



October 17, 2012

Mr. Michael L. Bachand, P.E.  
Levee Safety Program Manager  
United States Army Corps of Engineers  
New England District  
696 Virginia Road  
Concord, MA 01742

**RE: Request for District Engineer Review Of Engineering Assessment Which Outlines the Procedures that Will Result in No Modification or Alternation to a Corps of Engineers Project: Blasting Associated With Construction of New Bedford Marine Commerce Terminal, New Bedford, MA**

On behalf of the Commonwealth of Massachusetts, and pursuant to 33 U.S.C 408, Apex Companies has prepared this document and the attached plans and report in accordance with:

*U.S. Army Corps of Engineers (USACE)  
MEMORANDUM FOR MAJOR SUBORDINATE COMMANDS,  
Subject: Policy and Procedural Guidance for the Approval of Modification and Alteration of  
Corps of Engineer Projects, dated October 23, 2006*

*And*

*USACE MEMORANDUM FOR SEE DISTRIBUTION,  
SUBJECT: Clarification Guidance on the Policy and Procedural Guidance for the Approval of  
Modifications and Alterations of Corps of Engineers Projects, dated November 17, 2008.*

The Commonwealth of Massachusetts is proposing to construct a multiuse marine facility, the New Bedford Marine Commerce Terminal (NBMCT), within New Bedford Harbor, in the vicinity of the New Bedford Hurricane Protection System (HPS) in New Bedford Massachusetts (a Corps of Engineers project subject to 33 CFR 208.10 and 33 U.S.C. 408). The Commonwealth anticipates that it will require the use of blasting to assist in the removal of rock in construction of the NBMCT. Pursuant to Section 408, which prohibits the impairment of works built by the United States, the Commonwealth conducted a detailed engineering assessment to outline a methodology that would allow implementation of blasting without impact to the New Bedford Hurricane Protection System.

The Commonwealth is providing the results of this assessment to assure the U.S. Army Corps of Engineers (Corps) that the proposed construction of the facility will not alter, modify, injure or impair the HPS. The work in question will require no alteration or modification to a Corps of Engineers Project. This document has been prepared only as a means to submit the attached documents to the USACE for review and approval. Please note that the permitting of this project is being completed directly by USEPA under its CERCLA authority associated with the New Bedford Harbor Superfund Site, and the State Enhanced Remedy provision of the 1998 Record of Decision.

In multi-agency reviews of the NBMCT the USACE expressed concern that the construction of the Commonwealth's facility may impact the HPS, specifically that the potential blasting of rock within the proposed navigational channel for the facility may adversely affect the HPS. The Commonwealth has employed a consultant (GZA Geoenvironmental, Inc. or GZA) to study the potential impacts to the hurricane barrier from blasting, and the resulting report is included with this document. The consultant's report specifies the maximum charge size which can be used to fracture rock relative to a given distances from the HPS without impacts to the design Factors of Safety integral to the Corps operated structure. The following is a table from GZA's report of the recommended maximum charge weight per delay associated with blasting, as it relates to the distance of that charge from the HPS:

<b>Distance from Hurricane Barrier (ft)</b>	<b>60 to 90 Hz</b>
	<b>Charge Weight per delay (lbs)</b>
350	8.9
400	11.7
450	14.8
500	18.2
550	22.1
600	26.2
700	35.7
800	46.7
900	59.1
1000	72.9
1100	88.2
1200	105.0

In their report, GZA states that it is their opinion that if the blast levels are kept below these recommended levels, the stability of the hurricane barrier will not be adversely affected, and that negligible settlement of the barrier will result due to blasting activities. GZA recommends within its report, that maximum blast charge weights be kept at 90% of the values listed above;

however, in order to add an additional factor of safety, the Commonwealth proposes that the maximum blast charge weight be 50% of the value calculated by GZA (adding an additional factor of safety of 2).

The resulting maximum charge weights would be:

Distance from Hurricane Barrier (ft)	60 to 90 Hz
	Charge Weight per delay (lbs)
350	4.4
400	5.8
450	7.4
500	9.1
550	11.0
600	13.1
700	17.8
800	23.3
900	29.5
1000	36.4
1100	44.1
1200	52.5

The Commonwealth will incorporate the findings of the report into the project plans and specifications, and ensure their implementation. No alteration to the HPS is planned as part of the construction of the NBMCT, and the Commonwealth will continue to design the facility with the input of the USACE to ensure that the HPS is not adversely affected by construction activities.

With regard to Executive Order 11988, as there is no planned modification to the HPS and the contemplated blasting will be designed such that no alteration occurs, there are no anticipated changes to the floodplain of the Acushnet river nor to the protections offered by the HPS.

For completeness in submitting materials for review under the guidance documents cited above, the following materials are included as attachments:

**Attachment 1:** "Assessment of Blasting Impacts to the New Bedford-Fairhaven Hurricane Barrier, New Bedford Marine Commerce Terminal, New Bedford Massachusetts." Prepared for Apex Companies, LLC, Boston, Massachusetts. Prepared By: GZA GeoEnvironmental, inc., Providence, Rhode Island.

**Attachment 2:** New Bedford Marine Commerce Terminal Design Drawings: Sheets E-2.1, P-2.6, x-1.1, X-2.1 and X-2.2

**Attachment 3: New Bedford Marine Commerce Terminal Boring Logs**

Sincerely,  
**Apex Companies, LLC.**



Chet H. Myers, PE, LSP

- Attachments:
- 1) "Assessment of Blasting Impacts to the New Bedford-Fairhaven Hurricane Barrier, New Bedford Marine Commerce Terminal, New Bedford Massachusetts." Prepared for Apex Companies, LLC, Boston, Massachusetts. Prepared By: GZA GeoEnvironmental, inc., Providence, Rhode Island.
  - 2) New Bedford Marine Commerce Terminal Design Drawings: Sheets E-2.1, P-2.6, x-1.1, X-2.1 and X-2.2
  - 3) New Bedford Marine Commerce Terminal Boring Logs

## **Attachment 1**



**ASSESSMENT OF BLASTING IMPACTS TO  
THE NEW BEDFORD-FAIRHAVEN  
HURRICANE BARRIER  
NEW BEDFORD MARINE COMMERCE  
TERMINAL  
NEW BEDFORD, MASSACHUSETTS**

**PREPARED FOR:**  
Apex Companies, LLC  
Boston, Massachusetts

**PREPARED BY:**  
GZA GeoEnvironmental, Inc.  
Providence, Rhode Island

October, 2012  
File No. 33734.03

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October 5, 2012  
(Revised October 11, 2012)  
File No. 33734.03



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<http://www.gza.com>

Mr. Chet Myers  
Apex Companies, LLC  
184 High Street, Suite 502  
Boston, Massachusetts 02110

Re: Assessment of Blasting Impacts to the New Bedford-Fairhaven Hurricane Barrier  
New Bedford Marine Commerce Terminal  
New Bedford, Massachusetts

Dear Mr. Meyers:

GZA GeoEnvironmental, Inc. (GZA) is pleased to provide you with this geotechnical letter report pertaining to proposed blasting in the vicinity of the New Bedford-Fairhaven Hurricane Barrier. This report was prepared in accordance with our proposal dated September 4, 2012. The primary objective of this letter report is to present our assessment of blasting induced ground vibrations and its effects on the global stability of the existing New Bedford-Fairhaven Hurricane Barrier for the proposed New Bedford Marine Commerce Terminal project. This report is subject to the Limitations presented in Appendix A.

## **BACKGROUND**

The New Bedford-Fairhaven hurricane barrier spans across New Bedford Harbor between New Bedford and Fairhaven, Massachusetts, and is located immediately south of Palmer Island. The barrier was constructed in the 1960's as part of a flood control infrastructure program. It is generally comprised of an earth fill embankment consisting of layered armor stone, filter stone, and earth fill layers. There is an access roadway that extends the length of the barrier positioned on the harbor side of the embankment. Two gated conduits were incorporated into the barrier which, under normal operating conditions, allows water to easily flow from one side of the barrier to the other during tidal fluctuations. A gated navigation channel is also located on the eastern side of the barrier.

This hurricane barrier is located immediately south of the proposed New Bedford Marine Commerce Terminal project (see Figure 1, Locus Plan). The project involves the development of a waterfront parcel into an all purpose marine terminal having specific applications to the offshore wind industry. The development will include the construction of a cellular cofferdam bulkhead and near-shore dredging along the cofferdam bulkhead to

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facilitate berthing of larger vessels. The proposed bulkhead and limits of dredging are shown in Figure 2 (Apex Figure P-2.6).

In 2011, the U.S. Army Corps of Engineers (USACE) requested a global stability analysis of the hurricane barrier which addressed the potential impacts to the barrier due to the proposed dredge elevations. GZA completed a report addressing this request, titled “Global Stability Analysis, New Bedford-Fairhaven Hurricane Barrier, New Bedford Marine Commerce Terminal, New Bedford, Massachusetts” dated November 23, 2011.

Recently, USACE requested that the stability of the hurricane barrier be re-assessed considering vibrations resulting from any proposed blasting activities. Blasting of shallow bedrock may be allowed at the site in order to meet the proposed dredge elevations.

## **REVIEW OF EXISTING DOCUMENTATION**

Original USACE drawings were provided to GZA by Apex Companies, LLC (Apex). The following drawings were used to develop a cross section of the hurricane barrier for this analysis. These drawings are included in Appendix B.

- “New Bedford-Fairhaven Barrier, General Plan”, April 1962
- “New Bedford-Fairhaven Barrier, Harbor Barrier and Dike, Plan and Profile No. 2”, 1962
- “New Bedford-Fairhaven Barrier, Harbor Barrier and Dike, Typical Sections No. 1”, 1962
- “New Bedford-Fairhaven Barrier, Parking Area, New Bedford”, 1962

All current project elevations reference the Mean Lower Low Water (MLLW) datum; however, all of the original USACE drawings and accompanying subsurface information reference the Mean Sea Level (MSL) Datum, which was assumed to be NGVD 1929. These elevations were converted to MLLW using the following information provided by Apex:  $MLLW = NGVD\ 1929 + 1.52\ ft.$

The subsurface boring logs used to generate a design cross section included recent test boring logs by Apex and original USACE borings. The logs and the location plans are included in Appendix C.

In the immediate vicinity of the hurricane barrier (Dredge Area 1), shallow dredging to approximate elevation -14 feet referenced to the Mean Lower Low Water (MLLW) datum is proposed. The dredge areas are shown in Figure 2 (Apex Figure P-2.6). According to Apex, it is possible that in the future, this area could be dredged to elevation -20 feet. In review of the subsurface data provided by Apex, it is likely that bedrock excavation will not be required in Dredge Area 1. However, based on the available subsurface data,



bedrock excavation may be required in Dredge Areas 2 and 3. Based on the subsurface data, bedrock elevations range between approximately -25 and -30 feet MLLW indicating that between approximately 2 and 7 feet of bedrock may need to be removed to meet the proposed dredge elevations. It is possible that blasting will be allowed during construction to remove the bedrock. The distance between the toe of the hurricane barrier and proposed blasting activities at the lower dredge elevation would be approximately 450 feet.

### **FACTOR OF SAFETY**

The literature was reviewed for an acceptable factor of safety for the hurricane barrier under these seismic conditions. The United States Army Corps of Engineers (USACE) Slope Stability Engineering Manual EM 1110-2-1902 dated October 31, 2003 was reviewed. Minimum required factors of safety for new and earth and rock-fill dams were given, but no guidance was given for seismic loading conditions. The manual referred to a USACE Engineering Circular "Dynamic Analysis of Embankment Dams" which was still in preparation at the time of publication. A search of the USACE manuals and guidance documents did not produce the reference. The USACE Engineering Report "Recommended Guidelines for Safety Inspection of Dams", ER 1110-2-106, dated September 26, 1979 (also republished in July 1, 2011, as 33 CFR Ch II, Section 222.6 National Program for Inspection of Non-Federal Dams, Appendix D) recommended a factor of safety of 1.0 for an embankment dam under earthquake or seismic loading. GZA also reviewed the textbook "Soil Strength and Slope Stability" by J. Michael Duncan and Stephen G. Wright published in 2005. In a section devoted to seismic slope stability, the authors recommended a factor of safety of 1.0 or 1.15 for pseudostatic analyses such as those used in this report.

The USACE Design Memorandum No. 5 on the New Bedford Hurricane Barrier titled "Embankments and Foundations for the New Bedford, Fairhaven and Acushnet Hurricane Protection Project, New Bedford, Massachusetts" dated November 3, 1961 was also reviewed. The USACE conducted slope stability analyses of critical portions of the hurricane barrier during the original design of the barrier. The calculated factors of safety of 1.19 and 1.36 (during construction), and 1.33 (after construction) were considered adequate. Seismic conditions were not considered in the original design. Based on the review of the available information, and a range of recommended factors of safety of 1.0 to 1.15, an acceptable factor of safety of 1.15 for seismic conditions was used for these analyses.

### **SLOPE STABILITY**

GZA used the computer model of the hurricane barrier previously established for the global stability analysis using the Slope/w 2007 program. The cross section of the hurricane barrier analyzed is shown on Figure P-2.6 (Appendix B). A dredge elevation in the vicinity of the hurricane barrier of -20 feet MLLW was used in the analysis based on



the possible proposed future dredging depths. It is GZA's understanding, that although the design plans currently call for a dredge depth of -14 feet, a lower dredge depth of -20 may be considered in the future.

The effects of seismic forces such as from blasting or earthquakes are commonly modeled in slope stability analyses by applying an inertial force to the slope, which is referred to as a pseudostatic analysis. GZA conducted a pseudostatic analysis for this study and applied various seismic forces to the slope to determine the effect of the seismic forces on the stability of the hurricane barrier. The forces were applied in vertical and horizontal directions, and failure of both the ocean side and land side of the embankment was considered. A horizontal seismic force of 0.079g was determined to be the critical force that would result in an acceptable factor of safety on the slope stability. The results of the slope stability analysis are shown in Figures 3 through 6.

Each figure shows the predicted critical failure surface as a green circular surface going through the hurricane barrier. The factor of safety of the critical failure surface is shown in red next to the large red dot. The rest of the grid of smaller red dots represent locations of other possible failure surfaces that were analyzed, each with a different factor of safety. The factors of safety are contoured in green, again with the lowest factor of safety shown with in red.

## **CONTROL OF BLAST INDUCED VIBRATIONS**

The maximum allowable seismic force was related to proposed blasting forces using a relationship incorporating weight of the charge per delay and distance from the structure. GZA then determined the maximum charge weights that can be used during construction as a function of distance from the hurricane barrier. This approach is described in more detail in the following sections.

Typically, construction vibrations are measured in terms of peak particle velocity having units of inches-per-second (ips) measured some distance from the blast site by portable seismographs. At a minimum, seismographs measure and report particle velocities in three mutually perpendicular directions: lateral, transverse, and vertical. The following equation can be used to convert between peak particle velocity and acceleration, given the assumption that the motion is sinusoidal.

$$PPV = \frac{GA}{2\pi F}$$

Where,

PPV = peak particle velocity, in/sec

G = gravitational constant = 386.1 in/sec<sup>2</sup>

A = acceleration coefficient, units of g

F = Frequency, Hz



This relationship between acceleration and peak particle velocity was used to generate blasting criteria using the acceleration from the pseudostatic analysis. The following formula, as published in the 1971 U.S. Bureau of Mines Bulletin 656, "Blast Vibrations and Structures", relates charge weight, distance, and particle velocity.

$$PPV = H \left[ \frac{D}{\sqrt{W}} \right]^{\beta}$$

Where,

D = distance, feet

W = weight of charge per delay, lbs

B = slope factor

H = peak particle velocity intercept, in/sec, at a value of  $D/(W)^{0.5}$  equal to 1

The Bureau of Mines Bulletin reports that vibrations levels are independent of the delay interval, and that the maximum charge weight per delay should be considered in analyzing their effects. For the development of blasting criteria, conservative values for the parameters H and  $\beta$  were used. Data published in the Bulletin collected from blasting at various sites across the country was analyzed by GZA. Typical values of H were found to vary between 20 to 50. A conservative value of 100 was used for these recommendations. The value of  $\beta$  was reported to vary approximately between -1.1 and -1.6 (Bureau of Mines 1971 and Wiss 1981). A conservative value of -1.6 was used for these recommendations. The values of  $\beta$  and H are generally site specific and should be verified and adjusted during a blasting test program, which is described in more detail in later sections of this report.

Based on these assumed values, GZA estimated the maximum allowable charge weights as a function of distance from the hurricane barrier. The frequency content of a blast is highly variable. Blasting frequencies are generally higher than earthquakes and other construction induced vibrations. A conservative range of frequency of the blast was chosen to be 60 Hz to 90 Hz based on typical values for blasting (Wiss 1981). In addition, for an additional factor of safety, GZA recommends that the levels of charge weight be reduced to 90% of the maximum, for the allowable charge weights shown in Table 1. If the frequency content of the blast vibrations is measured to be considerably different at the site than those assumed, then the maximum charge weights should be adjusted accordingly.



Table 1. Allowable Charge Weight per Delay as a Function of Distance from Hurricane Barrier.

Distance from Hurricane Barrier (ft)	60 to 90 Hz
	Charge Weight per delay (lbs)
350	8.9
400	11.7
450	14.8
500	18.2
550	22.1
600	26.2
700	35.7
800	46.7
900	59.1
1000	72.9
1100	88.2
1200	105.0

It is GZA's opinion that if the blast levels are kept below these recommended levels, the stability of the hurricane barrier will not be adversely affected, and that negligible settlement of the barrier will result due to blasting activities.

### PROJECT BLAST TESTING PROGRAM

GZA recommends that a test blast program be performed in the field by the contractor to verify the input parameters used in these analyses, including the blasting frequencies.

The test blast program should consist of performing small test blasts and measuring particle velocity with distance from the blast with various seismographs. The test blasts should be located a significant distance away from the hurricane barrier. Portable seismographs capable of measuring peak particle velocity in three mutually perpendicular directions and frequency are recommended for this work.

A site specific graph of scaled distance versus peak particle velocity should be generated on a log-log plot as shown in Figure 7. The scaled distance is the distance in feet from the blast divided by the square root of W (weight of charge per delay, lbs). The data from the test program should be analyzed by fitting a best-fit regression line to provide the site specific values of velocity intercept (H) and slope factor ( $\beta$ ) as defined previously. The



frequency of the blast vibrations will also be reviewed and compared to the assumed values.

These site-specific values can then be used to determining the final allowable blasting criteria for production blasting at the site. Vibration monitoring is also recommended during the production blasting.

## **CONCLUSIONS AND RECOMMENDATIONS**

The dredging phases of the New Bedford Marine Commerce Terminal Project will require the removal of approximately 2 to 7 feet of bedrock to meet the proposed dredge elevations at a distance of approximately 450 feet away from the toe of hurricane barrier. Since blasting to remove the bedrock is being considered, GZA conducted an analysis to assess the effect of the vibrations on the hurricane barrier.

GZA evaluated the levels of seismic vibrations that the hurricane barrier can tolerate. These limits were related to proposed blasting operations on the site by an established relationship from the U. S. Bureau of Mines. GZA recommends limiting the charge weights to 90% of the limiting values as an initial blasting criterion. The recommended charge weights per delay are given in Table 1 of this report. These recommended values were based on conservative parameter values. A test blast program is recommended in order to verify the design parameters for site-specific values. It is GZA's opinion that if these recommendations are followed, vibration levels can be controlled to within safe limits for the hurricane barrier and surrounding structures.

