Croton Yacht Club, Croton-on-the-Hudson, NY

Design Protocol Report - Rev. 4

September 2011

Prepared For:

Village of Croton-on-Hudson

Prepared By:

OCEAN AND COASTAL CONSULTANTS

Croton Yacht Club, Croton-on-the-Hudson, NY

Design Protocol Report - Rev 4

September 2011

Version	4.0
Date of issue	September 27, 2011
Prepared	KERU
Checked	SAFA
Approved	SAFA

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1 Project Understanding

The Croton Yacht Club was established in 1957 and consists of a one story frame building with a wooden deck and concrete walk, 125 slip marina, upland boat storage, and approximately 500 feet of steel bulkhead. Figure 1 depicts the various components of the project site. The site is situated adjacent the Metro North railway system (located approximately 200 feet away from the southwest bulkhead at the site).

Figure 1- Project Components

Ocean and Coastal Consultants (OCC) is providing the Village of Croton with engineering design services for the replacement of approximately 433 feet of the 500 feet of existing steel sheet pile bulkhead at the site.

1.1 Shoreline Segments

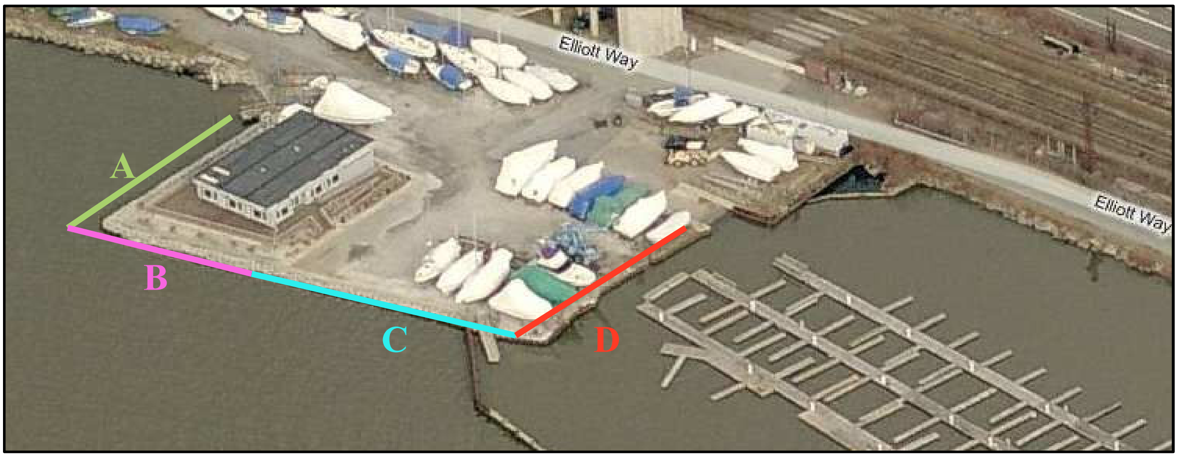


Figure 2- Shoreline Segments Identifier

The existing shoreline segments include the following:

Shoreline Segment	Lineal Foot (FT)	Adjacent Upland Restrictions /Concerns
Segment A - North Building Area	101	Removable Dock, Gabion Baskets, Building
Segment B - Southwest Building Area	100	Gabion Baskets, Building
Segment C - Southwest Non Building Area	125	Gabion Baskets, Gravel; Boats Storage
Segment D - South Non Building Area	107	Gravel; Boats Storage
Total	**433**	

Table 1- Shoreline Segment Types

Photo 1- Shoreline Segment A "North Building Area"

Photo 2- Shoreline Segment B "Southwest Building Area"

Photo 3- Shoreline Segment C "SW Non Building Area"

Photo 4- Shoreline Segment D "South Non Building Area"

2 Design Principles

2.1 Primary Design Code

The design basis will be based on the following standards and codes:

General:

1. International Building Code (IBC)
2. American Society of Civil Engineers (ASCE) 7 Minimum Design Loads for Buildings

Concrete Structures:

1. American Concrete Institute (ACI)
   - ACI 318 - Building Code and Commentary
   - ACI 315 - Details and Detailing of Concrete
   - ACI 301 - Standard Specifications for Structures

Steel Structures:

1. American Institute of Steel Construction (AISC) Steel Construction Manual, 13th Edition
2. American Welding Society (AWS) Structural Welding Code - Steel

2.2 Design Life

The design life of the new bulkhead is 30 years; with cathodic protection and regular maintenance inspections can be increased to 50 years.

2.3 Design Surcharge Loads

The design surcharge loads for the bulkhead are identified by the two areas as depicted on Figure 3 and include the following:

- Building Area (North and part of Southwest Bulkhead): 100 PSF
- Non-Building Area (South Bulkhead and part of Southwest Bulkhead): 200 PSF

Figure 3- Design Surcharge Load Map

2.4 Material Properties

The material types and strengths assumed in the conceptual design are depicted in Table 2.

Concrete	f'c = 5,000 psi Maximum Slump = 4" at placement location W/C ratio = 0.4 Minimum Cover to Reinforcement = 3" Air Entrainment = 6% +/-1% (recommended)
Concrete Reinforcement	F_y = 60,000 psi per ASTM A615 Epoxy Coated per ASTM A775
Structural Steel	
W Sections	F_y = 50,000 psi per ASTM A572
HP Sections	F_y = 50,000 psi per ASTM A572
Sheet Piles	F_y = 50,000 psi per ASTM A572
Steel Tubes	F_y = 42,000 psi per ASTM A500 Grade B
Steel Pipe Piles	F_y = 45,000 psi per ASTM A500 Grade B Minimum Wall Thickness of 0.5"
High Strength Bolts	3/4" diameter minimum per ASTM A325 - Galvanized
Anchor Rods	1" diameter minimum per ASTM F1554 F_y = 36,000 psi

Table 2- Material Properties

3 Survey and Layout

3.1 Unit Systems

The design for the bulkhead structures shall be completed in US customary units.

3.2 Datums

A datum is a standard set of known control points used to create a geographic coordinate system. Both horizontal and vertical datums are necessary to fully control the position of a project.

3.2.1 Horizontal Datum

The horizontal positions from the Hydrographic Survey were referenced to NY East State Plane (NAD83).

3.2.2 Vertical Datum

The vertical datum used for the site is NGVD29.

4 Site Conditions

4.1 Location

The Croton Yacht Club is located adjacent the Hudson River in the Village of Croton on Hudson, Westchester County, New York (Figure 4) and is in NOAA Chart 12343 from New York to Wappinger Creek (Figure 5).

Figure 4- Site Location

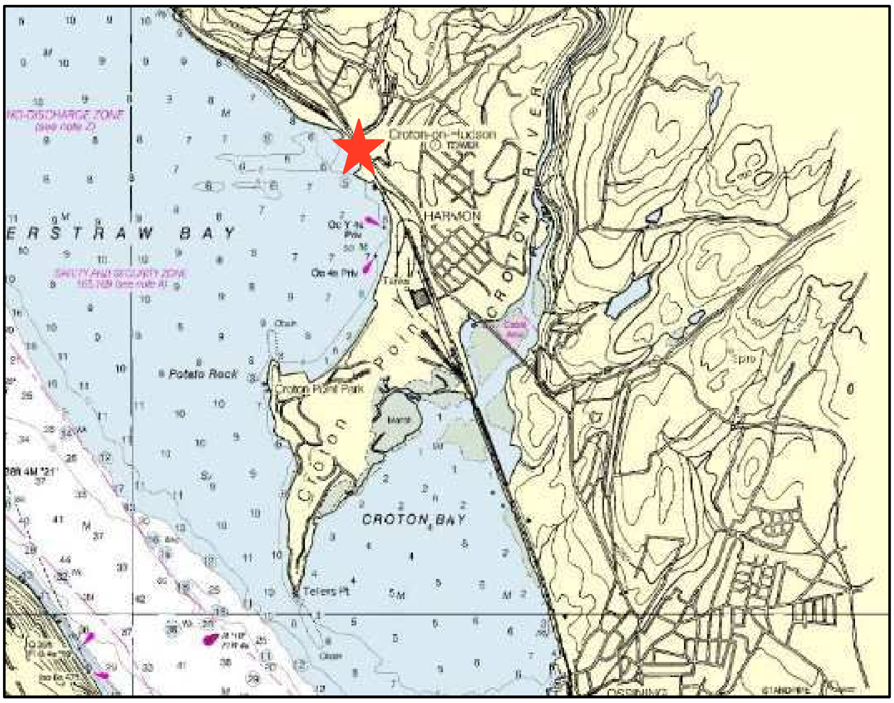


Figure 5- NOAA Chart 12343

4.2 Geophysical & Geotechnical Parameters

4.2.1 Bathymetry

A hydrographic survey was conducted 15 March 2011 which identified the water depths along the existing bulkhead. The survey is included in the base site plan located in Appendix A.

4.2.2 Subsurface Conditions

The majority of the project site is located in a soft clay soil region (except for the North section of the bulkhead which is adjacent the Yacht Club Building). The SPT values collected from the additional borings conducted provided soil parameters used for the design calculations of the bulkhead. Copies of the boring logs are provided in Appendix C.

4.3 Stray Current Analysis

OCC's sub-consultant, Henkels & McCoy, performed a two day study of potential readings beginning on 13 June 2011. The purpose of the study was to determine if the direct current at the nearby rail line could potentially affect the bulkhead.

The results from the analysis indicate the stray current can be a problem at the site. The potential difference between simultaneous readings at different ends of the bulkhead was as great as 0.5 volts. This can be a significant problem when considering that a potential shift when using cathodic protection is typically 0.2 to 0.3 volts.

As a result of the above findings, OCC recommends installing an impressed current cathodic protection (ICCP) system on the bulkhead and performing regular underwater inspections to maximize the bulkhead's service life. In addition, we will need to design the new bulkhead's components to be electrically isolated from existing structures and from new elements that can act as voltage return paths (i.e. ground anchors).

5 Meteorological - Ocean Parameters and Environmental Loads

5.1 Wave Generated Waves

Storm recurrence interval wind speeds were determined for the 1-year, 10-Year, 50-year, and 100-year storms. These wind speeds were converted to a 1-hour duration based on methods provided by the USACOE. The 1-hour duration is suitable for wind wave generation in the river. The results of the shallow-water restricted fetch analysis for each storm recurrence interval are provided in Table 3. Please refer to Attachment B for more details.

Recurrence Interval	H_s (ft)	T_p (sec)
1-yr	2.25	2.84
10-yr	3.22	3.37
25-yr	3.60	3.57
50-Yr	3.90	3.71
100-Yr	4.19	3.84

Table 3- Wave Height Analysis Results

5.2 Tide Conditions

The tide elevations were predicted using VDatum; a software tool developed by the National Ocean Service that allows transforming geospatial data among a variety of geoidal, ellipsoidal, and tidal vertical datums. The tides in Hudson River are affected by freshets, winds, and droughts. According to VDatum at the project site, the mean tide range is 2.6 feet; other tide elevations are given in Table 4.

	Tide Elevation (ft)[1]
MHHW	3.60
MHW	3.33
MTL	1.66
MLW	0.00
MLLW	-0.18

Table 4- Tide Elevations

[1] Tide elevations reference MLW datum

5.3 Environmental Climate Change

The changes in climate due to temperature, precipitation, and sea level rise will continue to impact the Hudson River; these will primarily be demonstrated by water depth and velocity which results in sedimentation changes (bank failure, local scour, locations of aggradations and degradation). By 2020, the projected sea level rise in the Mid-Hudson Valley and Capital Region is 1 to 4 inches and possibly 4 to 9 inches with the rapid ice-melt scenario.[2] Sea level rise will also cause other concerns such as a higher water table, storm surge, increased salinity, flooding, and erosion.

[2] New York State Sea Level Rise Task Force. 2010. *New York State Sea Level Rise Task Force*. http://www.dec.ny.gov/docs/administration_pdf/slrtffinalrep.pdf.

6 Concept Design Alternatives

OCC performed a review of shoreline stabilization options for the Croton Yacht Club site. Some of the options initially considered but then ruled out after examination of the site conditions include stone revetment and cantilever bulkhead. Each option and our reasoning behind not pursuing them further is described below.

Photo 5 - Stone Revetment (left) and Cantilever Bulkhead (right)

Stone revetment: This method of stabilization includes the placement of stone rocks at a 1V:1.5H slope along the shoreline (Photo 5). A stone revetment was ruled out as a possibility for the Croton Yacht Club site due to the usage of the upland area adjacent to the shoreline, regulatory concerns, and navigational limitations. Permitting such a structure requires limited encroachment into the water area past the existing bulkhead. In order to maintain the proper slope and the encroachment limitations, the bottom of the revetment would have to be in line with the current bulkhead and the top of the revetment would fall very close to the yacht club building. This would decrease the usable land area for yacht storage, reduce or eliminate the public access area, and limit the ability to launch boats.

Cantilever Bulkhead: This shoreline stabilization method consists of the placement of vertical steel sheet pile (Photo 5). This option was not a possibility for the site due to the soil conditions and the surcharge loads along the upland adjacent the shoreline.

Based on the loading and soil, we identified two design alternatives using steel sheet pile that were appropriate for replacement of the bulkhead at the site. Both alternatives utilize the same design for Segments C and D (the Non Building Area). However, the design for Segments A and B (the Building Area) differ within each proposed alternative. Steel was selected as the primary material since vinyl or composite sheets would not have the structural strength for the loading and poor soil conditions.

6.1 Alternative 1 - Ground Anchors Throughout Site

For Alternative 1, we propose using a steel sheet pile bulkhead with ground anchors throughout the site.

