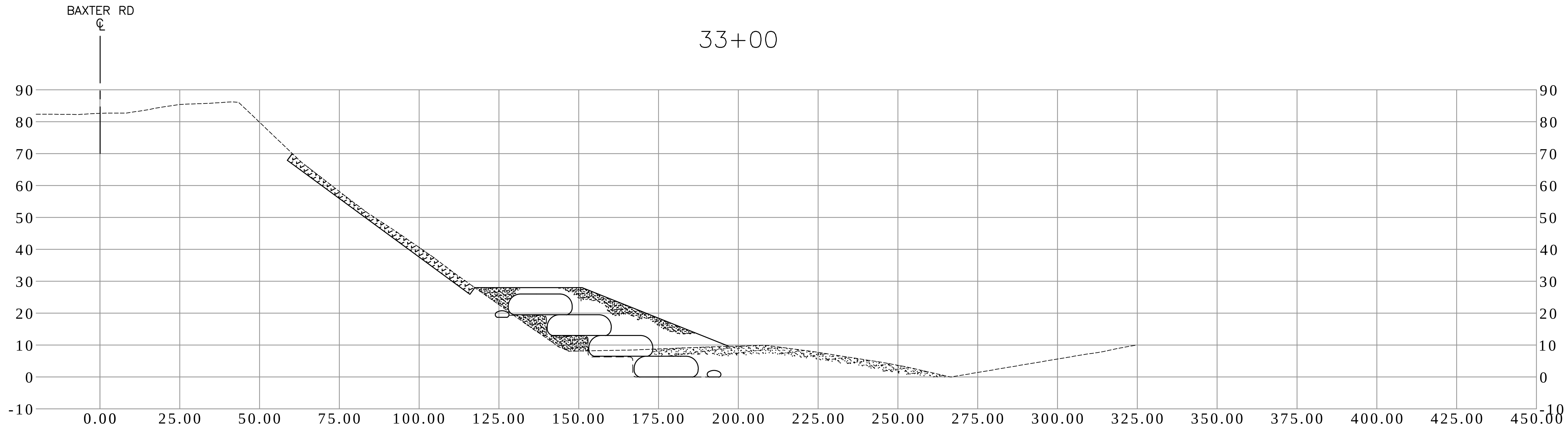
DATE: OCT. 25, 2013

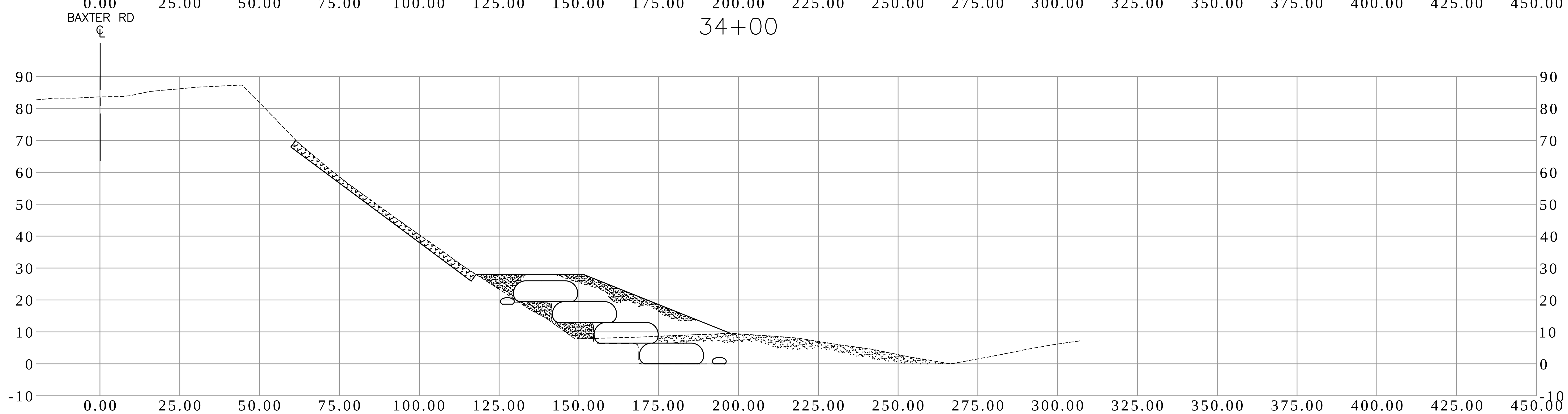
PROJECT NO. 2967-11

SHEET NO. 7 OF 9

SHEET NAME: **X-SECTION**







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0' 10' 20'
0 1/4" 1/2"

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CROSS SECTIONS - TEMPORARY SLOPE STABILIZATION

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

DESIGNED	DRAWN	CHECKED
RSD	SMW	---

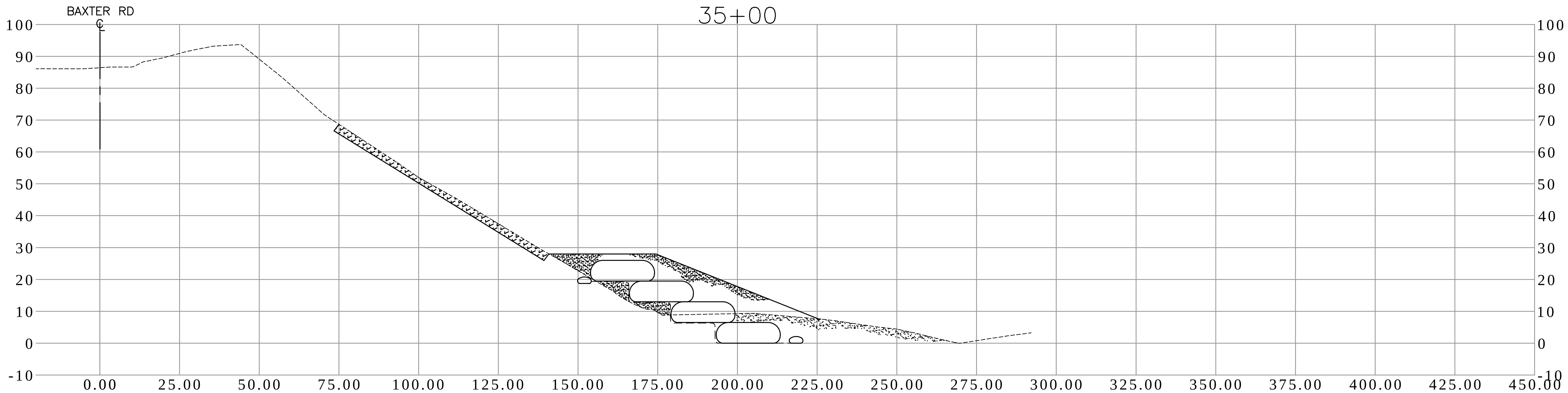
SCALE: HOR: 1" = 40'
VERT: 1" = 40'

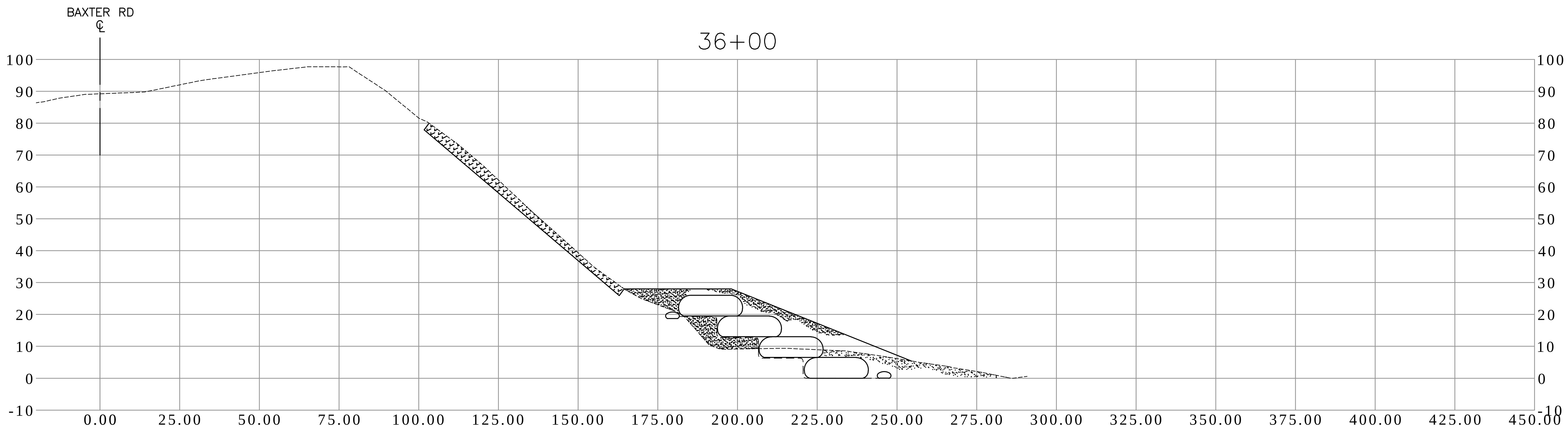
DATE: OCT. 25, 2013

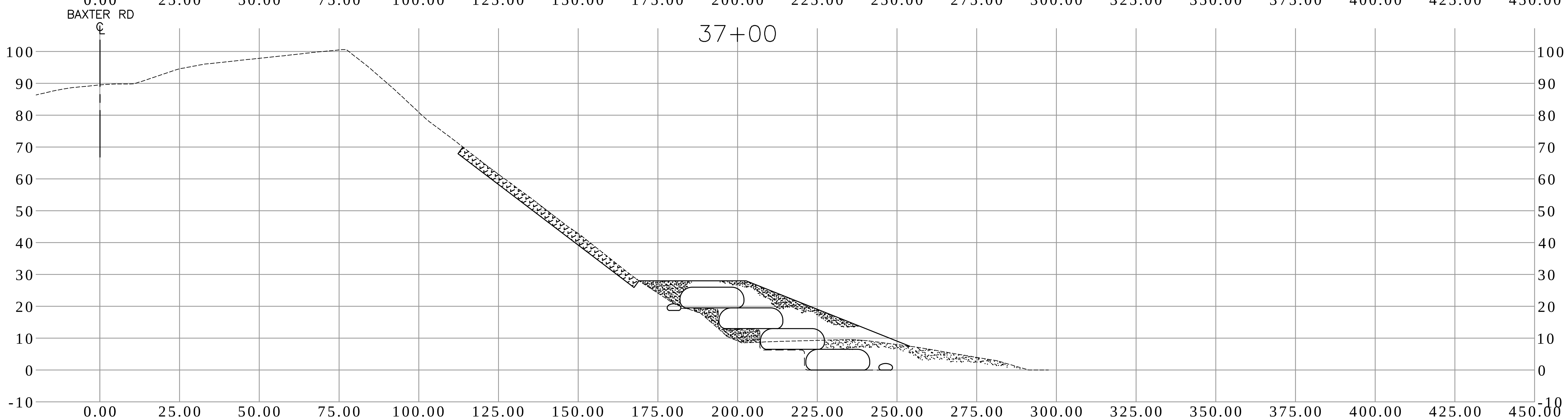
PROJECT NO.: 2967-11

SHEET NO.: □OF 9

SHEET NAME: X-SECTION







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DESCRIPTION	DATE	BY

CROSS SECTIONS - TEMPORARY SLOPE STABILIZATION

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

RSD	SMW	---
DESIGNED	DRAWN	CHECKED

SCALE: HOR: 1" = 40' VERT: 1" = 40'

DATE: OCT. 25, 2013

PROJECT NO.: 2967-11

SHEET NO.: 9 OF 9

SHEET NAME: X-SECTION

Attachment A
Baxter Road Stabilization Alternatives Analysis

MEMORANDUM

TO: Kara Buzanoski, Director of Public Works, Town of Nantucket

FROM: Nicolle Burnham, Milone & MacBroom, Inc.

DATE: October 1, 2013

RE: Alternatives Analysis Summary
Baxter Road Temporary Stabilization
Nantucket, Massachusetts
MMI #2967-11

Per request of the town of Nantucket, Milone & MacBroom, Inc. has evaluated potential methods of stabilizing Baxter Road to protect access to private residences and existing sewer and water utilities located beneath the roadway. As noted on our memorandum of September 24, 2013 the goal of this current effort is to maintain vehicular access and utility service to the residential properties on Baxter Road from Bayberry Lane north to the Sankaty Head Lighthouse. The project limits evaluated by MMI are limited to those areas where Baxter Road appears in imminent danger of failure from bank failure. Specifically, our project area extends from 85 to 91 Baxter Road and from 99 to 107.

Design Criteria
For the purposes of MMI's work, measures installed will be considered temporary and intended to provide some level of protection for the short term, while long term solutions are considered by the SBPF and the town. The town has requested that the measures implemented under MMI's work consider a three year life. Given the varied erosion rates from year to year it is not possible to guarantee a specific design life of any stabilization measure here.

After considering the project site and having discussions with Haley & Aldrich, who has performed geotechnical evaluations on behalf of SBPF, we evaluated four potential stabilization methods:

1. Steel sheet piling along the toe of the bluff
2. Steel sheet piling along the top of the bluff (adjacent to Baxter Road)
3. Geotubes along the toe of the bluff
4. Grout injections for soil stabilization beneath the glacial till layer

Attached please find a matrix that compares each alternative, a plan view that depicts the installation location of each, and cross sections views that detail each alternative. Each alternative is described below.

Alternate 1
This alternate would entail driving steel sheet piling along the toe of the bluff for a distance of approximately 1720 feet, essentially through the project sections defined above, and to a depth of approximately 20 feet. The sheet piling would serve to protect the toe of slope from erosion due to wave action. To maintain this system, sand may have to be replaced along the waterward face of sheeting periodically as erosion occurs. Construction would result in steel sheeting being visible from the existing ground surface to elevation 22.0, with an average exposed height of five feet. Not only would this create less than desirable aesthetics, the sheeting would create an unnatural physical barrier paralleling the shoreline. The bulkhead would likely be capped with poured-in-place concrete. This option, focusing on

addressing the toe of slope, is considered technically feasible but costly and unlikely to be permitted by the Town's Conservation Commission.