## **CONTRACT DOCUMENT REVIEW AND CONSTRUCTION SERVICES**

GZA would welcome the opportunity to be retained to revise the plans and specifications in accordance with these recommendations. GZA can also provide services that could include vibration monitoring during the blast testing program and production blasting, reduction of the vibration data, preparation of ground calibration parameters, and preparation of final production blasting criteria.

Apex Companies, LLC

October 5, 2012  
(Revised October 11, 2012)

File No. 33734.00

Page 8



We trust that this report addresses the current geotechnical issues of this project. Please do not hesitate to contact the undersigned with any questions or comments.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

A handwritten signature in blue ink that reads "Diane Baxter".

Diane Baxter, Ph.D.  
Senior Project Manager

A handwritten signature in blue ink that reads "Thomas E. Billups".

Thomas E. Billups, P. E.  
Consultant/Reviewer

A handwritten signature in blue ink that reads "David R. Carchedi".

David R. Carchedi, Ph.D.  
Senior Principal

DYB/DRC:jm



**REFERENCES:**

Duncan, J. M. and Wright, S. G., “Soil Strength and Slope Stability”, John Wiley & Sons, Inc., New Jersey, 2005.

Nicholls, H. R., Johnson, C. F., and Duvall, W. I., “Blasting Vibrations and Their Effects on Structures”, United States Bureau of Mines, Bulletin 656, 1971.

United States Army Corps of Engineers, “Slope Stability Engineering Manual”, EM 1110-2-1902, October 31, 2003.

United States Army Corps of Engineers, “Recommended Guidelines for Safety Inspection of Dams”, ER 1110-2-106, September 26, 1979. (Also republished as 33 CFR Ch II, Section 222.6, “National Program for Inspection of Non-Federal Dams”, Appendix D, July 1, 2011).

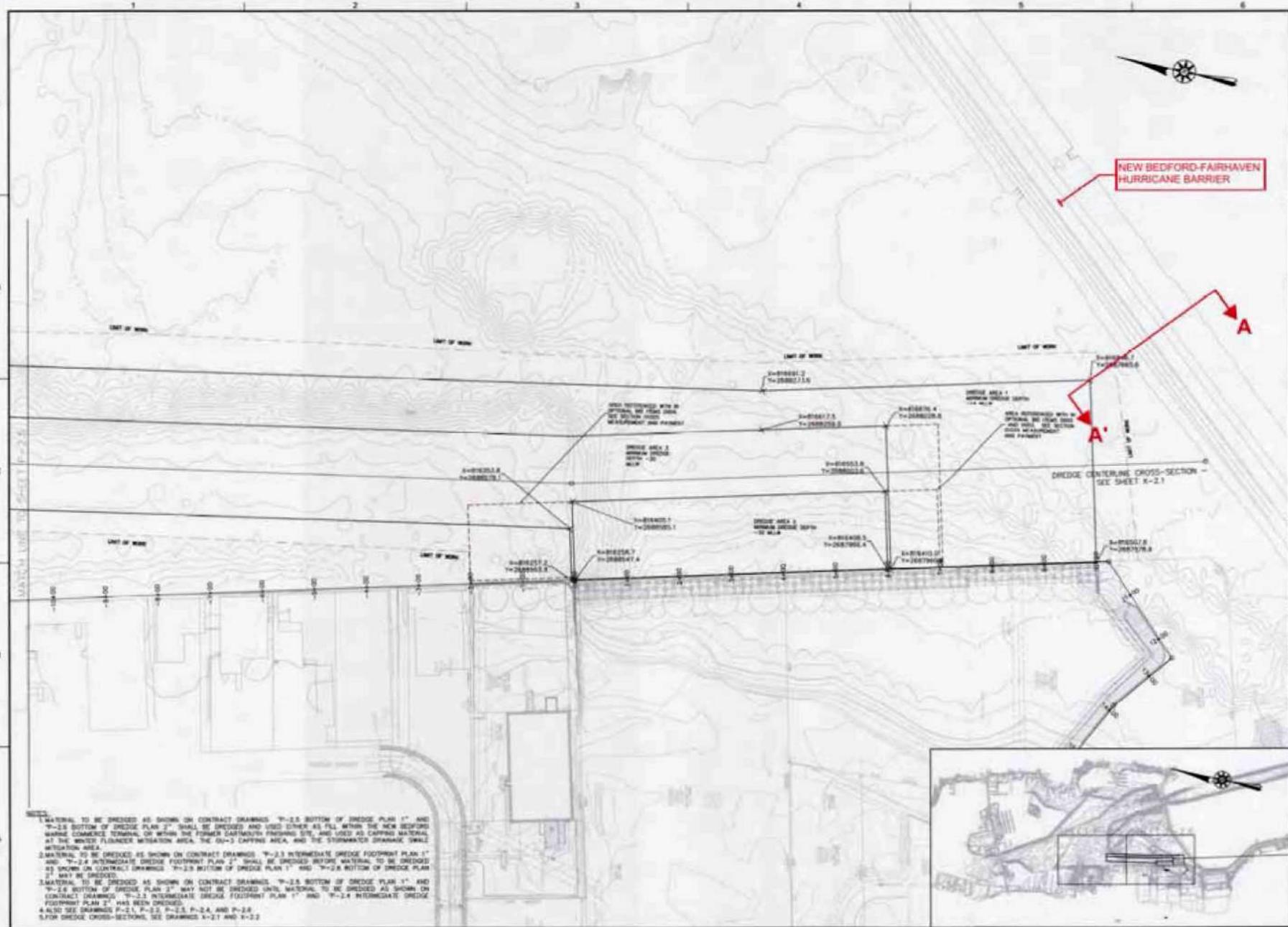
United States Army Corps of Engineers, “Design Memorandum No. 5 - Embankments and Foundations for the New Bedford, Fairhaven and Acushnet Hurricane Protection Project, New Bedford, Massachusetts”, November 3, 1961.

Wiss, J. F., “Construction Vibrations: State of the Art”, *Journal of the Geotechnical Engineering Division*, Proceedings of the American Society of Civil Engineers, ASCE, Vol. 107, No. GT2, February, 1981, pp. 167-181.

Attachments:            Figure 1. Locus Plan  
                                 Figure 2. Bottom of Dredge Plan  
                                 Figure 3. Slope Stability Run 1  
                                 Figure 4. Slope Stability Run 2  
                                 Figure 5. Slope Stability Run 3  
                                 Figure 6. Slope Stability Run 4  
                                 Figure 7. Test Blast Figure  
                                 Appendix A: Limitations  
                                 Appendix B: Original USACE Drawings  
                                 Appendix C: Subsurface Boring Logs

## **FIGURES**





1. MATERIAL TO BE DREDGED AS SHOWN ON CONTRACT DRAWINGS "P-2.6 BOTTOM OF DREDGE PLAN 1" AND "P-2.6 BOTTOM OF DREDGE PLAN 2" SHALL BE SPECIES AND USED COVER AS FOLLOWS WITHIN THE NEW BEDFORD MARINE COMMERCE TERMINAL OF WITHIN THE FORMER CARTMOUTH FISHING SITE, AND USED AS CAPPING MATERIAL AT THE MARINE FLOUNDER MITIGATION AREA, THE GO-3 CAPPING AREA, AND THE STORMWATER DRAINAGE DRAINAGE MITIGATION AREA.

2. MATERIAL TO BE DREDGED AS SHOWN ON CONTRACT DRAWINGS "P-2.3 INTERMEDIATE DREDGE FOOTPRINT PLAN 1" AND "P-2.4 INTERMEDIATE DREDGE FOOTPRINT PLAN 2" SHALL BE SPECIES RESTORE MATERIAL, TO BE DREDGED AS SHOWN ON CONTRACT DRAWINGS "P-2.3 BOTTOM OF DREDGE PLAN 1" AND "P-2.4 BOTTOM OF DREDGE PLAN 2" MAY BE DREDGED.

3. MATERIAL TO BE DREDGED AS SHOWN ON CONTRACT DRAWINGS "P-2.5 BOTTOM OF DREDGE PLAN 1" AND "P-2.6 BOTTOM OF DREDGE PLAN 2" MAY NOT BE DREDGED UNTIL MATERIAL TO BE DREDGED AS SHOWN ON CONTRACT DRAWINGS "P-2.3 INTERMEDIATE DREDGE FOOTPRINT PLAN 1" AND "P-2.4 INTERMEDIATE DREDGE FOOTPRINT PLAN 2" HAS BEEN DREDGED.

4. ALSO SEE DRAWINGS P-2.1, P-2.2, P-2.3, P-2.4, P-2.5, AND P-2.6.

5. FOR DREDGE CROSS-SECTIONS, SEE DRAWINGS X-2.1 AND X-2.2.



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NEW YORK, NY

NO. 400 CROFT, SUITE 200  
BOSTON, MA 02108

NEW BEDFORD MARINE COMMERCE TERMINAL  
SOUTH WINDSOR, CT

The design is prepared by Apex for the project and is not to be used for any other project without the written consent of Apex. The design is not to be used for any other project without the written consent of Apex. The design is not to be used for any other project without the written consent of Apex.



PROJECT  
**NEW BEDFORD MARINE COMMERCE TERMINAL**

OWNER  
MASSACHUSETTS CLEAN ENERGY COUNCIL  
55 SUMNER STREET, 9TH FLOOR  
BOSTON, MASSACHUSETTS

NO.	DATE	DESCRIPTION	BY
PROJECT NO.	MMB		
DATE FILE	8.1.2008		
DESIGNED BY	GGD		
DRAWN BY	DMW		
CHECKED BY	CHM		
DATE	8/20/11		
DRAWING SCALE	1"=10'		



SHEET TITLE  
**BOTTOM OF DREDGE PLAN 2**

DRAWING NO.  
**P-2.6**

FIGURE 2 - BOTTOM OF DREDGE PLAN

Scenario 4: Dredge Conditions Based off Drawing P-9  
 Dredge Elevation -20 feet MLLW  
 New Bedford-Fairhaven Hurricane Barrier  
 Slope Stability Analysis: Section A-A'  
 Minimum Factor of Safety - 1.15  
 Maximum Horizontal Acceleration - 0.079g

GZA GeoEnvironmental, Inc.  
 By: JIM 10/2/2012  
 Chk: DYB MM/DD/YY

New Bedford South Terminal  
 File No. 3373403  
 File Name: J:\Geo\3373403\dyb\Work\Slope Stability\33734100\_Section A-A'-Dredge\_HORIZONTAL\_1-R.gsz  
 Name: GRANULAR FILL Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1  
 Name: BEDROCK Model: Un drained (Impenetrable) Piezometric Line: 1  
 Name: SAND AND GRAVEL Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1  
 Name: ORGANIC SILT Model: Undrained (Phi=0) Unit Weight: 100 Cohesion: 20 Piezometric Line: 1  
 Name: RPPRAP Model: Mohr-Coulomb Unit Weight: 150 Cohesion: 0 Phi: 30 Phi-B: 0 Piezometric Line: 1  
 Name: Embankment Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 34 Phi-B: 0 Piezometric Line: 1  
 Name: Glacial Till Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 2 Phi: 36 Phi-B: 0 Piezometric Line: 1

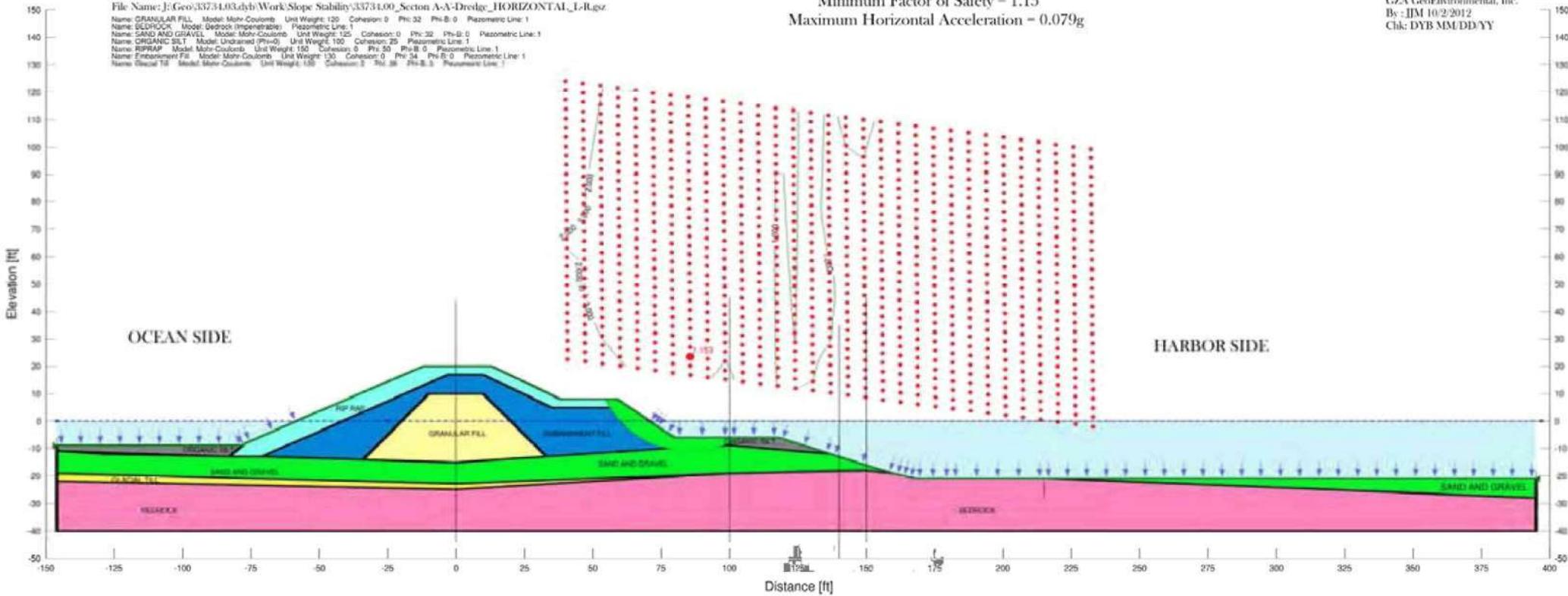


FIGURE 3 - SLOPE STABILITY RUN 1

Scenario 4: Dredge Conditions Based off Drawing P-9  
 Dredge Elevation -20 feet MLLW  
 New Bedford-Fairhaven Hurricane Barrier  
 Slope Stability Analysis: Section A-A'  
 Minimum Factor of Safety - 1.15  
 Maximum Horizontal Acceleration = 0.108g

GZA GeoEnvironmental, Inc.  
 By: JIM 10/2/2012  
 Chk: DYB MM/DD/YY

New Bedford South Terminal  
 File No. 3373403  
 File Name: J:\Geo\3373403\dyb\Work\Slope Stability\33734100\_Section A-A'-Dredge\_HORIZONTAL\_R-L.gpz  
 Name: GRANULAR FILL Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1  
 Name: BEDROCK Model: Unbreak (Impenetrable) Piezometric Line: 1  
 Name: SAND AND GRAVEL Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1  
 Name: ORGANIC SILT Model: Undrained (Phi=0) Unit Weight: 100 Cohesion: 20 Piezometric Line: 1  
 Name: SILT Model: Mohr-Coulomb Unit Weight: 150 Cohesion: 0 Phi: 30 Phi-B: 0 Piezometric Line: 1  
 Name: Embankment Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 34 Phi-B: 0 Piezometric Line: 1  
 Name: Glacial Till Model: Mohr-Coulomb Unit Weight: 135 Cohesion: 0 Phi: 36 Phi-B: 0 Piezometric Line: 1

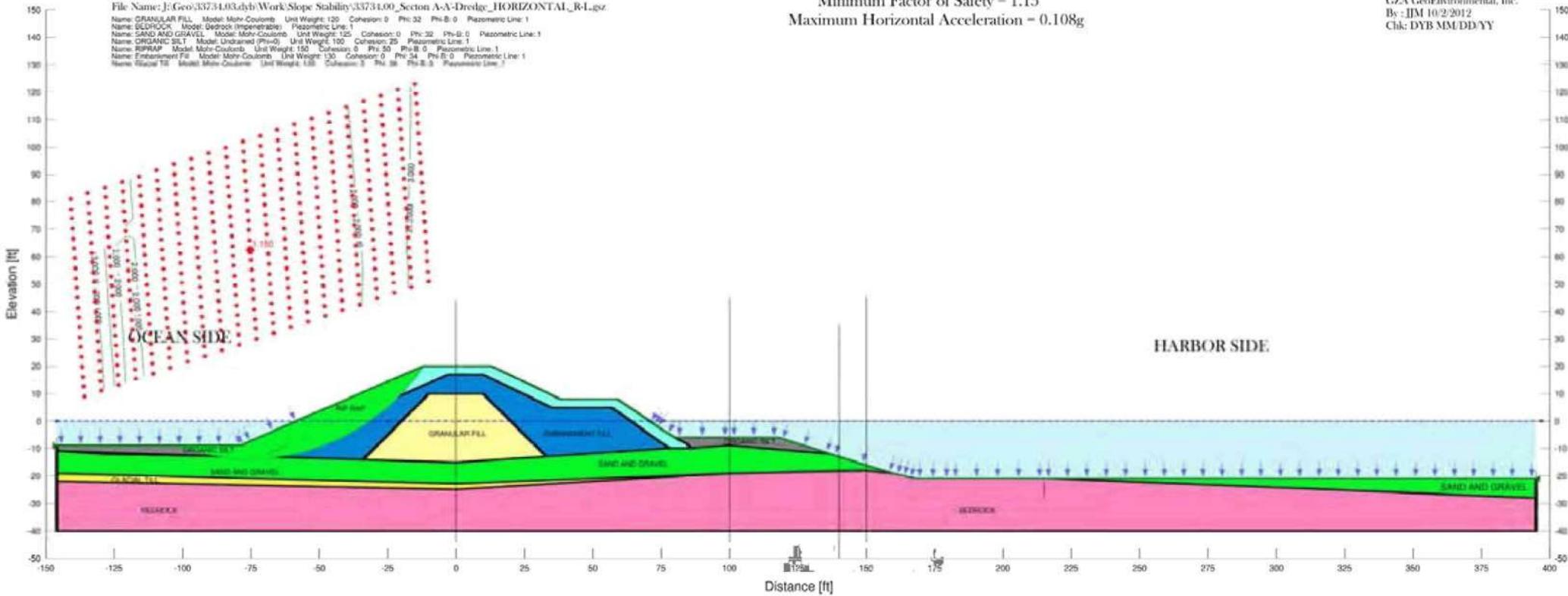


FIGURE 4 - SLOPE STABILITY RUN 2

Scenario 4: Dredge Conditions Based off Drawing P-9  
 Dredge Elevation -20 feet MLLW  
 New Bedford-Fairhaven Hurricane Barrier  
 Slope Stability Analysis: Section A-A'  
 Minimum Factor of Safety = 1.15  
 Maximum Vertical Acceleration = -0.348g

GZA GeoEnvironmental, Inc.  
 By: JIM 10/2/2012  
 Chk: DYB MM/DD/YY

New Bedford South Terminal  
 File No. 3373403  
 File Name: J:\Geo\3373403\dyb\Work\Slope Stability\33734100\_Section A-A'-Dredge\_VERTICAL\_L-R.gsr  
 Name: GRANULAR FILL Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1  
 Name: BEDROCK Model: Drisrock (Impenetrable) Piezometric Line: 1  
 Name: SAND AND GRAVEL Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1  
 Name: ORGANIC SILT Model: Undrained (Phi=0) Unit Weight: 100 Cohesion: 20 Piezometric Line: 1  
 Name: RPPRAP Model: Mohr-Coulomb Unit Weight: 150 Cohesion: 0 Phi: 30 Phi-B: 0 Piezometric Line: 1  
 Name: Embankment Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 34 Phi-B: 0 Piezometric Line: 1  
 Name: Special Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 2 Phi: 36 Phi-B: 0 Piezometric Line: 1