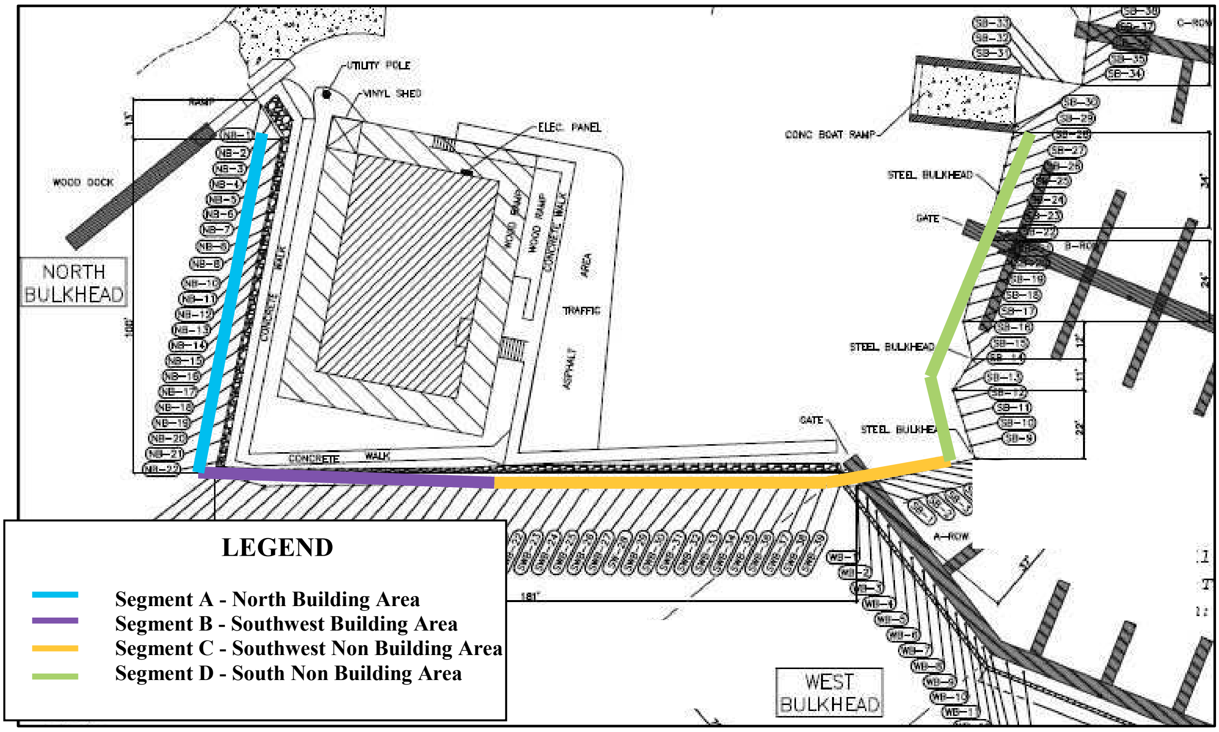


Figure 6 - Alternate 1 Site Layout

Shoreline Segment	Lineal Foot (FT)	Preliminary Proposed Design
Segment A - North Building Area	101	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor
Segment B - Southwest Building Area	100	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor
Segment C - Southwest Non Building Area	125	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor
Segment D - South Non Building Area	107	Headwall: AZ19-40' Sheet Pile Anchor: Tieback w/ Ground Anchor
Total Length	**433**	

Table 5- Alternate 1 Proposed Design Breakdown

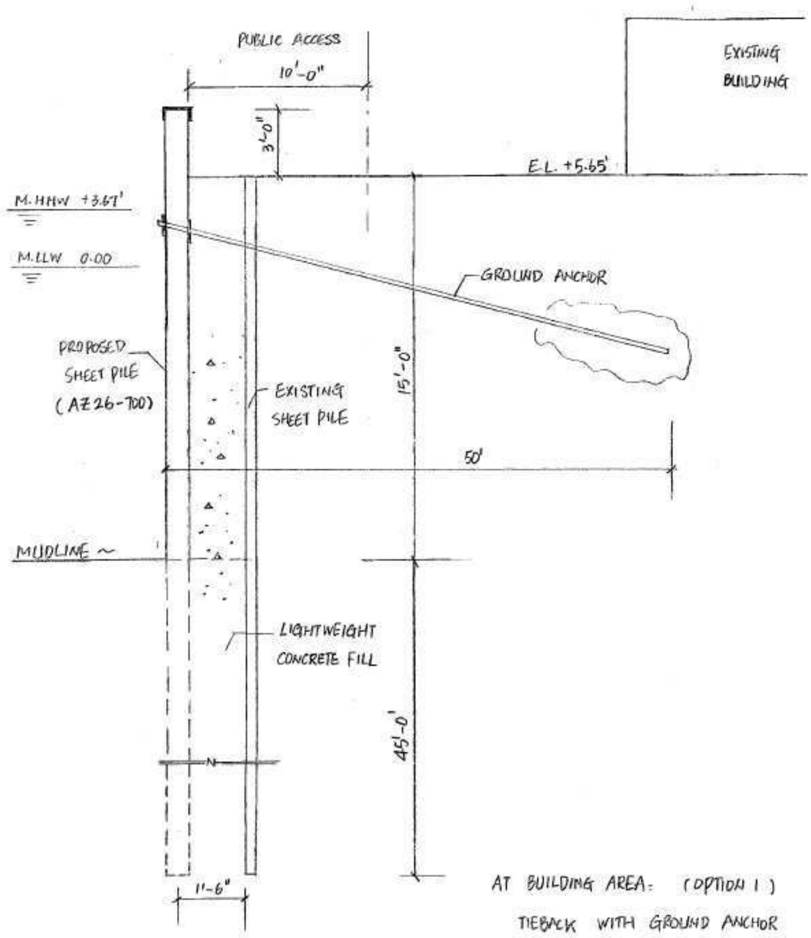


Figure 7- Typical Cross Section for Segments A & B using Alternative 1 (Tie back with Ground Anchor System)

This alternative involves utilizing a tie back ground anchor system for all segments. A deadman anchor system could not be used for Segments A and B due to the close proximity of the Yacht Club building to the shoreline. In addition, reusing the existing anchor system has been excluded as an option since it is not likely to provide the required anchor capacity.

6.1.1 Constructability

For all segments, new sheet pile will be installed within 1'-6" of the front of the existing sheet pile to a depth of 45 feet for Segments A, B, and C and a depth of 24 feet for Segment D. The shorter length of sheets can be used near Segment D since the elevation of better soil is higher at this end of the site. Lightweight concrete fill will be placed behind the new sheet pile and in front of the existing sheet pile from the mudline to the ground level. The new sheet pile will extend 3 feet above the current ground elevation. The upland area adjacent the existing bulkhead will be excavated back 10 feet and a new concrete paver walkway (approximately 10 feet wide) will be constructed behind.

6.1.2 Opinion of Probable Cost (OPC)

The total probable cost of Alternative 1 is approximately $3,295,000.

Segment	Length (ft)	Cost/LF (USD)	Total Cost (USD)
Segment A - North Building Area	101	$6,580	$665,000
Segment B - Southwest Building Area	100	$7,040	$704,000
Segment C - Southwest Non Building Area	125	$7,615	$952,000
Segment D - South Non Building Area	107	$6,300	$674,000
Cathodic Protection	-	-	$300,000
TOTAL	**433**		**$3,295,000**

Table 6 Opinion of Probable Cost for Alternative 1
(Values based on 2011 prevailing wage rates and 20% contingency)

6.2 Alternative 2 - Ground Anchors and Anchored Bulkhead

For Alternative 2, we propose Segments A and B utilize a new ground anchor system and Segments C and D utilize an anchored bulkhead.

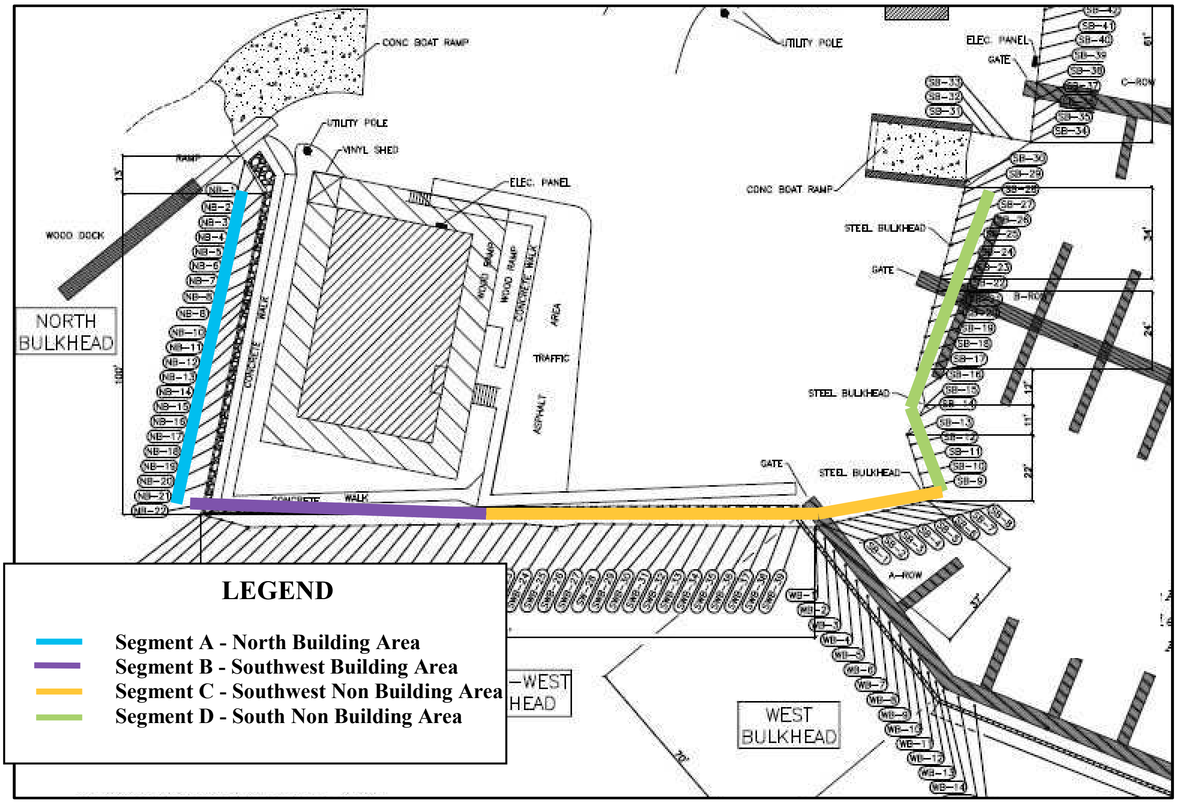


Figure 8- Alternate 2 Site Layout

Shoreline Segment	Lineal Foot (FT)	Preliminary Proposed Design
Segment A - North Building Area	101	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor
Segment B - Southwest Building Area	100	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor
Segment C - Southwest Non Building Area	125	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Deadman Deadman: AZ12-15'
Segment D - South Non Building Area	107	Headwall: AZ19-40' Sheet Pile Anchor: Tieback w/ Deadman Deadman: AZ12-15'
Total Length	**433**	

Table 7- Alternate 2 Proposed Design Breakdown

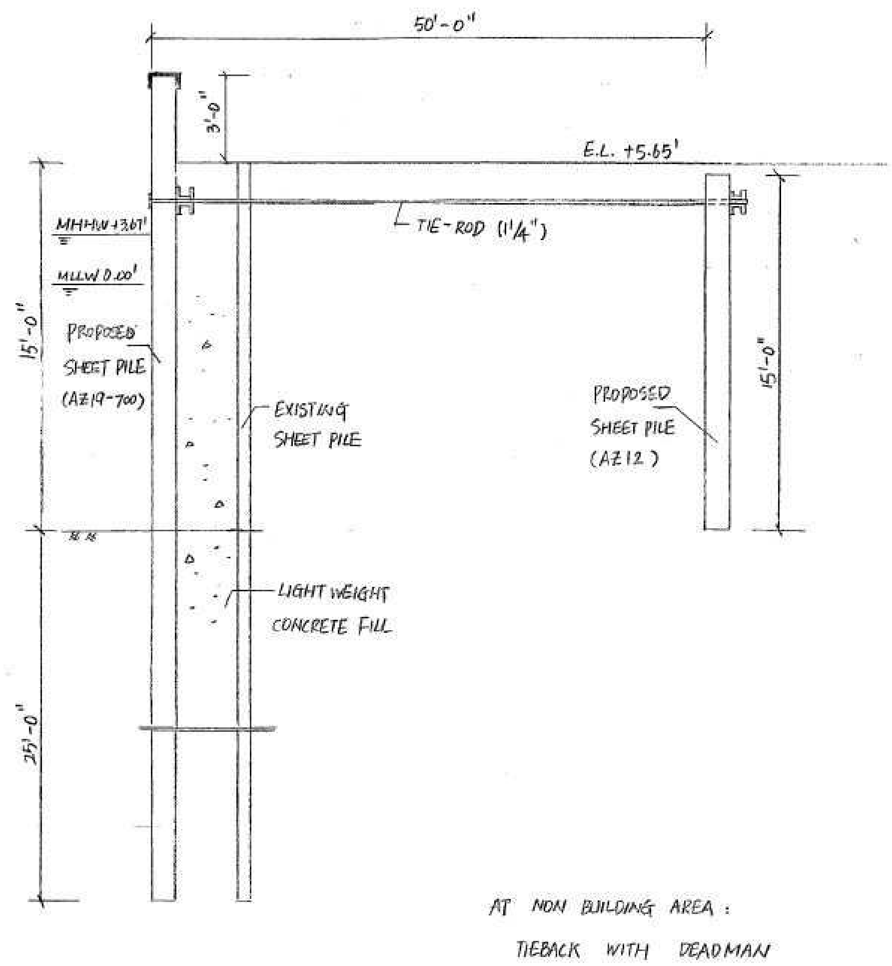


Figure 9- Typical Cross Section for Segments C & D for Alternative 2 (Tie back with Deadman Anchoring System)

6.2.1 Constructability

The construction will be the same as what is described for Alternative 1 except Segments C and D will utilize a traditional anchor system connected to a new steel sheet pile deadman upland at the site. This type of construction will greatly affect the upland site since it requires the new tie rods to be placed below grade across the site and connected to a new bulkhead driven inshore. Access to the site for use by the marina staff and equipment will be greatly reduced during construction.