Alternate 2

The second alternative would involve driving steel sheet piling along the edge of Baxter Road, or the edge of the town-owned roadway right-of-way, generally to the limits described above. The intent is to protect the town-owned infrastructure, rather than address toe failure. The premise behind this alternative is that the sheet piling would support the roadway in the event of a total or partial but significant slope failure. Theoretically this alternative is viable, however considering the practicality of construction and geotechnical limitations of the area, several issues suggest that driving sheeting along the roadway is not feasible. First, the sheets would be very long and difficult to drive through the thick glacial till layer. Additionally, a substantial tieback system would be required, extending under the street and likely conflicting with utilities. The depth of the sheets would be determined, in part, by the assumed retained height based on some failure scenario. Accommodating a complete slope failure would be largely infeasible, and planning for a partial failure would be difficult given the nature of the sandy soil layer along the toe of slope and difficulty in establishing slope stability in conjunction with the sheet piling. Finally, while this alternative attempts to protect the roadway and related infrastructure, it affords no protection for the privately owned properties. For these reasons, this alternative has been deemed infeasible.

Alternative 3

This alternative entails placement of sand-filled geotextile tubes along the toe of slope to provide temporary protection from wave and tidal action. This alternative is largely constructible, the sand fill is readily available, and the option presents a costs effective, short term solution for protecting the toe of slope within the town's study area. In protecting the slope, this treatment may result in short-term slope stabilization. It is critical to understand, however, that these structures could be overtopped and/or undermined even with detailed design consideration. Failure of the geotubes could result in failure of Baxter Road and we cannot predict when this may occur. While these measures are considered temporary, the installation of geotextile tubes can be expected to retard slope failure and can be designed to prevent slope failure from normal tidal events. While there would be some impact to aesthetics, we would anticipate this alternative can be permitted locally, given its temporary nature. For these reasons this alternative is deemed a viable option for the short-term.

Alternative 4

Alternative 4 was presented by Haley & Aldrich (H&A) in our discussions with them. The grout would be injected into the cohesionless sand layer at the toe of the slope and would serve to strengthen or enhance the properties of the otherwise weak soil. From our discussions with H&A and based on their previous findings in the field, the grouted sand layer would be approximately 35 feet thick. The weak sand layer is overlain by a thick glacial till. This material in itself can be stabilized under normal conditions, however given it is founded on the cohesionless underlying sand makes the glacial till susceptible to failure as has been the case. This alternative has the advantage of being low impact when compared to other options, particularly given the fact the grout will be 'invisible' from the surface following construction and restoration of the impacted areas. While this alternative may be cost prohibitive as a temporary solution, we are not dismissing this option and recommend it be studied further.

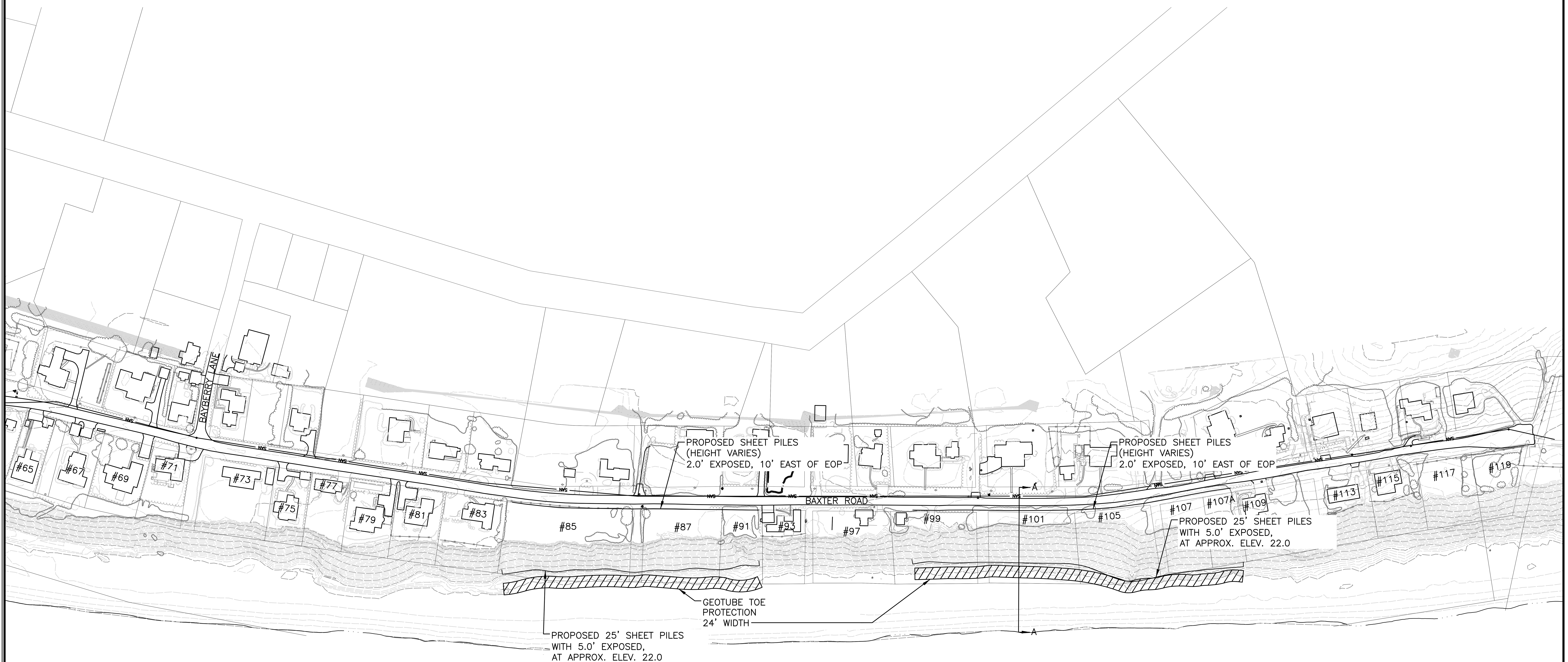
Discussion on Alternatives

After discussing this project with Haley and Aldrich we find that the selected alternative for short-term improvements should be one which, at a minimum, protects the cohesionless sand layer along the toe of the slope. Ideally the best long term solution should be one which stabilizes the cohesionless sand layer more permanently. Based on these principles, Alternative 2 has been deemed infeasible. Haley & Aldrich prepared a memorandum detailing this further in a memorandum to SBPF dated September 27, 2013. Based on where our investigations have led us thus far, we recommend the town pursue Alternative 3, sand filled geotextile tubes at the toe of slope, to provide short-term protection while long term solutions are further explored.

Further Discussion
In reviewing the slope stability analysis completed by Haley & Aldrich in 2007 and their memorandum of September 27, 2013 we note that their conclusions indicate that the slope would be stable at and approximately 40 degree angle. The current slope in our project area ranges from 31 to 40 degrees with some sections near the top of slope as steep as 56 to 68 degrees. The implication is that the top of the slope in our project area is inherently unstable, even with toe protection. In 2007 Haley & Aldrich recommended toe stabilization combined with flattening the slope as the appropriate means of stabilizing this area. None of the options we evaluated suggest grading the slope. In our opinion we need to make the town aware of this issue, but we would not use a lack of proposed grading as a means to delay short term toe revetment installation. Without doing anything the bank will likely fail. By installing the toe revetment the failure may be delayed long enough to develop a long term solution.

In addition to the toe stabilization we recommend that “run-on” to this slope from roadway and lawn drainage and irrigation water be avoided. As the soils at the top of slope become saturated, weight is added to the bank, increasing the instability.

Emergency Preparedness
In a letter to the town dated September 24, 2013 we recommended that emergency planning measures be developed to address emergency access and water and sewer service the Baxter Road in the event that failure occurs. To that end, we suggest the town develop a written action plan to provide physical access, water and sewer facilities to the dwellings on Baxter Road in the event of a failure of one or more of those town-owned facilities. In addition to having a written plan, with buy-in from appropriate emergency and other staff, securing the necessary permissions and/or materials which may be necessary to respond in an emergency situation would obviously improve response time. We understand the town has initiated this process.



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PLAN VIEW - SLOPE STABILIZATION ALTERNATIVES

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

RSD	SW	---
DESIGNED	DRAWN	CHECKED

SCALE: 1" = 100'

DATE: SEPT. 27, 2013

PROJECT NO.: 2967-11

SHEET NO.: 1 OF 6

SHEET NAME

STABILIZATION ALTERNATIVE	DESCRIPTION	ALTERNATIVE ADVANTAGES	ALTERNATIVE DISADVANTAGES	APPROXIMATE CONSTRUCTION ESTIMATE	APPROXIMATE CONSTRUCTION DURATION
ALTERNATIVE #1 STEEL SHEET PILES	SHEET PILES DRIVEN AT TOE OF SLOPE, AT APPROXIMATE ELEVATION 22.0. PILES TO BE 25.0' LONG WITH 5.0' LEFT EXPOSED	SHEETING PROVIDES SOLID PROTECTION FROM UNDERMINING AND EROSION OF TOE THROUGH WAVE ACTION DURING STORMS. PILES INSTALLED IN SAND LENS AT TOE OF SLOPE MORE EASILY INSTALLED. SOIL COMPOSITION REQUIRES LESS IMPACT OR VIBRATION TO REACH DESIRED INSTALLATION DEPTH. INSTALLATION FROM BEACH PROVIDES RESULTS IN FEWER DISRUPTIONS TO BAXTER ROAD VEHICLE TRAFFIC AND LOCAL RESIDENTS.	STEEL SHEETING IS A FORM OF HARD ARMORING EROSION PROTECTION. WAVE REFLECTION MAY BECOME A CONCERN IF THE SAND IN FRONT OF THE SHEETING ERODES. ANY SAND WHICH ERODES FROM IN FRONT OF THE SHEETING WILL NEED TO BE REPLENISHED PRIOR TO REMOVAL OF SHEETING. SAND MAY NEED TO BE REPLENISHED EACH SPRING. CRANE AND OTHER EQUIPMENT WILL REQUIRE ADDITIONAL MOBILIZATION TO REMOVE PILES. MATERIAL/EQUIPMENT WILL NEED TO BE BARGED TO SHORE. DANGER OF FLANKING AT ENDS.	SHEET PILE ESTIMATE APPROXIMATE TOTAL SHEET PILE WALL LENGTH = 1,270 FT TYPICAL DRIVEN DEPTH = 25.0 FT UNIT PRICE = $50/SF INSTALLED SHEETING COST = $1,587,500 SAND REPLENISHMENT ESTIMATE TOTAL REPLENISHMENT VOLUME = 6,600 CY UNIT PRICE = $50/CY SAND REPLENISHMENT COST = $330,000 (PER APPLICATION) TOTAL ESTIMATED COST = $1,917,500	ESTIMATED DAILY OUTPUT = 1000 SF PER 8 HOUR DAY TOTAL BURIED SHEETING SQUARE FOOTAGE = 28,575 SF ESTIMATED CONSTRUCTION DURATION = 29 WORK DAYS
ALTERNATIVE #2 STEEL SHEET PILES	SHEET PILES DRIVEN AT THE TOP OF SCONSET BLUFF, APPROXIMATELY 10' EAST OF THE EASTERN EDGE OF BAXTER ROAD.	SHEETING CAN BE INSTALLED FROM THE TOP OF THE BLUFF, ELIMINATING THE NEED TO BARGE EQUIPMENT ONTO THE BEACH. SHEETING SHOULD PREVENT SUDDEN CATASTROPHIC COLLAPSE OF BAXTER ROAD AND EXISTING UTILITIES SHOULD THE BLUFF ERODE AND RETREAT TOWARDS THE ROADWAY.	TO PREVENT GLOBAL FAILURE OF THE SLOPE PILES WILL NEED TO HAVE A LENGTH OF 80 FT OR MORE. INSTALLATION IS IN CLOSE PROXIMITY TO RESIDENCES. DUE TO THE DENSE SOIL COMPOSITION AT THE TOP OF THE BLUFF THE SHEET PILES WILL NEED TO BE HAMMERED INTO THE GROUND. THIS INSTALLATION TECHNIQUE WILL BE DISRUPTIVE TO RESIDENTS. DRIVING OF PILES IN CLOSE PROXIMITY TO EXISTING WATER MAIN ALONG BAXTER ROAD COULD CREATE UNSEEN DAMAGE AND/OR LEAKS. SHEET PILE INSTALLATION AT TOP OF BLUFF DOES NOT PREVENT/RETARD EROSION AT THE TOE OF THE SLOPE. IF THE SLOPE FAILS UP TO THE SHEET PILES FUTURE REMOVAL MAY BECOME DIFFICULT/IMPOSSIBLE. CRANE WILL NEED TO BE INSTALLED WITHIN BAXTER ROAD, BLOCKING ACCESS TO AREAS TO THE NORTH.	SHEET PILE ESTIMATE APPROXIMATE TOTAL SHEET PILE WALL LENGTH = 1,160 FT TYPICAL DRIVEN DEPTH = 80 FT UNIT PRICE = $50/SF INSTALLED SHEETING COST = $4,640,000 TOTAL ESTIMATED COST = $4,640,000	ESTIMATED DAILY OUTPUT = 750 SF PER 8 HOUR DAY TOTAL BURIED SHEETING SQUARE FOOTAGE = 92,800 SF ESTIMATED CONSTRUCTION DURATION = 124 WORK DAYS
ALTERNATIVE #3 SAND-FILLED GEOTUBES	LARGE GEOTEXTILE TUBE FILLED WITH SAND. INSTALLED AT TOE OF SLOPE TO PROTECT AGAINST UNDERMINING OF SAND TOE.	INSTALLATION MATERIAL (OTHER THAN GEOTUBE) IS AVAILABLE ON ISLAND. INSTALLATION CAN BE COMPLETED WITH A RELATIVELY SMALL WORK CREW IN A VERY SHORT TIMEFRAME IN A COST-EFFECTIVE MANNER. TOE SCOUR IS PREVENTED BY THE ADDITION OF A GEOTEXTILE FABRIC WING WHICH IS PART OF THE GEOTUBE SYSTEM. REMOVAL OF GEOTUBE AT COMPLETION OF TEMPORARY STABILIZATION REQUIRES ONLY THE REMOVAL OF GEOTEXTILE FABRIC. SAND FILLING COULD REMAIN ON BEACH, IF DESIRED, WHICH COULD BE USED FOR FUTURE REPLENISHMENT.	GEOTEXTILE FABRIC COULD BE TORN BY LARGE DEBRIS CONTAINED WITHIN STORM WAVES. SAND BACKFILL MAY NEED TO BE REPLENISHED AFTER EACH STORM SEASON. SAND DELIVERY SYSTEM AT TOP OF BLUFF (CRANE W/HOPPER, CONVEYOR BELT, ETC.) COULD BE DISRUPTIVE TO RESIDENTS. DANGER OF FLANKING AT ENDS OF GEOTUBE.	GEOTUBE ESTIMATE APPROXIMATE TOTAL GEOTUBE LENGTH = 1,220 FT UNIT PRICE = $560/LF INSTALLED GEOTUBE COST = $683,200 SAND BACKFILL ESTIMATE TOTAL BACKFILL VOLUME = 4,300 CY UNIT PRICE = $50/CY SAND BACKFILL COST = $215,000 TOTAL ESTIMATED COST = $898,200	ESTIMATED DAILY OUTPUT = 150 FT PER 8 HOUR DAY APPROXIMATE TOTAL GEOTUBE LENGTH = 1,220 SF ESTIMATED CONSTRUCTION DURATION = 9 WORK DAYS
ALTERNATIVE #4 GROUT INJECTION	SHAFTS ARE DRILLED INTO THE SLOPE FROM THE TOE UPWARD, FOLLOWED BY PRESSURE INJECTION OF GROUT WHICH HARDENS/STRENGHTENS THE WEAK SAND AT THE BASE OF THE SLOPE.	WEAK SAND LAYER AT BASE OF BLUFF IS HARDENED, INCREASING ITS RESISTANCE TO EROSION DUE TO STORM WAVE ACTION. GROUTING CAN BE COMPLETED FROM THE BEACH, ELIMINATING POTENTIAL IMPACTS TO RESIDENTS. GROUT COMPOSITION DOES NOT CHANGE THE APPEARANCE OF SAND. GROUTED SECTION SHOULD NOT REQUIRE ANY MAINTENANCE.	TO ADEQUATELY STRENGTHEN THE SLOPE, GROUTING WOULD BE REQUIRED OVER A RELATIVELY LARGE AREA (35 FT HEIGHT X 35 FT DEPTH). SOIL GROUTING NEEDS TO BE USED IN TANDEM WITH ADDITIONAL SLOPE STABILIZATION TO PROTECT AGAINST WAVE SCOUR (E.G. GEOTUBE). MATERIAL/EQUIPMENT WILL NEED TO BE BARGED ONTO THE BEACH FOR INSTALLATION. GROUT COMPOSITION NEEDS TO BE CUSTOMIZED BASED ON EXISTING SOIL CONDITIONS, INCREASING LEAD TIME. ESTIMATED CONSTRUCTION DURATION IS EXCESSIVE BASED ON PROJECT NEEDS.	GROUT INJECTION ESTIMATE APPROXIMATE GROUT CROSS SECTIONAL VOLUME = 80 CY/FT TOTAL GROUTED SLOPE LENGTH = 1,220 FT UNIT PRICE = $375/CY INSTALLED GROUTING COST = $36,600,000 GEOTUBE ESTIMATE INSTALLED GEOTUBE COST (FROM ABOVE) = $845,950 TOTAL ESTIMATED COST = $37,445,950	ESTIMATED DAILY OUTPUT = 500 CY PER 8 HOUR DAY TOTAL GROUTED VOLUME = 97,600 CY ESTIMATED CONSTRUCTION DURATION = 196 WORK DAYS