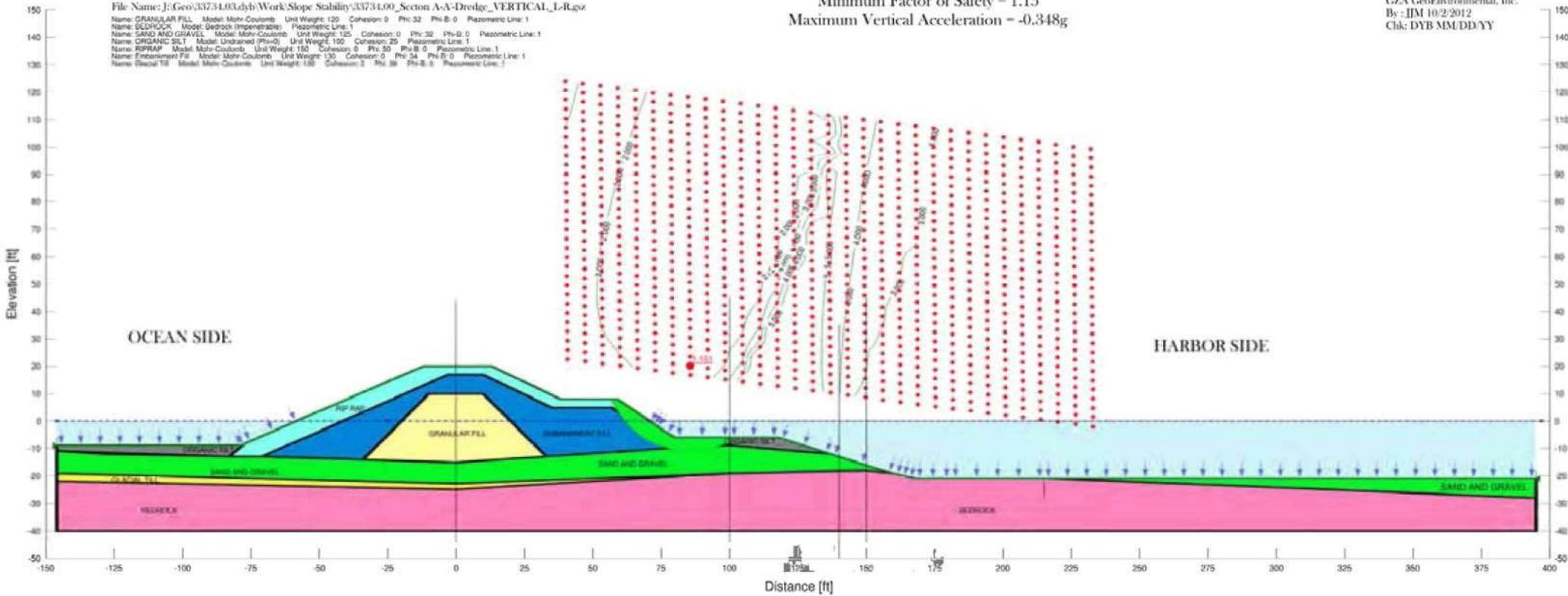


FIGURE 5 - SLOPE STABILITY RUN 3

Scenario 4: Dredge Conditions Based off Drawing P-9  
 Dredge Elevation -20 feet MLLW  
 New Bedford-Fairhaven Hurricane Barrier  
 Slope Stability Analysis: Section A-A'  
 Minimum Factor of Safety = 1.15  
 Maximum Vertical Acceleration = -0.451g

GZA GeoEnvironmental, Inc.  
 By: JIM 10/2/2012  
 Chk: DYB MM/DD/YY

New Bedford South Terminal  
 File No. 3373403  
 File Name: J:\Geo\3373403\dyb\Work\Slope Stability\33734100\_Section A-A'-Dredge\_VERTICAL\_R4.gzd  
 Name: GRANULAR FILL Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1  
 Name: BEDROCK Model: Drisback (Impenetrable) Piezometric Line: 1  
 Name: SAND AND GRAVEL Model: Mohr-Coulomb Unit Weight: 125 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1  
 Name: ORGANIC SILT Model: Undrained (Phi=0) Unit Weight: 100 Cohesion: 20 Piezometric Line: 1  
 Name: RPPRAP Model: Mohr-Coulomb Unit Weight: 150 Cohesion: 0 Phi: 30 Phi-B: 0 Piezometric Line: 1  
 Name: Embankment Fill Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 34 Phi-B: 0 Piezometric Line: 1  
 Name: (Space T) Model: Mohr-Coulomb Unit Weight: 130 Cohesion: 0 Phi: 36 Phi-B: 0 Piezometric Line: 1

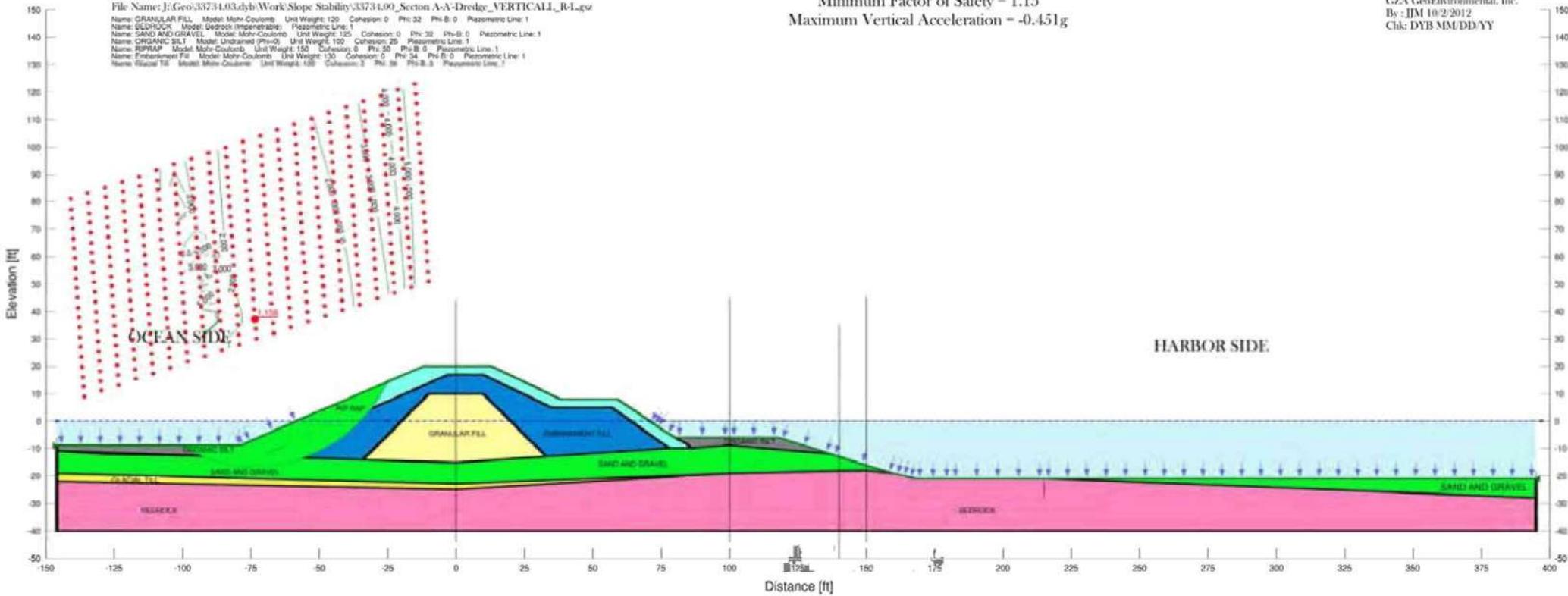


FIGURE 6 - SLOPE STABILITY RUN 4

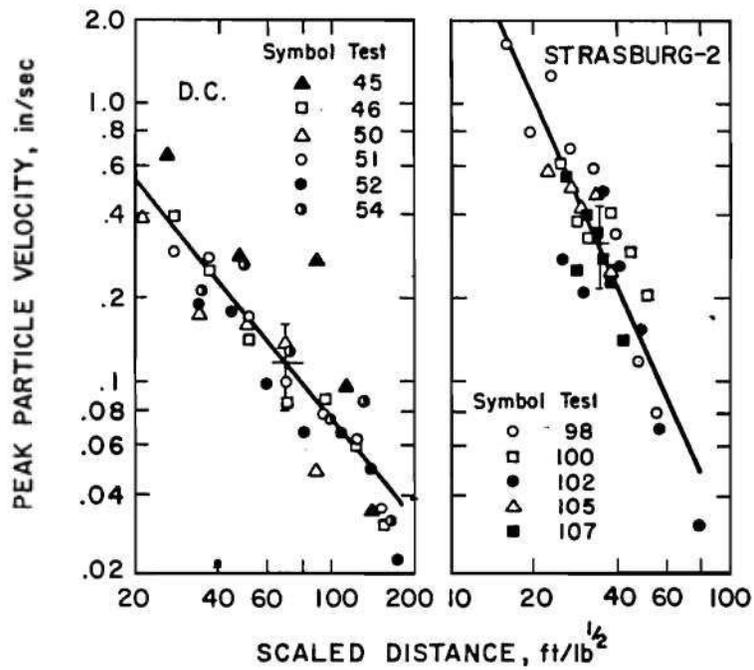


FIGURE 7

EXAMPLE OF SCALED DISTANCE VS.  
PEAK PARTICLE VELOCITY  
(BUREAU OF MINES, 1971)

**APPENDIX A**  
**LIMITATIONS**



## GEOTECHNICAL LIMITATIONS

### Use of Report

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

### Standard of Care

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in Proposal for Services and/or Report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the design has been altered in any way, GZA shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions .
3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

### Subsurface Conditions

4. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs.
5. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein which were made available to GZA at the time of our evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.
6. Water level readings have been made in test holes (as described in the Report) and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The water table encountered in the course of the work may differ from that indicated in the Report.

7. GZA's services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.
8. Recommendations for foundation drainage, waterproofing, and moisture control address the conventional geotechnical engineering aspects of seepage control. These recommendations may not preclude an environment that allows the infestation of mold or other biological pollutants.

#### Compliance with Codes and Regulations

9. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.

#### Cost Estimates

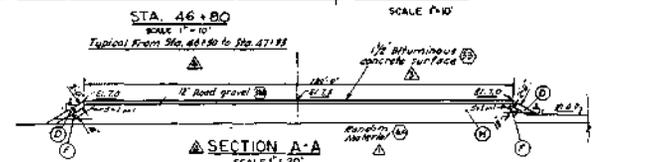
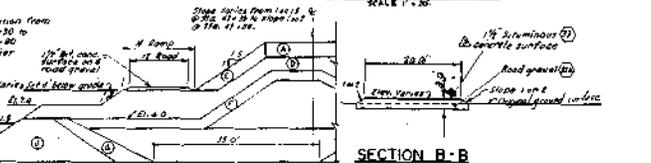
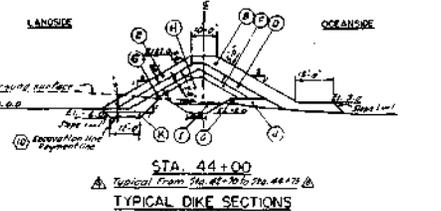
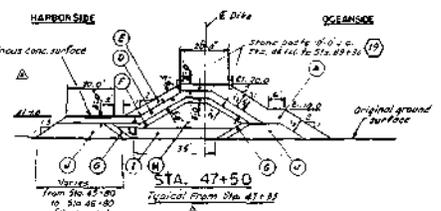
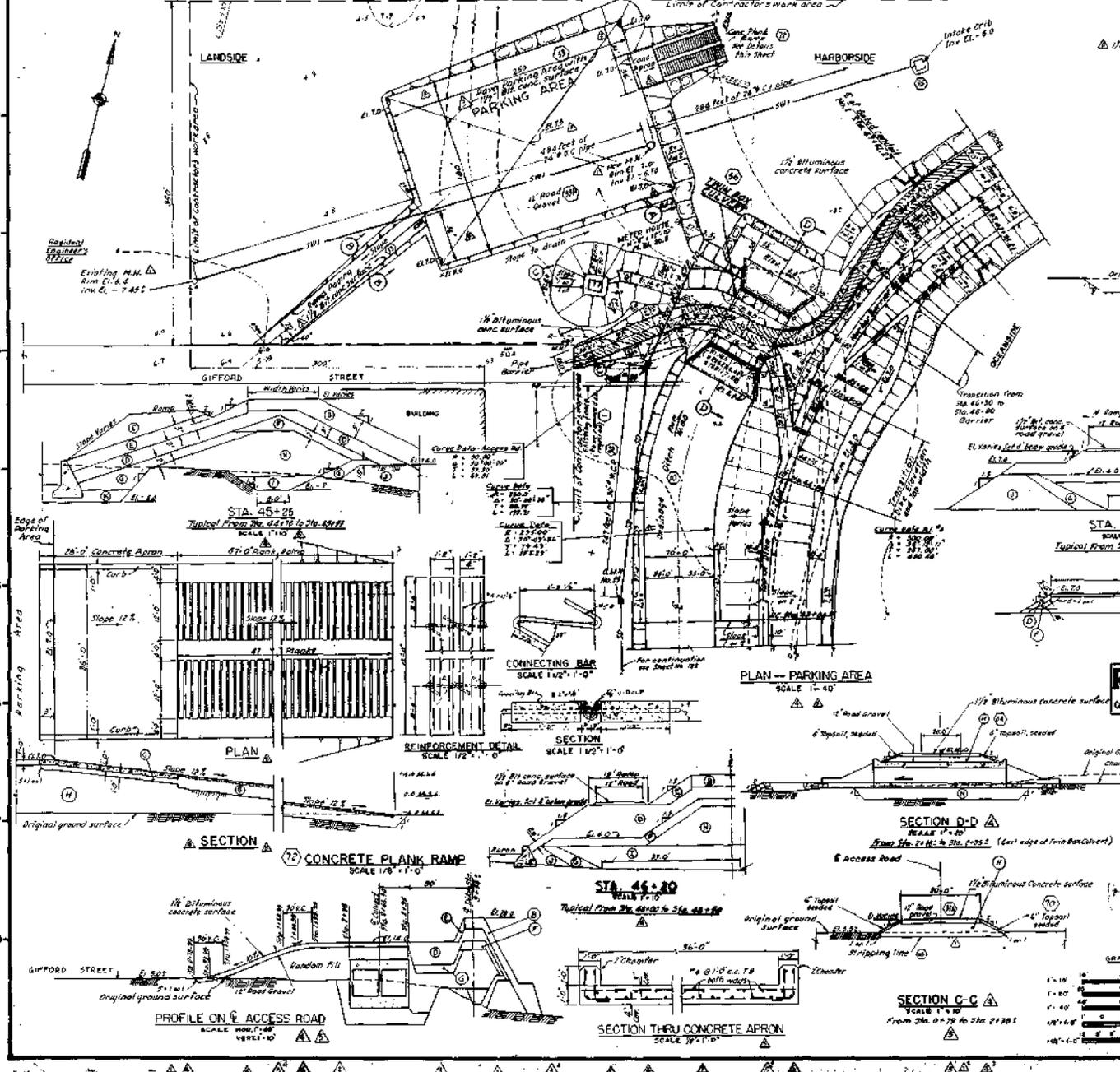
10. Unless otherwise stated, our cost estimates are only for comparative and general planning purposes. These estimates may involve approximate quantity evaluations. Note that these quantity estimates are not intended to be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in this Report. Further, since we have no control over either when the work will take place or the labor and material costs required to plan and execute the anticipated work, our cost estimates were made by relying on our experience, the experience of others, and other sources of readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

#### Additional Services

11. GZA recommends that we be retained to provide services during any future: site observations, design, implementation activities, construction and/or property development/redevelopment. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

**APPENDIX B**  
**ORIGINAL USACE DRAWINGS**





**Record Drawing**  
 Contract No. DA-19016 CIV ENG 62-64

**NOTES**

1. See general notes, see sheet No. 2.
2. Turn 110' radius placed West of Access Road, Slab 28 and for Working Area, shall be 300mm material.
3. For Plan and Section of Trench Bar Channel see sheet No. 41 & 42.
4. For details of 2" Pipe Material, see sheet No. 37.
5. For details of Water Table, see sheet No. 35.
6. For details of Guard Channel, see sheet No. 43 & 44.
7. For details of embankment material, see sheet No. 38.
8. For details of Utilities, see sheet No. 18.
9. Utility relocations to be done by others.

