RETURN TO SER AR INDEX

From: Keegan, Michael F NAE
To: Sneeringer, Paul J NAE
Subject: FW: Potential Hurricane Barrier Impact (UNCLASSIFIED)
Date: Tuesday, May 15, 2012 10:28:20 AM
Attachments: SOUTH_TERMINAL_EXPANSION-9-20-10_W_CROSS_SECTIONSred.pdf
P-2.6red.pdf
33734.00_Hurricane Barrier Reportred.pdf

Classification: UNCLASSIFIED
Caveats: NONE

FYI

Mike

-----Original Message-----
From: Chet Myers [mailto:cmyers@apexcos.com]
Sent: Monday, December 05, 2011 12:35 PM
To: Firicano, Anthony J NAE
Cc: Jay Borkland; Keegan, Michael F NAE
Subject: Re: Potential Hurricane Barrier Impact

Hi Mr. Firicano,

Not sure if you remember this issue, but Apex contacted you approximately one year ago to discuss the proposed New Bedford Marine Commerce Terminal (which is an extension of the existing South Terminal in New Bedford) and the potential impact of a portion of the dredging on the New Bedford Hurricane Barrier.

At the time, Apex had forwarded to you the proposed dredge footprint and cross-section (attached as "South Terminal Expansion 9-20-10 W Cross-Sectionsred"). You had requested a slope-stability analysis to be performed on this footprint.

Since that time, the dredge footprint has changed slightly, and we have had a slope stability analysis performed by GZA on both the original and two versions of the altered dredge footprint.

The new dredge footprint is attached as "P-2.6red". This new footprint brings the dredging closer to the Hurricane Barrier, but is also slightly shallower (-14 MLLW vs. -20 MLLW in our 9-20-10 submission).

Although there are no plans to dredge deeper than -14 MLLW at this time, the future allowable dredge depth for the bulkhead extension in this area is -20 MLLW. Therefore GZA assumed that it was possible that the new footprint could also be dredged to -20 MLLW in the future.

Therefore, GZA conducted its slope-stability analysis on three different scenarios:

1). The original 9-20-10 footprint dredged to -20 MLLW.
2). The new footprint dredged to -14 MLLW.
3). The new footprint dredged to -20 MLLW.

GZA created cross-sections and ran the three scenarios through their slope-stability software. GZA's conclusion in their report ("33734.00 Hurricane Barrier Reportred") was that "all of the proposed dredge scenarios have acceptable factors of safety".

We are more than happy to discuss the issue with you further, or to meet with you to discuss the reports and the dredge footprints. Finally, higher resolution files for the Hurricane Barrier Report are available (we just didn't want to overwhelm your servers).

Thanks,

SDMS DocID 517381

Chet Myers
Apex Companies, LLC
O) 617-728-0070 M) 617-908-5778

-----Original Message-----
From: Keegan, Michael F NAE [mailto:Michael.F.Keegan@usace.army.mil]
Sent: Wednesday, October 06, 2010 12:07 PM
To: Chet Myers
Cc: Jay Borkland; Firicano, Anthony J NAE
Subject: RE: Potential Hurricane Barrier Impact

Chet,

I did engage both Larry and John since they are the two individuals in charge of the Canal. However they asked me to coordinate with our Geotechnical folks since they have the expertise to determine if they felt that there would be an issue. Tony Firicano is the Chief of Geotech and I asked him to have someone from his shop take a look at things. Tony indicated that, based on a cursory review, we wouldn't expect any impact to the barrier given the proposed cross-section. Tony did indicate that typically in these situations, we require the Contractors to provide analysis or backup for their section design for our review, and that would be the preferred approach.

I've included Tony in this email. He can be reached at 978-318-8396. I'd prefer it if you two talk directly instead of me being the middleman here.
However, please keep me in the loop so I can make sure that coordinate on the canal folks. Thanks

Mike

-----Original Message-----
From: Chet Myers [mailto:cmyers@apexcos.com]
Sent: Friday, October 01, 2010 5:09 PM
To: Keegan, Michael F NAE
Cc: Jay Borkland
Subject: Potential Hurricane Barrier Impact

Mike,

Just wanted to check with you regarding the review of the proposed dredging in front of the Hurricane Barrier.

My understanding is that you referred us to either Mr. Larry Davis or Mr.
John Macpherson at the Cape Cod Canal office, who are actually doing the review.

I will attempt to contact them, if it is OK with you. If you wouldn't mind letting them know that I will be calling to schedule a meeting, I would be grateful.

Thanks,

Chet Myers, PE, LSP

Apex Companies, LLC

184 High Street, Suite 502

Boston, MA 02110

O: 617-728-0070 X-113

F: 617-728-0080

C: 617-908-5778

Classification: UNCLASSIFIED
Caveats: NONE

GLOBAL STABILITY ANALYSIS
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

November, 2011
File No. 33734

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GZA
GeoEnvironmental, Inc.

Engineers and Scientists

November 23, 2011
File No. 33734.00

530 Broadway
Providence
Rhode Island
02909
401-421-4140
Fax: 401-751-8613
http://www.gza.com

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

Re: Global Stability Analysis
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 report for the New Bedford-Fairhaven Hurricane Barrier global stability analysis. The primary objectives of this report were to review available information for the site and to assess the potential impacts to the global stability of the existing New Bedford-Fairhaven hurricane barrier due to the proposed dredging for the New Bedford Marine Commerce Terminal project. This report is subject to the Limitations and Terms and Conditions of Engagement 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. The barrier 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 runs the length of the barrier positioned on the harbor side of the embankment. Two gated structures were incorporated into the barrier which, under normal 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

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of a cellular cofferdam bulkhead and nearshore dredging along the cofferdam bulkhead to facilitate berthing of larger vessels. Dredging is planned in the vicinity of the hurricane barrier to either elevation -14 feet or -20 feet Mean Lower Low Water (MLLW). Mudline elevation in this area is approximately -5 MLLW which corresponds to overall dredge depths between 9 and 15 feet. A 3H: 1V slope has been proposed to be constructed along the perimeter of the dredge area to transition from the existing mudline elevations to the desired dredge elevation. Refer to the attached figures, drawing P-4 "South Terminal Marine Infrastructure Park Proposed Bulkhead", and drawing P-9 "Bottom of Dredge-Plan 1" for plan views of the proposed dredge scenarios.

The U.S. Army Corps of Engineers (USACE) has requested a global stability analysis of the hurricane barrier which addresses the potential impacts to the barrier due to the proposed dredging.

REVIEW OF EXISTING DOCUMENTATION

Electronic copies of the original USACE drawings titled "New Bedford-Fairhaven Plan of Harbor Explorations and Geologic Sections", dated 1960, "New Bedford-Fairhaven, Record of Foundation Explorations, No. 4", dated 1960, "New Bedford-Fairhaven Barrier, Harbor Barrier and Dike, Plan and Profile No. 2", dated 1962, "New Bedford-Fairhaven Barrier, Harbor Barrier and Dike, Typical Sections No. 1", dated 1962, and "New Bedford-Fairhaven Barrier, Parking Area, New Bedford", dated 1962 were provided to GZA by Apex Companies, LLC (Apex) for use in this analysis. These drawings are included in Appendix C.

All current project elevations reference Mean Lower Low Water (MLLW) datum; however, all of the original USACE drawings and accompanying subsurface information reference Mean Sea Level (MSL) datum which was assumed to reference the 1960-1983 epoch. These elevations were converted to MLLW, with respect to the current epoch, for consistency when comparing original information with current conditions. The conversion used was MSL 1960-1878 = 1.84 MLLW[1].

The original USACE documentation, Figure 2, "Dredge Footprint Cross Section", dated September, 2010, drawing P-9, "South Terminal Marine Infrastructure Park Proposed Bulkhead", dated September, 2010, and recent subsurface boring logs by Apex were used to generate a design cross section and subsurface profile for use in the global stability analysis. Apex boring logs used in the analysis are included in Appendix D. Section line A-A', as shown on drawing P-4, "South Terminal Marine Infrastructure Park Proposed Bulkhead", was chosen due to the close proximity of proposed dredging activities to the hurricane barrier.

[1] NOAA Tides and Currents, Elevations on Station Datum, Buzzards Bay, MA, Station 8447270.

SLOPE STABILITY ANAYLSIS

Recent borings, A-2010-B7, A-2011-B23, and A-2011-B28 performed by Apex on September 24, 2010, March 17 and March 28, 2011, respectively, and original USACE borings FD-95 and FD-97 performed on August 27 and September 3, 1959, respectively, were used to develop a typical subsurface profile along section line A-A' shown on Drawing P-4. The generalized subsurface conditions at the site consist of a 5 to 7 foot thick layer of soft sandy organic silt underlain by approximately 4 to 13 feet of medium dense to very dense fine to coarse sand and/or sand and gravel, both having varying amounts of silt, isolated portions of a very thin layer of very dense glacial till, and bedrock. The general construction of the hurricane barrier at section line A-A' consists of riprap armor stone layer, chocking stone and sand and gravel filter layers, and an earth fill core. Based on the original USACE documents, it was assumed that the organic silt had been dredged prior to construction of the barrier. This profile and section thicknesses obtained from the original construction documents were modeled using the software program GeoStudios Slope/W 2007 by Geo-Slope International, LLC. Selected soil parameters, including total unit weight and angle of internal friction for each of the soil layers along with the embankment materials can be seen on the attached Slope/W output. The bedrock was modeled as an impenetrable surface.

Additionally, water levels on the hurricane barrier were modeled in Slope/W using FEMA flood maps for the area. FEMA flood insurance maps were reviewed, and a 100 year flood elevation of 17.0 feet, referenced to the North American ertical Datum of 1988 (NAVD 88) was used for the area. This elevation was converted to MLLW and corresponds to elevation 14.7 feet. Based on information provided by Apex, the conversion is MLLW = (NAVD of 1988) - 2.34 ft. A "worst case" scenario was modeled which assumed that the gate structures had been closed and that the water elevation within the harbor was 0.0 feet and that the 100 year flood elevation was present on the ocean side of the barrier, corresponding to elevation 14.7 feet. A diagonal line was assumed for a phreatic surface through the barrier connecting the differing water elevations.