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TYPICAL CROSS SECTION - SLOPE STABILIZATION

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

DESIGNED	DRAWN	CHECKED
RSD	SW	---

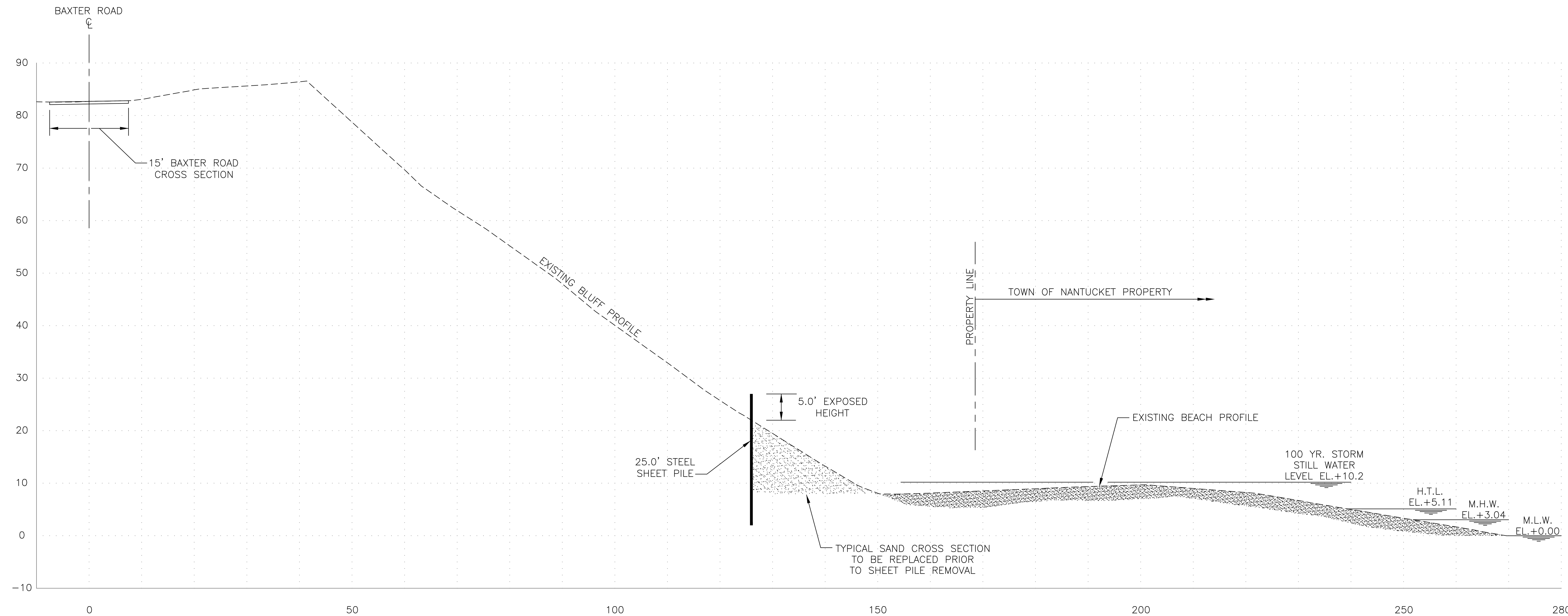
SCALE: N.T.S.

DATE: SEPT. 27, 2013

PROJECT NO.: 2967-11

SHEET NO.: 2 OF 6

SHEET NAME: **MATRIX**



SECTION A–A: ALTERNATIVE 1

STABILIZATION ALTERNATIVE	DESCRIPTION	ALTERNATIVE ADVANTAGES	ALTERNATIVE DISADVANTAGES	APPROXIMATE CONSTRUCTION ESTIMATE	APPROXIMATE CONSTRUCTION DURATION
ALTERNATIVE #1 STEEL SHEET PILES	SHEET PILES DRIVEN AT TOE OF SLOPE, AT APPROXIMATE ELEVATION 22.0. PILES TO BE 25.0' LONG WITH 5.0' LEFT EXPOSED	SHEETING PROVIDES SOLID PROTECTION FROM UNDERMINING AND EROSION OF TOE THROUGH WAVE ACTION DURING STORMS. PILES INSTALLED IN SAND LENS AT TOE OF SLOPE MORE EASILY INSTALLED. SOIL COMPOSITION REQUIRES LESS IMPACT OR VIBRATION TO REACH DESIRED INSTALLATION DEPTH. INSTALLATION FROM BEACH PROVIDES RESULTS IN FEWER DISRUPTIONS TO BAXTER ROAD VEHICLE TRAFFIC AND LOCAL RESIDENTS.	STEEL SHEETING IS A FORM OF HARD ARMORING EROSION PROTECTION. WAVE REFLECTION MAY BECOME A CONCERN IF THE SAND IN FRONT OF THE SHEETING ERODES. ANY SAND WHICH ERODES FROM IN FRONT OF THE SHEETING WILL NEED TO BE REPLENISHED PRIOR TO REMOVAL OF SHEETING. SAND MAY NEED TO BE REPLENISHED EACH SPRING. CRANE AND OTHER EQUIPMENT WILL REQUIRE ADDITIONAL MOBILIZATION TO REMOVE PILES. MATERIAL/EQUIPMENT WILL NEED TO BE BARGED TO SHORE. DANGER OF FLANKING AT ENDS.	SHEET PILE ESTIMATE APPROXIMATE TOTAL SHEET PILE WALL LENGTH = 1,270 FT TYPICAL DRIVEN DEPTH = 25.0 FT UNIT PRICE = $50/SF INSTALLED SHEETING COST = $1,587,500 SAND REPLENISHMENT ESTIMATE TOTAL REPLENISHMENT VOLUME = 6,600 CY UNIT PRICE = $50/CY SAND REPLENISHMENT COST = $330,000 (PER APPLICATION) TOTAL ESTIMATED COST = $1,917,500	ESTIMATED DAILY OUTPUT = 1000 SF PER 8 HOUR DAY TOTAL BURIED SHEETING SQUARE FOOTAGE = 28,575 SF ESTIMATED CONSTRUCTION DURATION = 29 WORK DAYS

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DESCRIPTION	DATE	BY

TYPICAL CROSS SECTION - SLOPE STABILIZATION - ALTERNATIVE 1

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

DESIGNED	DRAWN	CHECKED
RSD	SW	---

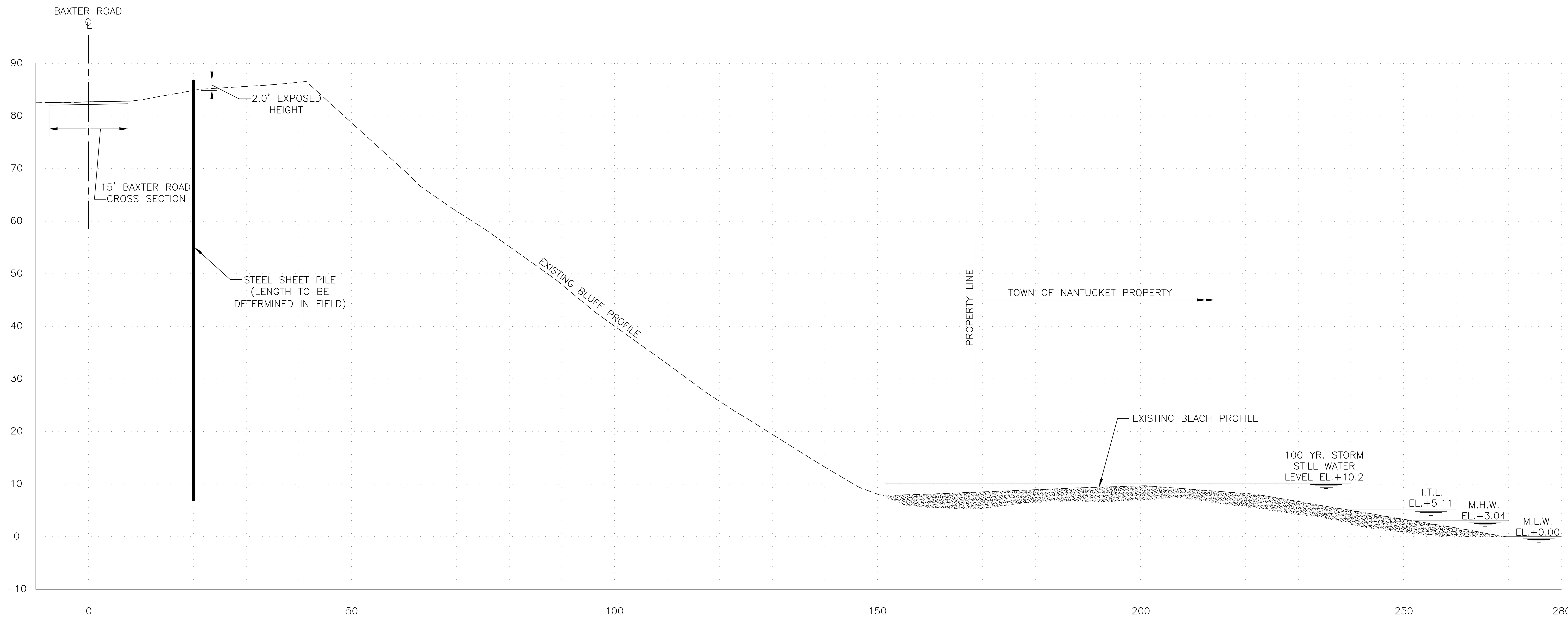
SCALE: 1" = 10'