62-64	Total Field Construction	
62-65	Dike, Access Road and Ramp, Channel, Retention	
62-66	Parking Area, Access Road and Ramp	
62-67	Channel, Retention, Access Road and Ramp	
62-68	Channel, Retention, Access Road and Ramp	
62-69	Channel, Retention, Access Road and Ramp	
62-70	Channel, Retention, Access Road and Ramp	
62-71	Channel, Retention, Access Road and Ramp	
62-72	Channel, Retention, Access Road and Ramp	
62-73	Channel, Retention, Access Road and Ramp	
62-74	Channel, Retention, Access Road and Ramp	
62-75	Channel, Retention, Access Road and Ramp	
62-76	Channel, Retention, Access Road and Ramp	
62-77	Channel, Retention, Access Road and Ramp	
62-78	Channel, Retention, Access Road and Ramp	
62-79	Channel, Retention, Access Road and Ramp	
62-80	Channel, Retention, Access Road and Ramp	
62-81	Channel, Retention, Access Road and Ramp	
62-82	Channel, Retention, Access Road and Ramp	
62-83	Channel, Retention, Access Road and Ramp	
62-84	Channel, Retention, Access Road and Ramp	
62-85	Channel, Retention, Access Road and Ramp	
62-86	Channel, Retention, Access Road and Ramp	
62-87	Channel, Retention, Access Road and Ramp	
62-88	Channel, Retention, Access Road and Ramp	
62-89	Channel, Retention, Access Road and Ramp	
62-90	Channel, Retention, Access Road and Ramp	
62-91	Channel, Retention, Access Road and Ramp	
62-92	Channel, Retention, Access Road and Ramp	
62-93	Channel, Retention, Access Road and Ramp	
62-94	Channel, Retention, Access Road and Ramp	
62-95	Channel, Retention, Access Road and Ramp	
62-96	Channel, Retention, Access Road and Ramp	
62-97	Channel, Retention, Access Road and Ramp	
62-98	Channel, Retention, Access Road and Ramp	
62-99	Channel, Retention, Access Road and Ramp	
62-100	Channel, Retention, Access Road and Ramp	

U. S. ARMY ENGINEER DIVISION, NEW ORLEANS  
 CORPS OF ENGINEERS

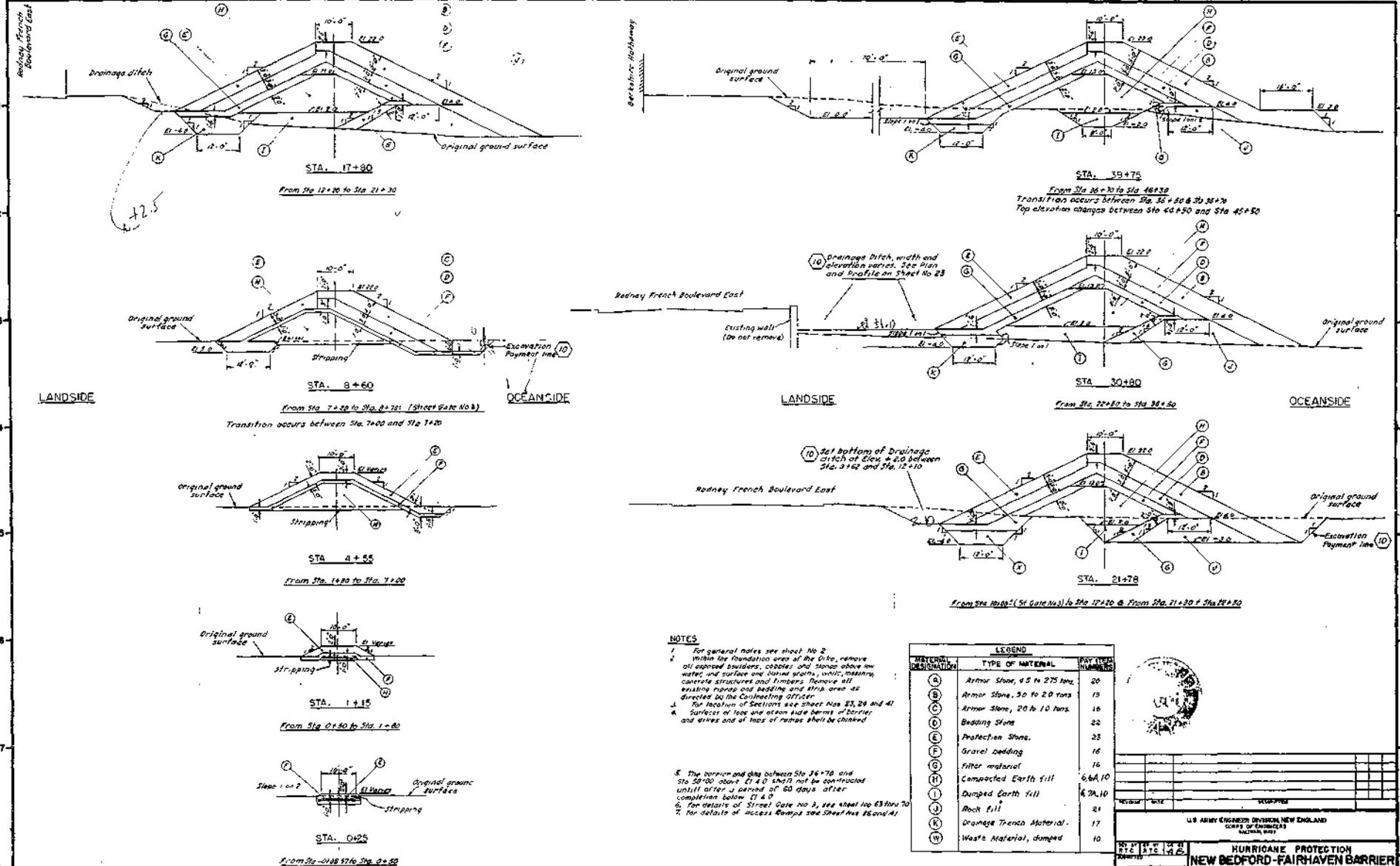
**HURRICANE PROTECTION  
 NEW BEDFORD-FAIRHAVEN BARRIER  
 PARKING AREA  
 NEW BEDFORD**

NEW BEDFORD HARBOR MASSACHUSETTS  
 DATE APRIL 1942

SCALE 1" = 10' (SEE SHEET NO. 18)

NBF-1-1071





NOTES

1. For general notes see sheet No. 2
2. Within the foundation area of the Dike, remove all approved boulders, cobbles and stones above low water and surface and buried straps, utility, masonry, concrete structures and timbers. Remove all existing riprap and bedding and strip area as directed by the Contracting Officer.
3. For location of Sections see sheets Nos. 23, 24 and 41
4. Surfaces of logs and stone side berms of barrier and dikes and of tops of ramps shall be checked

5. The bottom and dike between Sta. 26+70 and Sta. 50+00 above 21.40 shall not be constructed until after a period of 60 days after completion below 21.40
6. For details of Street Gate No. 3, see sheet No. 63 thru 70
7. For details of access Ramps see Sheet Nos. 66 and 67

LEGEND		
ALPHABETIC DESIGNATION	TYPE OF MATERIAL	MIN. THICK. IN FEET
A	Armor Stone, 45 to 275 tons	20
B	Armor Stone, 30 to 20 tons	15
C	Armor Stone, 20 to 10 tons	16
D	Bedding Stone	22
E	Protection Stone	25
F	Gravel bedding	16
G	Filter material	15
H	Compacted Earth fill	6.6A, 10
I	Dumped Earth fill	6.7A, 10
J	Rock fill	21
K	Drainage Trench Material	17
L	Waste Material, dumped	10

TYPICAL SECTIONS  
SCALE: 1" = 10'



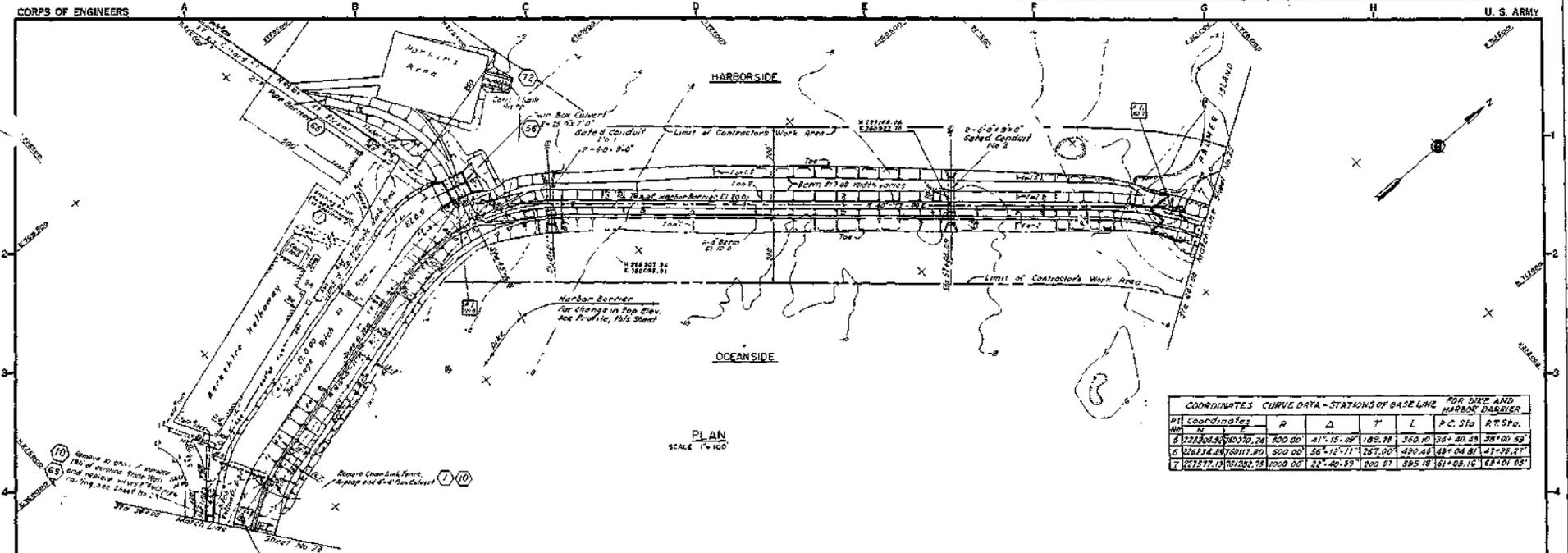
U. S. ARMY ENGINEER DIVISION, NEW ENGLAND  
CORPS OF ENGINEERS  
MAINE, 1951

**HURRICANE PROTECTION  
NEW BEDFORD-FAIRHAVEN BARRIER  
HARBOR BARRIER AND DIKE  
TYPICAL SECTIONS NO. 1**

NEW BEDFORD MASSACHUSETTS

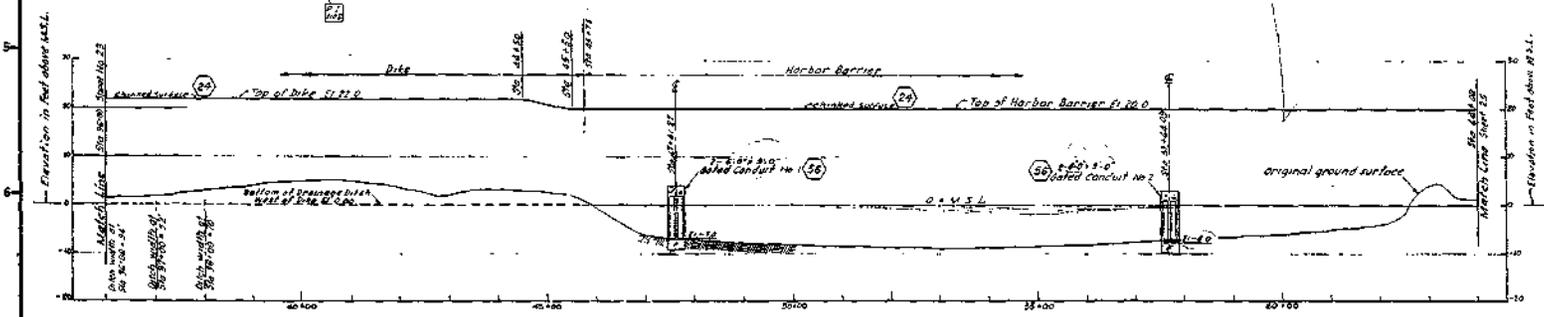
APPROVED: \_\_\_\_\_ DATE: 6/20/53  
DRAWN BY: \_\_\_\_\_

SCALE: 1" = 10' SHEET NO. NBF-1-1038



PLAN  
SCALE 1"=100'

PI	Coordinates	R	Δ	T	L	P.C. Sta	R.T. Sta.
1	222308.85 50370.74	500.00	47° 15' 28"	186.78	560.10	35+00.00	38+00.00
2	124274.89 78011.80	500.00	36° 12' 21"	287.00	490.48	43+04.81	47+08.27
3	121577.14 761282.78	1000.00	27° 26' 29"	200.27	595.18	181+02.14	183+01.25



PROFILE ON C OF DIKE AND HARBOR BARRIER  
SCALE HOR. 1"=100'  
VERT. 1"=10'

- NOTES**
1. For general notes see sheet No. 2
  2. For Plans and Details of Parking Area see sheet No. 41
  3. For Details of Twin Box Culvert see sheet No. 42 and 43
  4. For Details of Gated Conduit No. 1 and 2 see sheet No. 45 and 46
  5. For Typical Sections of Dike and Harbor Barrier see sheet Nos. 23 and 24
  6. For existing and new utility details see sheet No. 12B-15, 16
  7. For Details of 2" Pipe Barrier see sheet No. 37
  8. Utilities are shown on sheet No. 12B-15, 16
  9. Utility relocations to be done by others
  10. For details of 2" S.W.I. pipe to utility see sheet No. 86



NO. BY	DATE	BY	DATE
1	12/15/52	J.S.	12/15/52
2	1/10/53	J.S.	1/10/53
3	1/10/53	J.S.	1/10/53
4	1/10/53	J.S.	1/10/53
5	1/10/53	J.S.	1/10/53
6	1/10/53	J.S.	1/10/53
7	1/10/53	J.S.	1/10/53
8	1/10/53	J.S.	1/10/53
9	1/10/53	J.S.	1/10/53
10	1/10/53	J.S.	1/10/53

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND  
CORPS OF ENGINEERS  
MILITARY MAP

**HURRICANE PROTECTION  
NEW BEDFORD FAIRHAVEN BARRIER  
HARBOR BARRIER AND DIKE  
PLAN AND PROFILE NO. 2**

NEW BEDFORD HARBOR MASSACHUSETTS  
DATE: APRIL 1952

SCALE: HORIZONTAL 1"=100' VERTICAL 1"=10'

DRAWING NUMBER  
MBF-1-1034

SHEET 24

**APPENDIX C**  
**SUBSURFACE EXPLORATION LOGS**



**APEX**  
 INCORPORATED, 100  
 STATE STREET, SUITE 1000, BOSTON, MA 02109  
 TEL: 617.552.3000 FAX: 617.552.3001  
 WWW.APEXENGINEERS.COM



**PROJECT**  
 NEW BEDFORD  
 MARINE COMMERCE  
 TERMINAL

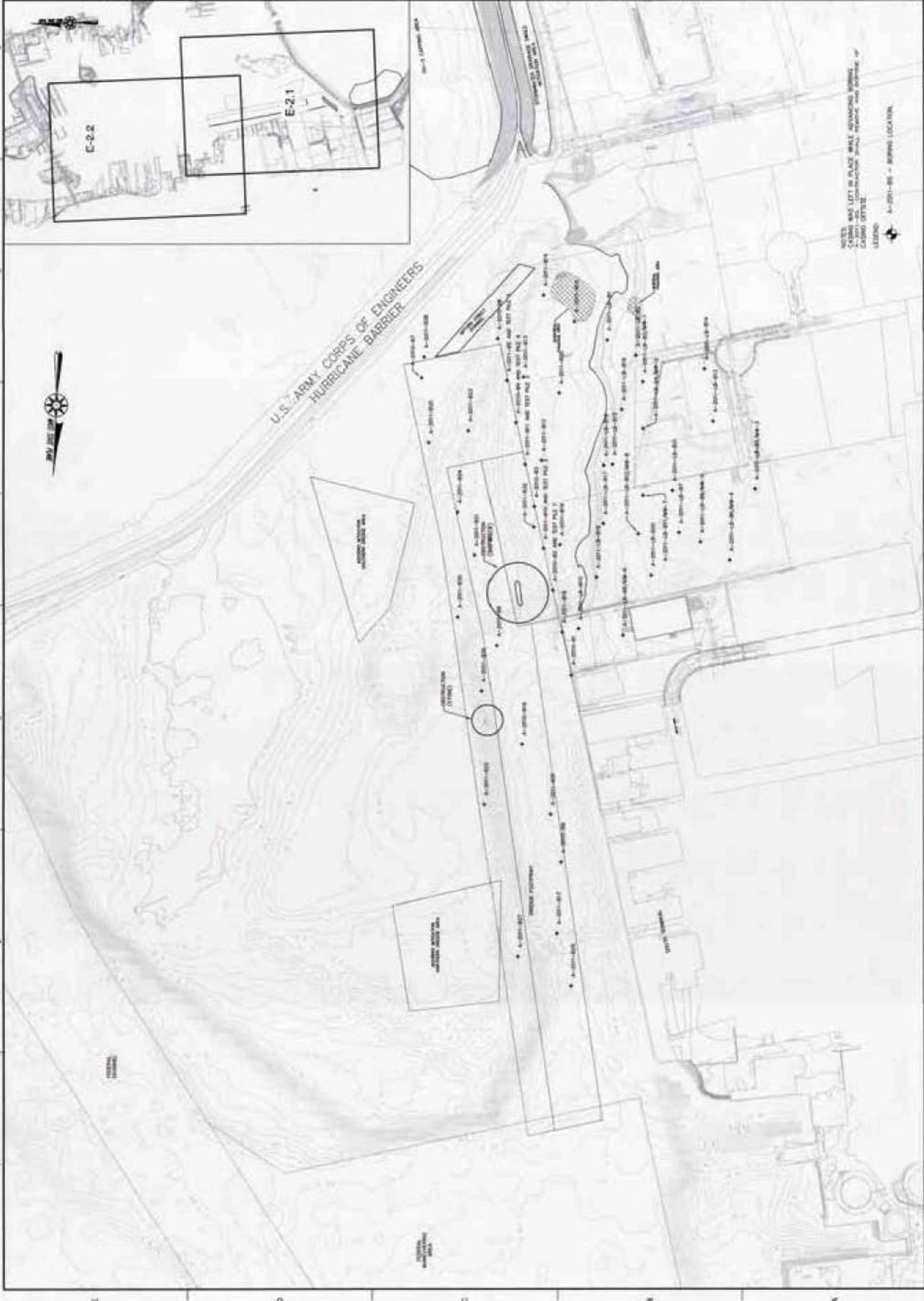
**OWNER**  
 MASSACHUSETTS CLEAN ENERGY CENTER  
 20 SUMMIT STREET, 9TH FLOOR  
 BOSTON, MASSACHUSETTS

PROJECT NO.	10000
DATE FILED	10/1/10
DESIGNED BY	SKD
DRAWN BY	SKD
CHECKED BY	SKD
DATE	10/1/10
DRAWING SCALE	1"=40'
DATE	10/1/10
NO.	1
DATE	10/1/10
DESCRIPTION	EXISTING CONDITIONS

**EXISTING  
 CONDITIONS  
 DREDGE  
 FOOTPRINT  
 SHEET 1**

**E-2.1**

11 OF 11





Date: 9/24/2010  
Time: 12:15 PM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.005	X: 816781.1
Location: South Terminal Expansion		Y: 2687710.6
Elevation at mudline: -5.5	Datum: MLLW	Boring No: A-2010-B7
Casing Type: Steel	Boring Depth: -28.0' MLLW	
Casing Diameter: 4"	Drill Rig: CME 45	Sheet: 1 of 1
Drill Co: NH Boring	Method: Drill and Wash	
Driller: Todd Pentacost	Log By: GAD	

Depth below mudline (ft)	ROD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 12"	WOR,6,8,8	0-1' Black, organic SILT 1'-2' Olive Grey, fine to medium SAND, some shell hash, trace silt	-7.5
4		24" 12"	9/11/12/16	Olive Grey, fine to medium SAND, some shell hash, trace silt	-9.5
6		24" 12"	7/5/7/5	4'-4.5' Olive Grey, fine to medium SAND, some shell hash, trace silt 4.5'-6' Greenish grey, fine SAND and SILT	-11.5
8		24" 17"	15/23/100-5"	6'-7' Olive Grey, fine to medium SAND, some shell hash, trace silt 7'-7.4' Olive grey, fine SAND and SILT	-13.5
10		24" 24"	18/14/12/17	8'-8.5' Greenish grey, fine to medium SAND and fine angular GRAVEL 8.5'-9.5' Light grey, fine to medium SAND, some coarse SAND 9.5'-10' Greenish grey, fine SAND and SILT	-15.5
12		24" 24"	15/18/24/58	10'-11.5' Greenish grey, fine SAND and SILT, trace fine angular gravel 11.5'-12' Olive grey, medium to coarse SAND, trace rock fragments at tip.	-17.5
12.5				Drove casing to refusal, cleaned hole, and began core run at -18.0 MLLW	-18
17.5	88%	60" 56"	11/10/12/15/ 12	Rock Core #1: -18.5to -23.5 MLLW - Highly to moderately fractured grey and pink Granitic Gneiss	-23
22.5	61%	60" 40"	8/8/7/8/9	Rock Core #2: -23.5 to -28.5 MLLW - Highly to moderately fractured grey and pink Granitic Gneiss	-28

Comments: Core run was completed at less revolutions per minute than recommended by core barrel manufacturer, drill time is not a good indicator of rock competency.