Acceptable factors of safety under static loading conditions are generally considered to be 1.3 for normal structures, or 1.5 for structures that support critical utilities or infrastructure or any other sites with low tolerance for failure[2]. Four scenarios were run for this global stability analysis. Scenario 1 modeled the existing conditions and used the generalized hurricane barrier section and soil profile and Scenarios 2, 3, and 4 modeled the proposed dredge scenarios. Scenario 2 modeled the dredge footprint outlined on drawing P-4 and Scenarios 3 and 4 modeled the dredge footprint on drawing P-9 with final dredge elevations of -14 feet and -20 feet MLLW. Elevation -14 is the dredge elevation proposed for the project at this time, and elevation -20 is the elevation for possible subsequent

[2] AASHTO Standard Specifications for Highway Bridges

deeper dredging. The predicted potential failure surfaces for all scenarios displayed factors of safety greater than the recommended minimum of 1.5.

The results of the analyses indicate that the factor of safety for global stability for the existing condition is approximately 2.2 and that the proposed dredging would likely have minimal impacts on the global stability of the hurricane barrier. The factor of safety determined in Scenario 2 remained 2.2 and the factor of safety for Scenario 3 showed a slight reduction to 1.9 for a dredge elevation of -14 feet and 1.7 for a dredge elevation of -20 feet MLLW. Therefore, under the 100 year flood condition, all of the proposed dredge scenarios have acceptable factors of safety.

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

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

James J. Marsland
Geotechnical Engineer

Diane Baxter, Ph.D., P.E.
Senior Project Manager

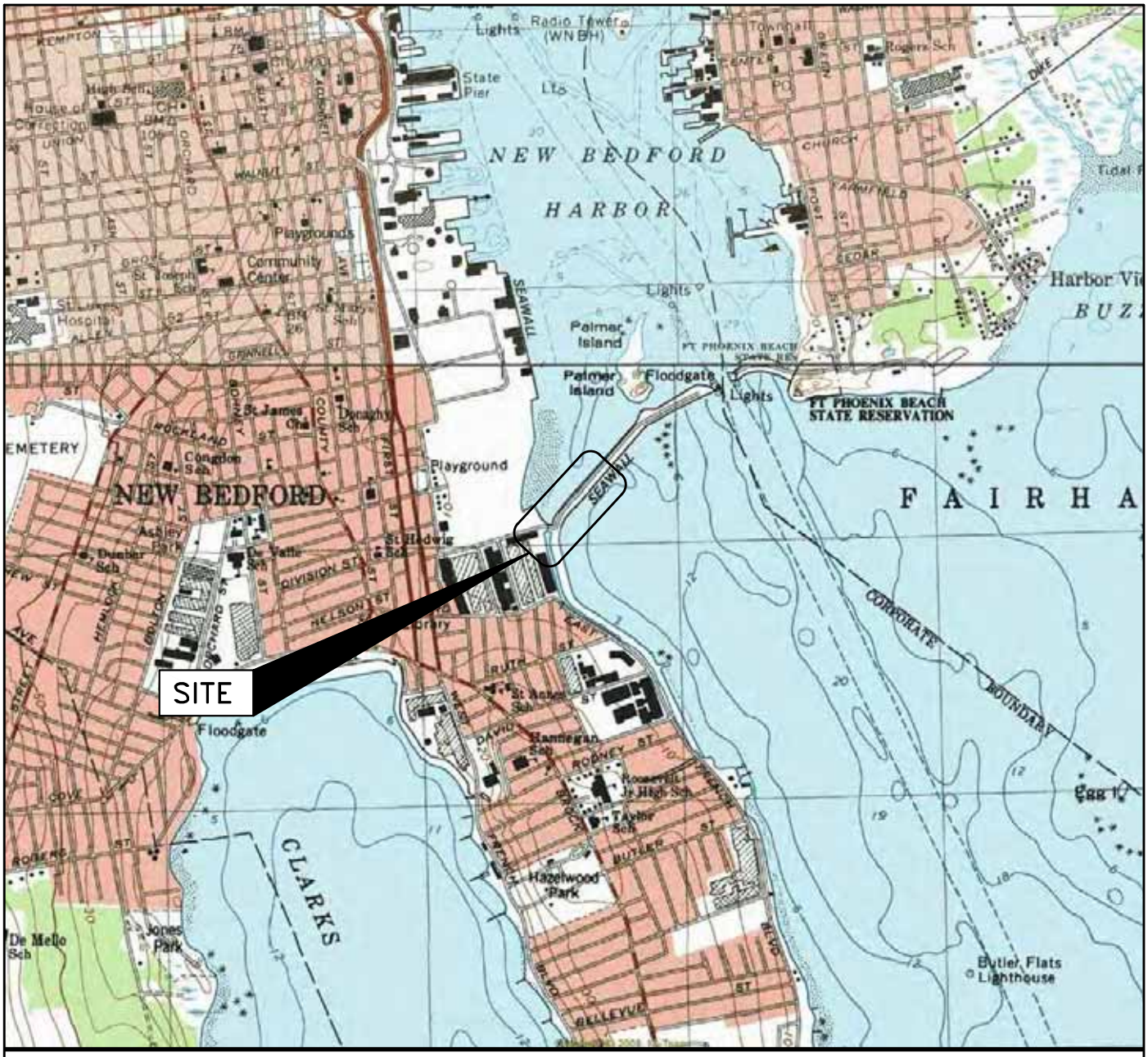
David R. Carchedi, Ph.D., P.E.
Senior Principal

DYB/DRC:jm

Attachments:	Figure 1:	Locus Plan
	Appendix A:	Limitations
	Appendix B:	Apex Companies, LLC Drawings
	Appendix C:	Original USACE Drawings
	Appendix D:	Subsurface Exploration Logs
	Appendix E:	Slope Stability Analysis

j:\geo\33734.00.dyb\report\hurricane barrier\33734.00_hurricanebarrier_rep.doc

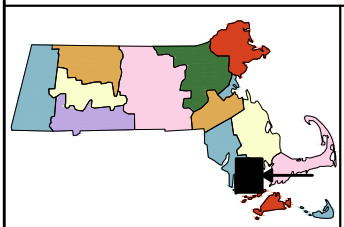
FIGURES



APPROXIMATE SCALE IN FEET

0' 1000' 2000' 4000'

N W E S



MASSACHUSETTS

QUADRANGLE LOCATION

SOURCE:

BASE MAP FROM THE FOLLOWING USGS QUADRANGLE MAP:
NEW BEDFORD SOUTH, MASSACHUSETTS (1977)

DIGITAL TOPOGRAPHIC MAPS PROVIDED MY MAPTECH. INC.

CONTOUR ELEVATIONS REFERENCE NGVD 29,
CONTOURS ARE SHOWN IN FEET AT 10 FOOT INTERVALS

UNLESS SPECIFICALLY STATED BY WRITTEN AGREEMENT, THIS DRAWING IS THE SOLE PROPERTY OF GZA GEOENVIRONMENTAL, INC. (GZA). THE INFORMATION SHOWN ON THE DRAWING IS SOLELY FOR USE BY GZA'S CLIENT OR THE CLIENT'S DESIGNATED REPRESENTATIVE FOR THE SPECIFIC PROJECT AND LOCATION IDENTIFIED ON THE DRAWING. THE DRAWING SHALL NOT BE TRANSFERRED, REUSED, COPIED, OR ALTERED IN ANY MANNER FOR USE AT ANY OTHER LOCATION OR FOR ANY OTHER PURPOSE WITHOUT THE PRIOR WRITTEN CONSENT OF GZA. ANY TRANSFER, REUSE, OR MODIFICATION TO THE DRAWING BY THE CLIENT OR OTHERS, WITHOUT THE PRIOR WRITTEN EXPRESS CONSENT OF GZA, WILL BE AT THE USER'S SOLE RISK AND WITHOUT ANY RISK OR LIABILITY TO GZA.

NEW BEDFORD SOUTH TERMINAL
NEW BEDFORD , MASSACHUSETTS

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
APEX COMPANIES, LLC

HURRICANE BARRIER SLOPE STABILITY

PROJ MGR: DYB	REVIEWED BY: DRC	CHECKED BY: JJM	FIGURE
DESIGNED BY: JJM	DRAWN BY: MEA	SCALE: AS NOTED	1
DATE: SEPT. 2011	PROJECT NO. 33734.00	REVISION NO. 0	SHEET NO. 1 OF

© 2011 – GZA GeoEnvironmental, Inc. GZA–J:\Geo\33734.00.dyb\Figures\GZA DWGS\33734.00_LOCUS.dwg [LOCUS] September 09, 2011 – 2:24pm michael.aubin

APPENDIX A

LIMITATIONS

GEOTECHNICAL LIMITATIONS

Explorations

1. The analyses and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

3. Water level readings have been made in the drill holes and monitoring wells at times and under conditions stated on the boring logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors occurring since the time measurements were made.

Review

4. In the event that any changes in the nature, design or location of the proposed building are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by GZA GeoEnvironmental, Inc (GZA). It is recommended that this firm be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications.

Construction

5. It is recommended that this firm be retained to provide soil engineering services during construction of the excavation and foundation phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to start of construction.