6.2.2 Opinion of Probable Cost (OPC)

The total cost predicted for Alternative 2 is $3,317,000.00 as shown in the figure below. The total cost is effectively the same as for Alternative 1.

Segment	Length (ft)	Cost/LF (USD)	Total Cost (USD)
Segment A - North Building Area	101	$6,858	$665,000
Segment B - Southwest Building Area	100	$7,040	$704,000
Segment C - Southwest Non Building Area	125	$8,140	$1,018,000
Segment D - South Non Building Area	107	$5,890	$630,000
Cathodic Protection	-	-	$300,000
TOTAL	**433**		**$3,317,000**

Table 8- Opinion of Probable Cost for Alternative 2
(Values based on 2011 prevailing wage rates and 20% contingency)

7. Summary and Recommendations

Based upon the results of the site investigation and information obtained from the hydrographic survey and soil borings, OCC identified two design alternatives appropriate for replacement of the approximately 433 FT of bulkhead at the site and provided a opinion of probable costs for both alternatives. Alternative 1 consists of using ground anchors for the restraining the bulkhead and Alternative 2 consists of the using ground anchors and a traditional anchored bulkhead.

As shown in Tables 9 and 10, the total construction costs for the project are effectively the same for both design alternatives.

Segment	Alternative 1 Total Cost (USD)	Alternative 2 Total Cost (USD)
Segment A - North Building Area	$665,000	$665,000
Segment B - Southwest Building Area	$704,000	$704,000
Segment C - Southwest Non Building Area	$952,000	$1,018,000
Segment D - South Non Building Area	$674,000	$630,000
Cathodic Protection	$300,000	$300,000
TOTAL	**$3,295,000**	**$3,317,000**

Table 9- Alternatives Total Cost Comparison

Segment	Alternative 1 Preliminary Design	Alternative 2 Preliminary Design
Segment A - North Building Area	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor
Segment B - Southwest Building Area	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor
Segment C - Southwest Non Building Area	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Ground Anchor	Headwall: AZ26-60' Sheet Pile Anchor: Tieback w/ Deadman Deadman: AZ12-15'
Segment D - South Non Building Area	Headwall: AZ19-40' Sheet Pile Anchor: Tieback w/ Ground Anchor	Headwall: AZ19-40' Sheet Pile Anchor: Tieback w/ Deadman Deadman: AZ12-15'

Table 10- Alternatives Design Comparison

OCC recommends that the bulkhead be replaced in accordance with Alternative 1, using the ground anchor system for the entire site. The steel sheet piling and wale channels should be coated on both sides with Devoe Bar Rust 235 from the top of the bulkhead to 5 feet below the mudline, and the wale channels would be fully coated. The anchor wall steel sheet piles would be coated the full height as well. The tie rods and tie rod hardware should typically be FBE epoxy coated per ASTM A775. Ground anchors need to be double corrosion protected in accordance with PTI recommendations for rock and soil anchors.

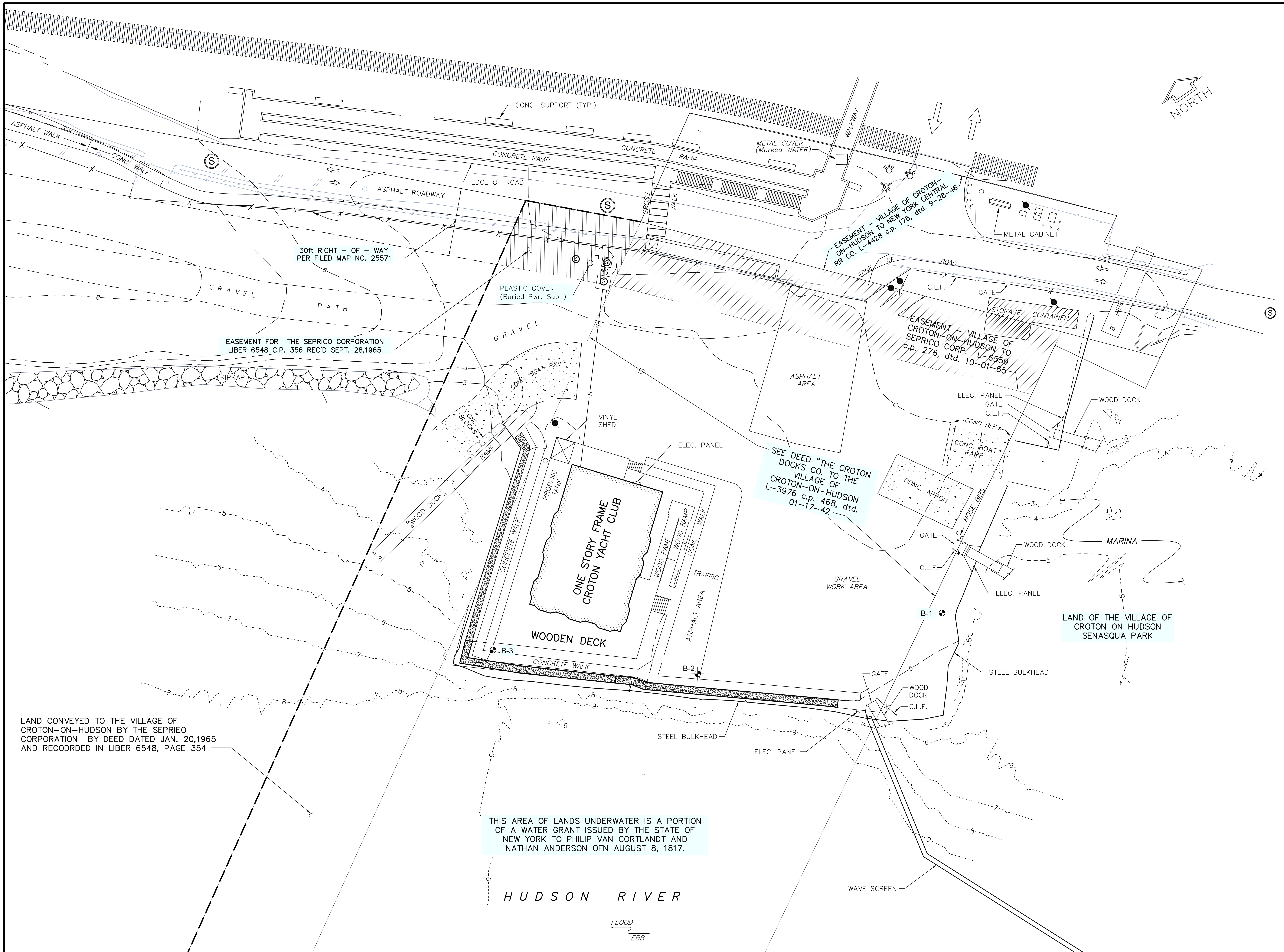
OCC also strongly advises that the new bulkhead utilize an impressed current cathodic protection system in addition to proper protective coating of the steel. This will increase the overall design life of the structure, and with routine maintenance inspections can provide a 50 year design life. It will also mitigate stray current corrosion.

The next steps for proceeding with Alternative 1 consist of the Regulatory Permitting Phase. Since the regulatory process can be arduous and lengthy, OCC recommends proceeding with the preparation of permit applications and supporting materials as soon as possible after approval of the recommended design alternative. The proposed plans which accompany the application materials are typically at a "preliminary", or 35% design level. Final design effort is typically not needed or recommended for permitting and is typically performed after the regulatory agencies have had a chance to provide feedback about the project.

The typical time frame is 6-12 months from the initial submission of the permit applications to receiving the permits from the regulatory agency. This is due to the number of federal, state, or local approvals required as it requires coordinated review among the agencies. Once approved, State DEC and US Army Corps of Engineers individual permits are usually good for three years. However since bulkhead replacement is a No. 3 (Maintenance) activity, it should be covered by the USACE's Nationwide Permit Program. Therefore once the permits are issued there isn't any expiration dates imposed.

Upon receiving the permit approvals, OCC will proceed with the final design and preparation of the contract documents.

Appendix A - Site and Hydrographic Survey



LEGEND

- B-1 SOIL BORING NUMBER AND APPROXIMATE LOCATION
- FIRE HYDRANT
- MANHOLE (SEWER)
- WATER SERVICE VALVE
- UTILITY POLE

NOTES

1. BASE PLAN TAKEN FROM DRAWING ENTITLED "TOPOGRAPHIC SURVEY OF PROPERTY SITUATE IN THE VILLAGE OF CROTON-ON-HUDSON TOWN OF CORTLANDT WESTCHESTER COUNTY NEW YORK" PREPARED BY LINK LAND SURVEYORS P.C., MAHOPAC, N.Y., DATED AUG. 8, 2005 WITH LATEST REVISION DATE OF JULY 13, 2006.
2. HYDROGRAPHIC SURVEY DATA SHOWN HEREON WAS COLLECTED BY SOUND SURVEYS, LLC ON MARCH 14, 2011 AND CAN ONLY REFLECT CONDITIONS AS THEY EXISTED AT THE TIME OF THE SURVEY.
3. ALL SOUNDINGS ARE IN FEET, REFERENCE THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD-29) AND ARE NEGATIVE UNLESS SHOWN WITH A PLUS (+).
4. SOIL BORINGS PERFORMED BY HARDIMAN CO. & ASSOCIATES, INC., SHELTON, CT. FROM DECEMBER 30, 2010 TO JANUARY 11, 2011.
5. TIDAL INFORMATION FROM STATION 8518924 AT HAVERSTRAW BAY, NY CONVERTED TO NGVD-29.

	N.G.V.D.
M.H.H.W.	+3.02'
M.H.W.	+2.75'
M.S.L.	+1.15'
M.L.W.	−0.48'
M.L.L.W.	−0.65'

GRAPHIC SCALES

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REVISIONS	DESCRIPTION	DATE	BY	DESCRIPTION	DATE	BY

OCEAN AND COASTAL CONSULTANTS

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35 Corporate Drive
Trumbull, CT 06611
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A New York State Registered Company

VILLAGE OF CROTON-ON-HUDSON

1 VAN WYCK STREET, CROTON-ON-HUDSON, N.Y. 10520

DESIGNED BY: ROSN/KERU
DRAWN BY: CAMA
CHECKED BY: SAFA

CROTON YACHT CLUB
BULKHEAD REPLACEMENT PROJECT

EXISTING SITE PLAN

SCALE 1"=20'-0" | DATE 5/20/11 | REVISION 0

DRAWING NO. 210082-1-01

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LEGEND

- EXIST. FIRE HYDRANT
- EXIST. MANHOLE (SEWER)
- EXIST. WATER SERVICE VALVE
- EXIST. UTILITY POLE

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Fax: (203) 268-8821
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VILLAGE OF CROTON-ON-HUDSON
1 VAN WYCK STREET, CROTON-ON-HUDSON, N.Y. 10520

DESIGNED BY: ROSN/KERU
DRAWN BY: CAMA
CHECKED BY: SAFA

CROTON YACHT CLUB
BULKHEAD REPLACEMENT PROJECT

PROPOSED BULKHEAD
ALTERNATE 1 OVERSHEETING PLAN

SCALE 1"=10'-0"
DATE 5/20/11
REVISION 0
DRAWING NO. 210082-1-02

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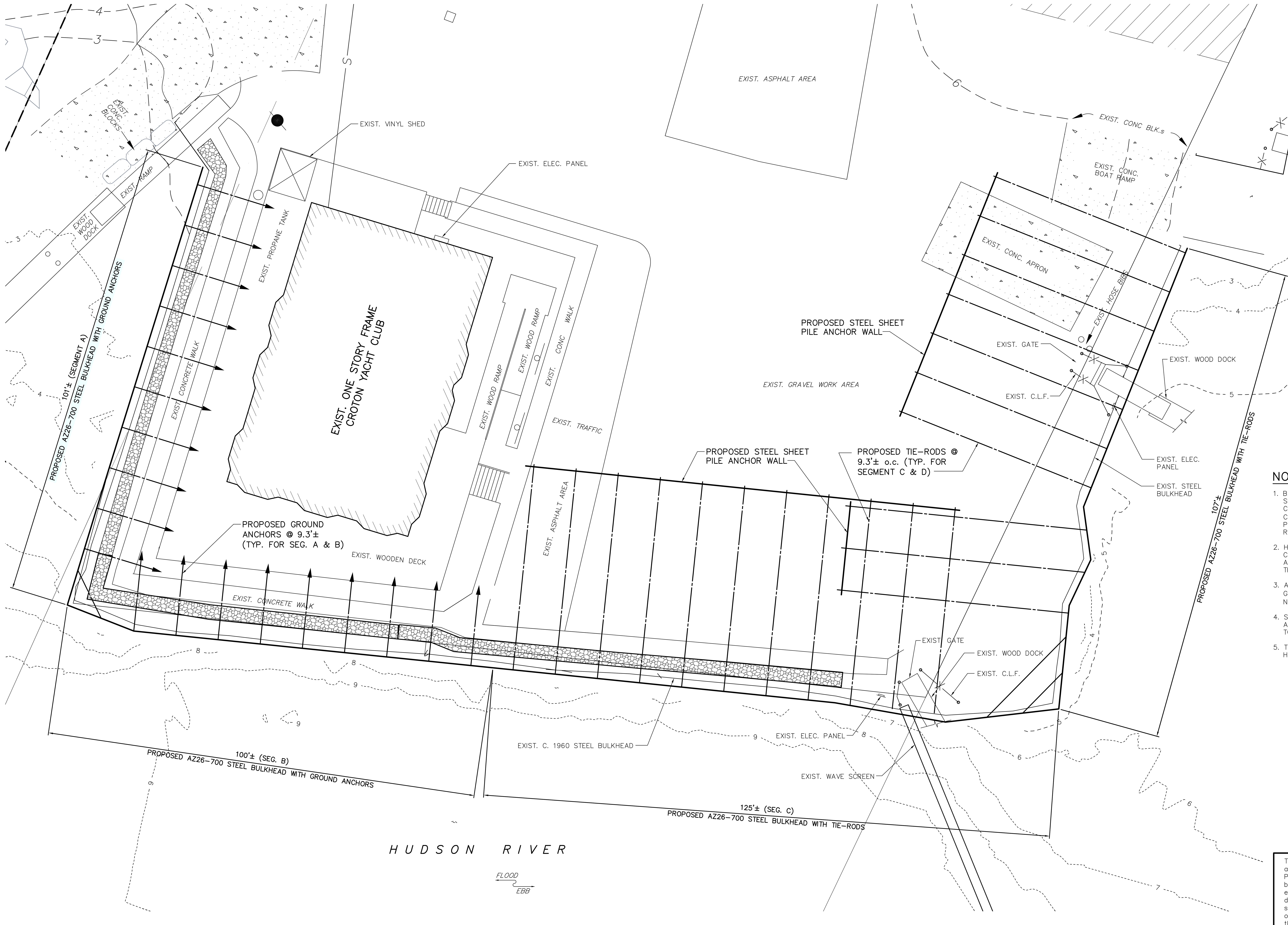

LEGEND

- EXIST. FIRE HYDRANT
- EXIST. MANHOLE (SEWER)
- EXIST. WATER SERVICE VALVE
- EXIST. UTILITY POLE

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DESIGNED BY: ROSN/KERU	CROTON YACHT CLUB BULKHEAD REPLACEMENT PROJECT	SCALE 1"=10'-0"	REVISION 0
DRAWN BY: CAMA		DATE 5/20/11	
CHECKED BY: SAFA	PROPOSED BULKHEAD ALTERNATE 2 OVERSHEETING PLAN	DRAWING NO. 210082-1-03	

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Appendix B - Wave and Climate Analysis

Wind Generated Waves:

The U.S. Army Corps of Engineers (USACOE) *Automated Coastal Engineering System* (ACES) wave prediction application "Wind speed Adjustment and Wave Growth" provides estimates for wave growth over open-water and restricted fetches in deep and shallow water. For this project, the model was utilized to convert wind speed and direction data into wave information in the Hudson River area adjacent to the project site.