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/17/2011

Time: 1:00 PM

# BORING LOG

Project:	Phase IV Dredging	Project No:	6690.008	X:	816606
Location:	South Terminal Expansion			Y:	2687892
Elevation at mudline:	-10.65	Datum:	MLLW		
Casing Type:	Steel	Boring Depth:	-38.65' MLLW	Boring No:	A-2011-B23
Casing Diameter:	4"	Drill Rig:	CME 45		
Drill Co:	NH Boring	Method:	Drill and Wash	Sheet:	1 of 1
Driller:	Norman Stuttard	Log By:	GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 8"	WOR, WOR, WOR, WOR	Top 4": Black, organic SILT. Last 4": Dark gray, fine to medium SAND and SILT, trace shell hash.	-12.65
7		24" 12"	13,13,17,21	Light gray, fine to coarse SAND.	-17.65
10		0" 0"	100/2"	No recovery.	-20.55
18.25				Obstruction encountered at -23.4 MLLW. Advanced roller bit through a series of obstructions, believed to be either a series of boulders or rock fragments to -28.85 MLLW.	-28.85
18.25		0" 0"	100/0"	No recovery.	-28.85
18.25				Cleaned hole and began core run at -28.85 MLLW.	-28.85
23	65%	4.8' 4.55'	8,9,9,10,11	Rock Core #1: -28.85 to -33.65 MLLW 0.0'-4.8' Intensely to moderately fractured pink grey GRANITE.	-33.65
28	85%	5' 5'	8,8,7,9,9	Rock Core #2: -33.65 to -38.65 MLLW 0.0'-5.0' Moderately fractured pink grey granitic GNEISS.	-38.65

Comments:

Notes:

- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
- 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/28/2011

Time: 9:29 AM

# BORING LOG

Project:	Phase IV Dredging	Project No: 6690.008	X: 816775
Location	South Terminal Expansion		Y: 2687636
Elevation at mudline:	-5.2	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-24.0' MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Norman Stuttard	Log By:	GCD
			Boring No: A-2011-B28
			Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 14"	WOR, WOR, WOR, WOR	Black, organic SILT, trace fine to coarse sand, trace shell hash.	-7.2
4		24" 16"	10,6,10,12	Grey, fine to medium SAND, little shell hash.	-9.2
6		24" 16"	9,12,11,13	Tan to grey, very fine SAND, trace inorganic silt.	-11.2
8		24" 7"	10,18,17,18	Grey, fine SAND, little inorganic silt, little medium to coarse sand, trace gravel.	-13.2
10		24" 9"	10,20,29,32	Grey fine SAND, little silt, trace coarse gravel.	-15.2
12		24" 12"	20,27,29,43	Grey fine to coarse SAND, little silt, little fine to coarse gravel.	-17.2
13		12" 6"	24,37, 100/0"	Grey, fine to coarse SAND, little silt, little fine to coarse gravel.	-18.2
14.3				Encountered obstruction at -19.5 MLLW. Cleaned hole and began core run.	-19.5
18.8	36%	4.5' 4.5'	5,4,5,5	Rock Core #1: -19.5 to -24.0 MLLW - Intensely to moderately fractured pink grey granitic GNEISS.	-24.0

Comments: Intervals 0-2, 2-4. and 4-6 Sampled using a 3" diameter split spoon sampler, all of the other intervals were sampled using a standard 2" diameter split-spoon.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.  
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.





## **Attachment 2**





1 2 3 4 5 6

E

D

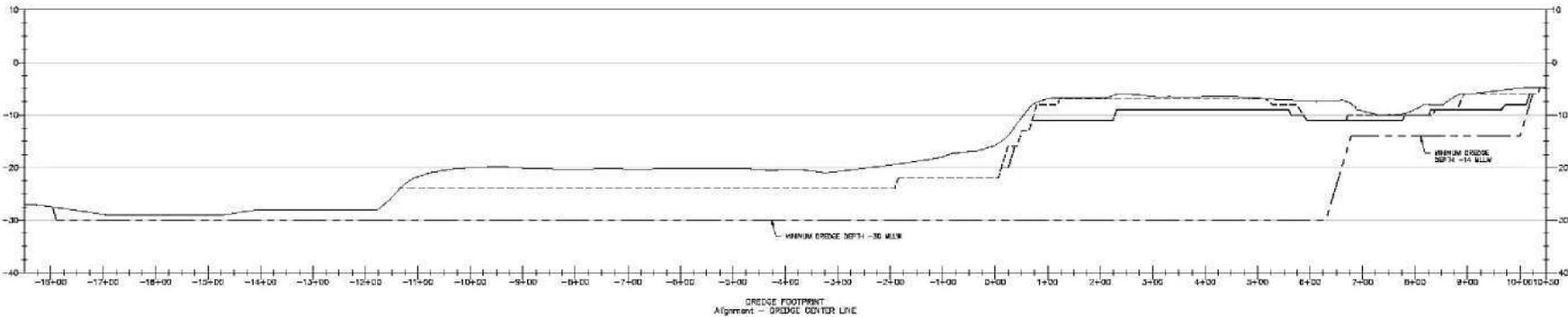
C

B

A

LINE TYPE	SURFACE
—————	DRAINING SURFACE
-----	BOTTOM OF DREDGE
-----	TOP OF DREDGE
—————	INTERMEDIATE DREDGE

NOTE: FOR CROSS SECTION LOCATION, SEE SHEET X-2.0, @ 9'-11"




**APEX**  
ROCKVILLE, MD  
SOUTH WINDSOR, CT - BOSTON, MA -  
NEW BEDFORD, MA - HOLYOKE, MA  
BOSTON, MA 02110  
NEW BEDFORD, MA 01910  
SOUTH WINDSOR, CT

The undersigned consent to Apex for this project use information of this work for use and/or report in the project, and Apex shall be deemed the author of the Drawing and shall hold it in trust for the client, and shall not be used in any other project, for purposes not intended or for purposes of this project, without written agreement in writing and with appropriate compensation to Apex.

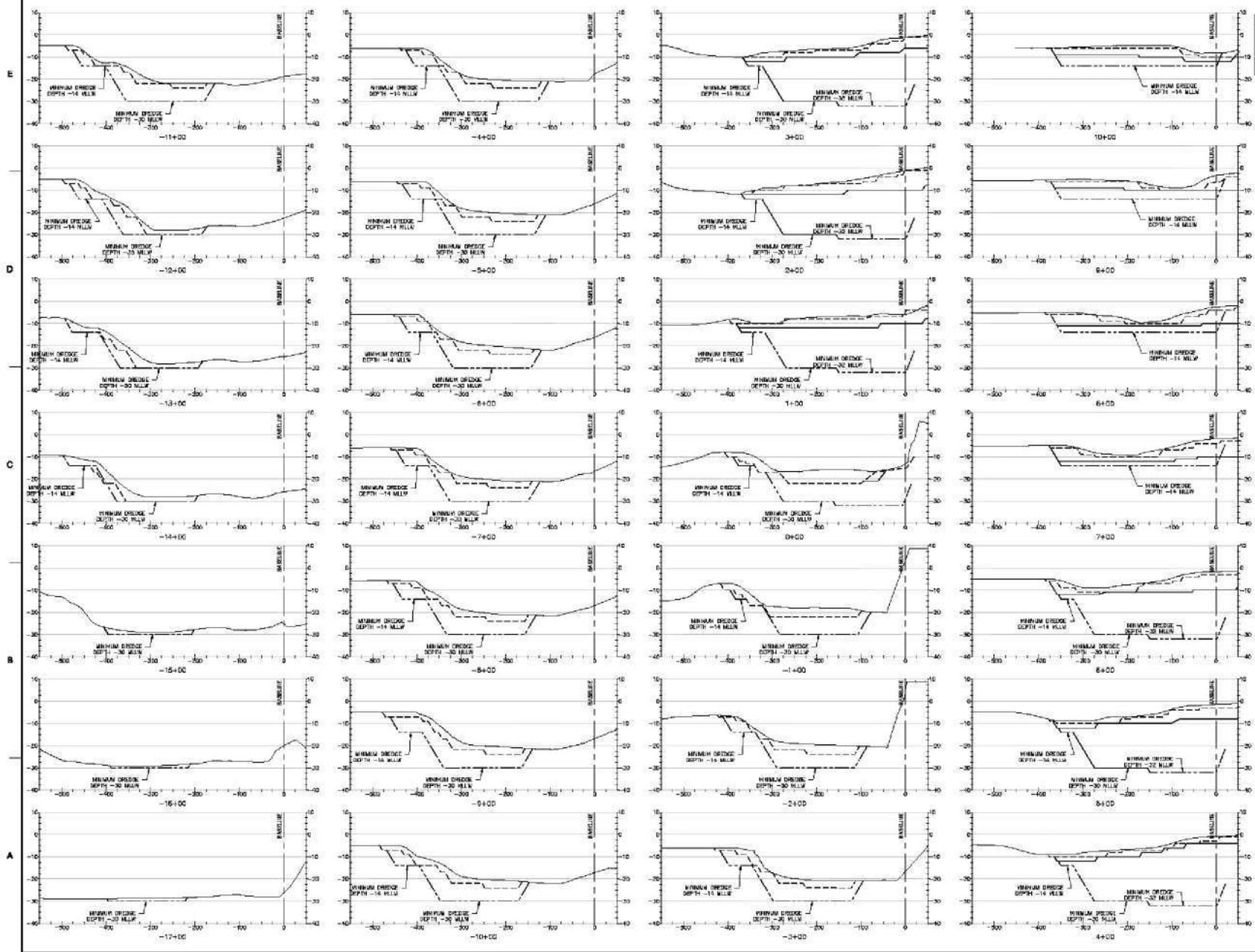
PROJECT <b>NEW BEDFORD MARINE COMMERCE TERMINAL</b>	OWNER <b>MASSACHUSETTS CLEAN ENERGY CENTER 95 SUMMER STREET, 8TH FLOOR BOSTON, MASSACHUSETTS</b>

NO.	DATE	DESCRIPTION	BY
PROJECT NO.	650		
DRAWING FILE	ALL INFORMATION CONTAINED		
DESIGNED BY	CWM		
DRAWN BY	CWM		
CHECKED BY	C-M		
DATE	8-8-11		
DRAWING SCALE	N.T.S.		
GRAPHIC SCALE			

SHEET TITLE  
**DREDGE  
CROSS-SECTIONS 1**

DRAWING NO.  
**X-2.1**

1 2 3 4 5 6



LINE TYPE	SURFACE
---	EXISTING WAREHOUSE
- - - -	BOTTOM OF DREDGE
---	TOP OF DREDGE
---	INTERMEDIATE DREDGE

NOTES:  
 1) FOR CROSS SECTION  
 LOCATION, SEE SHEET X-2.1 &  
 X-2.2  
 2) ALSO SEE DRAWINGS P-2.1,  
 P-2.2, P-2.3, P-2.4, P-2.5,  
 AND P-2.6 FOR PLANS. MOST OF  
 THE TOP OF DREDGE,  
 INTERMEDIATE DREDGE AND  
 BOTTOM OF DREDGE MINIMUM  
 DREDGE DEPTHS.

**APEX**  
 ROCKVILLE, MD SOUTH WINDSOR, CT BOSTON, MA  
 NEW BRIDGFORD, MA HOLYOKE, MA  
 186 1/2 HIGH STREET, SUITE 800  
 BOSTON, MA 02110  
 800 333 0272 / 617 452 4000  
 SOUTH WINDSOR, CT

The undersigned consent to Apex for this project use information of this project for use and/or report in the project, and Apex and its agents, the authority of the Drawing and shall not be used in other projects, for purposes in the project or for completion of this project for others, unless by agreement in writing and with appropriate compensation to Apex.

PROJECT: **NEW BEDFORD MARINE COMMERCE TERMINAL**

OWNER: **MASSACHUSETTS CLEAN ENERGY CENTER  
 95 SUMMER STREET, 8TH FLOOR  
 BOSTON, MASSACHUSETTS**

NO.	DATE	DESCRIPTION	BY
PROJECT NO.	680		
DWG FILE	ALL INFORMATION CONTAINED		
DESIGNED BY	CWM		
DRAWN BY	CWM		
CHECKED BY	CJM		
DATE	8-8-11		
DRAWING SCALE	N.T.S.		
GRAPHIC SCALE			

SHEET TITLE  
**DREDGE  
 CROSS-SECTIONS 2**

DRAWING NO.  
**X-2.2**

78 OF 97

## **Attachment 3**



Date: 9/14/2010  
Time: 8:00 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.005	X: 816198.2
Location: South Terminal Expansion		Y: 2688154.5
Elevation at mudline: -23.15'	Datum: MLLW	Boring No: A-2010-B1
Casing Type: Steel	Boring Depth: -38.5' MLLW	
Casing Diameter: 4"	Drill Rig: CME 45	Sheet: 1 of 1
Drill Co: NH Boring	Method: Drill and Wash	
Driller: Todd Pentacost	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 6"	11,2,11,13	Dark Grey, fine to coarse SAND, some silt, some fine to coarse gravel.	-25.15
4		24" 5"	19,33,39,18	Grey SILT and fine to coarse SAND, some fine to coarse gravel - TILL	-27.15
4.75		9" 4"	15, 100/3"	Grey SILT some fine to coarse sand, some fine to coarse gravel. Refusal at -27.9 MLLW.	-27.9
5.35				Cleaned hole for coring run, start core run at -28.5 MLLW.	-28.5
11	50%	5' 4.6'	7,6,6,10,14	Rock Core #1: -28.5 to - 33.5 MLLW - Intensely to moderately fractured grey Granitic Gneiss	-33.5
16	97%	5' 4.85	6,6,6,9,11	Rock Core #2: -33.5 to -38.5 MLLW - Moderately fractured grey Granitic Gneiss	-38.5

Comments: Core run was completed at less revolutions per minute than recommended by core barrel manufacturer, so drill time is not a good indicator of rock competency.

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 9/15/2010  
Time: 11:30 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.005	X: 816277.4
Location: South Terminal Expansion		Y: 2688458.0
Elevation at mudline: -6.3'	Datum: MLLW	Boring No: A-2010-B2
Casing Type: Steel	Boring Depth: -39.4' MLLW	
Casing Diameter: 4"	Drill Rig: CME 45	Sheet: 1 of 1
Drill Co: NH Boring	Method: Drill and Wash	
Driller: Todd Pentacost	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 15"	1,1,1,1	Black to dark grey, Organic SILT, some fine sand, little shell hash, becomes grey in nose of spoon	-8.3
4		24" 15"	2,5,10,14	Dark Grey fine SAND, some organic silt grades to fine SAND, some inorganic silt, trace fine to coarse gravel	-10.3
6		24" 21"	12,14,14,19	-10.3 to -10.8 MLLW Grey fine SAND some fine to coarse gravel, trace coarse -10.8 to -12.0 MLLW Grey fine SAND grading to inorganic SILT and fine SAND -12.0 to -12.3 MLLW Grey Coarse SAND and fine to coarse GRAVEL	-12.3
8		24" 15"	9,17,16,20	Grey, medium to coarse SAND, little fine to coarse gravel	-14.3
10		24" 14"	5,15,15,12	Grey, medium to coarse SAND, little fine to coarse gravel, grades to fine to medium SAND	-16.3
12		24" 21"	3,4,10,12	10 - 11 Grey, fine SAND, trace silt, grades to fine to medium SAND. 11-12 Grey, fine to coarse SAND, trace fine gravel, grading to coarse SAND	-18.3
14		24" 21"	6,7,9,12	Grey, fine to medium SAND, little fine to coarse gravel	-20.3
16		24" 12.5"	14,16,24,24	Grey fine to coarse SAND, some silt, some fine to coarse gravel, mottle at 15.0 to 15.4 red/orange tan.	-22.3
18		24" 11"	8,10,3,3	Grey and Tan mottled, fine to coarse SAND, some silt, some fine to coarse gravel, grades to fine to medium SAND and SILT in nose of spoon	-24.3
19.75		21" 16"	23,32,34, 100/3"	Grey and tan mottled, fine to coarse SAND, and SILT, some fine to coarse gravel. Refusal at -26.2' MLLW.	-26.05
23.6				Drilled with button tooth roller bit through cobbles, drove casing to refusal and began core run at -29.9 MLLW	-29.9
28.1	48%	60" 47"	6,8,8,10, 5min/6"	Rock Core #1: -29.9 to -34.4 MLLW - Moderately to intensely fractured grey Granitic Gneiss, core barrel jammed at 4.5 feet into core run.	-34.4
33.1	50%	60" 44"	7,8,10,10, 10	Rock Core #2: -34.4 to -39.4 MLLW - Moderately to intensely fractured grey Granitic Gneiss	-39.4

Comments: Core run was completed at less revolutions per minute than recommended by core barrel manufacturer, drill time is not a good indicator of rock competency.

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 9/16/2010  
Time: 11:20 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.005	X: 816365.6
Location: South Terminal Expansion		Y: 2688161.5
Elevation at mudline: -1.1'	Datum: MLLW	
Casing Type: Steel	Boring Depth: -35.7' MLLW	Boring No: A-2010-B3
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Todd Pentacost	Log By: GCD	

Depth below mudline (ft)	RCD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 18"	7,5,5,4	Dark Grey, very fine to fine SAND, little organic silt, trace shell hash, one juvenile clam.	-3.1
7		24" 5"	10,13,20,17	Grey, fine to coarse SAND, trace silt, sharp color change to tan, fine to medium SAND, little silt. Gravel caught in nose of spoon	-8.1
12		24" 6"	16,19,20,23	4" of Grey, fine to coarse GRAVEL and fine to medium SAND, trace silt. 2" of Grey tan, SILT, some fine to coarse SAND, some fine to coarse gravel. TILL.	-13.1
17		24" 4"	17,18,14,14	Grey, SILT and fine SAND, some fine to coarse gravel, little medium to coarse sand, gravel stuck in tip of split spoon.	-18.1
22		24" 5"	80,60,40,61	Tan, fine SAND, some silt, some fine to coarse gravel, trace medium to coarse sand, gravel stuck in top of split spoon.	-23.1
24.6				Refusal while advancing casing to next interval. Cleaned hole with button toothed roller bit, flushed hole and began coring at -25.7' MLLW	-25.7
29.6	25%	5' 3.3'	5,6,19 (Jams)	Rock Core #1: -25.7 to -30.7 MLLW - Very intensely fractured grey Granitic GNEISS, with pegmatic intrusions (pink and grey).	-30.7
34.6	37%	5' 4.6'	(Frequent Jams)	Rock Core #2: -30.7 to -35.7 MLLW - Intensely fractured grey Granitic GNEISS with pegmatic (pink and grey) intrusions.	-35.7

**Comments:** Core run was completed at less revolutions per minute than recommended by core barrel manufacturer, drill time is not a good indicator of rock competency, drill times were not recorded after the first 3 feet of penetration, due to frequent starts and stops of coring process as barrel jammed and was cleared.