Use of Report

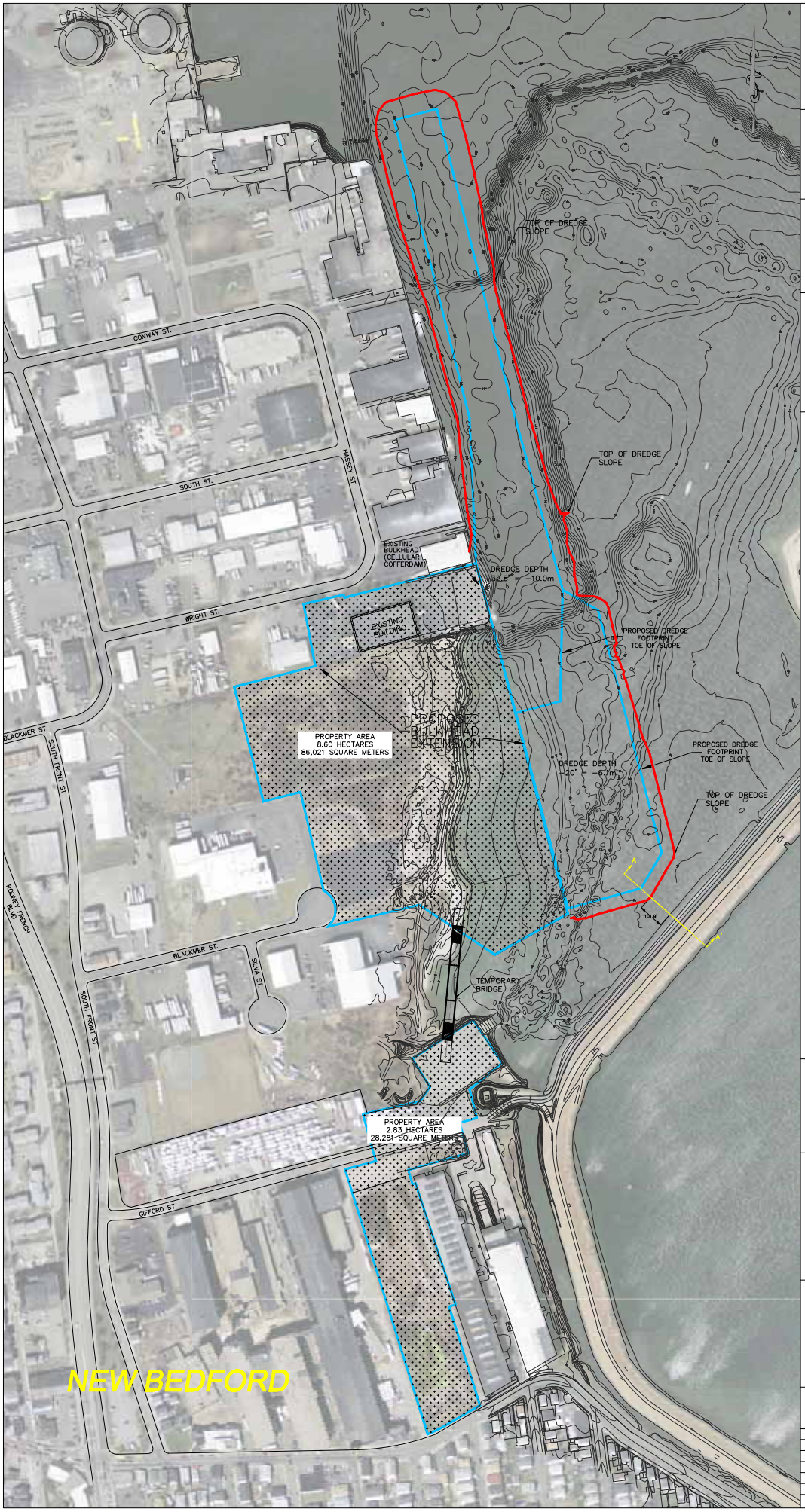
6. This report has been prepared for the exclusive use Apex Companies, LLC for specific application to the New Bedford-Fairhaven Hurricane Barrier located in New Bedford, Massachusetts in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made.

7. This soil and foundation engineering report has been prepared for this project by GZA. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only.

8. This report may contain comparative cost estimates for the purpose of evaluating alternative foundation schemes. These estimates may also involve approximate quantity evaluations. It should be noted that quantity estimates may not be accurate enough for construction bids. Since GZA has no control over labor and materials cost and design, the estimates of construction costs have been made on the basis of experience. GZA does not guarantee the accuracy of cost estimates as compared to contractor's bids for construction costs.

APPENDIX B

APEX COMPANIES, LLC DRAWINGS



Apex Companies, LLC.

1 WAMSUTTA STREET
SUITE 8
NEW BEDFORD, MA 02740
(508) 996-9828

184 HIGH STREET
SUITE 502
BOSTON MA 02110
(617) 728-0070

REVISIONS

NO.	DATE	DESCRIPTION
1.	9-2-10	TOP OF SLOPE ADDED
2.	9-20-10	CROSS SECTION ADDED

THESE DRAWINGS PREPARED BY APEX FOR THIS PROJECT ARE INSTRUMENTS OF APEX'S SERVICE FOR USE SOLELY WITH RESPECT TO THIS PROJECT, AND APEX SHALL BE DEEMED THE AUTHOR OF THE DRAWING AND SHALL RETAIN ALL COMMON LAW, STATUTORY AND OTHER RESERVED RIGHTS WITH RESPECT THERETO, INCLUDING COPYRIGHT. THE DOCUMENTS SHALL NOT BE USED ON OTHER PROJECTS, FOR ADDITIONS TO THIS PROJECT OR FOR COMPLETION OF THIS PROJECT BY OTHERS, EXCEPT BY AGREEMENT IN WRITING AND WITH APPROPRIATE COMPENSATION TO APEX.

PREPARED FOR:

THE NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
NEW BEDFORD, MASSACHUSETTS

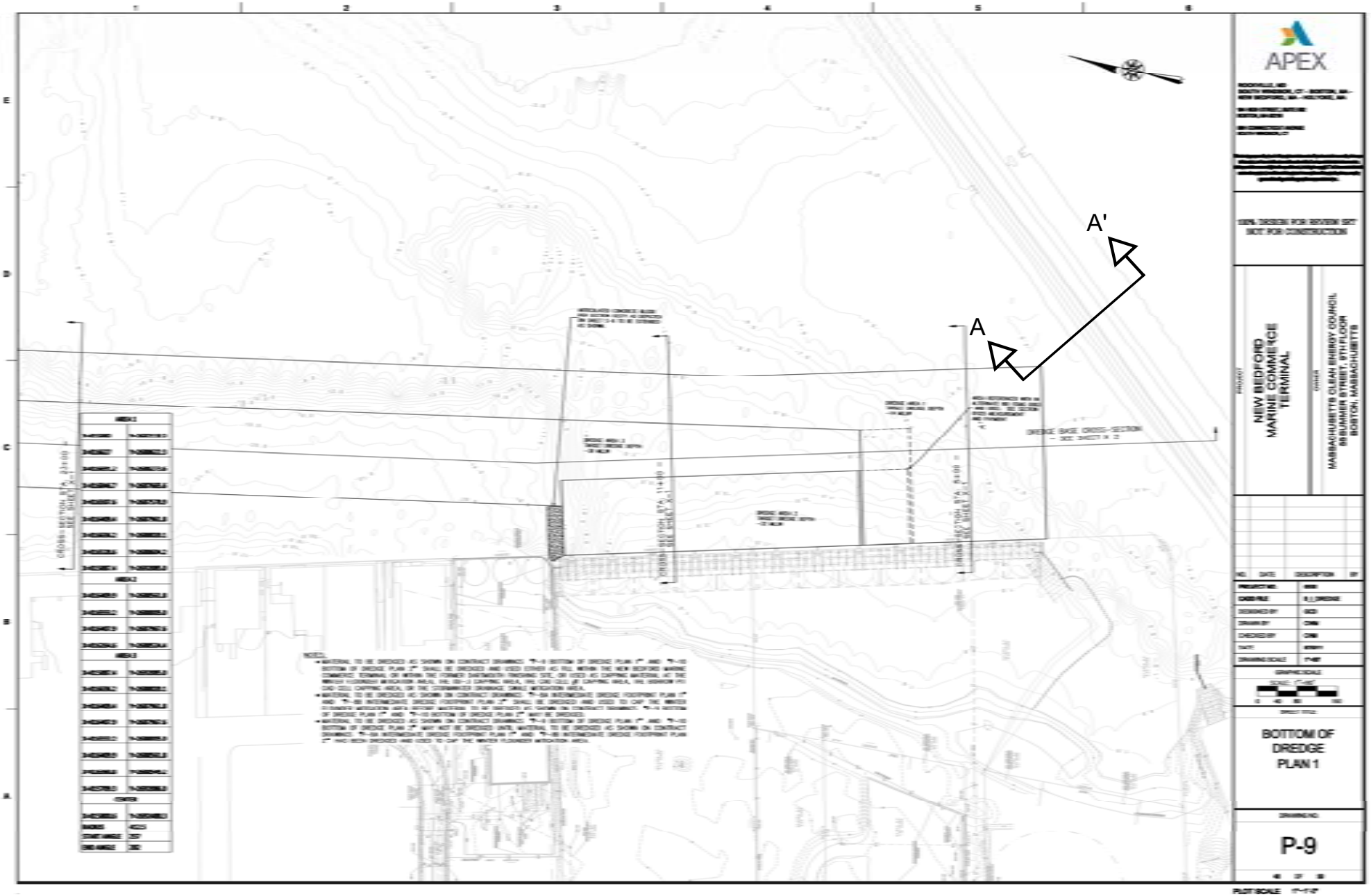
DRAWING TITLE:

SOUTH TERMINAL MARINE INFRASTRUCTURE PARK PROPOSED BULKHEAD

Scale: 1"=150'