Due to the restricted nature of the project site, there are three main factors affecting the height and period of the wind generated waves; the fetch length, the water depth, and the wind speed. The wind blowing from any direction across the river generates waves that potentially impact the site. A restricted fetch analysis was performed to predict the wave climate at the project site by considering various wind fetch directions as shown in Figure 1 on the following page.

The ACES module was utilized using "shallow restricted" option to determine the common probabilistic storm parameters significant wave height and peak period. The significant wave height (H_s) is the average of the one third (1/3) highest waves in the wave field. The peak period (T_p) has the highest energy in the wave field. The blowing wind direction iteratively changed until the maximum significant wave was obtained. The most critical significant wave was found to be caused by wind blowing from the direction of 300^o from the North. The average depths were obtained from NOAA Chart 12343. The average depth for the selected fetch, which was used in ACES was estimated to be 15.6 feet at MHW.

Storm recurrence interval wind speeds were determined for the 1-year, 10-Year, 50-year, and 100-year storms. These wind speeds were converted to a 1-hour duration based on methods provided by the USACOE. The 1-hour duration is suitable for wind wave generation in the river. The results of the shallow-water restricted fetch analysis for each storm recurrence interval are provided in Table B1.

Recurrence Interval	H_s (ft)	T_p (sec)
1-yr	2.25	2.84
10-yr	3.22	3.37
25-yr	3.60	3.57
50-Yr	3.90	3.71
100-Yr	4.19	3.84

Table B1 -Results of ACES Analysis

Figure B1: Google earth view with wind fetch directions located.

Tides:

The tide elevations were predicted using VDatum; a software tool developed by the National Ocean Service that allows transforming geospatial data among a variety of geoidal, ellipsoidal, and tidal vertical datums. The tides in Hudson River are affected by freshets, winds, and droughts. According to VDatum at the project site, the mean tide range is 2.6 feet; other tide elevations are given in Table B2.

	Tide Elevation[3] (FT)
MHHW	3.60
MHW	3.33
MTL	1.66
MLW	0.00
MLLW	-0.18

Table B2- Tide Elevations at the site

[3] Tide elevations references MLW datum

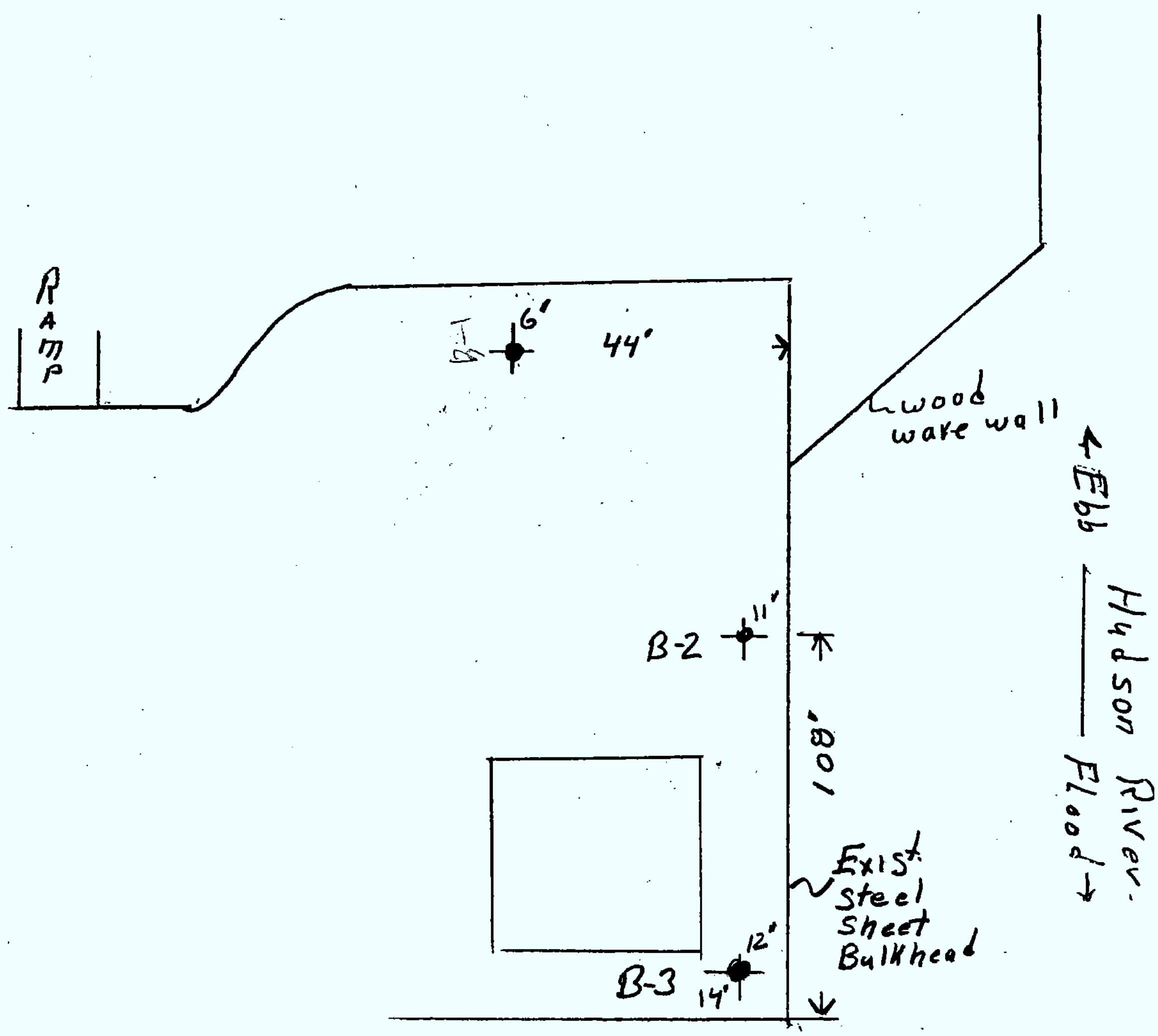
Appendix C - Boring Plan and Boring Logs

HARDIMAN CO. & ASSOCIATES, INC.
10 FOX HUNT ROAD
SHELTON,CT. 06484
(203) 926 – 0106 Fax (203) 926 – 0106

Boring Location Plan Croton Yacht Club, Croton – On – Hudson, NY.

HCA Job # O – 88   January 19, 2011

Not To Scale.



HARDIMAN CO. & ASSOC., INC. **10 Fox Hunt Road** **Shelton, CT 06484**	CLIENT: **OCEAN & COASTAL CONSULTANTS**	SHEET 1 OF 3 HOLE NO. **B - 1**
CONTRACTOR	PROJECT NO. O – 88	LINE
'REMAN—DRILLER .I,III	PROJECT NAME CROTON YACHT CLUB BULKHEAD	STATION
INSPECTOR	LOCATION CROTON-ON-HUDSON, NY.	OFFSET

GROUND WATER OBSERVATIONS		Casing	Sampler	Core Bar	
AT ____ FT. AFTER ______ HOURS	Type	H S A	SS		Date Start 12 / 29 / 10 Date Fin. 12 / 30 / 10
AT ____ FT. AFTER ______ HOURS	Size I.D.		1 3/8"		Surface Elev. Existing Ground.
	Hammer Wt.		140	BIT	Ground Water Elev. (Tidal)
	Hammer Fall		30"		

Depth	Casing Blows per Foot	Sample No	Type	Pen	Rec	Depth @ Bot	Blows Per 6" on Sampler (Force on Tube) 0-6	6-12	12-18	18 - 24	Strata Change Depth	Field Identification of Soil. Remarks Incl. Color, Loss of Wash Water, Seams in Rock, Etc.
												Misc. sand , gravel, concrete & steel. (Fill)
											2.5	Black organic silt , some sand , some ash. (Fill)
5												
		1	ss	2.0	0.1	7.0	4	2	1	1		
10											10.0	Gray fine sand. (Possible fill)
		2	ss	2.0	0.3	12.0	1	1	1	2		
											15.0	Gray organic silt.
		3	ss	2.0	1.0	17.0	1	1	1	1		
20												
		4	ss	2.0	1.5	22.0	1	1	1	1		
25											26.0	Gray organic silt , trace f/c sand @ 26'
		5	ss	2.0	2.0	27.0	wor	wor	1	1		
30												
		6	ss	2.0	2.0	32.0	1	2	2	1		
35											35.0	Gray organic silt.
		7	ss	2.0	1.5	37.0	1	1	0	1		

Ground Surface To _____ Ft Used __________ " Casing Then __________ " Casing To _____ Ft. **HOLE NO. B - 1**

D = Dry W = Washed C = Cored P = Pit A = Auger UP = Undisturbed Piston

UB = Undisturbed Ball Check T = Thin wall V = Vane Test

Proportions Used: Trace = 0 -10% little = 10 -20% Some = 20 -35% and = 35 -5 %

HARDIMAN CO. & ASSOC., INC. **10 Fox Hunt Road** **Shelton, CT 06484**	CLIENT: **OCEAN & COASTAL CONSULTANTS**	SHEET 2 OF 3 HOLE NO. **B - 1**
CONTRACTOR	PROJECT NO. O – 88	LINE
'REMAN—DRILLER I,III	PROJECT NAME CROTON YACHT CLUB BULKHEAD	STATION
INSPECTOR	LOCATION CROTON-ON-HUDSON, NY.	OFFSET

GROUND WATER OBSERVATIONS

AT ____ FT. AFTER ______ HOURS

AT ____ FT. AFTER ______ HOURS

	Casing	Sampler	Core Bar
Type	H S A	SS	
Size I.D.		1 3/8"	
Hammer Wt.		140	BIT
Hammer Fall		30"	

Date Start 12/29/10 Date Fin. 12/30/10

Surface Elev. Existing Ground.

Ground Water Elev. (Tidal)

Depth	Casing Blows per Foot	Sample No	Type	Pen	Rec	Depth @ Bot	Blows Per 6" on Sampler (Force on Tube) 0-6	6-12	12-18	18 - 24	Strata Change Depth	Field Identification of Soil. Remarks Incl. Color, Loss of Wash Water, Seams in Rock, Etc.
											41.0	Gray organic silt.
		8	ss	2.0	1.5	42.0	2	3	6	5		Gray clay , trace fine sand.
45											45.0	
												Gray fine sand.
		9	ss	2.0	1.5	47.0	5	4	6	5		
50												
		10	ss	2.0	1.5	52 0	3	3	5	8		
		11	ss	2.0	1.5	57.0	8	10	15	16		
60												
		12	ss	2.0	1.5	62.0	16	20	18	17		(1" layer of gray clay in tip of sampler)
65												
		13	ss	2.0	1.5	67.0	13	15	15	18		Gray fin e sand , trace silt.
70												
		14	ss	2.0	1.5	72.0	11	17	22	20		
											74.0	Brown f/m sand , trace clayey silt.
75												
		15	ss	2.0	1.5	77.0	9	16	19	24		

Ground Surface To _____ Ft Used _________ " Casing Then _________ " Casing To _____ Ft. **HOLE NO. B - 1**

D = Dry W = Washed C = Cored P = Pit A = Auger UP = Undisturbed Piston

UB = Undisturbed Ball Check T = Thin wall V = Vane Test

Proportions Used: Trace = 0–10% little = 10–20% Some = 20–35% and = 35–5-%

HARDIMAN CO. & ASSOC., INC. 10 Fox Hunt Road Shelton, CT 06484	CLIENT: **OCEAN & COASTAL CONSULTANTS**	SHEET 3 OF 3 HOLE NO. **B - 1**
CONTRACTOR	PROJECT NO. O – 88	LINE
?EMAN—DRILLER ?ill	PROJECT NAME CROTON YACHT CLUB BULKHEAD	STATION
INSPECTOR	LOCATION CROTON-ON-HUDSON, NY.	OFFSET

GROUND WATER OBSERVATIONS
AT _____ FT. AFTER _______ HOURS
AT _____ FT. AFTER _______ HOURS

	Casing	Sampler	Core Bar
Type	H S A	SS	
Size I.D.		1 3/8"	
Hammer Wt.		140	BIT
Hammer Fall		30"	

Date Start 12 / 30 / 11 Date Fin. 12 / 30 / 10
Surface Elev._ Existing Ground.
Ground Water Elev. (Tidal)

Depth	Casing Blows per Foot	Sample No	Type	Pen	Rec	Depth @ Bot	Blows Per 6" on Sampler (Force on Tube) 0-6	6-12	12-18	18 - 24	Strata Change Depth	Field Identification of Soil. Remarks Incl. Color, Loss of Wash Water, Seams in Rock, Etc.
												Brown fine sand , trace silt.
		16	ss	2.0	1.5	82.0	14	16	20	21		
85												
		17	ss	2.0	1.5	87.0	11	10	15	18		Brown f/m sand.
											89.0	Brown f/m sand , some gravel , trace silt.
90												
											91.0	Brown f/m sand , trace silt.
		18	ss	2.0	1.5	92.0	24	33	34	40		
		19	ss	2.0	1.5	97.0	22	20	27	29		
10												
		20	ss	2.0	1.5	102.0	15	13	18	25	102.0	E.O.B.
		16	ss	0.0	0.0	80.0						

Ground Surface To _____ Ft Used _________ " Casing Then _________ " Casing To _____ Ft.