DATE: SEPT. 27, 2013

PROJECT NO.: 2967-11

SHEET NO.: 3 OF 6

SHEET NAME: ALT 1



SECTION A–A: ALTERNATIVE 2

STABILIZATION ALTERNATIVE	DESCRIPTION	ALTERNATIVE ADVANTAGES	ALTERNATIVE DISADVANTAGES	APPROXIMATE CONSTRUCTION ESTIMATE	APPROXIMATE CONSTRUCTION DURATION
<u>ALTERNATIVE #2</u> STEEL SHEET PILES	SHEET PILES DRIVEN AT THE TOP OF SCONSET BLUFF, APPROXIMATELY 10' EAST OF THE EASTERN EDGE OF BAXTER ROAD.	SHEETING CAN BE INSTALLED FROM THE TOP OF THE BLUFF, ELIMINATING THE NEED TO BARGE EQUIPMENT ONTO THE BEACH. SHEETING SHOULD PREVENT SUDDEN CATASTROPHIC COLLAPSE OF BAXTER ROAD AND EXISTING UTILITIES SHOULD THE BLUFF ERODE AND RETREAT TOWARDS THE ROADWAY.	TO PREVENT GLOBAL FAILURE OF THE SLOPE PILES WILL NEED TO HAVE A LENGTH OF 80 FT OR MORE. INSTALLATION IS IN CLOSE PROXIMITY TO RESIDENCES. DUE TO THE DENSE SOIL COMPOSITION AT THE TOP OF THE BLUFF THE SHEET PILES WILL NEED TO BE HAMMERED INTO THE GROUND. THIS INSTALLATION TECHNIQUE WILL BE DISRUPTIVE TO RESIDENTS. DRIVING OF PILES IN CLOSE PROXIMITY TO EXISTING WATER MAIN ALONG BAXTER ROAD COULD CREATE UNSEEN DAMAGE AND/OR LEAKS. SHEET PILE INSTALLATION AT TOP OF BLUFF DOES NOT PREVENT/RETARD EROSION AT THE TOE OF THE SLOPE. IF THE SLOPE FAILS UP TO THE SHEET PILES FUTURE REMOVAL MAY BECOME DIFFICULT/IMPOSSIBLE. CRANE WILL NEED TO BE INSTALLED WITHIN BAXTER ROAD, BLOCKING ACCESS TO AREAS TO THE NORTH.	<u>SHEET PILE ESTIMATE</u> APPROXIMATE TOTAL SHEET PILE WALL LENGTH = 1,160 FT TYPICAL DRIVEN DEPTH = 80 FT UNIT PRICE = $50/SF INSTALLED SHEETING COST = $4,640,000 TOTAL ESTIMATED COST = <u>$4,640,000</u>	ESTIMATED DAILY OUTPUT = 750 SF PER 8 HOUR DAY TOTAL BURIED SHEETING SQUARE FOOTAGE = 92,800 SF ESTIMATED CONSTRUCTION DURATION = <u>124 WORK DAYS</u>

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TYPICAL CROSS SECTION - SLOPE STABILIZATION - ALTERNATIVE 2

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

RSD DESIGNED | SW DRAWN | --- CHECKED

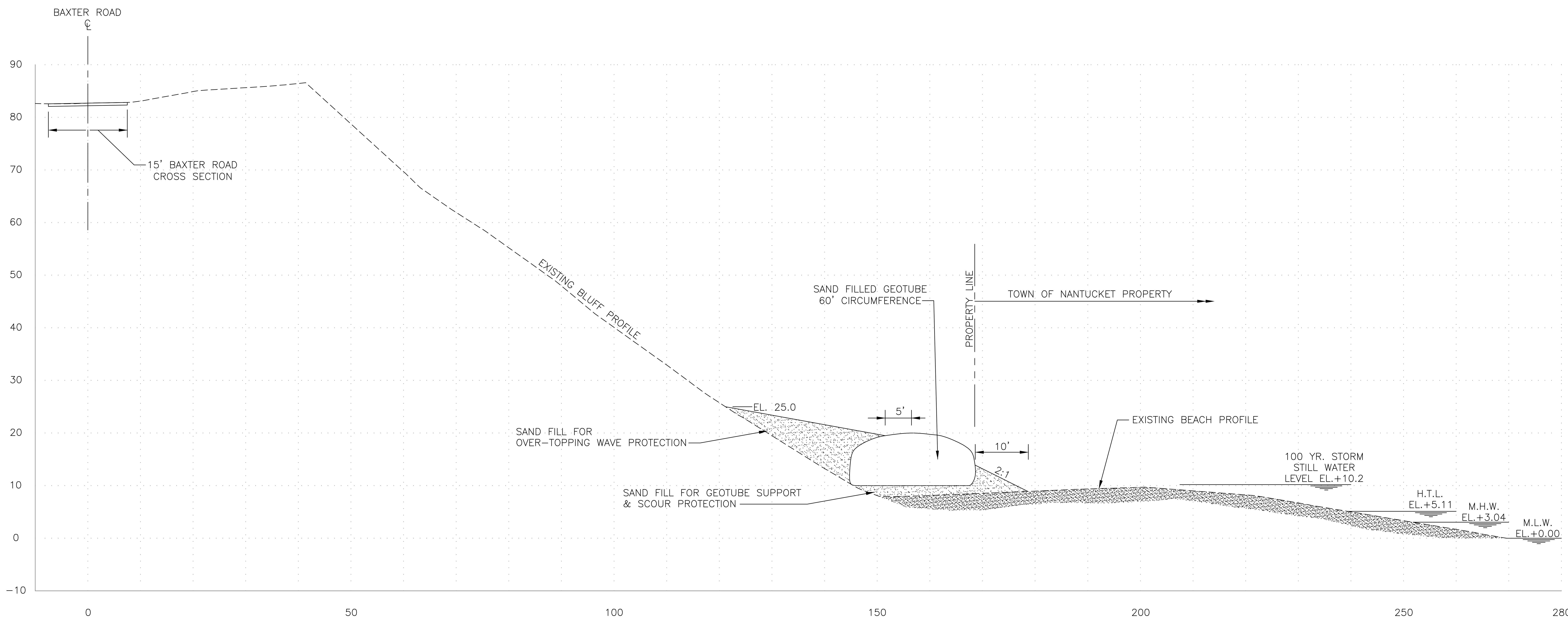
SCALE 1" = 10'

DATE SEPT. 27, 2013

PROJECT NO. 2967-11

SHEET NO. 4 OF 6

ALT 2
SHEET NAME



SECTION A–A: ALTERNATIVE 3

STABILIZATION ALTERNATIVE	DESCRIPTION	ALTERNATIVE ADVANTAGES	ALTERNATIVE DISADVANTAGES	APPROXIMATE CONSTRUCTION ESTIMATE	APPROXIMATE CONSTRUCTION DURATION
<u>ALTERNATIVE #3</u> SAND-FILLED GEOTUBES	LARGE GEOTEXTILE TUBE FILLED WITH SAND. INSTALLED AT TOE OF SLOPE TO PROTECT AGAINST UNDERMINING OF SAND TOE.	INSTALLATION MATERIAL (OTHER THAN GEOTUBE) IS AVAILABLE ON ISLAND. INSTALLATION CAN BE COMPLETED WITH A RELATIVELY SMALL WORK CREW IN A VERY SHORT TIMEFRAME IN A COST-EFFECTIVE MANNER. TOE SCOUR IS PREVENTED BY THE ADDITION OF A GEOTEXTILE FABRIC WING WHICH IS PART OF THE GEOTUBE SYSTEM. REMOVAL OF GEOTUBE AT COMPLETION OF TEMPORARY STABILIZATION REQUIRES ONLY THE REMOVAL OF GEOTEXTILE FABRIC. SAND FILLING COULD REMAIN ON BEACH, IF DESIRED, WHICH COULD BE USED FOR FUTURE REPLENISHMENT.	GEOTEXTILE FABRIC COULD BE TORN BY LARGE DEBRIS CONTAINED WITHIN STORM WAVES. SAND BACKFILL MAY NEED TO BE REPLENISHED AFTER EACH STORM SEASON. SAND DELIVERY SYSTEM AT TOP OF BLUFF (CRANE W/HOPPER, CONVEYOR BELT, ETC.) COULD BE DISRUPTIVE TO RESIDENTS. DANGER OF FLANKING AT ENDS OF GEOTUBE.	<u>GEOTUBE ESTIMATE</u> APPROXIMATE TOTAL GEOTUBE LENGTH = 1,220 FT UNIT PRICE = $560/LF INSTALLED GEOTUBE COST = $683,200 SAND BACKFILL ESTIMATE TOTAL BACKFILL VOLUME = 4,300 CY UNIT PRICE = $50/CY SAND BACKFILL COST = $215,000 TOTAL ESTIMATED COST = <u>$898,200</u>	ESTIMATED DAILY OUTPUT = 150 FT PER 8 HOUR DAY APPROXIMATE TOTAL GEOTUBE LENGTH = 1,220 SF ESTIMATED CONSTRUCTION DURATION = <u>9 WORK DAYS</u>

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TYPICAL CROSS SECTION - SLOPE STABILIZATION - ALTERNATIVE 3

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

DESIGNED	DRAWN	CHECKED
RSD	SW	---

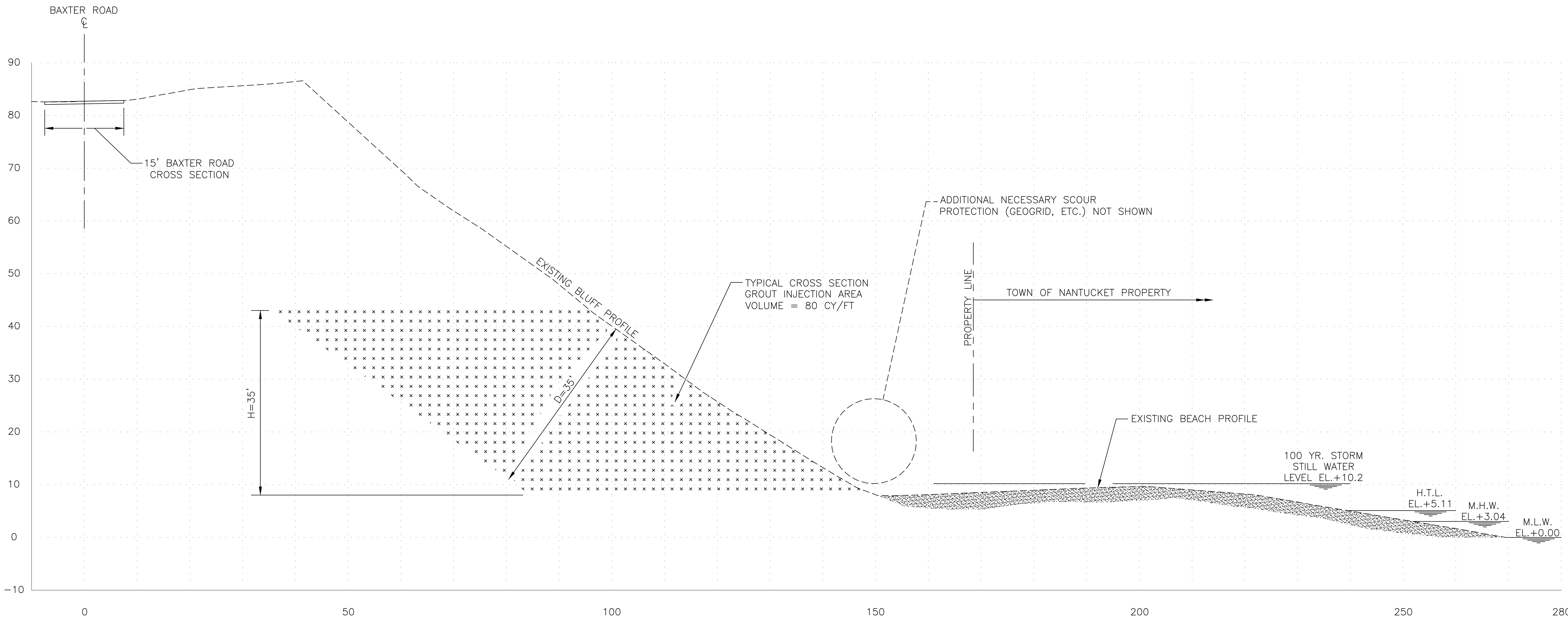
SCALE 1" = 10'

DATE SEPT. 27, 2013

PROJECT NO. 2967-11

SHEET NO. 5 OF 6

SHEET NAME ALT 3



SECTION A–A: ALTERNATIVE 4

STABILIZATION ALTERNATIVE	DESCRIPTION	ALTERNATIVE ADVANTAGES	ALTERNATIVE DISADVANTAGES	APPROXIMATE CONSTRUCTION ESTIMATE	APPROXIMATE CONSTRUCTION DURATION
ALTERNATIVE #4 GROUT INJECTION	SHAFTS ARE DRILLED INTO THE SLOPE FROM THE TOE UPWARD, FOLLOWED BY PRESSURE INJECTION OF GROUT WHICH HARDENS/STRENGHTENS THE WEAK SAND AT THE BASE OF THE SLOPE.	WEAK SAND LAYER AT BASE OF BLUFF IS HARDENED, INCREASING ITS RESISTANCE TO EROSION DUE TO STORM WAVE ACTION. GROUTING CAN BE COMPLETED FROM THE BEACH, ELIMINATING POTENTIAL IMPACTS TO RESIDENTS. GROUT COMPOSITION DOES NOT CHANGE THE APPEARANCE OF SAND. GROUTED SECTION SHOULD NOT REQUIRE ANY MAINTENANCE.	TO ADEQUATELY STRENGTHEN THE SLOPE, GROUTING WOULD BE REQUIRED OVER A RELATIVELY LARGE AREA (35 FT HEIGHT X 35 FT DEPTH). SOIL GROUTING NEEDS TO BE USED IN TANDEM WITH ADDITIONAL SLOPE STABILIZATION TO PROTECT AGAINST WAVE SCOUR (E.G. GEOTUBE). MATERIAL/EQUIPMENT WILL NEED TO BE BARGED ONTO THE BEACH FOR INSTALLATION. GROUT COMPOSITION NEEDS TO BE CUSTOMIZED BASED ON EXISTING SOIL CONDITIONS, INCREASING LEAD TIME. ESTIMATED CONSTRUCTION DURATION IS EXCESSIVE BASED ON PROJECT NEEDS.	GROUT INJECTION ESTIMATE APPROXIMATE GROUT CROSS SECTIONAL VOLUME = 80 CY/FT TOTAL GROUTED SLOPE LENGTH = 1,220 FT UNIT PRICE = $375/CY INSTALLED GROUTING COST = $36,600,000 GEOTUBE ESTIMATE INSTALLED GEOTUBE COST (FROM ABOVE) = $845,950 TOTAL ESTIMATED COST = $37,445,950	ESTIMATED DAILY OUTPUT = 500 CY PER 8 HOUR DAY TOTAL GROUTED VOLUME = 97,600 CY ESTIMATED CONSTRUCTION DURATION = 196 WORK DAYS

MILONE & MACBROOM®
One Financial Plaza
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Springfield, Massachusetts 01103
(413) 241-6920 Fax (413) 241-6911
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DESCRIPTION	DATE	BY

TYPICAL CROSS SECTION - SLOPE STABILIZATION - ALTERNATIVE 4

BAXTER ROAD
SLOPE STABILIZATION

NANTUCKET, MASSACHUSETTS

DESIGNED	DRAWN	CHECKED
RSD	SW	---

SCALE 1" = 10'