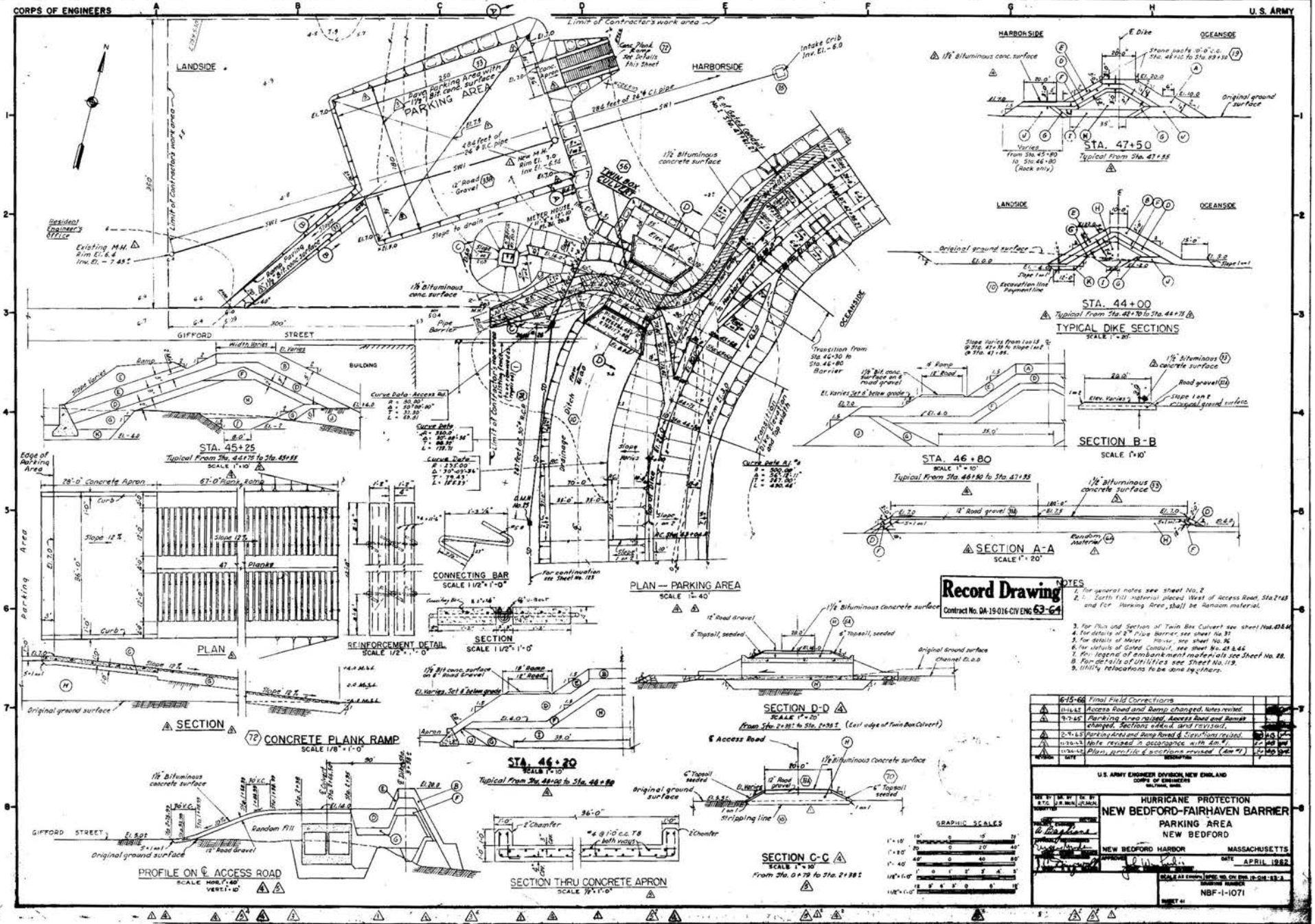
0 75 150 300 450 FEET

Date 3/24/10	Drawing No.
Proj. Mgr. JAB	
Design CWM	
Check CHM	P-4
Drawn GCD	
Job. No. 6690	
Last Rev. 8/23/10	

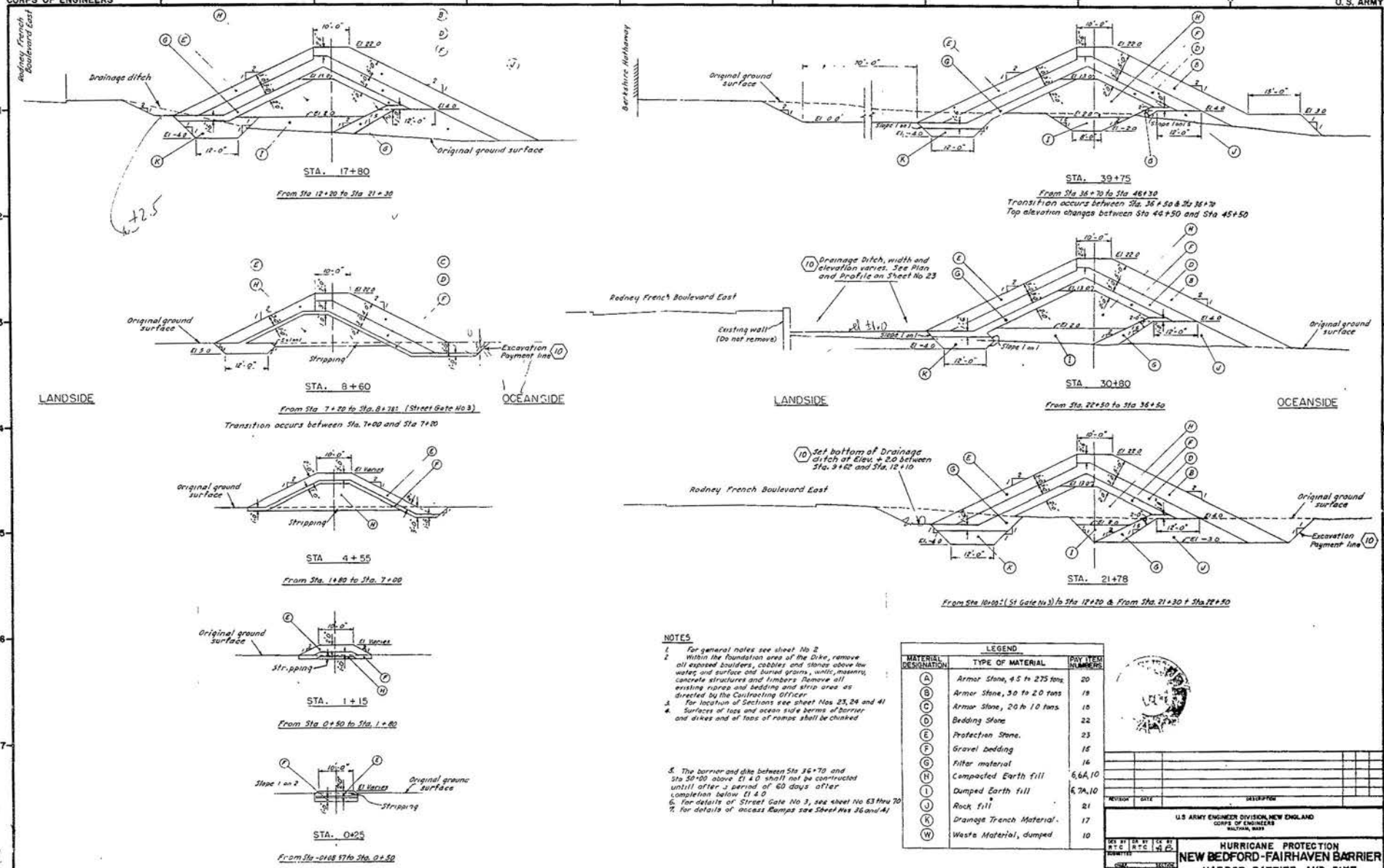

A
A'
APEX
NEW BEDFORD
MARINE COMMERCE
TERMINAL
MASSACHUSETTS CLEAN ENERGY COUNCIL
85 BUMMER STREET, 9TH FLOOR
BOSTON, MASSACHUSETTS
BOTTOM OF
DREDGE
PLAN 1
P-9

APPENDIX C

ORIGINAL USACE DRAWINGS


CORPS OF ENGINEERS
U. S. ARMY
LANDSIDE
HARBORSIDE
OCEANSIDE
PARKING AREA
GIFFORD STREET
BUILDING
TWIN BOX CULVERT
STA. 45+25
Typical From Sta. 44+75 to Sta. 45+55
SCALE 1" = 10'
STA. 46+80
Typical From Sta. 46+50 to Sta. 47+35
SCALE 1" = 10'
STA. 47+50
Typical From Sta. 47+35
STA. 44+00
Typical From Sta. 42+70 to Sta. 44+75
TYPICAL DIKE SECTIONS
SCALE 1" = 20'
SECTION B-B
SCALE 1" = 10'
SECTION A-A
SCALE 1" = 20'
PLAN — PARKING AREA
SCALE 1" = 40'
CONNECTING BAR
SCALE 1 1/2" = 1'-0"
SECTION
SCALE 1 1/2" = 1'-0"
REINFORCEMENT DETAIL
SCALE 1/2" = 1'-0"
PLAN
SECTION
CONCRETE PLANK RAMP
SCALE 1/8" = 1'-0"
STA. 46+20
SCALE 1" = 10'
Typical From Sta. 46+00 to Sta. 46+80
SECTION D-D
SCALE 1" = 20'
From Sta. 2+38± to Sta. 2+98± (East edge of Twin Box Culvert)
SECTION C-C
SCALE 1" = 10'
From Sta. 0+79 to Sta. 2+38±
PROFILE ON ℄ ACCESS ROAD
SCALE HOR. 1" = 40' VERT. 1" = 10'
SECTION THRU CONCRETE APRON
SCALE 1/2" = 1'-0"
GRAPHIC SCALES
Record Drawing
Contract No. DA-19-016-CIV ENG 63-64
NOTES
1. For general notes see sheet No. 2
2. Earth fill material placed West of Access Road, Sta. 2+43 and for Parking Area, shall be Random material.
3. For Plan and Section of Twin Box Culvert see sheet Nos. 43 & 44
4. For details of 2" Pipe Barrier see sheet No. 37
5. For details of Meter House, see sheet No. 36
6. For details of Gated Conduit, see sheet No. 45 & 46
7. For legend of embankment materials see Sheet No. 28.
8. For details of Utilities see Sheet No. 119.
9. Utility relocations to be done by others.
6-15-66 Final Field Corrections
11-16-65 Access Road and Ramp changed. Notes revised.
9-7-65 Parking Area raised, Access Road and Ramp changed. Sections added and revised.
2-9-65 Parking Area and Ramp Paved & Elevations revised.
11-20-62 Note revised in accordance with Am. #1.
11-26-62 Plan, profile & sections revised (Am #1)
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
HURRICANE PROTECTION
NEW BEDFORD-FAIRHAVEN BARRIER
PARKING AREA
NEW BEDFORD
NEW BEDFORD HARBOR
MASSACHUSETTS
APRIL 1962
NBF-1-1071

CORPS OF ENGINEERS U. S. ARMY



NOTES

1. For general notes see sheet No 2
2. Within the foundation area of the Dike, remove all exposed boulders, cobbles and stones above low water, and surface and buried grains, wells, 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 sheet Nos 23, 24 and 41
4. Surfaces of tops and ocean side berms of barrier and dikes and of tops of ramps shall be chinked
5. The barrier and dike between Sta 36+70 and Sta 50+00 above El 4.0 shall not be constructed untill after a period of 60 days after completion below El 4.0
6. For details of Street Gate No 3, see sheet No 63 thru 70
7. For details of access Ramps see Sheet Nos 36 and 41