HOLE NO. B - 1

D = Dry W = Washed C = Cored P = Pit A = Auger UP = Undisturbed Piston
UB = Undisturbed Ball Check T = Thin wall V = Vane Test
Proportions Used: Trace = 0–10% little = 10–20% Some = 20–35% and = 35–5-%

HARDIMAN CO. & ASSOC., INC. 10 Fox Hunt Road Shelton, CT 06484	CLIENT: **OCEAN & COASTAL CONSULTANTS**	SHEET 1 OF 3 HOLE NO. **B - 2**
CONTRACTOR	PROJECT NO. O – 88	LINE
REMAN—DRILLER I,III	PROJECT NAME CROTON YACHT CLUB BULKHEAD	STATION
INSPECTOR	LOCATION CROTON-ON-HUDSON, NY.	OFFSET

GROUND WATER OBSERVATIONS

AT ____ FT. AFTER ____ HOURS

AT ____ FT. AFTER ____ HOURS

	Casing	Sampler	Core Bar
Type	H S A	SS	
Size I.D.		1 3/8"	
Hammer Wt.		140	BIT
Hammer Fall		30"	

Date Start 12 / 30 / 10 Date Fin. 1 / 4 / 11

Surface Elev. Existing Ground.

Ground Water Elev. (Tidal)

Depth	Casing Blows per Foot	Sample No	Type	Pen	Rec	Depth @ Bot	Blows Per 6" on Sampler (Force on Tube) 0-6	6-12	12-18	18 - 24	Strata Change Depth	Field Identification of Soil. Remarks Incl. Color, Loss of Wash Water, Seams in Rock, Etc.
												Misc. sand , gravel , trace silt (Fill)m (Petroleum odor)
5											5.0	
		1	ss	0.2	0.2	5.2	100				6.0	Wood. (Fill)
												Black misc. sand , gravel , wood , some silt. (Fill) (Petroleum odor)
10												
		2	ss	2.0	0.3	12.0	25	12	13	9		
		3	ss	2.0	1.0	17.0	12	8	5	7		Gray f/c sand & clayey silt , trace wood , trace gravel. (Fill)
20												
		4	ss	2.0	0.3	22.0	1	1	1	1	22.0	Gray f/c sand , some silt , trace gravel. (Fill)
												Gray organic silt.
25												
		5	ss	2.0	1.5	27.0	1	1	1	1		
30												
		6	ss	2.0	1.5	32.0	1	0	0	0		
35												
		7	ss	2.0	1.5	37.0	1	0	1	0		

Ground Surface To ____ Ft Used ____ " Casing Then ____ " Casing To ____ Ft.

HOLE NO. B - 2

D = Dry W = Washed C = Cored P = Pit A = Auger UP = Undisturbed Piston

UB = Undisturbed Ball Check T = Thin wall V = Vane Test

Proportions Used: Trace = 0 - 10% little = 10 - 20% Some = 20 - 35% and = 35 - 5 %

HARDIMAN CO. & ASSOC., INC.
10 Fox Hunt Road
Shelton, CT 06484

CLIENT: **OCEAN & COASTAL CONSULTANTS**

SHEET 2 OF 3

HOLE NO. **B - 2**

CONTRACTOR

PROJECT NO. O – 88

LINE

'EMAN—DRILLER
,III

PROJECT NAME CROTON YACHT CLUB BULKHEAD

STATION

INSPECTOR

LOCATION CROTON-ON-HUDSON, NY.

OFFSET

GROUND WATER OBSERVATIONS
AT ____ FT. AFTER ______ HOURS
AT ____ FT. AFTER ______ HOURS

	Casing	Sampler	Core Bar
Type	H S A	SS	
Size I.D.		1 3/8"	
Hammer Wt.		140	BIT
Hammer Fall		30"	

Date Start 12/ 30 / 10 Date Fin. 1 / 4 / 11
Surface Elev. Existing Ground.
Ground Water Elev. (Tidal)

Depth	Casing Blows per Foot	Sample No	Type	Pen	Rec	Depth @ Bot	Blows Per 6" on Sampler (Force on Tube) 0-6	6-12	12-18	18 - 24	Strata Change Depth	Field Identification of Soil. Remarks Incl. Color, Loss of Wash Water, Seams in Rock, Etc.
												Gray organic silt.
		8	ss	2.0	0.5	42.0	1	1	2	1		
45												
		9	ss	2.0	1.5	47.0	1	1	2	2		
											50.0	
50												Gray organic silt , trace fine sand.
		10	ss	2.0	1.5	52.0	1	2	2	2		
												Gray organic silt.
		11	ss	2.0	2.0	57.0	2	2	2	2		
60												
											61.5	Gray fine sand , trace silt.
		12	ss	2.0	1.0	62.0	1	2	1	2		
65												
											66.0	Gray f/m sand , trace silt.
		13	ss	2.0	1.0	67.0	2	3	5	5		
70												
		14	ss	2.0	1.0	72.0	7	8	9	11		
											75.0	
75												Gray fine sand.
		15	ss	2.0	1.5	77.0	6	9	14	14		

Ground Surface To _____ Ft Used __________ " Casing Then __________ " Casing To _____ Ft.

HOLE NO. B - 2

D = Dry W = Washed C = Cored P = Pit A = Auger UP = Undisturbed Piston
UB = Undisturbed Ball Check T = Thin wall V = Vane Test
Proportions Used: Trace = 0 - 10% little = 10 - 20% Some = 20 - 35% and = 35 - 5 %

HARDIMAN CO. & ASSOC., INC. 10 Fox Hunt Road Shelton, CT 06484	CLIENT: **OCEAN & COASTAL CONSULTANTS**	SHEET 3 OF 3 HOLE NO. **B - 2**
CONTRACTOR	PROJECT NO. O – 88	LINE
REMAN—DRILLER .JII	PROJECT NAME CROTON YACHT CLUB BULKHEAD	STATION
INSPECTOR	LOCATION CROTON-ON-HUDSON, NY.	OFFSET

GROUND WATER OBSERVATIONS		Casing	Sampler	Core Bar	
AT ____ FT. AFTER ____ HOURS	Type	H S A	SS		Date Start 12 / 30 / 10 Date Fin. 1 / 4 / 11
AT ____ FT. AFTER ____ HOURS	Size I.D.		1 3/8"		Surface Elev. Existing Ground.
	Hammer Wt.		140	BIT	Ground Water Elev. (Tidal)
	Hammer Fall		30"		

Depth	Casing Blows per Foot	Sample No	Type	Pen	Rec	Depth @ Bot	Blows Per 6" on Sampler (Force on Tube) 0-6	6-12	12-18	18 - 24	Strata Change Depth	Field Identification of Soil. Remarks Incl. Color, Loss of Wash Water, Seams in Rock, Etc.
											80.0	Gray fine sand.
												Brown fine sand.
		16	ss	2.0	1.0	82.0	7	7	9	12		
85												
		17	ss	2.0	1.0	87.0	11	14	17	22		Brown fine sand , trace clay.
90												
		18	ss	2.0	1.0	92.0	14	18	22	27		
		19	ss	2.0	1.0	97.0	12	16	17	21		
10												
		20	ss	2.0	1.0	102.0	11	14	15	12	102.0	
												E.O.B.
		16	ss	0.0	0.0	80.0						

Ground Surface To ____ Ft Used ________ " Casing Then ________ " Casing To ____ Ft. **HOLE NO. B - 2**

D = Dry W = Washed C = Cored P = Pit A = Auger UP = Undisturbed Piston

UB = Undisturbed Ball Check T = Thin wall V = Vane Test

Proportions Used: Trace = 0–10%. little = 10–20%. Some = 20–35%. and = 35–5-%

HARDIMAN CO. & ASSOC., INC. 10 Fox Hunt Road Shelton, CT 06484	CLIENT: **OCEAN & COASTAL CONSULTANTS**	SHEET 1 OF 3 HOLE NO. **B - 3**
CONTRACTOR	PROJECT NO. O – 88	LINE
?EMAN—DRILLER .,III	PROJECT NAME CROTON YACHT CLUB BULKHEAD	STATION
INSPECTOR	LOCATION CROTON-ON-HUDSON, NY.	OFFSET

GROUND WATER OBSERVATIONS		Casing	Sampler	Core Bar	
AT ___ FT. AFTER ___ HOURS	Type	H S A	SS		Date Start 1 / 10 / 11 Date Fin. 1 / 11 / 11
AT ___ FT. AFTER ___ HOURS	Size I.D.		1 3/8"		Surface Elev. Existing Ground.
	Hammer Wt.		140	BIT	Ground Water Elev. (Tidal)
	Hammer Fall		30"		

Depth	Casing Blows per Foot	Sample No	Type	Pen	Rec	Depth @ Bot	Blows Per 6" on Sampler (Force on Tube) 0-6	6-12	12-18	18 - 24	Strata Change Depth	Field Identification of Soil. Remarks Incl. Color, Loss of Wash Water, Seams in Rock, Etc.
											0.4	Concrete
											2.0	Gravel
												Brown misc. sand , gravel & silt. (Fill)
5												
		1	ss	2.0	1.0	7.0	2	5	2	4		
10												
		2	ss	2.0	0.3	12.0	3	2	2	2		
											14.0	
												Wood.
		3	ss	0.9	0.3	15.9	34	100				
											17.0	
												Gray organic silt , sand & wood. (Fill)
20												
		4	ss	2.0	0.5	22.0	1	0	1	2		
25											25.0	
												Gray organic silt.
		5	ss	2.0	1.0	27.0	1	1	1	1		
30												
		6	ss	2.0	1.0	32.0	1	0	0	0		
35												
		7	ss	2.0	1.5	37.0	1	1	1	1		
											39.0	
												Gray f/c sand & organic silt.

Ground Surface To ___ Ft Used ___" Casing Then ___" Casing To ___ Ft. **HOLE NO. B - 3**

D = Dry W = Washed C = Cored P = Pit A = Auger UP = Undisturbed Piston

UB = Undisturbed Ball Check T = Thin wall V = Vane Test

Proportions Used: Trace = 0 -10% little = 10 -20% Some = 20 -35% and = 35 -5 %

HARDIMAN CO. & ASSOC., INC. 10 Fox Hunt Road Shelton, CT 06484	CLIENT: **OCEAN & COASTAL CONSULTANTS**	SHEET 2 OF 3 HOLE NO. **B - 3**
CONTRACTOR	PROJECT NO. O – 88	LINE
REMAN—DRILLER ill	PROJECT NAME CROTON YACHT CLUB BULKHEAD	STATION
INSPECTOR	LOCATION CROTON-ON-HUDSON, NY.	OFFSET

GROUND WATER OBSERVATIONS
AT ______ FT. AFTER ______ HOURS
AT ______ FT. AFTER ______ HOURS

	Casing	Sampler	Core Bar
Type	H S A	SS	
Size I.D.		1 3/8"	
Hammer Wt.		140	BIT
Hammer Fall		30"	

Date Start 1 / 10 / 11 Date Fin. 1 / 11 / 11
Surface Elev. Existing Ground.
Ground Water Elev. (Tidal)

Depth	Casing Blows per Foot	Sample No	Type	Pen	Rec	Depth @ Bot	Blows Per 6" on Sampler (Force on Tube) 0-6	6-12	12-18	18 - 24	Strata Change Depth	Field Identification of Soil. Remarks Incl. Color, Loss of Wash Water, Seams in Rock, Etc.
												Gray f/c sand & organic silt. Gray organic silt.
		8	ss	2.0	1.0	42.0	13	4	2	2		
45												
		9	ss	2.0	1.5	47.0	2	2	2	2		
50												
		10	ss	2.0	1.5	52.0	1	2	1	2		
		11	ss	2.0	1.5	57.0	2	3	3	3		
60												
		12	ss	2.0	1.0	62.0	1	2	1	2		
65											65.0	Gray organic silt & peat.
		13	ss	2.0	1.5	67.0	2	3	2	3		
70											70.5	Peat.
		14	ss	2.0	1.0	72.0	2	4	6	7		
75												
		15	ss	2.0	1.5	77.0	2	3	3	3		
											78.0	Brown f/c sand & gravel , some cobbles.
		16	ss	0.0	0.0	80.0						

Ground Surface To _____ Ft Used _________ " Casing Then _________ " Casing To _____ Ft.