DATE SEPT. 27, 2013

PROJECT NO. 2967-11

SHEET NO. 6 OF 6

SHEET NAME ALT 4

Attachment B
Boring Logs


Notes:
1. BASE PLAN DEVELOPED FROM EPSILON ASSOCIATES, INC. FIGURE 1, TITLED "PROPOSED APPROXIMATE LOCATIONS OF SEDIMENT DELIVERY BARGES AND TEMPORARY DISCHARGE TRENCHES, LIGHTHOUSE BEACH, NANTUCKET, MA" DATE 6/30/2004.
2. TOPOGRAPHIC CONTOURS FROM MASS GIS (2003).
3. BASE ORTHOPHOTO FROM MASS GIS (2003).
4. MASS WETLANDS DESIGNATIONS FROM MASS GIS (2007)
5. TEST BORING LOCATIONS BY HALEY & ALDRICH, INC., DRILLED BY GEOLOGIC, INC. JULY 23-27, 2007.
6. TRANSECT LOCATIONS BY HALEY & ALDRICH, INC.
MCQUADE 48-20
GUTTERSON 48-21
KORENGOLD 48-22
FURROW 49-8
B1(OW)
ACCESS ROAD
BAXTER RD
Transect 1: Lugosch North, 85 Baxter Rd.
LUGOSCH 49-35
B2
Transect 2: Lugosch South, 85 Baxter Rd.
RAUCH 49-34
THE BLUFF TRUST 49-33.1
B3
Transect 3: Ritter, 81 Baxter Rd.
RITTER 49-33
B4
WEYMAR 49-32
Transect 4: Posner, 73 Baxter Rd.
POSNER 49-31
OSBORN 49-30
73 BAXTER ROAD TRUST 49-27
BAYBERRY LA
TRANSECTS
BORING LOCATIONS
POST-1978 PROPERTY
PRE-1978 PROPERTY
ELEVATION CONTOURS (2003)
2 Foot Intervals
High Tide Line (4 Feet)
-14 Feet
MASS WETLANDS DESIGNATION (2007)
Coastal Bank, Bluff or Sea Cliff
Coastal Beach
Shrub Swamp
Open Water
N
W
E
S
0
100
200
1 INCH = 100 FEET
HALEY & ALDRICH
TERRACE FAILURE ANALYSIS
SCONSET BEACH PRESERVATION FUND
BAXTER ROAD
NANTUCKET, MA
SITE AND SUBSURFACE EXPLORATION PLAN
SCALE: AS SHOWN
SEPTEMBER 2007
G:\26894\Global\GIS\MapProjects\2007-0829-HAI-FIGURE2.mxd

FIGURE 2

HALEY & ALDRICH

TEST BORING REPORT

Boring No. B1(OW)D/S

Project	TERRACE INSTALLATION FAILURE STUDY NANTUCKET, MA
Client	SCONSET BEACH PRESERVATION FUND C/O NETCO
Contractor	GEOLOGIC, INC.

File No.	26694-001
Sheet No.	1 of 3
Start	July 27, 2007
Finish	July 27, 2007
Driller	C. O'Donnel
H&A Rep.	D. Warren
Elevation	79.0
Datum	MLW
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	3 1/4	1 3/8	--
Hammer Weight (lb)		140	-
Hammer Fall (in.)		30	-

Drilling Equipment and Procedures

Rig Make & Model: Acker Scout Track
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 65.0 ft
Hoist/Hammer: Cat-Head Doughnut Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0	3 4 6 8	S1 9,10	0.0 1.0			SP/ OL-OW	Loose brown poorly graded SAND (SP), intermixed with brown sandy ORGANIC SOIL (OL/OH), mps < 1 mm, no structure, no odor, dry -AEOLIAN/ORGANIC DEPOSITS-				35	35	40				
	9 100/5	S2 6	2.0 2.9		76.5 2.5	SM	Medium dense dark brown (organic), silty SAND (SM), mps < 1 mm, no structure, no odor, moist				25	30	45				
							Similar to above, except very dense -ORGANIC DEPOSITS-				25	30	45				
	52 55	S3 8	4.0 5.0			SP-SM	S3: Very dense dark orange brown, poorly graded SAND with silt (SP-SM), mps 0.5 in., no structure, no odor, moist NOTE: Similar material observed extremely well bonded in-situ in excavation adjacent to borehole. -GLACIAL TILL-		5	10	50	25	10				
5	63 48	S3A 10	5.0 6.0		74.0 5.0	SP	S3A: Very dense brown poorly graded SAND (SP), mps < 1 mm, no structure, no odor, dry				25	75					
	38 36 37 38	S4 17	6.0 8.0			SP	S4: Very dense gray brown poorly graded SAND (SP), mps < 1 mm, no structure, no odor, dry -GLACIOFLUVIAL DEPOSITS-				30	65	5				
					70.5 8.5												
10	17 20 25 24	S5 15	9.0 11.0			SM-SP	Very dense light gray silty SAND (SM), intermixed with layers of poorly graded SAND (SP), mps 0.5 in., weakly bonded in-situ, moist		5	5	20	40	25				
	18 17 21 16	S6 15	11.0 13.0			SM	Dense gray silty SAND (SM), mps 0.75 in., no structure, no odor, wet -GLACIAL TILL-		10	10	20	35	25				
	13 20 36 42	S7 17	13.0 15.0			SM	Similar to above		10	10	10	45	25				
15	10 11 9 10	S8 16	15.0 17.0			SC/ ML	Medium dense mottled gray to light brown clayey SAND (SC) to silty SAND (ML), mps 0.5 in., no structure, no odor, wet		5	5	10	35	45				
	11 16 32 22	S9 16	17.0 19.0		62.0 17.0	SP	Dense light brown to gray poorly graded SAND (SP), mps 0.75 in., well developed stratification, moist		5	5	60	30					
20	12 15 24 27	S10 15	19.0 21.0			SP	Similar to above, except mps 1.5 in. -GLACIOFLUVIAL DEPOSITS-	5	5	10	60	20					
	11 16	S11 17	21.0 23.0			SP-SW	Similar to above with occasional oxidized seams of well graded SAND (SW)	5	10	15	65	5					

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
7/27/07	0900		9.0	11.0	9.0

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	67.0
Rock Cored (ft)	-
Samples	S24

Boring No. B1(OW)D/S

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	18 14																
	16 26 36 28	S12 15	23.0 25.0			SP	Very dense light gray brown poorly graded SAND (SP), mps 0.75 in., well developed stratification, dry -GLACIOFLUVIAL DEPOSITS-		5	5	60	30					
25	16 18 26 28	S13 17	25.0 27.0		54.0 25.0	SP	Very dense light brown poorly graded SAND (SP), mps 0.5 in., no structure, no odor, dry, trace shell fragments -MARINE DEPOSITS-		5		35	60					
	24 23 33 41	S14 18	27.0 29.0			SP	Very dense light gray brown poorly graded SAND (SP), mps 0.5 in., well developed stratification, dry										
30	13 22 28 33	S15 17	30.0 32.0			SP-SM	Very dense light gray brown poorly graded SAND (SP) with silt, mps 1.0 in., well developed stratification, dry, occasional irregular oxidized pockets	5	5	5	60	25					
	22 42 41 52	S16 18	32.0 34.0			SP	Similar to above except mps 0.5 in.		5	5	60	30					
35	12 20 27 36	S17 18	35.0 37.0			SP	Similar to above, except dense		5	5	60	30					
	58 40 38 51	S18 15	37.0 39.0			SP	Similar to above, except very dense		5		65	30					
40	20 26 27 33	S19 17	40.0 42.0			SP	Similar to above, except mps 0.25 in.			5	55	40					
45	20 20 22 26	S20 14	45.0 47.0			SP	Similar to above, except dense with trace shell fragments			5	55	40					
50	16 20 24 32	S21 16	50.0 52.0			SP	Similar to above			10	60	30					

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY & ALDRICH

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
55	28 50 64 72	S22 18	55.0 57.0			SP	Similar to above except very dense with frequent very thin oxidized lenses and occasional thin laminae of gray sandy SILT (ML) -MARINE DEPOSITS-			10	45	40	5				
60	25 38 44 53	S23 19	60.0 62.0			SP-SW	Very dense light gray brown poorly graded SAND (SP), interbedded with seams (1.0 to 2.0 in.) of well graded SAND (SW), mps 0.5 in., well developed stratification dry, trace shell fragments		5	15	50	30					
65	31 48 56 71	S24 18	65.0 67.0		12.0 67.0	SP	Very dense light gray brown poorly graded SAND (SP), mps 0.25 in., weakly stratified, no odor, dry, trace shell fragments with occasional irregular oxidized pockets and seams										
							BOTTOM OF EXPLORATION AT 67.0 FT NOTE: 1.0 in diameter observation wells installed at 67.0 ft and 18.0 ft in single borehole upon completion.										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY & ALDRICH

TEST BORING REPORT

Boring No. B2

Project	TERRACE INSTALLATION FAILURE STUDY NANTUCKET, MA
Client	SCONSET BEACH PRESERVATION FUND C/O NETCO
Contractor	GEOLOGIC, INC.
File No.	26694-001
Sheet No.	1 of 3
Start	July 26, 2007
Finish	July 26, 2007
Driller	C. O'Donnel
H&A Rep.	D. Warren
Elevation	80.0
Datum	MLW
Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	--	Rig Make & Model: Acker
Inside Diameter (in.)	3 1/4	1 3/8	--	Bit Type: Cutting Head
Hammer Weight (lb)		140	-	Drill Mud: None
Hammer Fall (in.)		30	-	Casing: HSA Spun to 70.0 ft
				Hoist/Hammer: Cat-Head Doughnut Hammer
				PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						NOTE: Hand excavated.										
	1 1 4 5	S1 20	1.0 3.0	78.5 1.5	OL/OH	S1, Top 6.0 in.: Very soft brown sandy ORGANIC SOIL (OL/OH), mps < 1 mm, no structure, no odor, moist -GRASS MAT/TOPSOIL/FILL-					30	70				
					SM	Loose orange brown silty SAND (SM) mps < 1 mm, no structure, no odor, moist -AEOLIAN DEPOSITS-				15	60	25				
	5 7 8 8	S2 18	3.0 5.0	77.0 3.0	SP	Medium dense orange brown to light brown poorly graded SAND (SP), mps < 1 mm, no structure, no odor, moist				30	65	5				
5	6 7 22 34	S3 5	5.0 7.0		SP	Similar to above -UPPER GLACIOFLUVIAL DEPOSITS-				50	50					
				74.0 6.0	CH/SP-SM	Hard mottled orange brown to gray brown fat CLAY (CH), interbedded with irregular seams and layers of gray brown poorly graded SAND with silt (SP-SM), mps 0.5 in., weakly stratified, no odor, moist		5	5	20	20	50				
	45 27 23 26	S3A 14 S4 20	7.0 7.1 9.0		SM-ML	Very dense brown silty SAND (SM) to sandy SILT (ML), mps 0.75 in., moderately bonded in-situ, moist NOTE: Drill action indicates cobbles at 7.0 ft.		10	5		40	45				
10	15 24 25 26	S5 18	9.0 11.0		SM	Dense brown silty SAND (SM), mps 0.75 in., moderately bonded in-situ, moist -GLACIAL TILL-		10	5	5	45	35				
	18 24 28 24	S6 17	11.0 13.0		SM-SP	Similar to above except very dense interbedded with layers of orange brown to gray poorly graded SAND (SP)		10	5	20	30	35				
	15 19 21 22	S7 20	13.0 15.0		SM-SP	Dense brown silty SAND (SM), interbedded with layers of poorly graded SAND (SP), mps 0.5 in., no structure, no odor, moist		5	5	25	45	20				
15	17 26 29 25	S8 19	15.0 17.0		SM-SP	Very dense brown silty SAND (SM), interbedded with light gray poorly graded SAND (SP), mps 0.5 in., no structure (SM), stratified (SP), no odor, moist		5	5	25	45	20				
	22 27 28 26	S9 18	17.0 19.0		SP-SM/SM	Very dense brown poorly graded SAND with silt (SP-SM), interbedded with occasional layers (less than 4.0 in.) of brown well bonded silty SAND (SM), mps 0.5 in., weakly stratified, dry NOTE: Drill action indicates cobbles at 18.0 ft.		5	5	25	50	15				
				60.5 19.5												
20	14 27 34 47	S10 19	20.0 22.0		SP	Very dense light brown to light gray poorly graded SAND (SP), mps 0.5 in., stratified, no odor, dry		5	5	55	35					

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 74.0
Rock Cored (ft) -
Samples S22

Boring No. B2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY & ALDRICH

TEST BORING REPORT

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	32 40 43 41	S11 18	22.0 24.0		SP	Similar to above		5	5	60	30					
25	12 24 24 24	S12 18	25.0 27.0		SP	Similar to above, except dense, mps < 1 mm -GLACIOFLUVIAL DEPOSITS-				50	50					
30	10 25 42 52	S13 17	30.0 32.0		SP	Very dense light gray brown poorly graded SAND (SP), mps 1.0 in., well developed stratification, dry	5	5	5	65	20					
35	16 26 46 50	S14 19	35.0 37.0		SP	Similar to above, except mps 0.75 in.		10	5	60	25					
40	20 34 40 48	S15 20	40.0 42.0		SP	Similar to above NOTE: Drill action indicates coarse gravel/cobbles at 43.0 ft (possible ventifacts)		5	5	65	25					
45	20 33 50 59	S16 18	45.0 47.0		SP	Similar to above with occasional thin seams (less than 1.0 in) of well graded SAND (SW)			5	60	35					
50	14 18 16 15	S17 16	50.0 52.0		SP	Dense light gray brown poorly graded SAND (SP), mps 3/8 in., well developed stratification, dry		5	5	65	25					

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY & ALDRICH

TEST BORING REPORT

Boring No. B2
File No. 26694-001
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
55	10 20 30 34	S18 20	55.0 57.0		SP	Similar to above, except mps 0.25 in.			5	65	30					
						-GLACIOFLUVIAL DEPOSITS-										
60	27 37 51 74	S19 17	60.0 62.0		SP	Very dense light gray brown poorly graded SAND (SP), mps 1.5 in., stratified, no odor, dry	5	5	5	60	25					
65	25 24 38 72	S20 20	65.0 67.0		SP/ ML/ SW/ CL	Similar to above, interbedded with frequent thin laminae and seams of brown sandy SILT (ML) and light gray lean CLAY (CL), one seam of brown well graded SAND with gravel (SW) at approximately 66.3 to 66.5 ft, mps 0.5 in.		5	10	25	40	20				
70	16 36 53 75	S21 16	70.0 72.0		SP	Similar to S19	5	5	5	65	20					
	59 68 85 50/2	S22 15	72.0 73.7	6.3 73.7	SP	Similar to above, except mps 1.0 in.	5	5	10	60	20					
						BOTTOM OF EXPLORATION AT 73.7 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. B2

HALEY & ALDRICH

TEST BORING REPORT

Boring No. **B3**

Project	TERRACE INSTALLATION FAILURE STUDY NANTUCKET, MA
Client	SCONSET BEACH PRESERVATION FUND C/O NETCO
Contractor	GEOLOGIC, INC.