LEGEND

MATERIAL DESIGNATION	TYPE OF MATERIAL	PAY ITEM NUMBERS
A	Armor Stone, 4.5 to 2.75 tons	20
B	Armor Stone, 3.0 to 2.0 tons	19
C	Armor Stone, 2.0 to 1.0 tons	18
D	Bedding Stone	22
E	Protection Stone.	23
F	Gravel bedding	15
G	Filter material	16
H	Compacted Earth fill	6, 6A, 10
I	Dumped Earth fill	6, 7A, 10
J	Rock fill	21
K	Drainage Trench Material.	17
W	Waste Material, dumped	10

TYPICAL SECTIONS
SCALE. 1" = 10'

GRAPHIC SCALE
1" = 1'-0"

REVISION | DATE | DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES BY RTC | DR BY RTC | CK BY AB

SUBMITTED

CHIEF, SECTION

PROJECT ENGINEER

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

NEW BEDFORD HARBOR MASSACHUSETTS

APPROVED

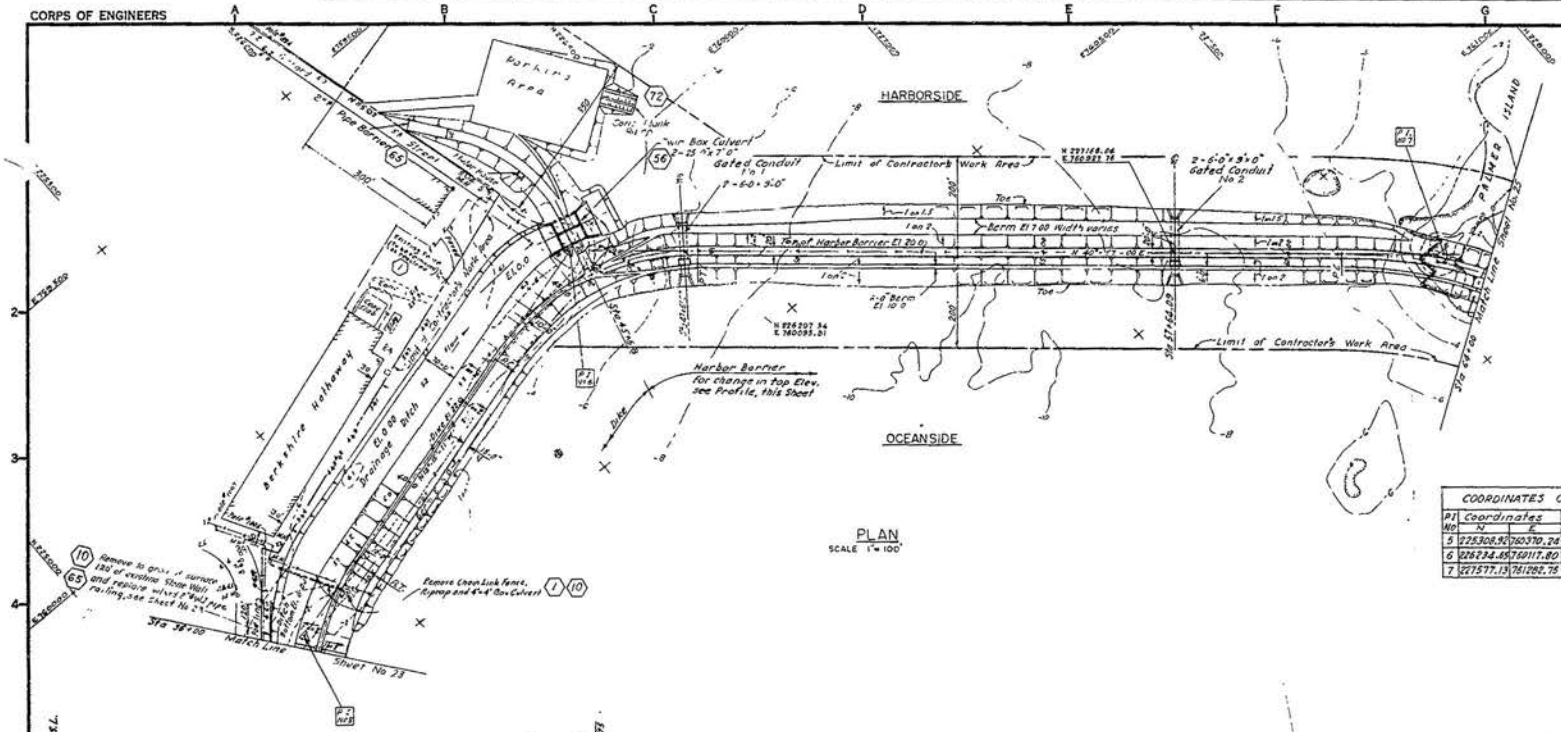
DATE APRIL 1962

SCALE. 1"=10' SPEC. NO CIV ENG 19-016-63-2

DRAWING NUMBER NBF-1-1058

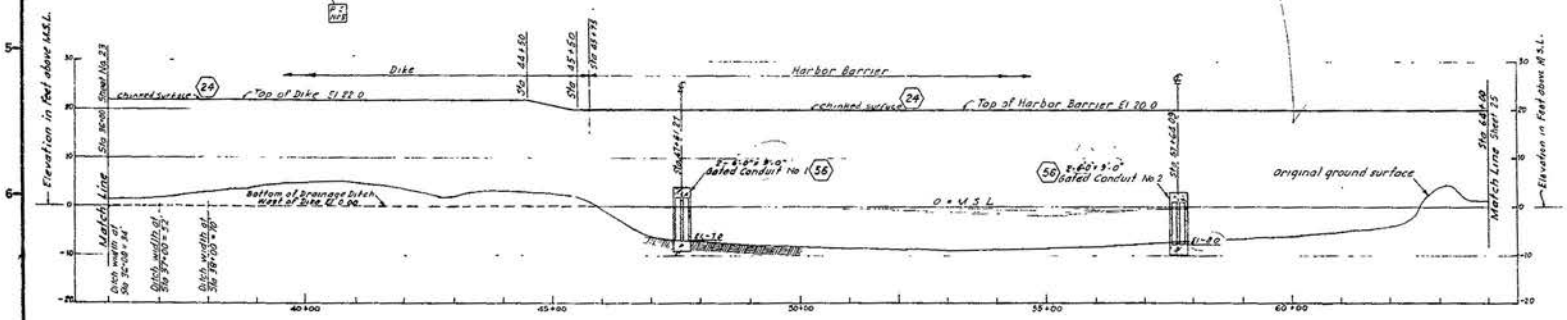
SHEET 28

CORPS OF ENGINEERS U. S. ARMY



PLAN
SCALE 1" = 100'

COORDINATES			CURVE DATA - STATIONS OF BASE LINE				FOR DIKE AND HARBOR BARRIER	
PI No	Coordinates N	Coordinates E	R	Δ	T	L	P.C. Sta	P.T. Sta.
5	225308.92	760370.24	500.00'	41°-15'-49"	188.25'	360.10'	34+40.43	38+00.53'
6	226234.85	760117.80	500.00'	55°-12'-11"	267.00'	490.46'	43+04.81'	47+95.27'
7	227577.13	761282.75	1000.00'	22°-40'-59"	200.57	395.18'	61+05.16'	65+01.05'



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

NOTES

1. For general notes see sheet No. 2
2. For Plan and Details of Parking Area see sheet No 41
3. For Details of Twin Box Culvert see sheet Nos 43 and 44
4. For Details of Gated Conduit No. 1 and 2 see sheet Nos 45 thru 48
5. For Typical Sections of Dike and Harbor Barrier see sheet Nos 28 and 29
6. For existing and new utility details see sheet Nos 122-135 incl
7. For details of 2" Pipe Barrier see sheet No 57
8. Utilities are shown on sheet Nos 122-135 incl
9. Utility relocations to be done by others
10. For details of 2" ϕ W.I. pipe railing see Sheet No 86

GRAPHIC SCALES
SCALE 1" = 10'
SCALE 1" = 100'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES BY RTC | DR BY JAM | CK BY KB
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P & R BRANCH
APPROVED
CHIEF, ENGINEERING DIVISION

HURRICANE PROTECTION
NEW BEDFORD-FAIRHAVEN BARRIER
HARBOR BARRIER AND DIKE
PLAN AND PROFILE NO 2
NEW BEDFORD HARBOR MASSACHUSETTS

DATE APRIL 1962

SCALE AS SHOWN SPEC. NO. CIV.ENG-19-018-63-35
DRAWING NUMBER NBF-I-1054
SHEET 24

APPENDIX D

SUBSURFACE EXPLORATION LOGS

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	
Casing Type: Steel		Boring Depth: -28.0' MLLW	Boring No: A-2010-B7
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) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
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.

BORING LOG

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

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) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
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