HOLE NO. B - 3

D = Dry W = Washed C = Cored P = Pit A = Auger UP = Undisturbed Piston
UB = Undisturbed Ball Check T = Thin wall V = Vane Test
Proportions Used: Trace = 0–10% little = 10–20% Some = 20–35% and = 35–5-%

HARDIMAN CO. & ASSOC., INC. **10 Fox Hunt Road** **Shelton, CT 06484**	CLIENT: **OCEAN & COASTAL CONSULTANTS**	SHEET 3 OF 3 HOLE NO. **B - 3**
CONTRACTOR	PROJECT NO. O – **88**	LINE
REMAN—DRILLER I,III	PROJECT NAME CROTON YACHT CLUB BULKHEAD	STATION
INSPECTOR	LOCATION CROTON-ON-HUDSON, NY.	OFFSET

GROUND WATER OBSERVATIONS

AT _____ FT. AFTER _______ HOURS

AT _____ FT. AFTER _______ HOURS

	Casing	Sampler	Core Bar
Type	H S A	SS	
Size I.D.		1 3/8"	
Hammer Wt.		140	BIT
Hammer Fall		30"	

Date Start 1 / 10 / 11 Date Fin. 1 / 11 / 11

Surface Elev. Existing Ground.

Ground Water Elev. (Tidal)

Depth	Casing Blows per Foot	Sample No	Type	Pen	Rec	Depth @ Bot	Blows Per 6" on Sampler (Force on Tube) 0-6	6-12	12-18	18 - 24	Strata Change Depth	Field Identification of Soil. Remarks Incl. Color, Loss of Wash Water, Seams in Rock, Etc.
												Brown f/c sand & gravel , some cobbles.
											82.0	
												Red-brown f/m sand , trace silt.
85												
		17	ss	2.0	1.0	87.0	19	16	15	15		
90											90.0	
												Red-brown f/c sand , some silt , trace gravel.
		18	ss	2.0	1.5	92.0	14	14	15	12		
		19	ss	2.0	1.5	97.0	16	17	14	17		
10												
		20	ss	2.0	1.5	102.0	16	18	20	24	102.0	
												E.O.B.
		16	ss	0.0	0.0	80.0						

Ground Surface To _____ Ft Used __________ " Casing Then __________ " Casing To _____ Ft.

HOLE NO. B - 3

D = Dry W = Washed C = Cored P = Pit A = Auger UP = Undisturbed Piston

UB = Undisturbed Ball Check T = Thin wall V = Vane Test

Proportions Used: Trace = 0–10% little = 10–20% Some = 20–35% and = 35–5-%

Appendix D - Cost Estimate Backup

OCEAN AND COASTAL
CONSULTANTS

OPINION OF PROBABLE COSTS

OCC PROJECT NO: 210082
OCC PROJECT NAME: CROTON YACHT CLUB BULKHEAD

CLIENT: VILLAGE OF CROTON-ON-HUDSON
SITE LOCATION: CROTON-ON-HUDSON, NEW YORK

PREPARED BY: THDU, REVISED BY AZSL 9/27/11
DATE: 18-Aug-11
CHECKED BY: SAFA

ITEM NO.	WORK ITEM DESCRIPTION	OPC PRICE (LUMP SUM)
1	ALTERNATIVE 1 - SEGMENT A	$665,000.00
2	ALTERNATIVE 1 - SEGMENT B	$704,000.00
3	ALTERNATIVE 1 - SEGMENT C	$952,000.00
4	ALTERNATIVE 1 - SEGMENT D	$674,000.00
5	CATHODIC PROTECTION	$300,000.00
	TOTAL	$3,295,000.00

OPINIONS OF PROBABLE COST INCLUDE THE FOLLOWING MARK-UPS:

GENERAL CONDITIONS:	**5%**
OVERHEAD:	**10%**
PROFIT:	**10%**
SALES TAX:	**0%**
INFLATION:	**0%**
CONTINGENCY:	**20%**

OPINION OF PROBABLE COSTS

OCC PROJECT NO: 210082
OCC PROJECT NAME: CROTON YACHT CLUB BULKHEAD

CLIENT: VILLAGE OF CROTON-ON-HUDSON
SITE LOCATION: CROTON-ON-HUDSON, NEW YORK

PREPARED BY: THDU, REVISED BY AZSL 9/27/11
DATE: 18-Aug-11
CHECKED BY: SAFA

ITEM NO.	WORK ITEM DESCRIPTION	OPC PRICE (LUMP SUM)
1	ALTERNATIVE 2 - SEGMENT A	$665,000.00
2	ALTERNATIVE 2 - SEGMENT B	$704,000.00
3	ALTERNATIVE 2 - SEGMENT C	$1,018,000.00
4	ALTERNATIVE 2 - SEGMENT D	$630,000.00
5	CATHODIC PROTECTION	$300,000.00
	TOTAL	$3,317,000.00

OPINIONS OF PROBABLE COST INCLUDE THE FOLLOWING MARK-UPS:

GENERAL CONDITIONS:	**5%**
OVERHEAD:	**10%**
PROFIT:	**10%**
SALES TAX:	**0%**
INFLATION:	**0%**
CONTINGENCY:	**20%**

PROJECT NO.: 210082
DATE: 18-Aug-11

REFERENCES:

THIS OPINION OF PROBABLE COST IS BASED UPON THE FOLLOWING DRAWINGS

PREPARED BY	DRAWING NAME	DRAWING NO.	REV.	DATE
OCC	PROPOSED BULKHEAD ALTERNATE 1 OVERSHEETING PLAN	210082-1-02	0	5/20/11
OCC	PROPOSED BULKHEAD ALTERNATE 2 OVERSHEETING PLAN	210082-1-03	0	5/20/11

PROJECT NO.: 210082
DATE: 18-Aug-11

ASSUMPTIONS:

1. COSTS ARE BASED ON FY 2011$

2. OPC IS BASED ON MATERIAL PRICING AND AVAILABILITY AS OF THE DATE OF THE OPC. MATERIAL PRICING AND AVAILABILITY AT TIME OF CONSTRUCTION MAY VARY.

3. RESOURCES USED FOR PRICING:
   a. DAVIS-BACON WAGE RATES FOR WESTCHESTER COUNTY, NY
   b. THE AED GREEN BOOK , 61st EDITION, 2010 RENTAL RATES & SPECIFICATIONS FOR CONSTRUCTION EQUIPMENT.
   c. R.S.MEANS 2011 BUILDING CONSTRUCTION COST DATA, 69th ANNUAL EDITION
   d. R.S.MEANS 2011 HEAVY CONSTRUCTION COST DATA, 25th ANNUAL EDITION

4. EXCLUDED ITEMS:
   a. DREDGING
   b. CONTAMINATED MATERIALS HANDLING AND DISPOSAL
   c. ITEMS NOT SPECIFICALLY LISTED IN "REFERENCES" SECTION OF THIS OPC.
   d. ENGINEERING AND CONSTRUCTION OVERSIGHT
   e. PERMIT ACQUISITION AND PERMIT FEES
   f. ARCHITECTURAL FINISHES
   g. MECHANICAL AND ELECTRICAL WORK (OTHER THAN FOR CATHODIC PROTECTION)

5. ACCESS FOR WORK IS FROM WATERBORNE AND UPLAND-BASED EQUIPMENT WITH UPLAND STAGING ADJACENT TO THE WORK AREA

6. IT IS ASSUMED THAT THERE WILL BE UNRESTRICTED ACCESS FOR THE WORK WITH NO DISRUPTIONS.

PROJECT NO.: 210082
DATE: 18-Aug-11

ALTERNATIVE 1 - SEGMENT A

OPINION OF PROBABLE COSTS

MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
STEEL SHEET PILES (AZ 26-700)	183000.00	LB	1.00	183000.00		
SSP COATING	4200.00	SF	3.60	15120.00		
FALSEWORK	101.00	LF	100.00	10100.00		ASSUME $100/LF
BENT PLATE	4160.00	LB	2.00	8320.00		(PORT CHESTER BULKHEAD)
DYWIDAG GROUND ANCHORS	10.00	EA	7500.00	75000.00		(PORT CHESTER BULKHEAD)
DYWIDAG TIE RODS	15.00	LF	15.00	225.00		
CONCRETE BACKFILL	85.00	CY	100.00	8500.00		
LANDSCAPING BEHIND BULKHEAD	1010	SF	15.00	15150.00		2011 MEANS - PC CONC PAVERS W/BASE
SUBTOTAL					315415.00	

LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
MOB/DE-MOB	1.00	LS	23000	23000.00		ASSUME 10% OF TOTAL COST
SET FALSEWORK, SET & DRIVE SSP	4.00	SHIFT	11913.77	47655.10		CREW 2 - 30 LF/DAY
INSTALL ANCHORS	10.00	SHIFT	3204.05	32040.48		CREW 4 - ASSUME 1 ANCHOR/DAY AVG
INSTALL TIE RODS	0.50	SHIFT	3275.09	1637.54		CREW 1 - ASSUME 1/2 SHIFT
INSTALL BENT PLATE	0.25	SHIFT	11913.77	2978.44		CREW 2 - 200 LF/DAY
BACKFILL BEHIND BULKHEAD	0.50	SHIFT	3275.09	1637.54		CREW 1 - 200 CY/DAY
SUPERINTENDENT	122.0	HOUR	75.00	9150.00		
PROJECT MANAGER	30.5	HOUR	75.00	2287.50		25% OF CONST. TIME
SUBTOTAL					120386.61	

SUBTOTAL PROJECT			435801.61
GENERAL CONDITIONS	5.00%	PERCENT	21790.08
OVERHEAD	10.00%	PERCENT	45759.17
PROFIT	10.00%	PERCENT	50335.09
SALES TAX	0.00%	PERCENT	0.00
INFLATION	0.00%	PERCENT	0.00
CONTINGENCY	20.00%	PERCENT	110737.19
TOTAL OPC			**$664,423.13**

PROJECT NO.: 210082
DATE: 18-Aug-11

ALTERNATIVE 1 - SEGMENT B

OPINION OF PROBABLE COSTS

MATERIALS	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
STEEL SHEET PILES (AZ 26-700)	191000.00	LB	1.00	191000.00		
SSP COATING	4400.00	SF	3.60	15840.00		
FALSEWORK	90.00	LF	100.00	9000.00		ASSUME $100/LF
BENT PLATE	3710.00	LB	2.00	7420.00		(PORT CHESTER BULKHEAD)
DYWIDAG GROUND ANCHORS	9.00	EA	7500.00	67500.00		(PORT CHESTER BULKHEAD)
DYWIDAG TIE RODS	0.00	LF	15.00	0.00		
CONCRETE BACKFILL	75.00	CY	100.00	7500.00		
LANDSCAPING BEHIND BULKHEAD	900	SF	15.00	13500.00		2011 MEANS - PC CONC PAVERS W/BASE
SUBTOTAL					311760.00	

LABOR & EQUIPMENT	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
MOB/DE-MOB	1.00	LS	69000	69000.00		ASSUME 10% OF TOTAL COST
SET FALSEWORK, SET & DRIVE SSP	3.00	SHIFT	11913.77	35741.32		CREW 2 - 30 LF/DAY
INSTALL ANCHORS	9.00	SHIFT	3204.05	28836.43		CREW 4 - ASSUME 1 ANCHOR/DAY AVG
INSTALL TIE RODS	0.00	SHIFT	3275.09	0.00		CREW 1 - ASSUME 1/2 SHIFT
INSTALL BENT PLATE	0.45	SHIFT	11913.77	5361.20		CREW 2 - 200 LF/DAY
BACKFILL BEHIND BULKHEAD	0.40	SHIFT	3275.09	1310.04		CREW 1 - 200 CY/DAY
SUPERINTENDENT	102.8	HOUR	75.00	7710.00		
PROJECT MANAGER	25.7	HOUR	75.00	1927.50		25% OF CONST. TIME
SUBTOTAL					149886.49	

SUBTOTAL PROJECT			461646.49
GENERAL CONDITIONS	5.00%	PERCENT	23082.32
OVERHEAD	10.00%	PERCENT	48472.88
PROFIT	10.00%	PERCENT	53320.17
SALES TAX	0.00%	PERCENT	0.00
INFLATION	0.00%	PERCENT	0.00
CONTINGENCY	20.00%	PERCENT	117304.37
TOTAL OPC			**$703,826.23**

PROJECT NO.: 210082
DATE: 18-Aug-11

ALTERNATIVE 1 - SEGMENT C

OPINION OF PROBABLE COSTS

MATERIALS	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
STEEL SHEET PILES (AZ 26-700)	274000.00	LB	1.00	274000.00		
SSP COATING	6300.00	SF	3.60	22680.00		
FALSEWORK	130.00	LF	100.00	13000.00		ASSUME $100/LF
BENT PLATE	5360.00	LB	2.00	10720.00		(PORT CHESTER BULKHEAD)
DYWIDAG GROUND ANCHORS	11.00	EA	7500.00	82500.00		(PORT CHESTER BULKHEAD)
DYWIDAG TIE RODS	40.00	LF	15.00	600.00		
CONCRETE BACKFILL	109.00	CY	100.00	10900.00		
LANDSCAPING BEHIND BULKHEAD	1300	SF	15.00	19500.00		2011 MEANS - PC CONC PAVERS W/BASE
SUBTOTAL					433900.00	

LABOR & EQUIPMENT	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
MOB/DE-MOB	1.00	LS	69000	69000.00		ASSUME 10% OF TOTAL COST
SET FALSEWORK, SET & DRIVE SSP	5.00	SHIFT	11913.77	59568.87		CREW 2 - 30 LF/DAY
INSTALL ANCHORS	11.00	SHIFT	3204.05	35244.53		CREW 4 - ASSUME 1 ANCHOR/DAY AVG
INSTALL TIE RODS	1.00	SHIFT	3275.09	3275.09		CREW 1 - ASSUME 1 SHIFT
INSTALL BENT PLATE	0.65	SHIFT	11913.77	7743.95		CREW 2 - 200 LF/DAY
BACKFILL BEHIND BULKHEAD	0.55	SHIFT	3275.09	1801.30		CREW 1 - 200 CY/DAY
SUPERINTENDENT	145.6	HOUR	75.00	10920.00		
PROJECT MANAGER	36.4	HOUR	75.00	2730.00		25% OF CONST. TIME
SUBTOTAL					190283.74	