File No.	26694-001
Sheet No.	1 of 3
Start	July 24, 2007
Finish	July 24, 2007
Driller	C. O'Donnel
H&A Rep.	D. Warren
Elevation	80.0
Datum	MLW
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	3 1/4	1 3/8	--
Hammer Weight (lb)		140	-
Hammer Fall (in.)		30	-

Drilling Equipment and Procedures

- Rig Make & Model: Acker Scout Track
- Bit Type: Cutting Head
- Drill Mud: None
- Casing: HSA Spun to 65.0 ft
- Hoist/Hammer: Cat-Head Doughnut Hammer
- PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0						NOTE: Hand excavated.										
	5 5 7 6	S1 17	1.0 3.0		SP-SM	Medium dense orange brown poorly graded SAND with silt (SP-SM), mps 0.25 in., no structure, no odor, dry -AEOLIAN DEPOSITS-			5	60	25	10				
	6 6 5 7	S2 15	3.0 5.0	77.0 3.0	SP	Medium dense light brown poorly graded SAND (SP), mps < 1 mm, no structure, no odor, dry				35	65					
5	7 8 8 9	S3 12	5.0 7.0		SP	Similar to above, except brown, mps 0.5 in. -UPPER GLACIOFLUVIAL DEPOSITS-		5	5	65	25					
	21 27 31 32	S4 14	7.0 9.0	73.0 7.0	SM/ML	Very dense brown sandy SILT (ML), to silty SAND (SM), mps 0.25 in., weakly bonded, stratified, no odor, moist		5	5	5	40	45				
10	25 26 21 23	S5 17	9.0 11.0		SM/ML-SP	Similar to above, interbedded with frequent seams of light brown to gray poorly graded SAND (SP) -GLACIAL TILL-		5	5	25	30	35				
	21 27 25 22	S6 16	11.0 13.0		SM/ML-SP	Similar to above, except dense		5	5	25	30	35				
	11 12	S7 12	13.0 14.0		ML	Similar to S4		5	5	25	30	35				
	12 10	S7A 9	14.0 15.0	66.0 14.0	SP	Medium dense light brown poorly graded SAND (SP), mps 0.25 in., no structure, no odor, dry		5	5	40	50					
15	21 27 38 42	S8 10	15.0 17.0		SP	Similar to above, except very dense, mps 1.5 in. -GLACIOFLUVIAL DEPOSITS-	5	5	5	65	20					
	29 22 24 27	S9 17	17.0 19.0		SP	Similar to above, except dense, except mps < 1 mm				60	30					
20	14 25 26 23	S10 16	19.0 21.0		SP	Very dense light brown poorly graded SAND (SP), mps 0.25 in., stratified, no odor, dry			5	65	30					
	21 27	S11 15	21.0 23.0		SP-SW	Similar to above, except light brown to gray interbedded with occasional seams of well graded SAND (SW), mps 0.5 in., stratified, no odor, dry		5	10	60	25					

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	67.0
Rock Cored (ft)	-
Samples	S31

Boring No. **B3**

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY & ALDRICH

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	27 32															
	14 22 24 32	S12 18	23.0 25.0		SP	Similar to above, except dense with no well graded seams, frequent thin oxidized laminae				65	35					
25	13 19 23 22	S13 16	25.0 27.0		SP	Dense light gray poorly graded SAND (SP), mps 0.25 in., stratified, no odor, dry, occasional irregular oxidized pockets (less than 1.0 in.)			5	60	35					
	13 16 29 27	S14 15	27.0 29.0		SP	Dense light gray brown poorly graded SAND (SP), 1 mm, stratified, no odor, dry, one piece decomposed coarse gravel in spoon tip										
30	17 23 24 32	S15 20	29.0 31.0		SP	Dense light gray brown poorly graded SAND (SP), mps 0.25 in., weakly stratified, no odor, wet			5	45	50					
	25 33 34 36	S16 18	31.0 33.0		SP	Similar to above, except very dense			5	50	45					
	13 18 26 28	S17 20	33.0 35.0		SP	Similar to above, except dense -GLACIOFLUVIAL DEPOSITS-			5	45	50					
35	21 22 26 26	S18 15	35.0 37.0		SP	Similar to above			5	60	35					
	34 32 33 39	S19 18	37.0 39.0		SP	Similar to above, except very dense			5	45	50					
40	24 26 25 32	S20 20	39.0 41.0		SP	Similar to above with well developed stratification and occasional thin seams of well graded SAND (SW)			10	50	40					
	46 51 55 47	S21 20	41.0 43.0		SP	Similar to above, except mps 0.75 in.		5	10	60	25					
	23 39 48 45	S22 17	43.0 45.0		SP	Similar to above, except mps 0.25 in.			5	65	30					
45	16 41 45 46	S23 19	45.0 47.0		SP	Similar to above			5	55	40					
	25 40 29 30	S24 16	47.0 49.0		SP	Similar to above			5	65	30					
50	32 50 44 73	S25 20	49.0 51.0		SP	Similar to above			5	55	40					
	55 55 40 37	S26 18	51.0 53.0		SP	Similar to above			5	65	30					
	18 25 36	S27 17	53.0 55.0	27.0 53.0	SP	Similar to above, except light gray -MARINE DEPOSITS			5	55	40					

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	37															
55	32 33 22 24	S28 16	55.0 57.0		SP	Similar to above			10	60	30					
	60 62 54 60	S29 15	57.0 59.0		SP	Similar to above -MARINE DEPOSITS-			5	55	40					
60	24 35 56 65	S30 18	60.0 62.0		SP	Very dense light gray poorly graded SAND (SP), mps 0.25 in., weakly stratified, no odor, dry			5	40	55					
65	25 42 56 46	S31 20	65.0 67.0	13.0 67.0	SP	Similar to above with occasional thin oxidized seams			5	50	45					
						BOTTOM OF EXPLORATION AT 67.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY & ALDRICH

TEST BORING REPORT

Boring No. B4

Project	TERRACE INSTALLATION FAILURE STUDY NANTUCKET, MA
Client	SCONSET BEACH PRESERVATION FUND C/O NETCO
Contractor	GEOLOGIC, INC.
File No.	26694-001
Sheet No.	1 of 3
Start	July 25, 2007
Finish	July 25, 2007
Driller	C. O'Donnel
H&A Rep.	D. Warren
Elevation	82.0
Datum	MLW
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	3 1/4	1 3/8	--
Hammer Weight (lb)		140	-
Hammer Fall (in.)		30	-

Drilling Equipment and Procedures

- Rig Make & Model: Acker Scout Track
- Bit Type: Roller Bit
- Drill Mud: None
- Casing: HSA Spun to 70.0 ft
- Hoist/Hammer: Cat-Head Doughnut Hammer
- PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						NOTE: Hand excavated. -GRASS MAT/TOPSOIL/FILL-										
	1 1 4 5	S1 18	1.0 3.0	81.0 1.0	SM	Loose orange brown silty SAND (SM), mps < 1 mm, no structure, no odor, moist -AEOLIAN DEPOSITS-				20	65	15				
	4 5 9 10	S2 16	3.0 5.0	79.5 2.5	SP	Medium dense light brown to brown poorly graded SAND (SP), mps 0.25 in., weakly stratified, no odor, dry -UPPER GLACIOFLUVIAL DEPOSITS-			5	65	30					
5	7 15 16 18	S3 20	5.0 7.0		SP	Top 10.0 in., dense brown poorly graded SAND (SP), mps 0.75 in., no structure, no odor, dry		5	10	60	25					
					SP	Bottom 10.0 in., dense brown silty SAND (SM) mps < 1 mm, no structure, no odor, moist					80	20				
	18 20	S4 9	7.0 8.0		SP	Dense brown poorly graded SAND (SP), mps 0.25 in., no structure, no odor, dry			5	55	40					
	22 26	S4A 9	8.0 9.0	74.0 8.0	SM	Dense brown silty SAND (SM), trace fine gravel, weakly bonded in-situ, no odor, moist, mps 0.75 in.		5	5	5	35	50				
10	21 24 26 20	S5 18	9.0 11.0		SP/ ML	Dense brown, poorly graded SAND (SP), mps 0.25 in., no structure, no odor, dry with one layer brown sandy SILT (ML), similar to S4A from approximately 9.5 to 10.0 ft -GLACIAL TILL-		5	5	40	25	25				
	16 20 21 15	S6 20	11.0 13.0	71.0 11.0	SP/ SP- SM	Dense light gray brown poorly graded SAND (SP), interbedded with occasional seams of brown poorly graded SAND with silt (SP-SM), mps 0.25 in., weakly stratified, occasional oxidized seams, dry			5	55	30	10				
	12 13 15 16	S7 14	13.0 15.0		SP	Medium dense light gray poorly graded SAND (SP), mps 0.25 in., weakly stratified with occasional irregular oxidized seams, no odor, dry -GLACIOFLUVIAL DEPOSITS-			5	65	30					
15	7 8	S8 6	15.0 17.0	67.0 15.0	ML/ SM	Loose brown sandy SILT to silty SAND with gravel (ML/SM), mps 0.5 in., weakly bonded stratified, no odor, moist -GLACIAL TILL (FLOW TILL)-		15	5	5	25	50				
	19 21	S8A 12	15.5 17.0	66.5 15.5	SP	Medium dense light gray brown poorly graded SAND (SP), mps 1.0 in., no structure, no odor, dry	5	5	5	55	30					
	7 8 19 21	S9 15	17.0 19.0		SP	Similar to above, except mps 0.75 in. -GLACIOFLUVIAL DEPOSITS-		5	5	65	25					
20	20 46 51 32	S10 6	19.0 21.0		SP	Very dense brown poorly graded SAND (SP), mps 1.5 in., no structure, no odor, dry NOTE: Poor recovery, spoon pushing coarse gravel.	5		5	20	70					
	24 23	S11 16	21.0 23.0		SP	Dense light brown to gray brown poorly graded SAND (SP), mps 0.25 in., weakly stratified, no structure, no odor, dry			5	60	35					

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Depth (ft) to: Bottom of Hole	Water

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

- Overburden (ft) 74.0
- Rock Cored (ft) -
- Samples S26

Boring No. B4

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY & ALDRICH

TEST BORING REPORT

Boring No. B4
File No. 26694-001
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	23 25															
	14 15 20 23	S12 17	23.0 25.0		SP	Similar to above -GLACIOFLUVIAL DEPOSITS-			5	60	35					
25	22 32 30 31	NR	25.0 27.0			NOTE: No recovery 25.0 to 27.0 ft.										
	40 42 50 48	S13 4	27.0 29.0		SP	Very dense brown poorly graded SAND (SP), mps 0.25 in., no structure, no odor, moist NOTE: Poor recovery, spoon pushing cobble/gravel.			5	60	35					
30	16 33 20 19	S14	29.0 31.0		SP	Very dense light gray brown poorly graded SAND (SP), mps 0.25 in., well developed stratification, dry with occasional irregular oxidized pockets			5	55	40					
	8 12 19 21	S15 17	31.0 33.0		SP	Similar to above, except dense with highly oxidized layer from approximately 32.0 to 32.5 ft			5	55	40					
	19 18 25 26	S16 16	33.0 35.0		SP	Similar to above with minor oxidation			5	45	50					
35	18 18 22 42	S17 18	35.0 37.0		SP	Similar to above			5	60	35					
	38 53 42 58	S18 20	37.0 39.0		SP	Similar to above, except very dense with trace coarse gravel mps 1.5 in.	5		5	65	25					
40	17 34 30 32	S19 18	40.0 42.0		SP	Similar to above, except mps 0.5 in.		5	5	65	25					
45	26 36 41 45	S20 18	45.0 47.0		SP	Similar to above		5	5	55	35					
50	20 31 36 39	S21 18	50.0 52.0		SP	Similar to above		5	5	65	25					

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. B4

HALEY & ALDRICH

TEST BORING REPORT

Boring No. B4
File No. 26694-001
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
55	28 45 44 39	S22 16	55.0 57.0		SP	Similar to above		5	5	65	25					
						-GLACIOFLUVIAL DEPOSITS-										
60	23 31 21 28	S23 19	60.0 62.0		SP	Very dense light gray brown poorly graded SAND (SP), mps 0.75 in., well developed stratification, no odor, dry										
65	32 34 33 81	S24 19	65.0 67.0		SP/ SW	Similar to above with frequent thin seams (less than 1.0 in.) of brown well graded SAND (SW), mps 0.75 in.		10	10	50	30					
				13.5 68.5												
70	32 47 55 56	S25 21	70.0 72.0		SP- SM	Very dense light gray poorly graded SAND with silt (SP-SM), mps 0.75 in., weakly stratified, no odor, dry		10	5	35	50					
	28 26 24 28	S26 18	72.0 74.0		SP	Similar to above, except mps 1.5 in. with no stratification	5	5	5	35	50					
						-MARINE DEPOSITS-										
				8.0 74.0		BOTTOM OF EXPLORATION AT 74.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. B4

Attachment C
Haley and Aldrich Memorandum Regarding Sheet Pile Installation (DRAFT)

Haley & Aldrich, Inc.
465 Medford St.
Suite 2200
Boston, MA 02129

Tel: 617.886.7400
Fax: 617.886.7600
HaleyAldrich.com

MEMORANDUM

27 September 2013
File No. 26694-001

TO: Sconset Beach Preservation Fund
c/o Les Smith, Epsilon Associates

FROM: Haley & Aldrich, Inc.
Mark X. Haley

SUBJECT: Evaluation of steel sheeting adjacent to Baxter Rd.