**Notes:** 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.  
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 9/20/2010  
Time: 8:05 AM

## BORING LOG

Project:	Phase IV Dredging	Project No: 6690.005	X: 816439.9
Location	South Terminal Expansion		Y: 2687856.3
Elevation at mudline:	-2.5'	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-43.75' MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Todd Pentacost	Log By:	GCD
			Boring No: A-2010-B4
			Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 24"	WOH, WOH, WOH, WOH	Black, Organic SILT, little shell hash, little fine to medium sand.	-4.5
4		N/A N/A	N/A	No split spoon this interval.	-6.5
6		24" 3.5"	1,1,1,1	Dark Grey to Black, fine to medium SAND and SILT, little shell hash.	-8.5
8		24" 13"	13,6,8,9	Grey, fine to medium SAND, some Silt, little fine to coarse gravel	-10.5
10		24" 12"	9,17,20,20	Grey, fine GRAVEL, some coarse sand, little coarse gravel. Coarse gravel stuck in nose of spoon.	-12.5
12		24" 11"	10,8,10,12	Grey, fine SAND, some silt, some fine to coarse gravel, trace medium to coarse sand.	-14.5
14		24" 8"	8,14,16,11	Grey, fine SAND, some fine to coarse gravel, trace silt.	-16.5
16		24" 9"	49,9,8,13	Grey SILT, some fine sand, little fine to coarse gravel, little medium to coarse sand. Mottled interval approx 0.25 to 0.5' becomes brown, then back to grey.	-18.5
18		24" 10"	24,20,18,16	SILT, some fine to coarse sand, some fine to coarse gravel, Color changes: 0.0-0.25' grey, 0.25-0.55' light grey, 0.55-0.80' brown .	-20.5
20		24" 10"	13,12,21,14	Tan SILT and GRAVEL, some fine to coarse sand	-22.5
21.66		20" 10"	17,10,15, 100/2"	Tan, SILT, some fine to coarse gravel, some fine to coarse sand. 3" of grey, completely weathered Granitic Gneiss in nose of spoon. Refusal at -24.16 MLLW.	-24.16
22.7				Drilled with button tooth roller bit, cleaned hole, and began core run at -25.2 MLLW.	-25.2
26.7	0%	48" 20"	10,12,19, (Jam)	Rock Core #1: -25.2 to -29.2 MLLW - Shattered greenish Grey Granitic Gneiss (11" in pieces none longer than 3") Potassium Feldspar rich Pegmatic intrusion (9" in pieces none longer than 3"), core barrel jammed at 1.5, water return stopped intermittently through core run, drilling paused each time	-29.2
29.7	0%	36" 25"	6,6,14, (Jam)	Rock Core #2: -29.2 to -32.2 MLLW - Interface of Pegmatite and Granitic Gneiss (2"), highly fractured grey Granitic Gneiss (23") No unfractured pieces greater than 4"	-32.2
31.7	0%	24" 16"	(Frequent Jams)	Rock Core #3: -32.2 to -34.2 MLLW - Highly fractured grey Granitic Gneiss (16") No unfractured pieces greater than 4"	-34.2
36.7	0%	60" 36"	(Frequent Jams)	Rock Core #4: -34.2 to -39.2 MLLW - Highly fractured pink and greenish grey Granitic Gneiss (36") No unfractured pieces greater than 4", shattered between 18" and 25" includes quartz vein 19"-20"	-39.2
41.7	82%	60" 58"	(Frequent Jams)	Rock Core #5: -39.2 to -43.75 MLLW - Highly fractured pink and greenish grey Granitic Gneiss (21") Grades to grey Granitic Gneiss until sharp increase in potassium feldspar content at 56" changes hue back to pink and grey Granitic Gneiss.	-43.75

Comments: Core run was completed at less revolutions per minute than recommended by core barrel manufacturer, drill time is not a good indicator of rock competency. Drill times were not recorded on portions of Rock Cores 1 and 2 as well as Rock Cores 3, 4, and 5, due to frequent starts and stops of coring process as barrel jammed and was cleared.

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/7/2011  
Time: 8:30 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816478
Location: South Terminal Expansion		Y: 2687708
Elevation at mudline: -3.7	Datum: MLLW	
Casing Type: Steel	Boring Depth: -45.30' MLLW	Boring No: A-2011-B5
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GAD	

Depth below mudline (ft)	RQD	Penetration/Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
3		36" 24"	WOR,WOR, WOR,WOR	Black, organic SILT, trace shell hash.	-6.7
5		24" 24"	WOR,WOR, WOR,WOR	Black, organic SILT, trace shell hash, trace gravel.	-8.7
7		24" 12"	3,1,5,10	Black, organic SILT, trace shell hash, trace fine gravel, grades to greenish-grey, fine to medium SAND, trace fine gravel.	-10.7
9		24" 18"	16,29,26,28	Greenish grey, fine to coarse SAND, some fine to coarse gravel, trace silt	-12.7
11		24" 6"	17,8,7,10	Greenish grey, fine SAND some fine to medium sand, little fine gravel	-14.7
13		24" 6"	37,31,20,30	Greenish grey, fine to medium SAND, some coarse sand, some fine gravel, trace silt	-16.7
15		24" 12"	14,10,12,17	Greenish grey, fine to medium SAND, some coarse sand, some fine gravel, trace silt	-18.7
17		24" 0	25,9,8,11	No Recovery	-20.7
19		24" 2"	20,18,21,17	Greenish grey, fine to medium SAND, some coarse sand, some fine gravel, trace silt	-22.7
21		24" 10"	16,16,19,22	Olive grey, medium to coarse SAND, some fine sand, some fine gravel	-24.7
23		24" 12"	7,9,11,8	Olive grey, medium to coarse SAND, some fine sand, some fine gravel	-26.7
25		24" 12"	23,24,21,15	Olive grey, medium to coarse SAND, some fine sand, some fine gravel, transitions to olive grey, fine to medium SAND, trace silt	-28.7
26.25		15" 7"	17,16, 100/3"	Olive grey, fine to medium SAND, some silt, some gravel. Refusal at 29.95.	-29.95
26.60				Drilled with mill tooth roller bit, cleaned hole, and began core run at -30.30.	-30.3
31.60	48%	5.0' 4.4'	6,6,7,6,6	Rock Core #1 -30.30' to -35.30' MLLW. 0.0-4.0' intensely to moderately fractured grey, GRANITE, 4.0 to 4.4' intensely fractured moderately weathered grey GRANITE	-35.3
36.60	49%	5.0' 4.35'	8-7-8-7-7	Rock Core #2 -35.30' to -40.30' MLLW. 0.0' - 0.6' moderate to heavily weathered, moderately fractured grey, granitic GNEISS, 0.6' - 3.4' fresh, moderately fractured, grey, granitic GNEISS, gneissic banding progressively decreases, 3.4'-4.4' grey GRANITE	-40.3
41.60	74%	5.0' 4.9'	7-8-8-7-7	Rock Core #3 -40.30' to -45.30' MLLW. 0.0-2.2' intensely to moderately fractured grey, granitic GNEISS. 2.2-3.6' gradual transition into and out of intensely to moderately fractured pink and grey granite PEGMATITE, 3.6-4.9' intensely to moderately fractured grey granitic GNEISS	-45.3

Comments: The descriptions of the rock in the cores above are descriptions of the sampled rock in each recovered core length.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.  
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 9/23/2010  
Time: 9:30 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.005	X: 816518.5
Location: South Terminal Expansion		Y: 2687561.6
Elevation at mudline: -9.4	Datum: MLLW	Boring No: A-2010-B6
Casing Type: Steel	Boring Depth: -31.6' MLLW	
Casing Diameter: 4"	Drill Rig: CME 45	Sheet: 1 of 1
Drill Co: NH Boring	Method: Drill and Wash	
Driller: Todd Pentacost	Log By: GAD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 6"	WOR,WOR, WOR,WOR	0-1' Black, organic SILT 1'-2' Olive grey, medium to coarse SAND, some fine sand, trace silt	-11.4
6		24" 12"	20,22,41,30	Greenish grey, medium to coarse SAND, some fine gravel	-15.4
10		24" 12"	12,16,22,15	Greenish grey, medium to coarse SAND, some fine gravel.	-19.4
12.2				Drove casing to refusal, cleaned hole, and began core run at -21.6 MLLW	-21.6
17.2	73%	60" 51"	7,7,6,5,7	Rock Core #1: -21.6 to -26.6 MLLW - Intensely to moderately fractured grey granitic Gneiss.	-26.6
22.2	27%	60" 50"	8,12,6,7,6	Rock Core #2: -26.6 to -31.6 MLLW - Intensely fractured grey Granitic Gneiss (0"-36"), intensely fractured pink and grey Granite Pegmatite (36" to 50").	-31.6

Comments: Core run was completed at less revolutions per minute than recommended by core barrel manufacturer, drill time is not a good indicator of rock competency.

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 9/24/2010  
Time: 12:15 PM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.005	X: 816781.1
Location: South Terminal Expansion		Y: 2687710.6
Elevation at mudline: -5.5	Datum: MLLW	Boring No: A-2010-B7
Casing Type: Steel	Boring Depth: -28.0' MLLW	
Casing Diameter: 4"	Drill Rig: CME 45	Sheet: 1 of 1
Drill Co: NH Boring	Method: Drill and Wash	
Driller: Todd Pentacost	Log By: GAD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 12"	WOR,6,8,8	0-1' Black, organic SILT 1'-2' Olive Grey, fine to medium SAND, some shell hash, trace silt	-7.5
4		24" 12"	9/11/12/16	Olive Grey, fine to medium SAND, some shell hash, trace silt	-9.5
6		24" 12"	7/5/7/5	4'-4.5' Olive Grey, fine to medium SAND, some shell hash, trace silt 4.5'-6' Greenish grey, fine SAND and SILT	-11.5
8		24" 17"	15/23/100-5"	6'-7' Olive Grey, fine to medium SAND, some shell hash, trace silt 7'-7.4' Olive grey, fine SAND and SILT	-13.5
10		24" 24"	18/14/12/17	8'-8.5' Greenish grey, fine to medium SAND and fine angular GRAVEL 8.5'-9.5' Light grey, fine to medium SAND, some coarse SAND 9.5'-10' Greenish grey, fine SAND and SILT	-15.5
12		24" 24"	15/18/24/58	10'-11.5' Greenish grey, fine SAND and SILT, trace fine angular gravel 11.5'-12' Olive grey, medium to coarse SAND, trace rock fragments at tip.	-17.5
12.5				Drove casing to refusal, cleaned hole, and began core run at -18.0 MLLW	-18
17.5	88%	60" 56"	11/10/12/15/12	Rock Core #1: -18.5to -23.5 MLLW - Highly to moderately fractured grey and pink Granitic Gneiss	-23
22.5	61%	60" 40"	8/8/7/8/9	Rock Core #2: -23.5 to -28.5 MLLW - Highly to moderately fractured grey and pink Granitic Gneiss	-28

Comments: Core run was completed at less revolutions per minute than recommended by core barrel manufacturer, drill time is not a good indicator of rock competency.

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 9/27/2010  
Time: 11:50 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.005	X: 816477.0
Location: South Terminal Expansion		Y: 2688656.0
Elevation at mudline: -17.4	Datum: MLLW	
Casing Type: Steel	Boring Depth: -46.2' MLLW	Boring No: A-2010-B8
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Todd Pentacost	Log By: GAD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 0"	WOR, WOR, WOR, WOR	No recovery sample taken	-19.4
4		24" 18"	WOR, WOR, WOR, WOR	Black, organic SILT	-21.4
6		24" 12"	8/13/24/31	4'-5' Black, organic SILT 5'-6' Lt. grey, fine to medium SAND and SILT, trace rock fragments	-23.4
8		24" 12"	26/21/56/48	Lt. grey, fine to medium SAND and SILT, trace rock fragments	-25.4
10		24" 0"	100-0"	No recovery sample taken, drilled with button tooth roller bit through cobbles	-27.4
13				Drilled with button tooth roller bit through cobbles	-30.4
15		24" 12"	46/39/23/24	13'-15' Olive grey, coarse SAND, trace fine sand, trace fine gravel	-32.4
17		24" 12"	13/17/14/21	Olive grey, coarse SAND, some fine sand, trace rock fragments	-34.4
18				Drove casing to refusal, cleaned hole, and began core run at -36.2 MLLW	-34.5
23	53%	60" 54"	14/13/18/11/ 13	Rock Core #1: -36.2 to -41.2 MLLW - Intensely fractured dark grey Basalt(0-9.5"), moderately fractured pink and grey Granitic Gneiss (9.5-27"), dark grey intensely to moderately fractured Basalt (27"- 54").	-39.5
28	50%	60" 50"	12/15/11/12/ 14	Rock Core #2: - -41.2 to -46.2 MLLW - Intensely fractured dark grey Basalt (0-13"), moderately to intensely fractured pink and grey Granitic Gneiss (13"-19"), dark grey intensely to moderately fractured Basalt (19"-50").	-44.5

Comments: Core run was completed at less revolutions per minute than recommended by core barrel manufacturer, drill time is not a good indicator of rock competency.

- Notes:
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  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 9/28/2010  
Time: 11:10 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.005	X: 816215.8
Location: South Terminal Expansion		Y: 2689415.8
Elevation at mudline: -21.25	Datum: MLLW	Boring No: A-2010-B9  Sheet: 1 of 1
Casing Type: Steel	Boring Depth: -38.83' MLLW	
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	
Driller: Todd Pentacost	Log By: GAD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 12"	WOR,WOR, WOR,WOR	Black, organic SILT	-23.25
4		24" 12"	10/24/22/19	2'-2.5' Black, organic SILT 2.5'-4' Olive grey, fine to medium SAND, some silt, some angular fine gravel.	-25.25
6		24" 12"	56/33/27/52	Lt. grey, coarse sub rounded SAND, trace rock fragments in tip	-27.25
6.58		7" 7"	53/100-1"	Lt. grey, fine to medium SAND, trace silt, trace rock fragments	-27.83
11.58	35%	60" 37"	6/7/7/6/9	Rock Core #1: -27.83 to -32.83 MLLW - Intensely fractured pink and grey Granitic Gneiss.	-32.83
12.58				Drilled with button tooth roller bit through fractured rock	-33.83
17.58	0%	60" 26"	(Frequent Jams)	Rock Core #2: -33.83 to -38.83 MLLW - Intensely fractured grey Gneiss	-38.83

Comments: Core run was completed at less revolutions per minute than recommended by core barrel manufacturer, drill time is not a good indicator of rock competency. On second run, core barrel was jammed in the boring. Decision was made to move 20' north in order to obtain confirmation cores.

- Notes:
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  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.





Date: 2/21/2011  
Time: 8:20 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816322
Location: South Terminal Expansion		Y: 2688299
Elevation at mudline: -0.9	Datum: MLLW	Boring No: A-2011-B10
Casing Type: Steel	Boring Depth: -50.79' MLLW	
Casing Diameter: 4"	Drill Rig: CME 45	Sheet: 1 of 1
Drill Co: NH Boring	Method: Drill and Wash	
Driller: Norman	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6' / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 12"	2,4,4,4	Dark grey, very fine SAND, little organic silt, trace shell hash.	-2.9
7		24" 18"	2,1,1,1	Black to dark grey, organic SILT, little inorganic silt, trace fine sand.	-7.9
12		24" 20"	33,33,30,32	4" - Black to dark grey, organic SILT, little inorganic silt, trace fine sand.	-12.9
				Grey, fine to coarse SAND, little silt, trace to little fine to coarse gravel.	
17		24" 14"	17,23,20,20	Grey, fine SAND, little medium to coarse sand, trace fine to coarse gravel, trace silt, TILL	-17.9
19.05				Boulder encountered approx. elev.= -18.75 to -19.95 MLLW.	-19.95
22		24 12"	16,41,46,35	Grey, fine to coarse SAND, some fine to coarse gravel, little silt, TILL	-22.9
27		24" 8"	98,36,44,57	Grey, becoming tan, fine to coarse SAND, some silt, some fine to coarse gravel, TILL.	-27.9
30.89				Drilled with mill tooth roller bit. Boulder encountered approx. elev. -29.60 to -30.40 MLLW. Cleaned hole and began core run at -31.79 MLLW.	-31.79
35.89	13%	5.0'	5-5-5-5-15	Rock Core #1 -31.79 to -36.79 MLLW. Grey, intensely fractured to very intensely fractured Granitic GNEISS, sand filled seams throughout. Return water color changes at 2.3, 2.5, 2.8, 3.5-3.7, 3.9, 4.2. Barrel jamming last foot of run drilling time does not reflect hardness of rock.	-36.79
		2.9'			
39.89	22%	5.0'	4-3-3-10	Rock Core #2 -36.79 to -40.79 MLLW. Grey, intensely fractured to very intensely fractured Granitic GNEISS, with sand filled seams, Barrel jamming last foot of run drilling time does not reflect hardness of rock.	-40.79
		3.0'			
44.89	50%	5.0'	3-3-4-4-6	Rock Core #3 -40.79 to -45.79 MLLW. Grey, intensely to moderately fractured Granitic GNEISS,	-45.79
		5.0'			
49.89	75%	5.0'	5-4-3-3-3	Rock Core #4 -45.79 to -50.79 MLLW. Grey to pink, moderately to slightly fractured, Granite PEMATITE	-50.79
		4.9'			

Comments:

Notes:

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Date: 2/22/2011  
Time: 12:42 PM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816397
Location: South Terminal Expansion		Y: 2688013
Elevation at mudline: -1.5	Datum: MLLW	Boring No: A-2011-B11
Casing Type: Steel	Boring Depth: -40.65' MLLW	
Casing Diameter: 4"	Drill Rig: CME 45	Sheet: 1 of 1
Drill Co: NH Boring	Method: Drill and Wash	
Driller: Norman	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 9"	2,3,4,4	Dark grey, fine to medium SAND, little organic silt, little shell hash.	-3.5
7		24"	1,WOH,WOH, 2	3" Black organic SILT, little shell hash.	-8.5
		15'		12" Dark grey to black, fine SAND and organic/inorganic SILT, trace shell hash.	
12		24" 14'	39,36,38,30	Grey, inorganic SILT and fine to medium SAND, trace fine to coarse gravel, Till like	-13.5
16		12" 5"	57, 100/6"	Dark grey to black with brown, micaceous fine SAND and fine to coarse GRAVEL, little silt.	-17.5
17.2				Boulder encountered approx. elev.= -17.5 MLLW to -18.7 MLLW.	-18.7
22		24" 12"	15,16,25,19	Tan grey, fine to medium SAND, little to trace silt, trace coarse sand, trace fine gravel.	-23.5
25.83		10" 4"	55,100/4"	Tan, medium to coarse SAND, some fine to coarse gravel, trace silt. Cobble encountered at approximate elevation -27.33 MLLW.	-27.33
26.75				Drilled with mill tooth roller bit to approx. elevation -28.25 MLLW.	-28.25
29.15				Drove casing to refusal, drilled with mill tooth roller bit into rock and flushed casing before start of core run. Began first core run at -30.65 MLLW.	-30.65
31.75	74%	5.0'	6-4-7-4-5	Rock Core #1 -30.65 to -35.65 MLLW Grey, moderately fractured Granitic GNEISS	-35.65
		4.9'			
36.75	88%	5.0'	4-4-5-5-5	Rock Core #2 -35.65 to -40.65 MLLW Grey, intensely to moderately fractured, Granitic GNEISS	-40.65
		5.0'			

Comments:

- Notes:
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Date: 2/23/2011  
Time: 10:32 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816344
Location: South Terminal Expansion		Y: 2687989
Elevation at mudline: -1.2	Datum: MLLW	Boring No: A-2011-B12
Casing Type: Steel	Boring Depth: -49.15' MLLW	
Casing Diameter: 4"	Drill Rig: CME 45	Sheet: 1 of 1
Drill Co: NH Boring	Method: Drill and Wash	
Driller: Norman	Log By: GAD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 3"	4,1,WOH,2	Dark grey, very fine SAND, little organic silt, little shell hash.	-3.2
7		24" 6"	1,1,1,30	Greenish dark grey, SILT, little fine to coarse gravel.	-8.2
12		24" 0"	36,22,25,23	No Recovery in Split Spoon	-13.2
17		24" 15"	15,10,12,25	Grey, fine to medium SAND and GRAVEL, trace silt.	-18.2
22		24" 6"	33,37,29,81	Light grey, fine to medium SAND and SILT, some medium gravel.	-23.2
27.35				Drilled with mill tooth roller bit through cobbles with multiple sand seams. Encountered obstruction at approx. elev. -24.35 MLLW. Drilled through 1' boulder. Cleaned hole, and began core run at -26.15 MLLW.	-26.15
27.95	63%	3.0' 2.2'	no drill time available	Rock Core #1A -26.15 to -29.15 MLLW Grey and pink, moderately to intensely fractured, fresh to slightly weathered GRANITE pegmatite	-29.15
30.95	75%	2.0' 1.9'	no drill time available	Rock Core #1B -29.15 to -31.15 MLLW Grey and pink, moderately to intensely fractured fresh to slightly weathered granite PEGMATITE, shattered granite PEGMATITE -31.55 to -32.15 MLLW.	-32.15
34.95	82%	5.0' 5.0'	7-7-7-6-6	Rock Core #2 -31.15 to -36.15 MLLW Grey and pink, moderately to intensely fractured fresh to slightly weathered granite PEGMATITE, shattered granite PEGMATITE -35.65 to -36.15	-36.15
37.95	25%	3.0' 1.7'	4-4-5	Rock Core #3A -36.15 to -39.15 MLLW Grey and pink, intensely fractured, slightly weathered, granite PEGMATITE	-39.15
42.95	78%	5.0' 5.0'	4-3-4-4-4	Rock Core #3B -39.15 to -44.15 MLLW Grey, moderately fractured, fresh to slightly weathered, granitic GNEISS	-44.15
47.95	92%	5.0' 5.0'	4-4-3-5-4	Rock Core #4 -44.15 to -49.15 MLLW Grey, intensely to moderately fractured, fresh to slightly weathered, granitic GNEISS	-49.15