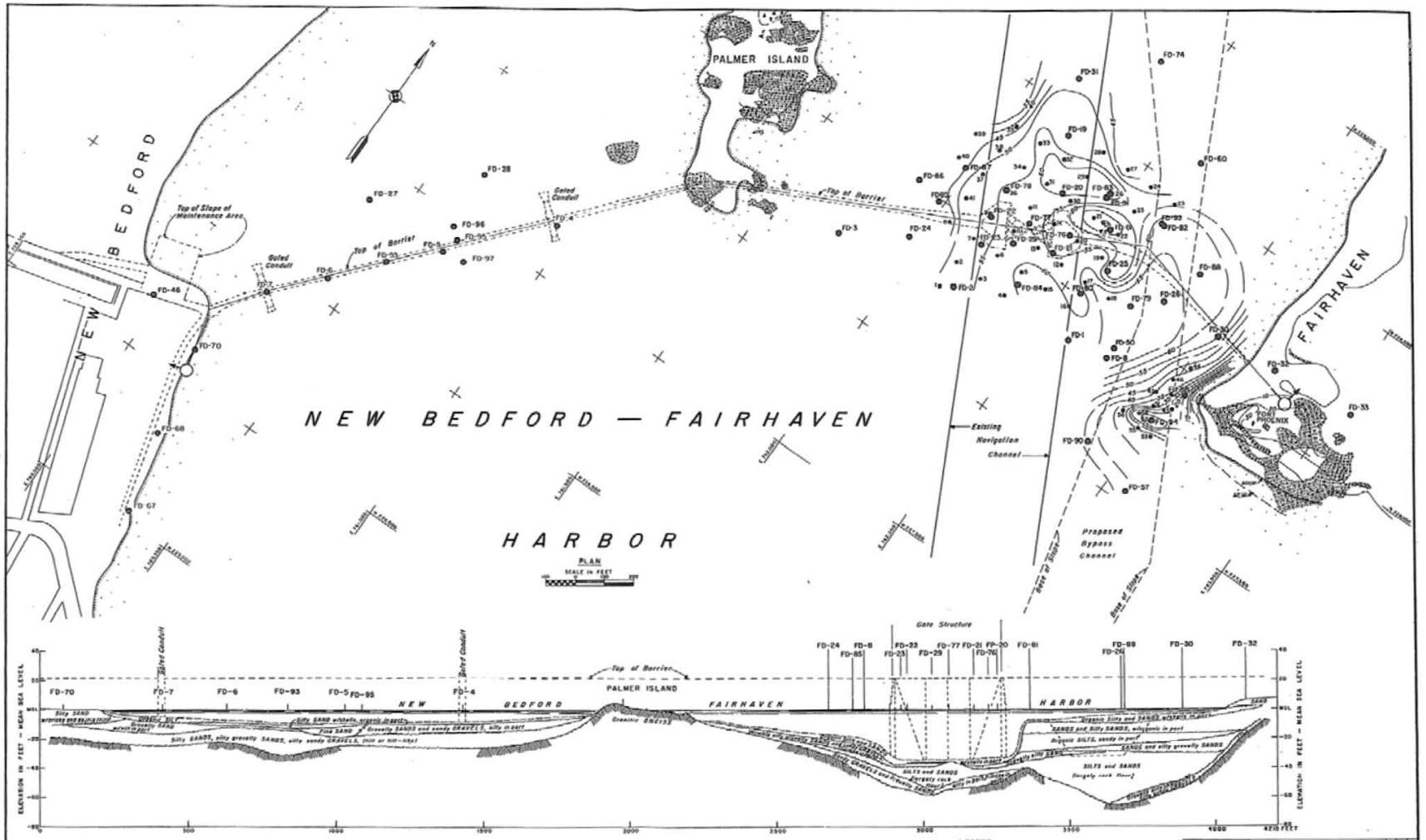
Date: 3/28/2011
Time: 9:29 AM

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) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%	Elevation (MLLW)
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.



GEOLOGIC SECTION – HARBOR ALIGNMENT

(LOOKING NORTH)

LEGEND

- FD-8 Foundation Test Boring
- 22 Foundation Test Probing
- Bedrock Outcrop
- Marsh
- Location and Orientation of Geologic Section

NOTES

Contours within the harbor represent assumed bedrock surface referred to Mean Sea Level.

Coordinates refer to the Massachusetts Grid System.

FD-91 and FD-92 are undisturbed sample borings.

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
NATICK, MASS.

HURRICANE PROTECTION

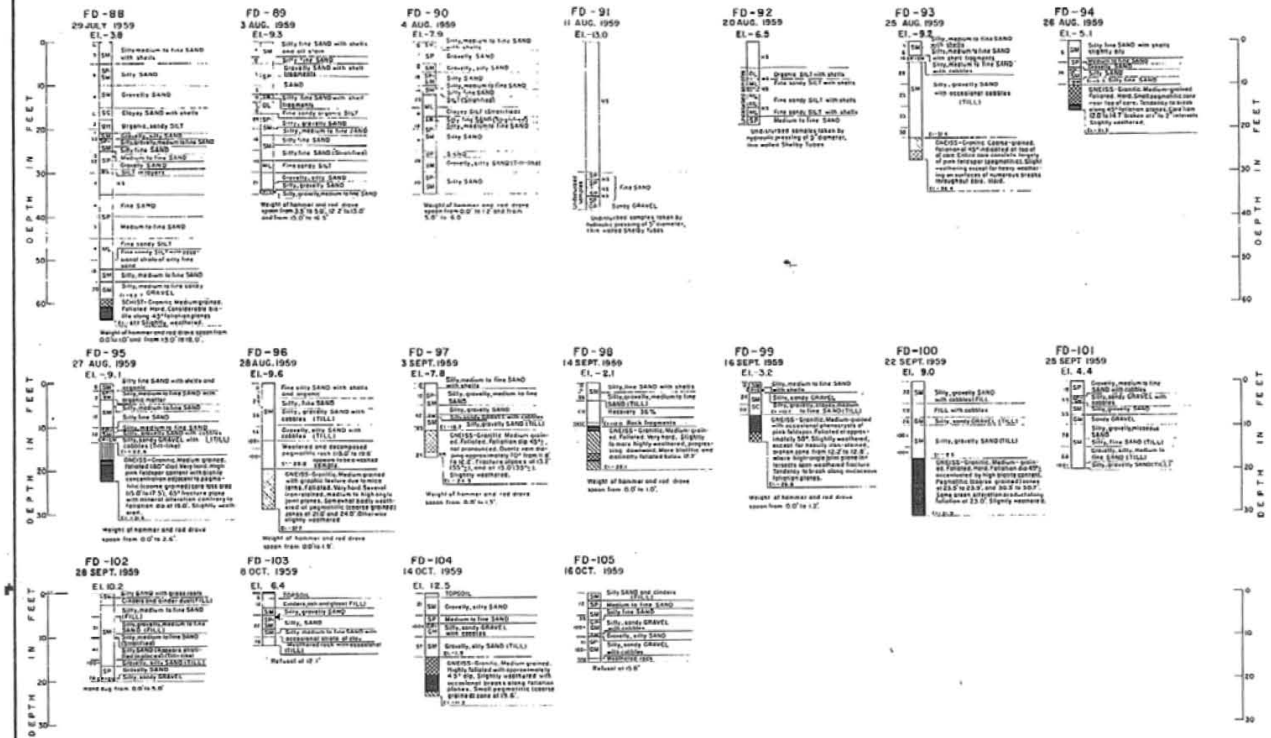
NEW BEDFORD - FAIRHAVEN

PLAN OF HARBOR EXPLORATIONS AND GEOLOGIC SECTION

NEW BEDFORD HARBOR MASSACHUSETTS

DATE FEB 1960

PLATE 3



NOTES

Locations of subsurface explorations are shown on Plate 2

Legend for graphic logs appears on Plate 5

Subsurface water levels in the explorations may be subject to tidal fluctuation.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

HURRICANE PROTECTION

NEW BEDFORD - FAIRHAVEN

RECORD OF FOUNDATION EXPLORATIONS NO. 4

NEW BEDFORD HARBOR MASSACHUSETTS

DATE FEB 1960

SCALE

SPEC NO.

DRAWING NUMBER

SHEET 6 OF 11

APPENDIX E

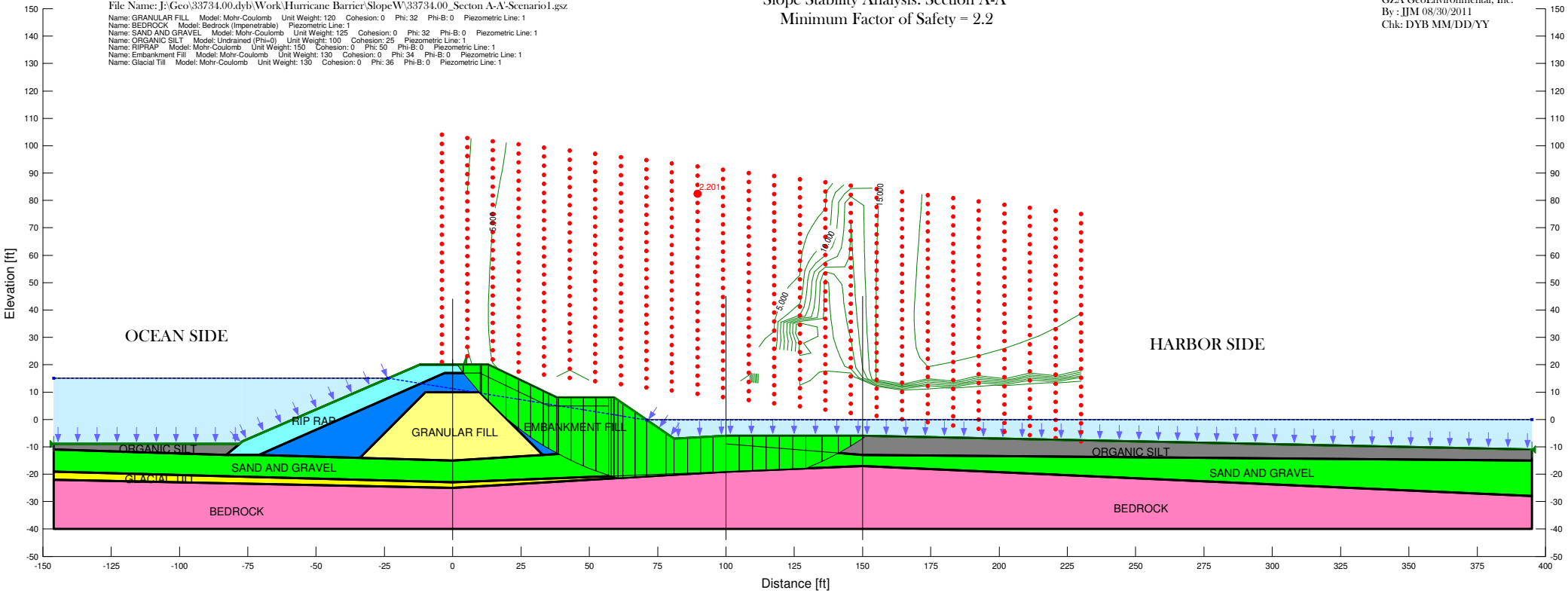
SLOPE STABILITY ANALYSIS

New Bedford South Terminal
File No. 33734.00
File Name: J:\Geo\33734.00.dyb\Work\Hurricane Barrier\SlopeW\33734.00_Secton A-A'-Scenario1.gsz

Name: GRANULAR FILL Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1
Name: BEDROCK Model: Bedrock (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: 25 Piezometric Line: 1
Name: RIPRAP Model: Mohr-Coulomb Unit Weight: 150 Cohesion: 0 Phi: 50 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: 0 Phi: 36 Phi-B: 0 Piezometric Line: 1

Scenario 1: Existing Conditions
New Bedford-Fairhaven Hurricane Barrier
Slope Stability Analysis: Section A-A'
Minimum Factor of Safety = 2.2