At your request, we have reviewed the proposed option for driving steel sheet piling at the edge of Baxter Road. The purpose of the sheet pile wall would be to provide temporary protection for the utilities located beneath Baxter Rd. from damage due to bank erosion. Although details of the proposal were not available to us, we have made certain assumptions. These include the following:

- Depth of sheeting 45 to 50 ft. below Baxter Road grade, approximately one half of slope height.
- Sheeting would be designed to cantilever about 20 ft. (Note: normal steel sheeting can only cantilever to about a 20 ft. height without bracing. If the sheet pile wall was required to retain a greater height of soil, bracing would be required.)
- A 'Z-type' sheet would be used.
- Sheet piling would be vibrated into place not top driven. This method of installation was selected to reduce vibrations during pile driving.
- That the sheeting can be driven through the dense near surface soils. (Note; the soils in upper portion of the slope consist of dense glacial till that will be difficult to advance a pile through.)

At first glance this proposal would appear to provide near surface soil retention adjacent to the road, but upon further evaluation of the option, a number of issues may make this option detrimental to the overall slope stability. These include the following:

- The sheeting line will create a joint or vertical plane at the edge of road, that may result in a shear plane, resulting in slope instability.
- Disturbance of the soil on both sides of the sheeting will allow water to seep into this zone and have the potential for weakening the soil and reducing slope stability.
- Having evaluated this slope in 2007 and again in 2012, the erosion and slope failure occurs from loss of ground at the toe of slope. The existing medium sand stratum at the toe of slope is highly erodible and once eroded by wave action the

slope becomes undermined causing slope failure of the soils above. This proposed option does not address toe of slope instability.

- The steel sheeting would probably only extend about half the height of slope, and could thus be undermined causing a significant global slope failure.
- The sheet pile line will prevent water flow towards the ocean, and water will build up behind the sheeting thus increasing the hydrostatic pressures in the slope, increasing the horizontal driving force and decreasing the stability of the slope.
- Installation of the sheeting will cause vibrations and potential downward movement of the soils along the slope face.

It is our opinion; that options to consider for slope stabilization on a temporary or permanent basis should be focused at the existing toe of slope. Protecting the soils at the toe of slope from erosion will reduce the undermining of the slope and slope instability. Based on recent surveys, summer 2013, the slope angles in the area of Lots 99,101 and 105 are in the range of 31 to 40 degrees except near top of slope where the slope is much steeper in the range of 56 to 68 degrees. Based on our slope evaluations in 2007 slope angles less than about 40 degrees are stable but become unstable when the slope angle approaches 45 degrees especially in a rain event where water is added to the soil stratigraphy.

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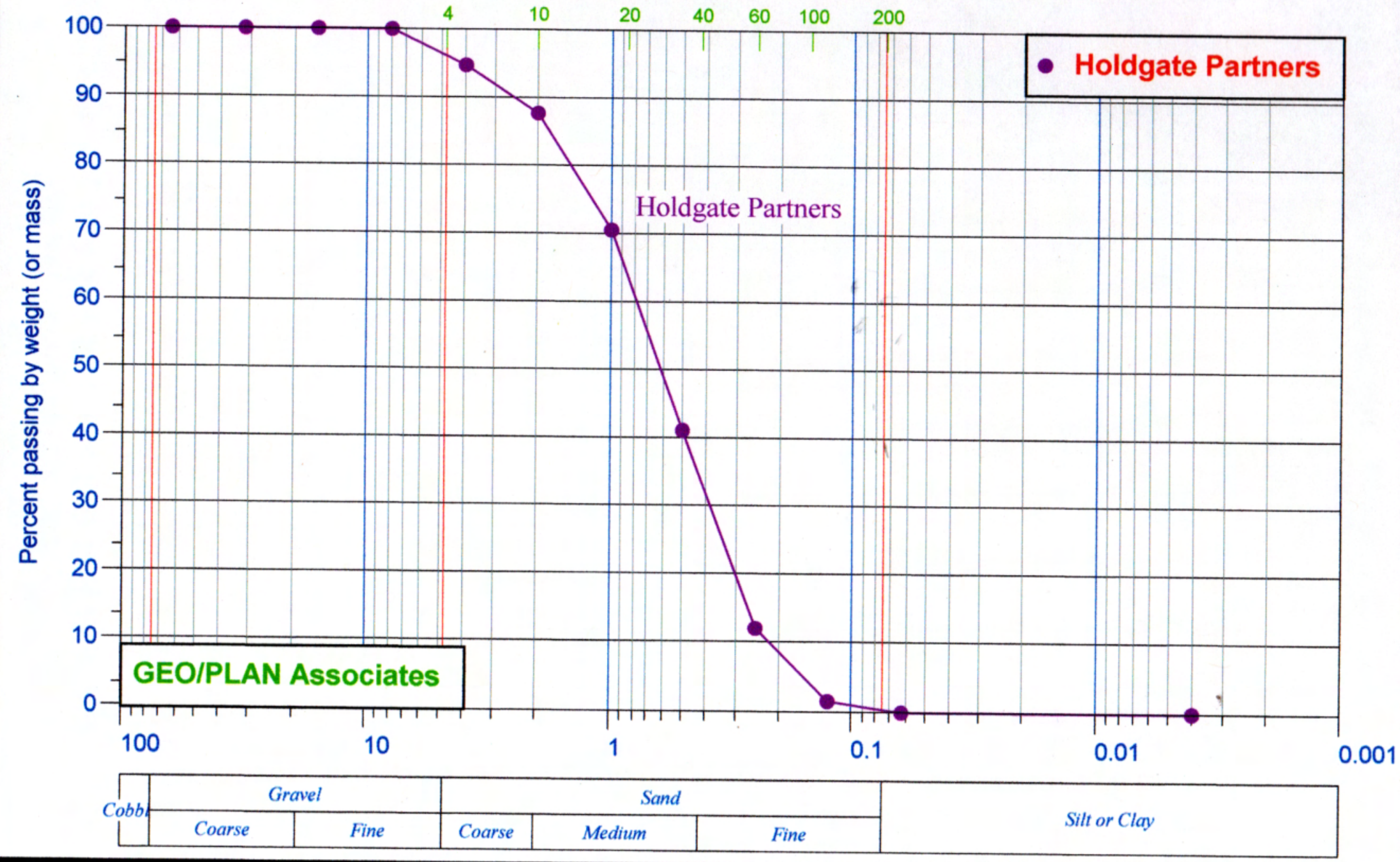
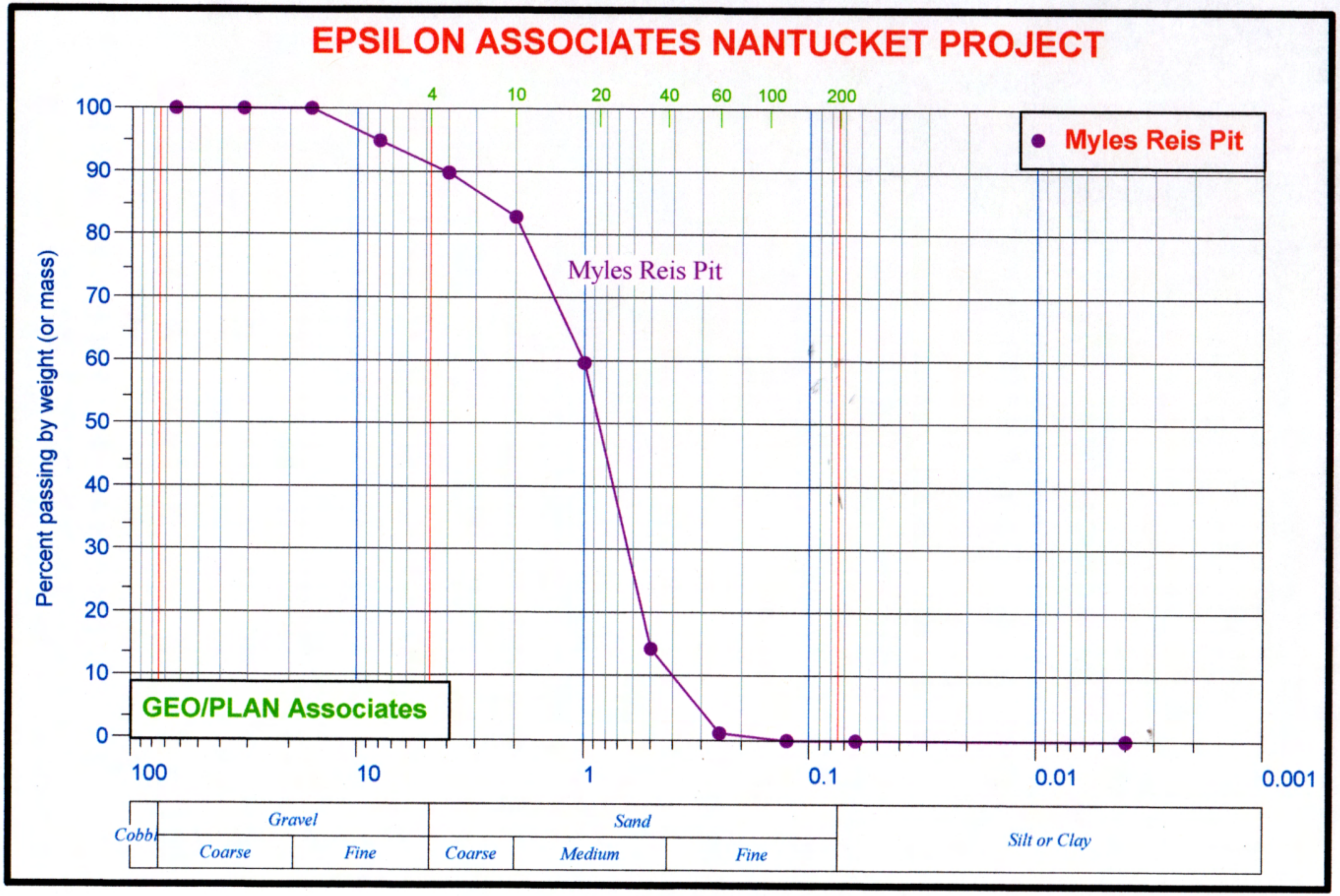
Attachment D
Sand Source Data and Analysis

EPSILON ASSOCIATES NANTUCKET PROJECT





EPSILON ASSOCIATES NANTUCKET PROJECT
4
10
20
40
60
100
200
Myles Reis Pit
Myles Reis Pit
Percent passing by weight (or mass)
100
90
80
70
60
50
40
30
20
10
0
GEO/PLAN Associates
100
10
1
0.1
0.01
0.001
Cobbl
Gravel
Coarse
Fine
Sand
Coarse
Medium
Fine
Silt or Clay

GEO/PLAN Associates
Sediment Grain Size Analysis
Client:Epsilon Associates
Project: Nantucket, MA
Project Location: Nantucket, MA
Project No.
Date: October 2011

Sample: **Holdgate Partners**

					Sand Only	
Phi	Cum Wt	Total Wt	% Wt	Cum %	% Wt	Cum %
>-5	0.00	0.00	0.00	0.00	0.00	0.00
-4	0.00	0.00	0.00	0.00	0.00	0.00
-3	0.00	0.00	0.00	0.00	0.00	0.00
-2	6.51	6.51	5.43	5.43	5.43	5.43
-1	14.87	8.36	6.97	12.40	6.97	12.40
0	35.37	20.50	17.10	29.50	17.10	29.50
1	70.62	35.25	29.39	58.89	29.39	58.89
2	105.38	34.76	28.99	87.88	28.99	87.88
3	118.26	12.88	10.74	98.62	10.74	98.62
4	119.91	1.66	1.38	100.00	1.38	100.00

Phi	Total Wt	Bkr Wt	Corr. Wt	Wt Frac	% Wt	Bk No.
Silt	0.0000	0.0000	0.0000	0.0000	0.0000	--
Clay	0.0000	0.0000	0.0000	0.0000	0.0000	--
		Disp. Wt	0.0000			

Wt. Coarse	119.9100
Wt Fine	0.0000
Total Wt	119.9100

Phi	Wt %	Phi Mid Pt	Wt % Mid Pt	Mid pt - Mean (=X)	X sq	X sq Wt %
>-5	0.00	-5.50	0.00	-6.07	36.88	0.00
-4	0.00	-4.50	0.00	-5.07	25.73	0.00
-3	0.00	-3.50	0.00	-4.07	16.59	0.00
-2	5.43	-2.50	-13.57	-3.07	9.44	51.26
-1	6.97	-1.50	-10.46	-2.07	4.30	29.96
0	17.10	-0.50	-8.55	-1.07	1.15	19.68
1	29.39	0.50	14.70	-0.07	0.01	0.16
2	28.99	1.50	43.48	0.93	0.86	24.92
3	10.74	2.50	26.85	1.93	3.71	39.89
4	1.38	3.50	4.83	2.93	8.57	11.83
Silt	0.00	6.00	0.00	5.43	29.45	0.00
Clay	0.00	9.00	0.00	8.43	71.02	0.00
TOTAL	100.00		57.28			177.69

Total Sample

Mean = 0.57

Variance = 1.78

Sample SD = 1.33

Coarse Only 100.00 57.28 177.69

Mean = 0.57

Variance = 1.78

Sample SD = 1.33

Gravel	Sand	Silt	Clay	Total
12.4	87.6	0.0	0.0	100.0

Sand	Silt	Clay	Total
100.0	0.0	0.0	100.0

GEO/PLAN Associates
Sediment Grain Size Analysis
Client:Epsilon Associates
Project: Nantucket, MA
Project Location: Nantucket, MA
Project No.
Date: October 2011

Sample: **Myles Reis Pit**

Phi	Cum Wt	Total Wt	% Wt	Cum %	Sand Only % Wt	Sand Only Cum %
>-5	0.00	0.00	0.00	0.00	0.00	0.00
-4	0.00	0.00	0.00	0.00	0.00	0.00
-3	5.91	5.91	5.05	5.05	5.05	5.05
-2	12.01	6.11	5.22	10.27	5.22	10.27
-1	20.16	8.15	6.97	17.24	6.97	17.24
0	47.07	26.92	23.02	40.25	23.02	40.25
1	100.01	52.94	45.27	85.53	45.27	85.53
2	115.54	15.53	13.28	98.81	13.28	98.81
3	116.91	1.37	1.17	99.98	1.17	99.98
4	116.93	0.03	0.02	100.00	0.02	100.00