SUBTOTAL PROJECT			624183.74
GENERAL CONDITIONS	5.00%	PERCENT	31209.19
OVERHEAD	10.00%	PERCENT	65539.29
PROFIT	10.00%	PERCENT	72093.22
SALES TAX	0.00%	PERCENT	0.00
INFLATION	0.00%	PERCENT	0.00
CONTINGENCY	20.00%	PERCENT	158605.09
TOTAL OPC			**$951,630.52**

PROJECT NO.: 210082
DATE: 18-Aug-11

ALTERNATIVE 1 - SEGMENT D

OPINION OF PROBABLE COSTS

MATERIALS	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
STEEL SHEET PILES (AZ 26-700)	130000.00	LB	1.00	130000.00		
SSP COATING	4500.00	SF	3.60	16200.00		
FALSEWORK	107.00	LF	100.00	10700.00		ASSUME $100/LF
BENT PLATE	4410.00	LB	2.00	8820.00		(PORT CHESTER BULKHEAD)
DYWIDAG GROUND ANCHORS	10.00	EA	7500.00	75000.00		(PORT CHESTER BULKHEAD)
DYWIDAG TIE RODS	0.00	LF	15.00	0.00		
CONCRETE BACKFILL	90.00	CY	100.00	9000.00		
LANDSCAPING BEHIND BULKHEAD	1070	SF	15.00	16050.00		2011 MEANS - PC CONC PAVERS W/BASE
SUBTOTAL					265770.00	

LABOR & EQUIPMENT	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
MOB/DE-MOB	1.00	LS	69000	69000.00		ASSUME 10% OF TOTAL COST
SET FALSEWORK, SET & DRIVE SSP	4.00	SHIFT	11913.77	47655.10		CREW 2 - 30 LF/DAY
INSTALL ANCHORS	10.00	SHIFT	3204.05	32040.48		CREW 4 - ASSUME 1 ANCHOR/DAY AVG
INSTALL TIE RODS	0.00	SHIFT	3275.09	0.00		CREW 1 - ASSUME 1 SHIFT
INSTALL BENT PLATE	1.00	SHIFT	11913.77	11913.77		CREW 2 - 200 LF/DAY
BACKFILL BEHIND BULKHEAD	1.00	SHIFT	3275.09	3275.09		CREW 1 - 200 CY/DAY
SUPERINTENDENT	128.0	HOUR	75.00	9600.00		
PROJECT MANAGER	32.0	HOUR	75.00	2400.00		25% OF CONST. TIME
SUBTOTAL					175884.44	

SUBTOTAL PROJECT			441654.44
GENERAL CONDITIONS	5.00%	PERCENT	22082.72
OVERHEAD	10.00%	PERCENT	46373.72
PROFIT	10.00%	PERCENT	51011.09
SALES TAX	0.00%	PERCENT	0.00
INFLATION	0.00%	PERCENT	0.00
CONTINGENCY	20.00%	PERCENT	112224.39
TOTAL OPC			**$673,346.36**

PROJECT NO.: 210082
DATE: 18-Aug-11

ALTERNATIVE 2 - SEGMENT A

OPINION OF PROBABLE COSTS

MATERIALS	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
STEEL SHEET PILES (AZ 26-700)	183000.00	LB	1.00	183000.00		
SSP COATING	4200.00	SF	3.60	15120.00		
FALSEWORK	101.00	LF	100.00	10100.00		ASSUME $100/LF
BENT PLATE	4160.00	LB	2.00	8320.00		(PORT CHESTER BULKHEAD)
DYWIDAG GROUND ANCHORS	10.00	EA	7500.00	75000.00		(PORT CHESTER BULKHEAD)
DYWIDAG TIE RODS	15.00	LF	15.00	225.00		
CONCRETE BACKFILL	85.00	CY	100.00	8500.00		
LANDSCAPING BEHIND BULKHEAD	1010	SF	15.00	15150.00		2011 MEANS - PC CONC PAVERS W/BASE
SUBTOTAL					315415.00	

LABOR & EQUIPMENT	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
MOB/DE-MOB	1.00	LS	23000	23000.00		ASSUME 10% OF TOTAL COST
SET FALSEWORK, SET & DRIVE SSP	4.00	SHIFT	11913.77	47655.10		CREW 2 - 30 LF/DAY
INSTALL ANCHORS	10.00	SHIFT	3204.05	32040.48		CREW 4 - ASSUME 1 ANCHOR/DAY AVG
INSTALL TIE RODS	0.50	SHIFT	3275.09	1637.54		CREW 1 - ASSUME 1/2 SHIFT
INSTALL BENT PLATE	0.25	SHIFT	11913.77	2978.44		CREW 2 - 200 LF/DAY
BACKFILL BEHIND BULKHEAD	0.50	SHIFT	3275.09	1637.54		CREW 1 - 200 CY/DAY
SUPERINTENDENT	122.0	HOUR	75.00	9150.00		
PROJECT MANAGER	30.5	HOUR	75.00	2287.50		25% OF CONST. TIME
SUBTOTAL					120386.61	

SUBTOTAL PROJECT			435801.61
GENERAL CONDITIONS	5.00%	PERCENT	21790.08
OVERHEAD	10.00%	PERCENT	45759.17
PROFIT	10.00%	PERCENT	50335.09
SALES TAX	0.00%	PERCENT	0.00
INFLATION	0.00%	PERCENT	0.00
CONTINGENCY	20.00%	PERCENT	110737.19
TOTAL OPC			**$664,423.13**

PROJECT NO.: 210082
DATE: 18-Aug-11

ALTERNATIVE 2 - SEGMENT B

OPINION OF PROBABLE COSTS

MATERIALS	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
STEEL SHEET PILES (AZ 26-700)	191000.00	LB	1.00	191000.00		
SSP COATING	4400.00	SF	3.60	15840.00		
FALSEWORK	90.00	LF	100.00	9000.00		ASSUME $100/LF
BENT PLATE	3710.00	LB	2.00	7420.00		(PORT CHESTER BULKHEAD)
DYWIDAG GROUND ANCHORS	9.00	EA	7500.00	67500.00		(PORT CHESTER BULKHEAD)
DYWIDAG TIE RODS	0.00	LF	15.00	0.00		
CONCRETE BACKFILL	75.00	CY	100.00	7500.00		
LANDSCAPING BEHIND BULKHEAD	900	SF	15.00	13500.00		2011 MEANS - PC CONC PAVERS W/BASE
SUBTOTAL					311760.00	

LABOR & EQUIPMENT	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
MOB/DE-MOB	1.00	LS	69000	69000.00		ASSUME 10% OF TOTAL COST
SET FALSEWORK, SET & DRIVE SSP	3.00	SHIFT	11913.77	35741.32		CREW 2 - 30 LF/DAY
INSTALL ANCHORS	9.00	SHIFT	3204.05	28836.43		CREW 4 - ASSUME 1 ANCHOR/DAY AVG
INSTALL TIE RODS	0.00	SHIFT	3275.09	0.00		CREW 1 - ASSUME 1/2 SHIFT
INSTALL BENT PLATE	0.45	SHIFT	11913.77	5361.20		CREW 2 - 200 LF/DAY
BACKFILL BEHIND BULKHEAD	0.40	SHIFT	3275.09	1310.04		CREW 1 - 200 CY/DAY
SUPERINTENDENT	102.8	HOUR	75.00	7710.00		
PROJECT MANAGER	25.7	HOUR	75.00	1927.50		25% OF CONST. TIME
SUBTOTAL					149886.49	

SUBTOTAL PROJECT			461646.49
GENERAL CONDITIONS	5.00%	PERCENT	23082.32
OVERHEAD	10.00%	PERCENT	48472.88
PROFIT	10.00%	PERCENT	53320.17
SALES TAX	0.00%	PERCENT	0.00
INFLATION	0.00%	PERCENT	0.00
CONTINGENCY	20.00%	PERCENT	117304.37
TOTAL OPC			**$703,826.23**

PROJECT NO.: 210082
DATE: 18-Aug-11

ALTERNATIVE 2 - SEGMENT C

OPINION OF PROBABLE COSTS

MATERIALS	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
STEEL SHEET PILES	318000.00	LB	1.00	318000.00		
SSP COATING	6300.00	SF	3.60	22680.00		
FALSEWORK	130.00	LF	100.00	13000.00		ASSUME $100/LF
BENT PLATE	5360.00	LB	2.00	10720.00		(PORT CHESTER BULKHEAD)
WALE ASSEMBLY	26200.00	LB	1.00	26200.00		(PORT CHESTER BULKHEAD)
DYWIDAG TIE RODS	590.00	LF	15.00	8850.00		
CONCRETE BACKFILL	109.00	CY	100.00	10900.00		
LANDSCAPING BEHIND BULKHEAD	1300	SF	15.00	19500.00		2011 MEANS - PC CONC PAVERS W/BASE
SUBTOTAL					429850.00	

LABOR & EQUIPMENT	QUANTITY	UNITS	UNIT $	EXTENDED $		COMMENTS
MOB/DE-MOB	1.00	LS	99000	99000.00		ASSUME 10% OF TOTAL COST
EXCAVATE FOR TIEBACKS	1.50	SHIFT	3275.09	4912.63		CREW 1
SET FALSEWORK, SET & DRIVE SSP	4.00	SHIFT	11913.77	47655.10		CREW 2 - 30 LF/DAY
DRIVE SSP ANCHOR WALL	1.00	SHIFT	9033.77	9033.77		CREW 3
INSTALL WALES FOR BULKHEAD	4.00	SHIFT	11913.77	47655.10		CREW 2 - ASSUME 30 LF/DAY
INSTALL WALES FOR ANCHOR WALL	0.50	SHIFT	9033.77	4516.89		CREW 3
INSTALL BENT PLATE	0.50	SHIFT	11913.77	5956.89		CREW 2 - 200 LF/DAY
BACKFILL BEHIND BULKHEAD	1.00	SHIFT	3275.09	3275.09		CREW 1 - 200 CY/DAY
INSTALL/BACKFILL TIEBACKS	1.50	SHIFT	3275.09	4912.63		CREW 1
SUPERINTENDENT	112.00	HOUR	75.00	8400.00		
PROJECT MANAGER	28.00	HOUR	75.00	2100.00		25% OF CONST. TIME
SUBTOTAL					237418.09	

SUBTOTAL PROJECT			667268.09
GENERAL CONDITIONS	5.00%	PERCENT	33363.40
OVERHEAD	10.00%	PERCENT	70063.15
PROFIT	10.00%	PERCENT	77069.46
SALES TAX	0.00%	PERCENT	0.00
INFLATION	0.00%	PERCENT	0.00
CONTINGENCY	20.00%	PERCENT	169552.82
TOTAL OPC			**$1,017,316.93**

PROJECT NO.: 210082
DATE: 18-Aug-11

ALTERNATIVE 2 - SEGMENT D

OPINION OF PROBABLE COSTS

MATERIALS	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
STEEL SHEET PILES	134000.00	LB	1.00	134000.00		
SSP COATING	4500.00	SF	3.60	16200.00		
FALSEWORK	107.00	LF	100.00	10700.00		ASSUME $100/LF
BENT PLATE	4410.00	LB	2.00	8820.00		(PORT CHESTER BULKHEAD)
WALE ASSEMBLY	21500.00	LB	1.00	21500.00		(PORT CHESTER BULKHEAD)
DYWIDAG TIE RODS	500.00	LF	15.00	7500.00		
CONCRETE BACKFILL	90.00	CY	100.00	9000.00		
LANDSCAPING BEHIND BULKHEAD	1070	SF	15.00	16050.00		2011 MEANS - PC CONC PAVERS W/BASE
SUBTOTAL					223770.00	

LABOR & EQUIPMENT	**QUANTITY**	**UNITS**	**UNIT $**	**EXTENDED $**		**COMMENTS**
MOB/DE-MOB	1.00	LS	24000	24000.00		ASSUME 10% OF TOTAL COST
EXCAVATE FOR TIEBACKS	2.00	SHIFT	3275.09	6550.18		CREW 1
SET FALSEWORK, SET & DRIVE SSP	4.00	SHIFT	11913.77	47655.10		CREW 2 - 30 LF/DAY
DRIVE SSP ANCHOR WALL	2.00	SHIFT	9033.77	18067.55		CREW 3 - 60LF/DAY
INSTALL WALES FOR BULKHEAD	3.00	SHIFT	11913.77	35741.32		CREW 2 - ASSUME 30 LF/DAY
INSTALL WALES FOR ANCHOR WALL	3.00	SHIFT	9033.77	27101.32		CREW 3
INSTALL BENT PLATE	0.50	SHIFT	11913.77	5956.89		CREW 2 - 200 LF/DAY
BACKFILL BEHIND BULKHEAD	1.00	SHIFT	3275.09	3275.09		CREW 1 - 200 CY/DAY
INSTALL/BACKFILL TIEBACKS	3.00	SHIFT	3275.09	9825.26		CREW 1
SUPERINTENDENT	116.0	HOUR	75.00	8700.00		
PROJECT MANAGER	29.0	HOUR	75.00	2175.00		25% OF CONST. TIME
SUBTOTAL					189047.70	

SUBTOTAL PROJECT		412817.70
GENERAL CONDITIONS	5.00% PERCENT	20640.89
OVERHEAD	10.00% PERCENT	43345.86
PROFIT	10.00% PERCENT	47680.44
SALES TAX	0.00% PERCENT	0.00
INFLATION	0.00% PERCENT	0.00
CONTINGENCY	20.00% PERCENT	104896.98
TOTAL OPC		**$629,381.87**

PROJECT NO.: 210082
DATE: 18-Aug-11

LABOR AND EQUIPMENT RATE BREAKDOWN

CREW 1 - SITE WORK

		FULL COST W / BURDEN	A DIRECT WAGES*	B FRINGES	A+B
LABOR					
	LABORER	104.87	35.77	38.06	73.83
	OPERATIOR - EXCAVATOR	119.51	43.61	38.06	81.67
EQUIPMENT					
	EXCAVATOR	125.00			
	UTILITY TRUCK	30.00			
	MISC	30.00			
TOTAL HOURLY RATE		409.39			
TOTAL SHIFT RATE		3275.09	BASED ON EIGHT (8) HOUR SHIFT		