GZA GeoEnvironmental, Inc.
By : JJM 08/30/2011
Chk: DYB MM/DD/YY

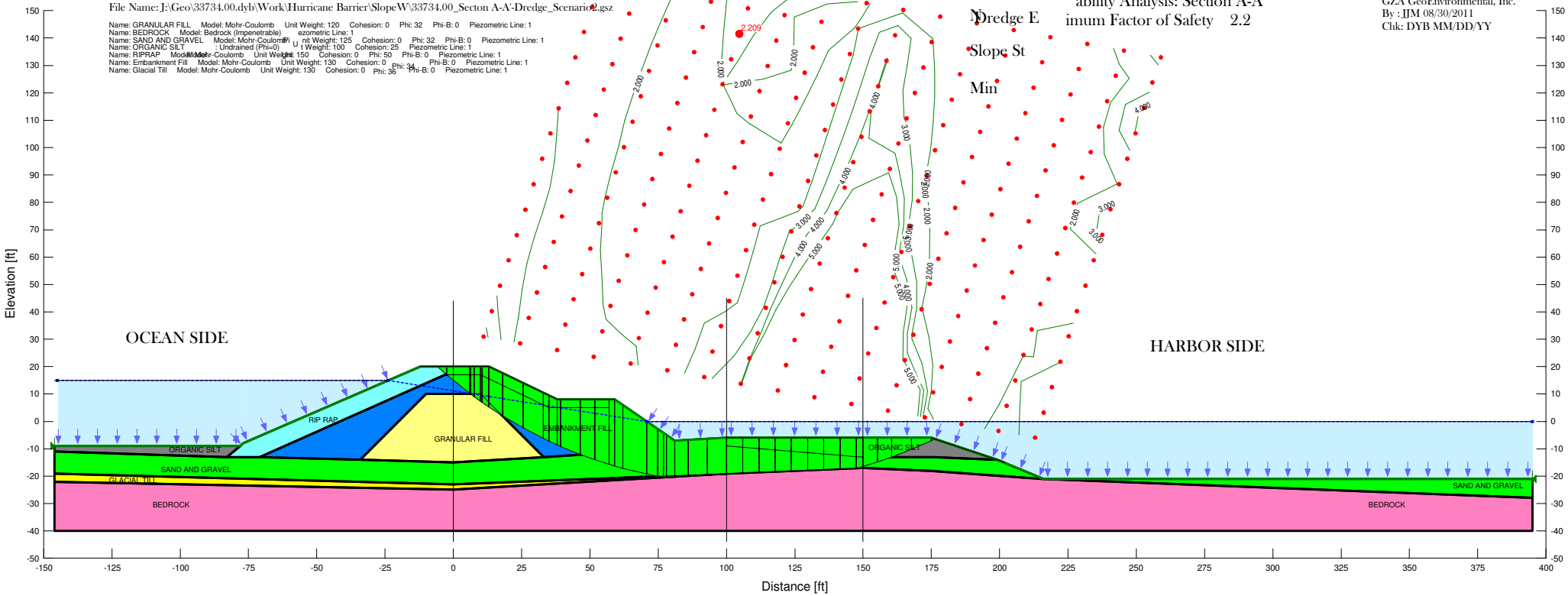


Scenario 2: Dredge Conditions Based of Drawing P-4
levation -20 feet MLLW
ew Bedford-Fairhaven Hurricane Barrier
ability Analysis: Section A-A'
imum Factor of Safety 2.2

New Bedford South Terminal
File No. 33734.00
File Name: J:\Geo\33734.00.dyb\Work\Hurricane Barrier\SlopeW\33734.00_Secton A-A'-Dredge_Scenario2.gsz

Name: GRANULAR FILL Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1
Name: BEDROCK Model: Bedrock (Impenetrable) ezometric 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 : Undrained (Phi=0) Unit Weight: 100 Cohesion: 25 Piezometric Line: 1
Name: RIPRAP Model: Mohr-Coulomb Unit Weight: 150 Cohesion: 0 Phi: 50 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: 0 Phi: 36 Phi-B: 0 Piezometric Line: 1

GZA GeoEnvironmental, Inc.
By : JJM 08/30/2011
Chk: DYB MM/DD/YY



Scenaro 3: Dredge Conditions Based off Drawing P-9

Hurricane Barrier

New Bedford-Fairhaven

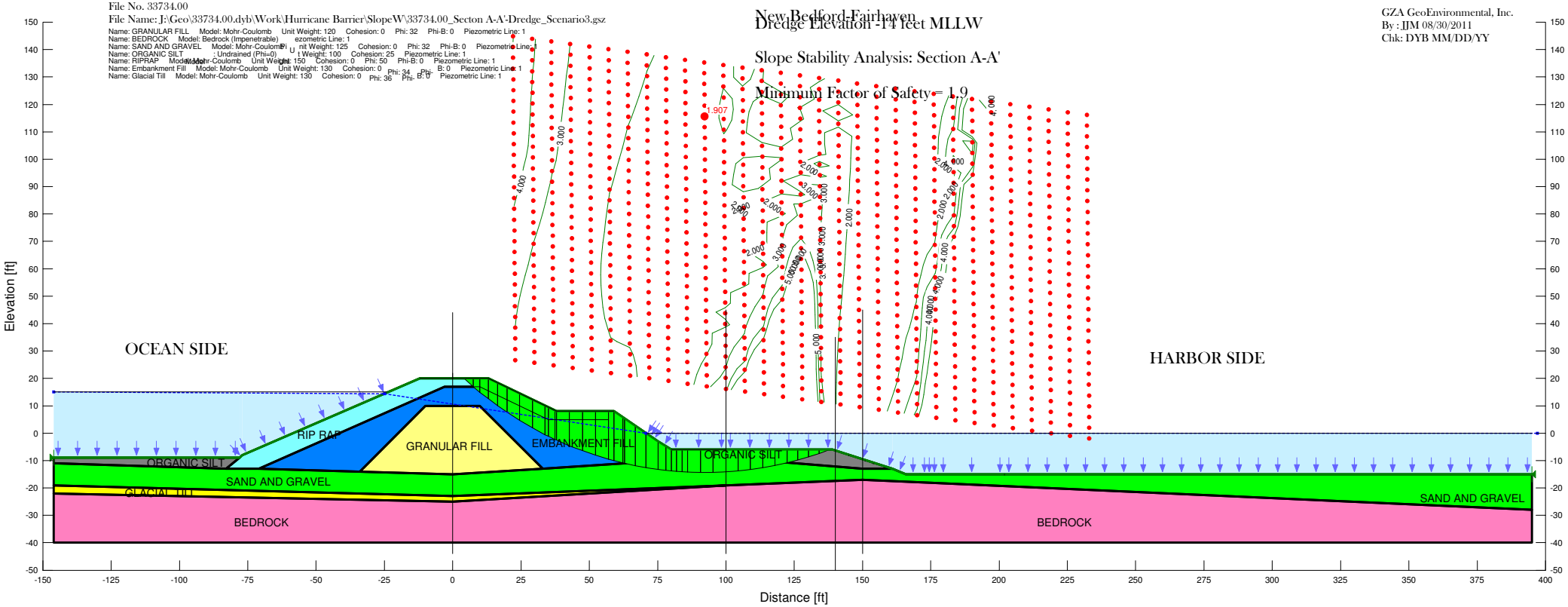
Dredge Elevation -14 feet MLLW

Slope Stability Analysis: Section A-A'

Minimum Factor of Safety= 1.9

New Bedford South Terminal
File No. 33734.00
File Name: J:\Geo\33734.00.dyb\Work\Hurricane Barrier\SlopeW\33734.00_Secton A-A'-Dredge_Scenario3.gsz

GZA GeoEnvironmental, Inc.
By : JJM 08/30/2011
Chk: DYB MM/DD/YY



Scenaro 4: Dredge Conditions Based off Drawing P-9

Hurricane Barrier

New Bedford-Fairhaven

Dredge Elevation -20 feet MLLW

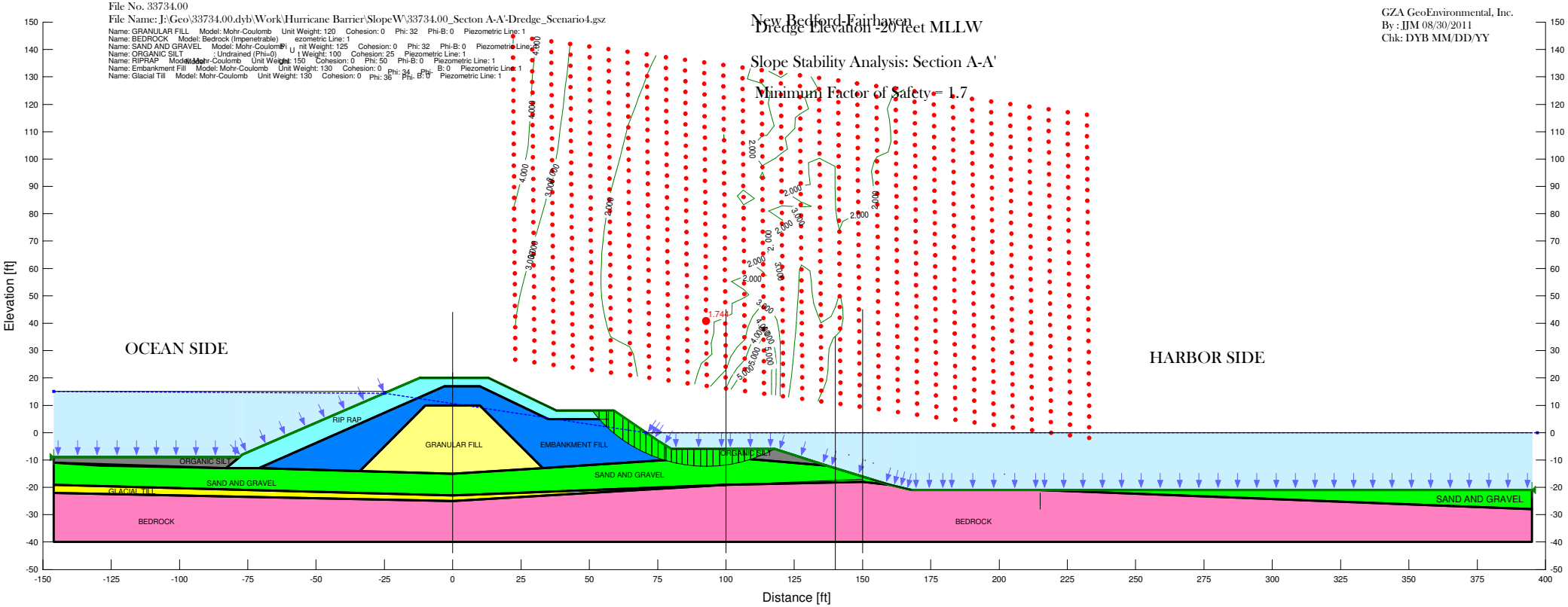
Slope Stability Analysis: Section A-A'