Phi	Total Wt	Bkr Wt	Corr. Wt	Wt Frac	% Wt	Bk No.
Silt	0.0000	0.0000	0.0000	0.0000	0.0000	--
Clay	0.0000	0.0000	0.0000	0.0000	0.0000	--
		Disp. Wt	0.0000			

Wt. Coarse	116.9300
Wt Fine	0.0000
Total Wt	116.9300

Phi	Wt %	Phi Mid Pt	Wt % Mid Pt	Mid pt - Mean (=X)	X sq	X sq Wt %
>-5	0.00	-5.50	0.00	-5.43	29.47	0.00
-4	0.00	-4.50	0.00	-4.43	19.61	0.00
-3	5.05	-3.50	-17.68	-3.43	11.76	59.37
-2	5.22	-2.50	-13.05	-2.43	5.90	30.80
-1	6.97	-1.50	-10.45	-1.43	2.04	14.22
0	23.02	-0.50	-11.51	-0.43	0.18	4.23
1	45.27	0.50	22.64	0.57	0.33	14.78
2	13.28	1.50	19.92	1.57	2.47	32.78
3	1.17	2.50	2.93	2.57	6.61	7.75
4	0.02	3.50	0.07	3.57	12.75	0.27
Silt	0.00	6.00	0.00	6.07	36.86	0.00
Clay	0.00	9.00	0.00	9.07	82.29	0.00
TOTAL	100.00		-7.13			164.19

Total Sample

Mean = -0.07

Variance = 1.64
Sample SD = 1.28

Coarse Only 100.00 -7.13 164.19

Mean = -0.07

Variance = 1.64
Sample SD = 1.28

Gravel	Sand	Silt	Clay	Total
17.2	82.8	0.0	0.0	100.0

Sand	Silt	Clay	Total
100.0	0.0	0.0	100.0

GEO/PLAN ASSOCIATES
30 MANN STREET
HINGHAM, MASSACHUSETTS 02043-1316
Voice & Fax: (781) 740-1340
Email: GeoPlanAssoc@gmail.com

October 20, 2011

Epsilon Associates
P.O. Box 700
Maynard, Massachusetts 01754-0700

Attention: Mr. Les Smith

Re: Sediment Compatibility Analysis, Siasconset Beach

Dear Mr. Smith:

I performed size analyses of composite sediment samples from two sand pits from Nantucket in October, 2011. The purpose of this letter is to evaluate the suitability of these pit sediment sources as mitigation sediment for a segment of beach along Siasconset Beach, Nantucket. The project area is within previously-identified sampling sites designated as sediment sampling transects (Line 15 through Line 19). Extensive sediment sampling of the area (beach, bank, dune) was performed in 2006 along these lines and adjacent areas by Coastal Planning and Engineering, Inc. Other grain size data from this beach area is available from earlier sampling in 1998, 2001 and 2003. Some of these samples I collected and analyzed.

The composite or mean sizes are compiled below for comparison. While the methodologies for analysis are consistent, the reporting of the data, the lateral extent of the sampling along Siasconset Beach, and the field sampling methods may vary. This doesn't affect the documentation of the sand characteristics, and that the resulting time-series provides a measure of variability of the natural sands over time. These mean sizes and other characteristics are compiled below.

A. Proposed Pit Sediment Sources:

Holdgate Partners	Mean: 0.57 phi	(coarse sand)
	88% sand 12% gravel	
	(most gravel granules or finer; <4mm); mud (insignificant)	
Myles Reis Pit	Mean –0.07 phi	(very coarse sand)
	83% sand 17% gravel	
	(most gravel fine pebbles or finer; <8mm); mud (insignificant)	

B. Natural Bank Sediments

2001:	2 phi,	(medium - fine sand) includes 8% mud
2003:	1.8 phi	(medium sand) includes 5.5% pebbles or granules
2006:	0.45 phi	(coarse sand) includes minor fine pebbles/granules

The bank sediments vary between medium-fine sand to coarse sand, and contain varying amounts of fine gravel and mud. Direct observation of this coastal bank has shown that, although dominantly sand, there is frequently a mud and gravel component and periodically mud layers and clay banks are part of the deposit. The fine or coarse tails and the variation in sizes are typical for glacial outwash sediments in this setting.

C. Beach Sediments

1998: 1.5 phi (medium sand)
2001: 1.0 phi (medium – coarse sand)
2003: 0.9 phi (coarse sand)
2006: 0.7 phi (coarse sand) [Line 15 – Line 19]

The more recent 2006 samples are coarser than the earlier samples, either due to natural variation in sand sizes over time, or any cyclic changes relating to energy. Regardless of the cause, these four sampling intervals indicate that the natural sediment on the beach is not coarser than the 0.7 phi 2006 samples.

D. Discussion

Compatible beach sediment is not sand that exactly matches the existing beach, but rather sediment that is stable and can coexist with the naturally deposited sediment in the coastal setting. If the compatibility of the sediment is evaluated relative to potential stability on the beach (which is generally the case), **compatible sediment is equal or coarser than the existing sediment**.

Both of the proposed source areas are also glacial outwash sediments. Both samples have insignificant mud (<1%), which is a plus for compatibility, as mud is quickly lost, and is the most common aesthetic and water turbidity objection. Both of the proposed source areas are geologically the same material (outwash sediments) from the same vicinity as the natural bank materials. Both samples contain gravel. While the gravel does not match surface beach sediment samples, small gravel is a visible component on these beaches and shallow nearshore. Importantly, both samples are coarse sand, which has the greatest likelihood of remaining stable on the Siasconset Beach. While the sizes are reported as means, there are ranges of sizes finer and coarser in all samples. However, both the natural beach sediment and both potential pit sources have very small amounts of sand finer that medium sand. This is the component of the sand that is most likely to be quickly lost from the beach. Therefore, the wave sorting will likely re-sort nourishment sand to have comparable sizes to existing conditions, or coarser, so most of the source material will have as great a probability of remaining within the adjacent beach system as the natural bank material.

Both source pits sediment samples are slightly coarser than both the natural bank and the existing beach sediments. Much of the variation in mean size is due to the differences in gravel content. The differences in gravel content, however, are not significant. Grain size is measured by weight, which is affected by gravel greater than if it were measured by volume, which is how sediment is specified for mitigation purposes. Therefore, both proposed source pit sediments are beach-compatible sediments.

Please feel free to contact me if there are further questions concerning the evaluation of these sand samples.

Yours truly,

Peter S. Rosen

Peter S. Rosen, Ph. D.

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September 4, 2013

Ms. Maria Hartnett
Epsilon Associates
3 Clocktower Place
Suite 260
Maynard, MA

Re: Evaluation of borrow area sand relative to natural coastal bank sand

Dear Ms. Hartnett:

I have evaluated the suitability of sand from two sand pits on Nantucket, Holdgate and Reis, for use to replace natural nourishment of beach sand from a portion of coastal bank on Baxter Road, Sconset, where a revetment is proposed.

I am using the same composite sand analysis for the two sand pits as I have used in previous evaluations (January 17, 2012). The coastal bank data is derived from the 2006 detailed sampling of the coastal bank by CP&E. The samples within the revetment area were combined to create a composite statistics.

These data are evaluated using the method of James (1974) to estimate the Overfill Factor (R_A), which estimates the additional amount of borrow area sand required to be equal to a given volume of beach sand. In this analysis, I compared the sand pit sand to the natural bank sand, and the result estimates how much additional sand, if any, is necessary to equal a volume of natural coastal bank feeding the adjacent beach.

I also reviewed earlier coastal bank samples in this area and noted that these composite samples were finer than the 2006 data. Therefore, 2006 is a worst-case of all the data available, and therefore yields a conservative estimate.

The attached diagram shows that the Overfill Factor for both sand sources is 1, in the range described by James as "Stable." This means that one cubic yard of sand from the pit is equivalent to one cubic yard of sand from the coastal bank.

This is not surprising, since in this setting the sand pits and the coastal bank are the same geological unit (glacial outwash) sampled in different locations.

I understand that there is some concern that the coastal bank sand is coarsening over time. Both from my evaluation of the sediment data, and my personal knowledge of that coastal bank over several decades, I do not believe that this is a trend of the bank deposits. There is a good deal of natural variation of the sand in a deposit of this size, even at a given time. However, the sediment throughout the bank and the outwash deposit in general, including the 1998, 2003, and 2006 sample sets is remarkably uniform in the medium sand range (1 to 2 phi), with good to moderate sorting values.

Please feel free to contact me if you have any further questions.

Yours truly,

Peter S. Rosen

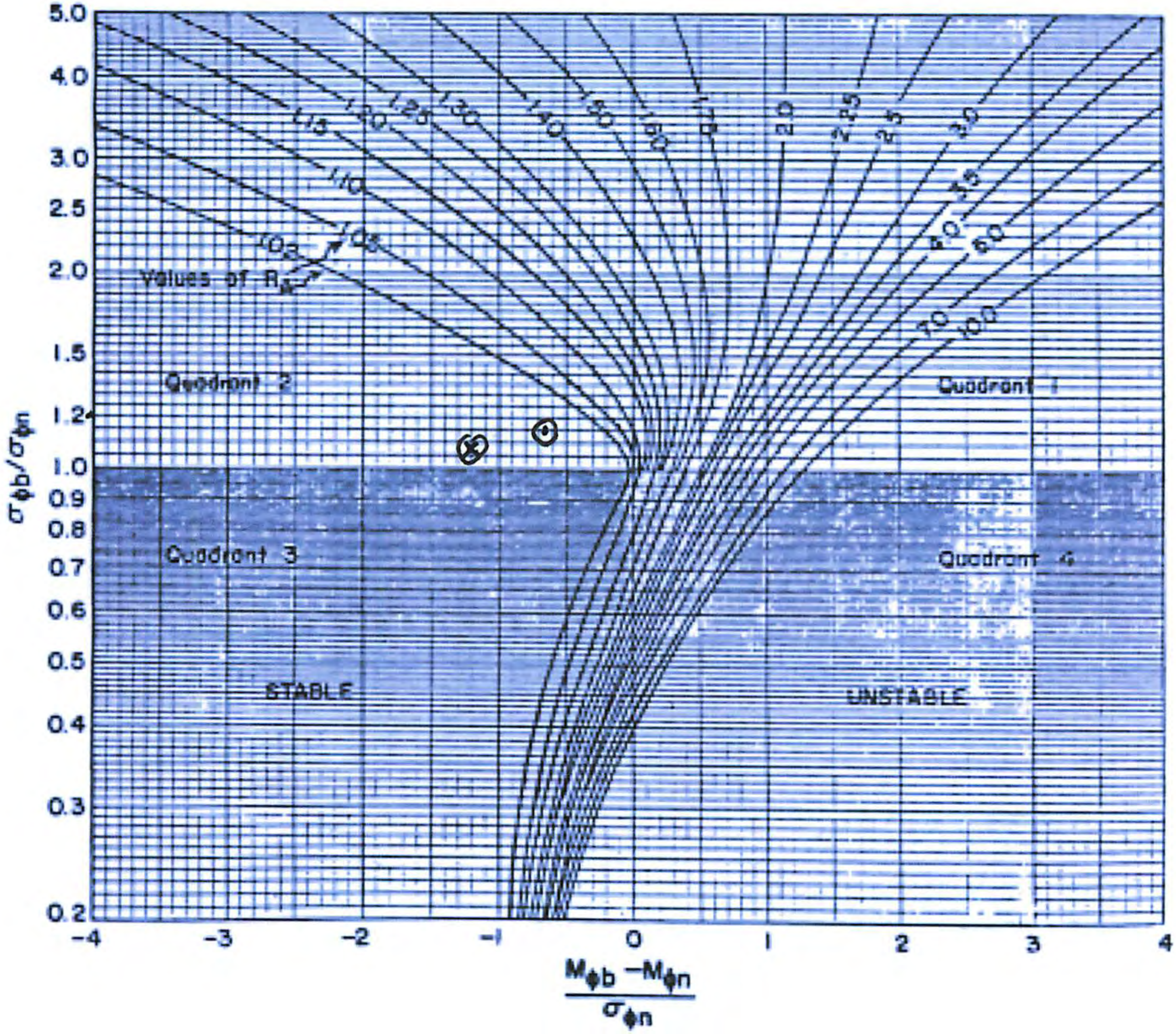
Peter S. Rosen, Ph. D.
Coastal Geologist

Attachments:

1. James Overfill Factor Plot
2. Data worksheet

JAMES OVERFILL FACTOR (R_A)

'BEACH': 2006 BANK COMPOSITE FROM REVETMENT AREA.



SOURCE: ⊙ HOLOGATE

⊗ REIS

Sconset Beach James Overfill Calculation Worksheet 4-Sep-13

Borrow area to bank comparisons

Borrow Area:	Beach/Bank	sd borrow/ sd beach	mean borrow - mean beach/ sd beach	Overfill Factor (RA)
Holdgate Pit	2006 bank data	1.14	-0.66	1
Reis Pit	2006 bank data	1.09	-1.21	1

Bank Composite (based on samples in revetment project area)

2006 bank composite	mean	1.34
	sd	1.17

2006 Bank Samples within Revetment area		
	Mean (phi)	Phi Sorting
L12 UBK	2	0.95
L12 MBK	1.14	1.28
L12 LBK	1.15	0.85
L13 UBK	2.4	0.93
L13 MBK	2.48	1.17
L13 LBK	0.57	0.77
L14 UBK	1.25	0.73
L14 MBK	1.78	1.36
L14 LBK	1.31	1.02
L15 UBK	1.26	1.31
L15 MBK	1.8	1.38
L15 LBK	1.48	1.44
L16 UBK	1.2	1.51
L16 MBK	1.23	1.3
L16 LBK	0.96	1.37
L17 UBK	1.12	1.42
L17 MBK	1.44	1.32
L17 LBK	0.73	1.22
L18 UBK	1.37	1
L18 MBK	0.8	1.01
L18 LBK	0.76	1.2
Mean of Samples in Revetment Project Area		
	1.34	1.17

Source:
2006 Data from CP&E spreadsheets, Lines 12-18