Comments:

Notes:

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Date: 2/24/2011  
Time: 12:30 PM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816419
Location: South Terminal Expansion		Y: 2687691
Elevation at mudline: -1.3	Datum: MLLW	
Casing Type: Steel	Boring Depth: -46.6' MLLW	Boring No: A-2011-B13
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GAD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 3"	WOH, WOH, WOH, WOH	Black, organic SILT, little shell hash.	-3.3
7		24" 15"	WOR,1,5,6	Greenish grey, fine SAND and SILT, trace shell hash.	-8.3
12		24" 0"	30,45,53,63	No Recovery in Split Spoon, piece of Granitic GNEISS in nose cone.	-13.3
17		24" 0"	54,58,61,71	No Recovery in Split Spoon, piece of Granitic GNEISS in nose cone. Encountered obstruction at approx. 18.5' below mudline - apparent 1' boulder.	-18.3
22		24" 2"	16,18,17,18	Grey, SILT, some fine to coarse gravel.	-23.3
27		24" 3"	18,21,23,20	Tan, coarse SAND and GRAVEL, trace fine sand, trace silt.	-28.3
28.3				Casing advanced to refusal at -29.6 MLLW. Cleaned hole, and began core run at -29.6 MLLW.	-29.6
35.30	42%	7.0'  5.0'	4-5-6-5-4	Rock Core #1 -29.6' to -30.6' MLLW highly fractured Granitic GNEISS (potential cobble layer or obstruction). At approximate elev. -30.6' MLLW, core barrel penetrated potential cobble layer or obstruction and entered a 2' layer of apparent sediment. Wash changed color from milky white to tan, and contained sand. Continued coring from -32.6 MLLW to -36.6 MLLW - fractured Granitic GNEISS.	-36.6
40.30	79%	5.0' 5.0'	5-4-3-4-5	Rock Core #2 -36.6 to -41.6 MLLW fractured Granitic GNEISS	-41.6
45.30	51%	5.0' 4.8	6-5-7-7-6	Rock Core #3B -41.6 to -46.6 MLLW fractured Granitic GNEISS	-46.6

**Comments:**

**Notes:**

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Date: 2/24/2011

Time: 12:30 PM

# BORING LOG

Project:	Phase IV Dredging	Project No:	6690.008	X:	816360
Location:	South Terminal Expansion	Y:	2687402		
Elevation at mudline:	-1.85	Datum:	MLLW		
Casing Type:	Steel	Boring Depth:	-31.95' MLLW	Boring No:	A-2011-B14
Casing Diameter:	4"	Drill Rig:	CME 45		
Drill Co:	NH Boring	Method:	Drill and Wash	Sheet: 1 of 1	
Driller:	Norman Stuttard	Log By:	GAD		

Depth below mudline (ft)	RQD	Penetration/Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 6"	WOR, WOR, WOR, WOR	Black, organic SILT.	-3.85
7		24" 15"	51,48,49,55	6" of Light grey, fine SAND and SILT. Light grey, fine to medium SAND, trace silt.	-8.85
12		24" 10"	63,58,52,58	8" Lt grey, fine to medium SAND, trace silt, becomes lt. grey, fine to coarse SAND, trace silt, trace gravel, 0.8' boulder encountered -14.2' MLLW	-13.85
17		24" 4"	24,9,10,14	Grey, fine to coarse SAND and fine GRAVEL.	-18.85
20.1				Casing advanced to -20.45 MLLW. Drilled with mill-tooth roller bit to -21.95 MLLW, cleaned hole, seated casing, and began core run.	-21.95
25.10	67%	5.0' 4.9'	6-8-8-7-8	Rock Core #1 -21.95 to -26.95 MLLW 4.5' fractured grey Granitic GNEISS, 0.4' pink Granite PEGMATITE	-26.95
30.10	60%	5.0' 5.1	5-5-5-5-5	Rock Core #2 -26.95 to -31.95 MLLW 0.5' pink Granite PEGMATITE, 0.3' shattered interface, grey fractured Granitic GNEISS	-31.95

Comments:

- Notes:
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Date: 3/2/2011  
Time: 7:15 AM

## BORING LOG

Project:	Phase IV Dredging	Project No: 6690.008	X: 816254
Location:	South Terminal Expansion		Y: 2687498
Elevation at mudline:	-0.6	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-40.55' MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Norman Stuttard	Log By:	GAD
			Boring No: A-2011-B15
			Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 18"	WOR, WOR, WOR, WOR	Black, organic SILT	-2.6
7		24" 18"	3,3,3,10	12" Black, organic SILT 6" Black, fine SAND and organic SILT	-7.6
12		24" 6"	33,40,34,56	Light grey, fine to coarse SAND, some fine gravel.	-12.6
17		24" 8"	31,76,40,27	Grey, medium to coarse SAND, trace fine sand, trace silt.	-17.6
19.5		6" 6"	100/6"	Blue grey, fine to coarse SAND, trace rock fragments. Refusal at -20.10' MLLW.	-20.1
19.95				Casing advanced to -20.55 MLLW. Cleaned hole, and began core run at -20.55 MLLW.	-20.55
24.95	44%	5.0' 5.0'	6-5-7-6-5	Rock Core #1 -20.55 to -25.55 MLLW 0.0 -1.0' moderate to intensely fractured dark grey DIABASE, 1.0-4.6 moderately to intensely fractured grey granitic GNEISS, 4.6'-5.0' interface of grey granitic GNEISS and dark grey DIABASE	-25.55
29.95	59%	5.0' 5.0'	5-6-6-5-6	Rock Core #2 -25.55 to -30.55 MLLW 0.0-0.75' intensely to moderately fractured grey granitic GNEISS, 0.75-1.75 intensely to moderately fractured dark grey DIABASE, 1.75'-4.8' moderately fractured grey granitic GNEISS showing reoriented gneissic banding, 4.8'-5.0 DIABASE	-30.55
34.95	68%	5.0' 5.0'	6-5-6-7-6	Rock Core #3 -30.55 to -35.55 MLLW 0.0-0.9' moderately fractured green grey DIABASE, 0.9-5.0 moderately fractured contact metamorphic and igneous mixing zone Gneiss and Diabase Xenoliths in GRANITE PEGMATITE.	-35.55
39.95	38%	5.0' 5.1'	7-6-7-7-8	Rock Core #4 -35.55 to -40.55 MLLW moderately fractured contact metamorphic and igneous mixing zone Gneiss and Diabase Xenoliths in GRANITE PEGMATITE.	-40.55

Comments: DIABASE in this boring is moderately to highly weathered.

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Date: 3/3/2011

Time: 8:20 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816262
Location: South Terminal Expansion		Y: 2688283
Elevation at mudline: -0.4	Datum: MLLW	
Casing Type: Steel	Boring Depth: -50.45' MLLW	Boring No: A-2011-B16
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 14"	11,12,10,2	Grey, fine SAND, little silt, trace shell hash.	-2.4
7		24" 12"	2,2,3,4	Dark grey, organic SILT, trace shell hash, grades to grey, inorganic and organic SILT, and very fine SAND, trace shell hash.	-7.4
12		24" 14"	60,33,29,48	Grey brown fine to coarse SAND and SILT trace fine to coarse gravel, TILL	-12.4
17		24" 9"	13,20,47,25	Grey, fine SAND, some medium to coarse sand, little fine to coarse gravel, little silt.	-17.4
22		24" 14"	50,43,46,29	Grey, SILT, some fine to coarse sand, little fine of coarse gravel, TILL, obstruction encountered -22.65' to approx. -24.05 MLLW (see comments).	-22.4
27		24" 6"	16,23,57,27	Grey and yellow brown, SILT and fine to coarse gravel, little fine to coarse sand, TILL.	-27.4
28.05				Drilled with mill tooth roller bit until obstruction encountered -27.95' MLLW. Cleaned hole, and began core run at -28.45 MLLW.	-28.45
33.05	72%	5.0' 4.9'	5-7-8-22-7	Rock Core #1 -28.45 to -33.45 MLLW 0.0 -1.0' moderate to intensely fractured grey granitic GNEISS	-33.45
38.15	60%	5.0' 5.0'	5-5-7-7-7	Rock Core #2 -33.45 to -38.55 MLLW 0.0'-5.0' intensely to moderately fractured granitic GNEISS, shattered pegmatic intrusion 0.4'-0.9', high angle fractures @ 1.9-2.2' and 4.5-5.0'	-38.55
43.15	30%	5.0' 5.0'	7-16-6-8-7	Rock Core #3 -38.55 to -43.55' MLLW 0.0-1.4' intensely to moderately fractured grey, granitic GNEISS, 1.4-4.3' intensely to moderately fractured grey GRANITE, 4.3-5.0' intensely to moderately fractured grey granitic GNEISS, core jammed in barrel 1.4'	-43.55
48.15	77%	5.0' 4.8'	6-15-7-6-7	Rock Core #4 -43.55 to -48.55 MLLW moderately fractured grey, granitic GNEISS	-48.55
50.05	100%	1.9 1.9	7-15	Rock Core #5 -48.55 to -50.45' MLLW slightly fractured grey, granitic GNEISS	-50.45

Comments: Obstruction encountered at -22.65 MLLW was not penetrated by roller bit, began coring at -23.25 MLLW, core barrel exited boulder at -24.05 MLLW, and soil cuttings in wash suggest till material encountered in interval above.

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Date: 3/8/2011  
Time: 8:40 AM

## BORING LOG

Project:	Phase IV Dredging	Project No: 6690.008	X: 816220
Location:	South Terminal Expansion		Y: 2689671
Elevation at mudline:	-20.8	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-36.4 MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Norman Stuttard	Log By:	GAD
			Boring No: A-2011-B17
			Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 8"	WOR,WOR, WOR,WOR	Black, organic SILT	-22.8
6.25		15" 9"	30,23, 100/3"	Greenish grey, fine to coarse SAND, some fine gravel	-27.05
8.5				Encountered Obstruction -28.9' MLLW, drilled with roller bit to -29.3' MLLW, then attempted core run.	-29.3
9.5	N/A	1.0' 1.0'	7	Rock Core #1 -29.3 to -30.3 MLLW - Penetrated obstruction (boulder). One foot of recovery in core barrel.	-30.3
15.6				Wash water indicates a series of nested boulders or highly fractured rock below obstruction. Unable to advance casing past obstruction. Drilled with roller bit through obstruction until top of competent rock (interpreted from cuttings in wash water). Final elevation at -36.4 MLLW.	-36.4

Comments:

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/9/2011  
Time: 8:15 AM

## BORING LOG

Project:	Phase IV Dredging	Project No: 6690.008	X: 816257
Location:	South Terminal Expansion		Y: 2688603
Elevation at mudline:	-20.9	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-48.4' MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Norman Stuttard	Log By:	GCD

Boring No: A-2011-B18  
Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 3"	WOR, WOR, WOR, WOR	Black, organic SILT, trace shell hash.	-22.9
7		24" 10"	7,9,15,19	First 6" - Gray, medium to coarse SAND and GRAVEL, some shell hash. Last 4" - Light brown, fine to coarse SAND, trace silt.	-27.9
10				Obstruction encountered -28.1' MLLW. Drilled with mill tooth roller bit through obstruction (approximately 8" thick). Collected split spoon from 10-12 feet.	-30.9
11.75		24" 8"	19,27,22,44	Light brown to gray, fine to coarse SAND, trace silt.	-32.65
12.5				Obstruction encountered -32.65' MLLW. Cleaned hole and began core run at -33.4 MLLW.	-33.4
17.5	68%	5.0' 4.75'	10-8-8-9-8	Rock Core #1 -33.4 to -38.4 MLLW 0.0 -2.7' Intensely to moderately fractured moderate to slightly weathered grey granitic GNEISS. 2.7' to 4.75' moderately to slightly weathered dark grey DIABASE.	-38.4
22.5	20%	5.0' 5.0'	8-9-8-8-9	Rock Core #2 -38.4 to -43.4 MLLW 0.0'-5.0' Intensely fractured moderately to slightly weathered dark grey DIABASE, iron stained vertical fractures from 3.4' to 5.0'.	-43.4
27.5	46%	5.0' 5.0'	8-9-8-8-8	Rock Core #3 -43.4 to -48.4' MLLW 0.0-2.6' Intensely fractured moderately fractured dark gray DIABASE. 2.6' - 4.4' moderately fractured granitic GNEISS, 4.4' - 5.0' moderately fractured gray DIABASE.	-48.4

**Comments:**

- Notes:**
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/10/2011  
Time: 8:00 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816372
Location: South Terminal Expansion		Y: 2689000
Elevation at mudline: -19.5	Datum: MLLW	
Casing Type: Steel	Boring Depth: -39.85' MLLW	Boring No: A-2011-B19
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 6"	WOR, WOR, 5, 5	Black, organic SILT.	-21.5
5.25		3" 3"	100-3"	Gray, medium to coarse SAND, trace fine sand.	-24.75
7.45				Obstruction encountered at -24.7 MLLW. Drilled with roller bit through obstruction. After penetration of obstruction, tool dropped approximately 0.5 feet. Obstruction encountered at -26.9 MLLW.	-26.9
10.4				Drilled with roller bit through obstruction. After penetration of obstruction, tool dropped approximately 0.3 feet. Roller bit then advanced another 0.6 feet. Cleaned hole and prepared for core run at -29.85 MLLW.	-29.85
15.4	65%	5.0' 5.0'	8-8-8-9-8	Rock Core #1 -29.85 to -34.85 MLLW - 0"-37" Moderately to intensely fractured grey Granitic GNEISS, 37"-60" Moderately to intensely fractured pink grey Granite PEGMATITE.	-34.85
20.4	54%	5.0' 4.42'	8-9-8-8-9	Rock Core #2 -34.85 to -39.85 MLLW - 0"-20" Moderately to intensely fractured pink grey Granite PEGMATITE, 20"-53" Moderately to intensely fractured grey Granitic GNEISS.	-39.85

Comments:

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



# BORING LOG

Date: 3/14/2011  
Time: 8:50 AM

Project:	Phase IV Dredging	Project No:	6690.008	X:	816746
Location:	South Terminal Expansion			Y:	2687940
Elevation at mudline:	-5.1	Datum:	MLLW		
Casing Type:	Steel	Boring Depth:	-46.65' MLLW	Boring No:	A-2011-B20
Casing Diameter:	4"	Drill Rig:	CME 45		
Drill Co:	NH Boring	Method:	Drill and Wash	Sheet:	1 of 1
Driller:	Norman Stuttard	Log By:	GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 7"	3,3,3,6	First 5" - Black fine to coarse SAND and organic SILT. Next 2" - Grey fine to coarse SAND, some inorganic silt.	-7.1
7.5		30" 0"	8,2,2,WOH	No Recovery	-12.6
12		24" 13"	25,26,21,28	Grey, fine to coarse SAND, some silt, little fine to coarse gravel.	-17.1
16.1		13" 7"	13,25, 100/1"	Grey fine SAND and SILT, little fine to coarse gravel.	-21.2
17.7				Obstruction encountered at -21.2 MLLW. Penetrated obstruction (8" thick) with roller bit to -22.8 MLLW.	-22.8
19.7		24" 7"	110,67,60, 27	Encountered second obstruction at -22.8 MLLW. Advanced roller bit through second obstruction and encountered coarse sand in drill cuttings. Advanced split spoon from -22.80 to -24.80 MLLW - Dark grey fine to coarse GRAVEL and SILT, little fine to coarse sand (TILL).	-24.8
25.07		2" 0"	110/2"	No recovery. Dark grey granite in light grey silty drill wash.	-30.17
29.9		0" 0"	100/0"	No recovery.	-35
31.55				Roller bit advanced to elevation -36.65 MLLW. Cleaned hole and prepared for core run.	-36.65
36.6	40%	5' 5'	5-5-6-6-6	Rock Core #1 -36.65 to -41.65 MLLW 0.0'-4.0' Intensely to very intensely fractured grey GNEISS, moderately to intensely fractured pink grey Granite PEGMATITE.	-41.65
41.6	40%	5' 4.0'	6-2-6-6-10	Rock Core #2 -41.65 to -46.65 MLLW - 0.0' - 3.1' Intensely to very intensely fractured pink grey Granite PEGMATITE, 3.1-4.0' intensely to very intensely fractured moderately weathered grey Granitic GNEISS. Core barrel penetrated a sediment-filled seam from between 1.3 to 2.0 feet.	-46.65

Comments:

- Notes:
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  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/15/2011  
Time: 8:00 AM

## BORING LOG

Project:	Phase IV Dredging	Project No:	6690.008	X:	816566
Location:	South Terminal Expansion	Y:	2688336	Boring No:	A-2011-B21
Elevation at mudline:	-7	Datum:	MLLW	Sheet:	1 of 1
Casing Type:	Steel	Boring Depth:	-47.7' MLLW		
Casing Diameter:	4"	Drill Rig:	CME 45		
Drill Co:	NH Boring	Method:	Drill and Wash		
Driller:	Norman Stuttard	Log By:	GCD		

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 18"	WOR, WOR, WOR, WOR	Black, organic SILT and fine SAND.	-9
7		24" 12"	16,16,18,20	Greenish-gray, fine to medium SAND, trace silt.	-14
12		24" 11"	36,27,38,35	Gray, fine to medium SAND, trace silt, trace fine gravel.	-19
12.1				Obstruction encountered at -19.1 MLLW. Penetrated obstruction with roller bit.	-19.1
15.9		11" 2"	36,100/5"	Gray, fine to coarse SAND and SILT, trace fine gravel.	-22.9
22.35		5' 3'	9,7,8,8,8	Encountered second obstruction at -23.95 MLLW. Roller bit advanced to elevation -24.35 MLLW. Cleaned hole and prepared for core run. Core run revealed nested boulders with seams of sediment. 1st Boulder estimated at 1.6 feet in length, 2nd Boulder at 0.3 feet in length, and 3rd boulder at 1.1 feet in length.	-29.35
27.6		24" 6"	25,20,12,10	Light gray, fine to coarse SAND and GRAVEL, trace silt.	-34.6
29.9		0" 0"	100/0"	Roller bit advanced to elevation -36.9 MLLW. Split spoon attempted at this elevation was 100/0". Cleaned hole and prepared for core run.	-36.9
31.9	28%	1.8' 1.33'	7,14	Rock Core #1 -36.9 to -38.7 MLLW 0.0'-1.33' Intensely to moderately fractured pink grey Granite PEGMATITE with xenoliths of granite, diabase and granitic gneiss.	-38.9
35.9	63%	4' 4'	8,7,6,9	Rock Core #2 -38.7 to -42.7 MLLW 0.0'-4.0' Intensely to moderately fractured grey Granite PEGMATITE with xenoliths of granite, gneiss, and diabase.	-42.7
40.9	50%	5' 5'	6,8,9,6,6	Rock Core #3 -42.7 to -47.7 MLLW 0.0'-5.0' Intensely to moderately fractured grey Granite PEGMATITE with xenoliths of granite, gneiss, and diabase.	-47.7