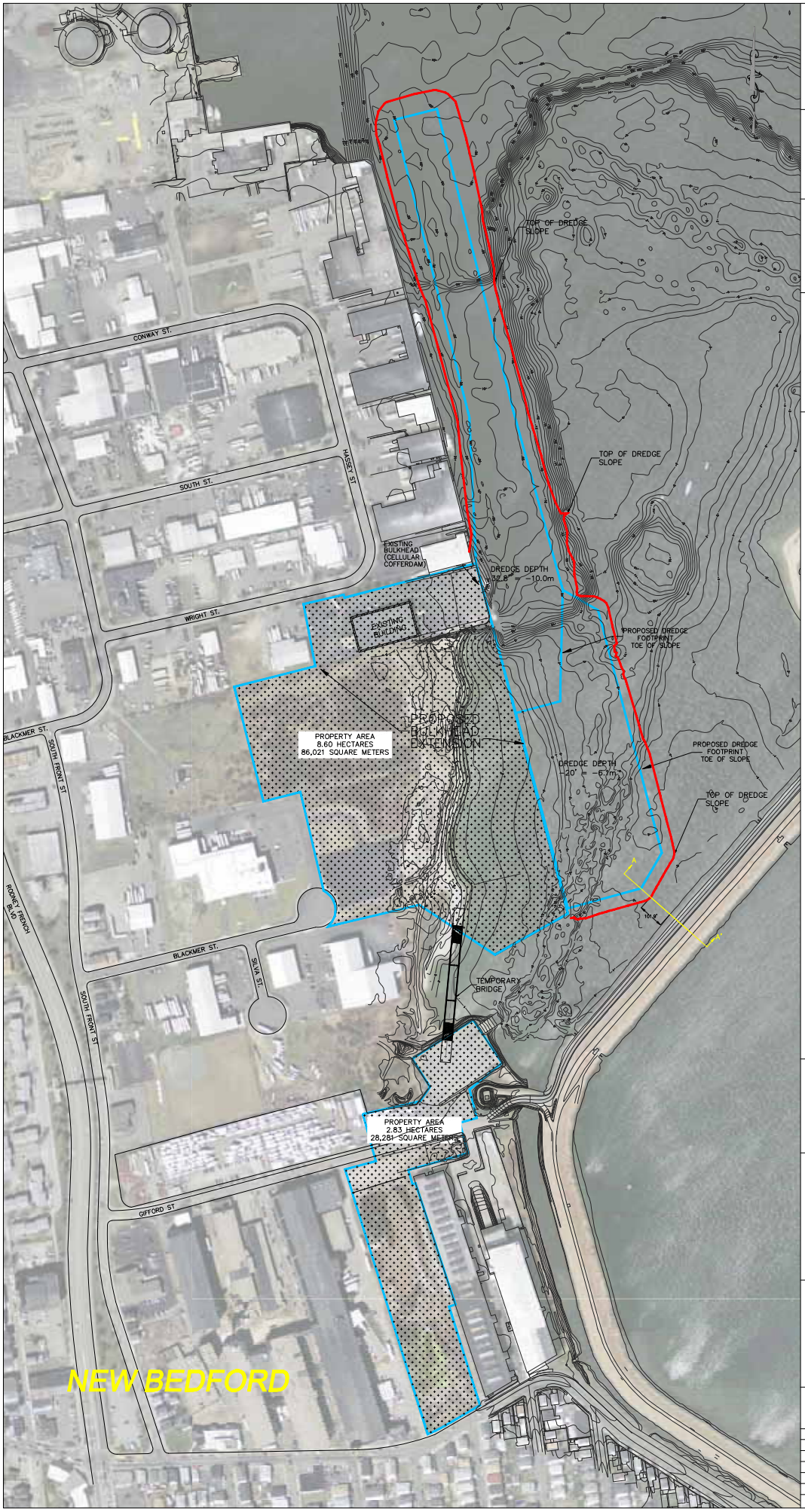
Minimum Factor of Safety= 1.7

New Bedford South Terminal
File No. 33734.00
File Name: J:\Geo\33734.00.dyb\Work\Hurricane Barrier\SlopeW\33734.00_Secton A-A'-Dredge_Scenario4.gsz

Name: GRANULAR FILL Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1
Name: BEDROCK Model: Bedrock (Impenetrable) ezometric Line: 1
Name: SAND AND GRAVEL Model: Mohr-Coulomb Pi nit Weight: 125 Cohesion: 0 Phi: 32 Phi-B: 0 Piezometric Line: 1
Name: ORGANIC SILT : Undrained (Phi=0) U t Weight: 100 Cohesion: 25 Piezometric Line: 1
Name: RIPRAP Model: Mohr-Coulomb Unit Weight: 150 Cohesion: 0 Phi: 50 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: 0 Phi: 36 Phi- B: 0 Piezometric Line: 1

GZA GeoEnvironmental, Inc.
By : JJM 08/30/2011
Chk: DYB MM/DD/YY





Apex Companies, LLC.

1 WAMSUTTA STREET
SUITE 8
NEW BEDFORD, MA 02740
(508) 996-9828

184 HIGH STREET
SUITE 502
BOSTON MA 02110
(617) 728-0070

REVISIONS

NO.	DATE	DESCRIPTION
1.	9-2-10	TOP OF SLOPE ADDED
2.	9-20-10	CROSS SECTION ADDED

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PREPARED FOR:

THE NEW BEDFORD HARBOR DEVELOPMENT COMMISSION
NEW BEDFORD, MASSACHUSETTS

DRAWING TITLE:

SOUTH TERMINAL MARINE INFRASTRUCTURE PARK PROPOSED BULKHEAD

Scale: 1"=150'

0 75 150 300 450 FEET

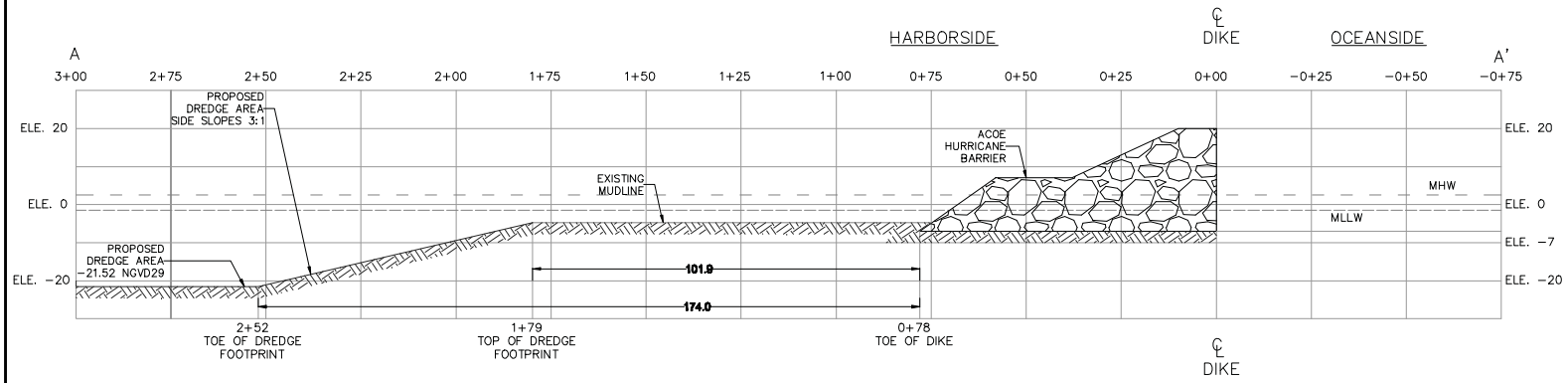
Date 3/24/10	Drawing No.
Proj. Mgr. JAB	
Design CWM	
Check CHM	P-4
Drawn GCD	
Job. No. 6690	
Last Rev. 8/23/10	

NOTES:

1. CROSS SECTION DETAIL OF US ARMY CORPS OF ENGINEERS NEW BEDFORD–FAIRHAVEN BARRIER ARE FROM SHEET 41 OF DRAWING NUMBER NBF–1–1071 DATED APRIL 1962; REVISED 6–15–66. CROSS SECTION DETAILS ARE TYPICAL FROM STATION 47+55; REVISED ON 9–7–65.

2. ELEVATIONS OF PLANS ARE ASSUMED TO BE NGVD29 AS THE DATUM IS NOT LISTED ON THE SHEET, AND THE GENERAL NOTES SHEET OF THE SET WAS NOT AVAILABLE AT THE TIME OF DRAWING PREPARATION.

3. PROPOSED DREDGE TOP AND TOE OF SLOPES ARE PROJECTIONS FROM DRAWING LABELED "SOUTH TERMINAL MARINE INFRASTRUCTURE PARK PROPOSED BULKHEAD", REVISION DATE 9–20–10.



Apex Companies, LLC.

ROCKVILLE, MD
SOUTH WINDSOR, CT - BOSTON, MA - NEW BEDFORD, MA - HOLYOKE, MA

59H CONNECTICUT AVENUE
SOUTH WINDSOR, CT

229 LINDEN STREET,
HOLYOKE, MA 01040

184 HIGH STREET, SUITE 502
BOSTON, MA 02210

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FIGURE 2
DREDGE FOOTPRINT
CROSS SECTION

SCALE: 1"=50'

0 25 150
FEET

MHW=2.54'
MLLW=−1.44'

PROPOSED
MAINTENANCE
DREDGING IN:
NEW BEDFORD
HARBOR/
ACUSHNET RIVER

AT:

SOUTH TERMINAL
NEW BEDFORD, MA
COUNTY OF: BRISTOL
DATE: 9/20/10
SHEET 2 OF 2