Comments:

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/16/2011  
Time: 10:00 AM

## BORING LOG

Project:	Phase IV Dredging	Project No: 6690.008	X: 816496
Location:	South Terminal Expansion		Y: 2689220
Elevation at mudline:	-5.7	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-50' MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Norman Stuttard	Log By:	GCD
			Boring No: A-2011-B22
			Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 3"	WOR, WOR, WOR, WOR	Black, organic SILT and shell hash.	-7.7
7		24" 18"	14,14,16,15	Greenish gray, fine SAND, trace silt, trace shell hash.	-12.7
12		24" 6"	10,10,10,10	Gray, fine to medium SAND, trace coarse sand.	-17.7
16.9		23" 5"	7,7,14, 100/5"	Gray, fine to coarse SAND.	-22.9
19.55		0" 0"	100/0"	No Recovery.	-25.55
24.92		5' 3'	9,7,8,8,8	Encountered obstruction at -25.55 MLLW. Roller bit advanced to bottom of obstruction at -26.3 MLLW. Roller bit advanced to -27.45 MLLW. Telescope set up to advance casing through obstruction to -30.62 MLLW.	-30.62
25.92		11" 0"	35,100/5"	No recovery.	-31.62
29.45		0" 0"	100/0"	Roller bit advanced to elevation -35.15 MLLW. Cleaned hole and began core run at -36.25 MLLW.	-35.15
34.30		1.8' 1.55'	8,5,7	Rock Core #1 -36.25 to -38.05 MLLW - Core run revealed a series of nested boulders and/or fractured rock. Roller bit advanced to -40 MLLW.	-40
39.3	48%	5' 4.3'	5,3,5,6,6	Rock Core #2 -40 to -45 MLLW 0.0'-5.0' Intensely to moderately fractured dark grey granitic GNEISS, Slightly to moderately weathered in fractures 2.5'-4.2' and 1.9'	-45
44.3	44%	5' 4.85'	5,7,6,7,8	Rock Core #3 -45 to -50 MLLW 0.0-1.5' Intensely to moderately fractured dark grey GNEISS, 1.5' - 4.8' Moderately fractured pink grey granite PEGMATITE.	-50

**Comments:**

- Notes:**
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/17/2011  
Time: 1:00 PM

## BORING LOG

Project:	Phase IV Dredging	Project No: 6690.008	X: 816606
Location:	South Terminal Expansion		Y: 2687892
Elevation at mudline:	-10.65	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-38.65' MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Norman Stuttard	Log By:	GCD

Boring No: A-2011-B23  
Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 8"	WOR, WOR, WOR, WOR	Top 4": Black, organic SILT. Last 4": Dark gray, fine to medium SAND and SILT, trace shell hash.	-12.65
7		24" 12"	13,13,17,21	Light gray, fine to coarse SAND.	-17.65
10		0" 0"	100/2"	No recovery.	-20.55
18.25				Obstruction encountered at -23.4 MLLW. Advanced roller bit through a series of obstructions, believed to be either a series of boulders or rock fragments to -28.85 MLLW.	-28.85
18.25		0" 0"	100/0"	No recovery.	-28.85
18.25				Cleaned hole and began core run at -28.85 MLLW.	-28.85
23	65%	4.8' 4.55'	8,9,9,10,11	Rock Core #1: -28.85 to -33.65 MLLW 0.0'-4.8' Intensely to moderately fractured pink grey GRANITE.	-33.65
28	85%	5' 5'	8,8,7,9,9	Rock Core #2: -33.65 to -38.65 MLLW 0.0'-5.0' Moderately fractured pink grey granitic GNEISS.	-38.65

**Comments:**

**Notes:**

- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
- 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



# BORING LOG

Date: 3/21/2011

Time: 8:00 AM

Project:	Phase IV Dredging	Project No: 6690.008	X: 816632
Location	South Terminal Expansion		Y: 2688166
Elevation at mudline:	-6.85	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-45.05' MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Norman Stuttard	Log By:	GCD
			Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 18"	WOR, WOR, 1, 1	Top 12": Black, organic SILT, trace shell hash. Next 3": Gray, fine SAND and SILT, trace shell hash. Last 3": Light brown fine SAND and SILT, trace shell	-8.85
7		24" 12"	14,10,10,12	Gray, fine to medium SAND, trace coarse sand, trace shell hash.	-13.85
12		24" 10"	21,20,12,10	Light gray, medium to coarse SAND, trace fine sand, trace shell hash.	-18.65
15				Obstruction encountered at -21.3 MLLW. Advanced roller bit through obstruction to -21.85 MLLW for next split-spoon.	-21.85
17		24" 12"	44,54,40,30	Light gray, fine to coarse SAND, some silt, trace fine gravel.	-23.85
22		24" 18"	13,12,23,16	Light gray, fine to coarse SAND, some silt and some fine gravel.	-28.85
25.92		11" 5"	46, 100/5"	Light gray, medium to coarse SAND, trace silt, trace fine gravel.	-32.76
28.2				Advanced casing to -33.25 MLLW. Advanced roller bit to -35.05 MLLW, cleaned hole and began core run.	-35.05
33.2	64%	5' 5'	6,6,6,6,6	Rock Core #1: -35.05 to -40.05 MLLW 0.0'-5.0' Intensely to moderately fractured grey granitic GNEISS.	-40.05
38.2	83%	5' 4.85'	7,6,6,6,6	Rock Core #2: -40.05 to -45.05 MLLW Intensely to moderately fractured grey granitic GNEISS.	-45.05

Comments:

Notes:

- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
- 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/22/2011  
Time: 9:45 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816289
Location: South Terminal Expansion		Y: 2687745
Elevation at mudline: -1.2	Datum: MLLW	
Casing Type: Steel	Boring Depth: -34.74' MLLW	Boring No: A-2011-B25
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 0"	WOR, WOR, WOR, WOR	No recovery.	-3.2
7		24" 6"	WOR, WOR, WOR, WOR	Black fine SAND and SILT, some shell hash.	-8.2
10		24" 12"	7,14,30,38	Gray, fine to coarse SAND, trace silt, trace fine gravel.	-11.2
15		24" 5"	29,31,36,43	Light gray fine to coarse SAND, trace silt.	-16.2
20		24" 10"	36,65,31,41	Light gray, fine to coarse SAND, trace silt, trace fine gravel	-21.2
22.54				Obstruction encountered at -22.35 MLLW. Advanced roller bit through obstruction (0.8 feet in length) to -23.15 MLLW. Advanced roller bit to -23.74 MLLW. Cleaned hole and began core run.	-23.74
25.54	31%	3' 2.35'	7,6,7	Rock Core #1: -23.74 to -26.74 MLLW Intensely to very intensely fractured grey granitic GNEISS.	-26.74
28.54	58%	3' 2.7'	6,5,5	Rock Core #2: -26.74 to -29.74 MLLW Intensely to moderately fractured grey granitic GNEISS.	-29.74
33.54	72%	5.0' 5.0'	7,6,7	Rock Core #1: -29.74 to -34.74 MLLW Intensely to moderately fractured pink grey granitic GNEISS.	-34.74

Comments:

- Notes:
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/23/2011  
Time: 11:15 AM

## BORING LOG

Project:	Phase IV Dredging	Project No: 6690.008	X: 816522
Location:	South Terminal Expansion		Y: 2688815
Elevation at mudline:	-16.75	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-47.65' MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Norman Stuttard	Log By:	GCD
			Boring No: A-2011-B26
			Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 5"	WOR, WOR, WOR, WOR	Black, fine SAND and organic SILT, trace shell hash.	-18.75
7		24" 12"	53,43,41,52	Top 6": Gray, fine to medium SAND. Middle 3": Black, fine to medium SAND, trace fine gravel. Bottom 3": Light gray fine to coarse SAND and fine GRAVEL, some ping stone fragments.	-23.75
10.25				Obstruction encountered at -24.8 MLLW. Advanced roller bit through boulder to elevation -27.0 MLLW.	-27
13.4		24" 6"	64,37,32,49	Light gray, fine to coarse SAND, trace silt, trace fine gravel.	-30.15
14				Obstruction encountered at -30.15 MLLW. Advanced roller bit through obstruction to -30.75 MLLW.	-30.75
18.2		10" 4"	34, 100/4"	Light gray, coarse SAND and fine GRAVEL, trace stone fragments.	-34.98
20.9				Advanced roller bit thru cobbles or fractured bedrock to -37.65 MLLW. Cleaned hole and began core run.	-37.65
25.9	47%	5' 5'	5,5,6,6,6	Rock Core #1: -37.65 to -42.65 MLLW 0.0' - 3.6' Intensely to moderately fractured dark grey DIABASE, 3.6'-5.0' Intensely to very intensely fractured dark grey DIABASE.	-42.65
30.9	26%	5' 4.2'	6,4,5,6,6	Rock Core #2: -42.65 to -47.65 MLLW 0.0'-1.3' Intensely to very Intensely fractured dark grey DIABASE highly weathered at interface, 1.3'-4.0' Intensely to moderately fractured grey granitic GNEISS	-47.65

Comments:

Notes:

- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
- 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/25/2011  
Time: 12:30 PM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816356
Location: South Terminal Expansion		Y: 2689759
Elevation at mudline: -13.75	Datum: MLLW	
Casing Type: Steel	Boring Depth: -42.05' MLLW	Boring No: A-2011-B27
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 6"	WOR, WOR, WOR, WOR	Black, fine SAND and SILT, trace shell hash.	-15.75
7		24" 16"	9,9,12,16	Top 3" - Gray, fine SAND, trace silt, trace fine gravel. Next 1/2" - Black, fine SAND, trace silt. Next 3" - Orange-brown, fine to coarse SAND, trace silt. Last 3" - Gray, fine to coarse SAND, trace silt.	-20.75
12		24" 15"	15,20,22,21	Top 10" - Gray, fine SAND and SILT, trace coarse sand and shell hash. Bottom 5" - Orange-brown, fine to coarse SAND and SILT, trace fine gravel.	-25.75
17		24" 4"	12,12,14,14	Gray, fine to coarse SAND and SILT, trace fine gravel, trace shell hash.	-30.75
21		12" 4"	62,80, 100/0"	Gray, fine to coarse SAND, trace silt and fine gravel.	-34.75
25				Obstruction encountered at -35.2 MLLW. Advanced roller bit through obstruction to elevation -38.30 MLLW.	-38.3
26.5		18" 16"	50,125, 172/6"	Tan, coarse to medium SAND, trace silt.	-40.25
28.3				Advanced roller bit to elevation -42.05 MLLW.	-42.05
				End of Boring	

**Comments:**

- Notes:**
- 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.
  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/28/2011  
Time: 9:29 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816775
Location: South Terminal Expansion		Y: 2687636
Elevation at mudline: -5.2	Datum: MLLW	
Casing Type: Steel	Boring Depth: -24.0' MLLW	Boring No: A-2011-B28
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%					
2		24" 14"	WOR, WOR, WOR, WOR	Black, organic SILT, trace fine to coarse sand, trace shell hash.	-7.2
4		24" 16"	10,6,10,12	Grey, fine to medium SAND, little shell hash.	-9.2
6		24" 16"	9,12,11,13	Tan to grey, very fine SAND, trace inorganic silt.	-11.2
8		24" 7"	10,18,17,18	Grey, fine SAND, little inorganic silt, little medium to coarse sand, trace gravel.	-13.2
10		24" 9"	10,20,29,32	Grey fine SAND, little silt, trace coarse gravel.	-15.2
12		24" 12"	20,27,29,43	Grey fine to coarse SAND, little silt, little fine to coarse gravel.	-17.2
13		12" 6"	24,37, 100/0"	Grey, fine to coarse SAND, little silt, little fine to coarse gravel.	-18.2
14.3				Encountered obstruction at -19.5 MLLW. Cleaned hole and began core run.	-19.5
18.8	36%	4.5' 4.5'	5,4,5,5	Rock Core #1: -19.5 to -24.0 MLLW - Intensely to moderately fractured pink grey granitic GNEISS.	-24.0

Comments: Intervals 0-2, 2-4, and 4-6 Sampled using a 3" diameter split spoon sampler, all of the other intervals were sampled using a standard 2" diameter split-spoon.

Notes: 1). Numbers in "Depth below mudline (ft)" column represent the depth below mudline of the bottom of the respective split-spoon, core run, or drill tool advancement.  
2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/29/2011  
Time: 7:00 AM

# BORING LOG

Project:	Phase IV Dredging	Project No: 6690.008	X: 816162
Location	South Terminal Expansion		Y: 2689857
Elevation at mudline:	-27.75	Datum:	MLLW
Casing Type:	Steel	Boring Depth:	-40.3' MLLW
Casing Diameter:	4"	Drill Rig:	CME 45
Drill Co:	NH Boring	Method:	Drill and Wash
Driller:	Norman Stuttard	Log By:	GCD

Boring No: A-2011-B29  
Sheet: 1 of 1

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
2		24" 9"	WOR, WOR, WOR, WOR	Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50% Black, organic SILT, trace fine sand, thin, hair-like filiments.	-29.75
6.25		15" 3"	WOR, WOR, 100/3"	Tan to grey, fine to medium SAND, some silt.	-34
7.55				Advanced roller bit through gravel/cobbles. Cleaned hole and prepared to core at -35.3 MLLW.	-35.3
12.55	82%	5' 4.2'	5,6,6,7,6	Rock Core #1: -35.3 to -40.3 MLLW - Moderately to slightly fractured grey and pink granitic GNEISS.	-40.3

Comments:

Notes:

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- 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



# BORING LOG

Date: 3/29/2011  
Time: 1:00 PM

Project: Phase IV Dredging	Project No: 6690.008	X: 816617
Location: South Terminal Expansion		Y: 2688559
Elevation at mudline: -7.8	Datum: MLLW	
Casing Type: Steel	Boring Depth: -36.6' MLLW	Boring No: A-2011-B30
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 6"	WOR, 2,2,2	Black, organic SILT and very fine SAND, little shell hash.	-9.8
7		24" 10"	10,12,10,13	Grey fine SAND, little medium to coarse sand. Grades to grey-tan medium SAND, little fine to coarse SAND.	-14.8
12		24" 10"	20,29,25,23	Grey fine to coarse SAND, some silt, little fine to coarse gravel.	-19.8
17		24" 3"	33,25,27,32	Grey fine to coarse SAND, some silt, little fine to coarse gravel (TILL).	-24.8
21.6		24" 5"	57,27,59, 126	Grey, fine to coarse GRAVEL and fine to coarse SAND, little silt (TILL).	-29.4
25.95		24" 2.5"	21,15,67,29	Coarse GRAVEL, some fine to medium sand, some silt (TILL).	-33.75
28.8				Refusal at -33.75 MLLW. Advanced roller bit through obstruction to -35.15 MLLW. Advanced roller bit to -36.60 MLLW. No rock core conducted.	-36.6
				End of Boring	

**Comments:**

- Notes:**
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# BORING LOG

Date: 3/30/2011  
Time: 10:05 AM

Project: Phase IV Dredging	Project No: 6690.008	X: 816259
Location: South Terminal Expansion		Y: 2689246
Elevation at mudline: -20.85	Datum: MLLW	
Casing Type: Steel	Boring Depth: -57.65' MLLW	Boring No: A-2011-B31
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
2		24" 3"	WOR, WOR, WOR, WOR	Black, organic SILT trace shell hash.	-22.85
7		24" 4"	16,27,31,40	Gray, medium to coarse SAND and fine GRAVEL, trace silt.	-27.85
8.35				Obstruction encountered at -28.3 MLLW. Advanced roller bit through obstruction until -29.2 MLLW.	-29.2
12		24" 6"	47,22,23,18	Gray, fine to coarse SAND, little fine gravel, trace silt.	-32.85
14.5				Obstruction encountered at -34.4 MLLW. Advanced roller bit through obstruction until -35.35 MLLW.	-35.35
16.8				Advanced roller bit to -37.65 MLLW. Cleaned hole and began core run.	-37.65
21.8	64%	5' 4.8'	5,3,4,5,5	Rock Core #1: -37.65 to -42.65 MLLW - Intensely to moderately fractured grey to dark grey granitic GNEISS.	-42.65
26.8	73%	5' 4.9'	6,5,4,4,4	Rock Core #2: -42.65 to -47.65 MLLW - 0.0-1.25' Intensely to moderately fractured pink grey GRANITE, 1.25-4.9' Intensely to moderately fractured dark grey granitic GNEISS.	-47.65
31.8	58%	5' 4.9'	5,5,5,5,5	Rock Core #3: -47.65 to -52.65 MLLW - Intensely fractured dark grey GNEISS	-52.65
36.8	78%	5' 5'	5,5,5,5,5	Rock Core #4: -52.65 to -57.65 MLLW - Intensely to moderately fractured dark grey GNEISS	-57.65

**Comments:**

- Notes:**
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  - 2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.



Date: 3/31/2011  
Time: 11:00 AM

## BORING LOG

Project: Phase IV Dredging	Project No: 6690.008	X: 816364
Location: South Terminal Expansion		Y: 2688225
Elevation at mudline: -0.8	Datum: MLLW	
Casing Type: Steel	Boring Depth: -46.6' MLLW	Boring No: A-2011-B32
Casing Diameter: 4"	Drill Rig: CME 45	
Drill Co: NH Boring	Method: Drill and Wash	Sheet: 1 of 1
Driller: Norman Stuttard	Log By: GCD	

Depth below mudline (ft)	RQD	Penetration/ Recovery	Blows per 6" / Drill Min. per Foot	Description (Color, Texture, Structure)	Elevation (MLLW)
				Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	
25.8				Encountered first obstruction at -25.7 MLLW. Advanced roller bit to -26.6 MLLW, cleaned hole and began core run.	-26.6
30.8	58%	5' 4.8'	4,4,4,4,4	Rock Core #1: -26.6 to -31.6 MLLW - 0.0'-3.25' Slightly fractured pink grey granitic GNEISS 3.25'-4.8' Intensely fractured highly weathered grey granitic GNEISS grades to unweathered quartz rich GRANITE.	-31.6
35.8	32%	5' 4.3'	6,5,5,5,4	Rock Core #2: -31.6 to -36.6 MLLW - 0.0'-4.2' Intensely fractured pink grey granitic GNEISS becomes very intensely fractured at 1.75'	-36.6
40.8	8%	5' 3.2	5,5,6,5,7	Rock Core #3: -36.6 to -41.6 MLLW - Intensely fractured pink grey granitic GNEISS	-41.6
45.8	47%	5' 5'	no drill time recorded	Rock Core #4: -41.6 to -46.6 MLLW - 0.0'-2.5' Intensely fractured grey granitic GNEISS 2.5'-4.9' moderately fractured grey granitic GNEISS	-46.6

Comments: Partial collapse of hole after withdrawal of Rock Core #4, due to presence of highly fractured rock falling into hole. Elevation of collapse approximately -38.85 MLLW.

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2). Numbers in "Elevation (MLLW)" column represent the elevation of the bottom of the respective split-spoon, core run, or drill tool advancement.