PROJECT NO.: 210082
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LABOR AND EQUIPMENT RATE BREAKDOWN

CREW 2 - WATERBOURNE MARINE CONSTRUCTION W/ PILE DRIVING

		FULL COST W / BURDEN	A DIRECT WAGES*	B FRINGES	A+B
LABOR					
	DOCKBUILDER FOREMAN	135.81	52.33	38.06	90.39
	DOCKBUILDER	119.51	43.61	38.06	81.67
	DOCKBUILDER	119.51	43.61	38.06	81.67
	DOCKBUILDER	119.51	43.61	38.06	81.67
	DOCKBUILDER	119.51	43.61	38.06	81.67
	OPERATOR	124.99	53.90	24.32	78.22
	OILER	81.36	30.54	24.32	54.86
EQUIPMENT					
	MATERIAL/CRANE BARGE	250.00			
	VIBRATORY HAMMER	125.00			
	COMPRESSOR	30.00			
	COMPRESSOR	30.00			
	FLOAT STAGE(S)	10.00			
	UTILITY TRUCK	12.00			
	UTILITY TRUCK	12.00			
	MISC	100.00			
	SMALL TUG	100.00			
TOTAL HOURLY RATE		1489.22			
TOTAL SHIFT RATE		11913.77	BASED ON EIGHT (8) HOUR SHIFT		

PROJECT NO.: 210082
DATE: 18-Aug-11

LABOR AND EQUIPMENT RATE BREAKDOWN

CREW 3 - UPLAND CONSTRUCTION W/ PILE DRIVING

		FULL COST W / BURDEN	A DIRECT WAGES*	B FRINGES	A+B
LABOR					
	DOCKBUILDER FOREMAN	135.81	52.33	38.06	90.39
	DOCKBUILDER	119.51	43.61	38.06	81.67
	DOCKBUILDER	119.51	43.61	38.06	81.67
	DOCKBUILDER	119.51	43.61	38.06	81.67
	DOCKBUILDER	119.51	43.61	38.06	81.67
	OPERATOR	124.99	53.90	24.32	78.22
	OILER	81.36	30.54	24.32	54.86
EQUIPMENT					
	VIBRATORY HAMMER	125.00			
	COMPRESSOR	30.00			
	COMPRESSOR	30.00			
	UTILITY TRUCK	12.00			
	UTILITY TRUCK	12.00			
	MISC	100.00			
TOTAL HOURLY RATE		1129.22			
TOTAL SHIFT RATE		9033.77	BASED ON EIGHT (8) HOUR SHIFT		

PROJECT NO.: 210082
DATE: 18-Aug-11

LABOR AND EQUIPMENT RATE BREAKDOWN

CREW 4 - GROUND ANCHOR INSTALLATION

			FULL COST W / BURDEN	A DIRECT WAGES*	B FRINGES	A+B
LABOR						
	DOCKBUILDER	25% OF TIME	29.88	43.61	38.06	81.67
	DOCKBUILDER	25% OF TIME	29.88	43.61	38.06	81.67
	OPERATOR	25% OF TIME	31.25	53.90	24.32	78.22
EQUIPMENT						
	MATERIAL/CRANE BARGE		62.50	25% OF TIME		
	MATERIAL BARGE		100.00			
	FLOAT STAGE(S)		10.00			
	UTILITY TRUCK		12.00			
	MISC		100.00			
	SMALL TUG		25.00	25% OF TIME		
TOTAL HOURLY RATE			400.51			
TOTAL SHIFT RATE			3204.05	BASED ON EIGHT (8) HOUR SHIFT		

PROJECT NO.: 210082
DATE: 18-Aug-11

LABOR AND EQUIPMENT RATE BREAKDOWN

CREW 5 - WATERBOURNE MARINE CONSTRUCTION

		FULL COST W / BURDEN	A DIRECT WAGES*	B FRINGES	A+B
LABOR					
	DOCKBUILDER FOREMAN	135.81	52.33	38.06	90.39
	DOCKBUILDER	119.51	43.61	38.06	81.67
	DOCKBUILDER	119.51	43.61	38.06	81.67
	DOCKBUILDER	119.51	43.61	38.06	81.67
	DOCKBUILDER	119.51	43.61	38.06	81.67
	OPERATOR	124.99	53.90	24.32	78.22
	OILER	81.36	30.54	24.32	54.86
EQUIPMENT					
	MATERIAL/CRANE BARGE	250.00			
	COMPRESSOR	30.00			
	FLOAT STAGE(S)	10.00			
	UTILITY TRUCK	12.00			
	UTILITY TRUCK	12.00			
	MISC	100.00			
	SMALL TUG	100.00			
TOTAL HOURLY RATE		1334.22			
TOTAL SHIFT RATE		10673.77	BASED ON EIGHT (8) HOUR SHIFT		

Appendix E - Stray Current Analysis Results

OCEAN & COASTAL CONSULTANTS
35 CORPORATE DRIVE
TRUMBULL, CT 06611

STRAY CURRENT CORROSION CONTROL EVALUATION AT CROTON-ON-HUDSON YACHT CLUB MARINE BULKHEAD

PREPARED BY:

HENKELS & MCCOY, INC.
INFRASTRUCTURE ENGINEERING GROUP
CORROSION CONTROL SERVICES
1395 ATWOOD AVENUE
JOHNSTON, RHODE ISLAND 02919

JULY 2011

HENKELS & McCOY, Inc.

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July 21, 2011

Ocean & Coastal Consultants Inc.
35 Corporate Drive
Trumbull, CT 06611

ATTN: Mr. Steven Famularo
Project Manager

RE: Stray Current Corrosion Control Evaluation – Report
Croton-on-Hudson, Yacht Club Marine Bulkhead

Dear Mr. Famularo,

The enclosed report completes documentation for the project at the Croton Yacht Club Marina. The results of our investigation indicate that this location is subject to moderate level voltage gradients associated with the operation of the nearby Metro-North tracks and substation. The static and dynamic voltage gradients in the soil and water at the Yacht Club have the potential to cause problems with metallic structures (replacement bulkhead) at this location. Because there is no clear source of this current, the problem is general in nature and will require some design consideration for the new bulkhead(s).

The presence of static stray current near the Metro-North substation can be problematic on fixed buried metallic structures such as the bulkhead sheet piles, tiebacks and the steel wave screen support structure.

Mitigation and or monitoring should be considered in the proposed design for this project. The following report discusses the testing and analysis of the data taken on-site during the period of June 13 -16 and some of the typical problems associated with stray current and possible mitigation strategies.

Thank you for the opportunity to be part of the initial investigation of this project site.

Sincerely,

HENKELS & MCCOY INC.
Corrosion Control Services

Peter A. Lamb
Area Manager – New England
NACE International –Cathodic Protection Specialist #3571

Contents

1.0 List of Figures

2.0 Executive Summary

This study was conducted to determine the presence of stray current activity at the Croton Marina and Yacht Club located in the town of Croton-on-Hudson, NY. The report provides:

1.) A description of what stray current activity is and how it might affect the facility/

2.) A description of the test procedures and methods.

3.) Conclusions for the site with respect to stray current activity and possible design considerations associated with the proposed development.

Henkels & McCoy Inc. conducted testing on June 13-16, 2011 to determine if stray current from the Metro-North Commuter Rail or other sources was present at the Marina. The testing was conducted using 24 hour digital voltage recorders and calibrated reference electrodes placed at selected locations throughout the parcel.

The results of the testing found that the Marina is subject to both Dynamic and Static stray current activity from Metro-North train operations. The presence of a Metro North Substation near the site provides additional influence in the area and will have some affect on new structures. The polarity of the voltage activity at the site seems to indicate that current is flowing away from the substation at this particular point. This is somewhat unusual but may be due to the fact that the substation is near the end of the electrified system. Testing found that voltage gradients in the earth path seem to be oriented away from the Metro-north substation located about 750 feet south of the marina. Substations typically have extensive low resistance grounding systems and are designed to collect returning stray current in the earth electrolyte. However, the Hudson River provides a very low resistance path for current to flow, with the majority of train activity farther south, the current may follow the river rather than the preferred metallic path. In this case, the proposed bulkhead improvements and possibly the future wave screen supports will be in this path and will likely show accelerated corrosion from one end to the other. The northernmost end of the proposed bulkhead will likely suffer accelerated attack as current picked up on the south end is discharged at the northern end.

The existing wave screen supports were tested (Figure 5 Green Graph) these tests indicate that potentials on the steel are severely depressed during the "Off" hours of the Metro-north System. The depression in potential is a clear indication of current discharge from the pilings. This is likely caused by changes in substation activity remote from the Marina and problems on the Metro-north ground path closer to the city.

Buried structural steel or other metallic components proposed for the site will require some additional measures to mitigate the effects of the stray current activity. All of the proposed sheet pile should be coated with at least a coal tar epoxy on both sides and electrically bonded together for continuity. The bulkhead should also be provided with a potentially controlled impressed current cathodic protection system (ICCP). Tie backs should be electrically isolated from the main wall and also coated if possible. Accelerated corrosion will occur due to stray current activity if it is not mitigated by design and/or active protection of the new facilities.

3.0 Introduction

This study was conducted at the Croton Yacht Club, Croton Beach Road, Croton-on-Hudson, NY. The purpose of the study was to determine if the operations of the adjacent Metro-north DC rail system would cause any adverse effects on the proposed bulkhead and also the wave screen supports for the Marina.

Metro-north operates at least two DC powered rail systems within about 280 feet east of the Marina and also has a mainline substation within about 750 feet to the south. The substation appears to be near the end of the electrified rail system and is only about 100 feet from the shore of the Hudson River.

The proposed bulkhead will run for about 250 feet across and in front of the existing bulkhead in front of the Marina Clubhouse and will have two returns of approximately 70 and 100 feet. A wave screen extends south from the shorter bulkhead and is supported by a series of steel H-piles and batter piles. The existing piling system is partially interconnected by a welded steel wale that provides continuity between the supports. The wale system appears to be unfinished and may be extended to include the remaining H-pile supports to the south. While the wave screen is not part of this project, it is being influenced by stray current, and mitigation measures may require its inclusion in any cathodic protection system for the new bulkhead.

DC operated railways can be the source of severe stray current in urban areas particularly in areas where rail bonds and other current return paths have been poorly maintained. Many areas along DC transit systems are subject to extremely severe stray current activity and mitigation is necessary on nearby underground or submerged structures. (Figure 1.)

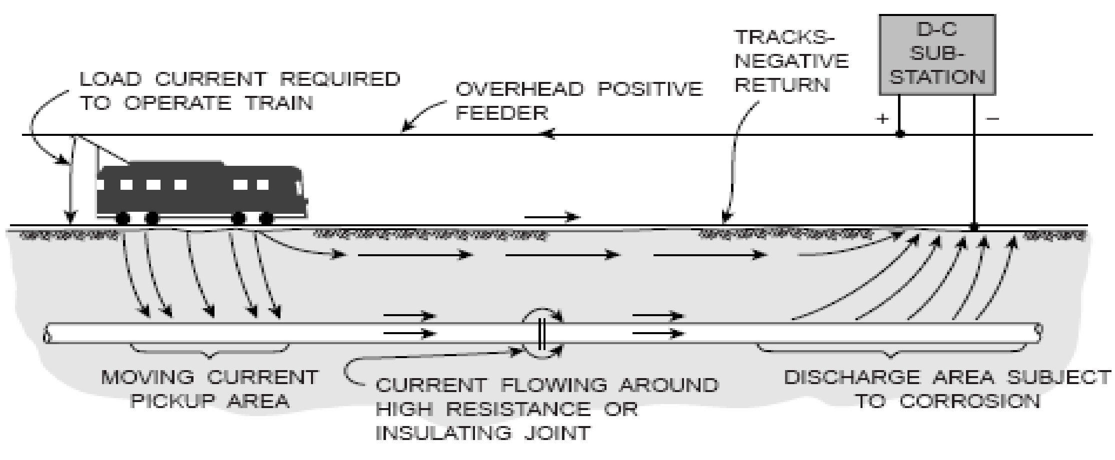

Figure 1 – Corrosion of metallic structures as a result of a DC transit system.

Henkels & McCoy performed voltage testing along the existing bulkheads and wave screen and along Croton Beach Road near the Metro-north substation. The electrical voltage surveys are used to detect stray current activity and provide information on the probability that buried or submerged structures will be affected by abnormal levels of stray current activity.

The testing conducted in this study involved recording voltages during an 18 hour period, with special attention given to obtaining data during the major rush hours in each time period. The period between 7:00 PM and 12:00 AM was also a priority as major fluctuations in train activity typically occur on the Metro-north system during that time. During rush hour the trains operate at their highest levels of the day. Fluctuations in activity usually correspond with acceleration of the trains out of the various stations on the line. During rush hour the rate and activity is usually more than double the train traffic during the rest of the day. The "System Off" period (actually a period of low activity when substations are taken off line and train activity is fairly minimal) provides a contrast to the normal data. Because few if any trains are active during that time period an analysis of static activity can be made.

Substations can be a focal point of stray current activity. This is because they are the point where the operating current originates, and all current that leaves the substation has to return. The current can return either by a hardwire system (rails or other conductors) or through the ground path (soil electrolyte). When current returns through the ground path, it becomes stray current and can cause damage. The substation is a well grounded structure and is designed to accept current through the soil electrolyte. Current flow through the soil electrolyte concentrates near the substation and can cause a fairly steep voltage gradient in the soil in the area of substation's grounding system. The steep voltage gradient combined with the current flow is what causes the damage on adjacent structures. Typically, the closer an unbonded underground structure is to the steepest area of the gradient the more corrosion that will take place. However, in this case it appears that the substation may be discharging current into the surrounding area. This is probably due to the fact that it is near the end of the line and is very close to a brackish section of the Hudson River.

Testing at this site has indicated that there is a fairly constant static current flow (Voltage gradient) near the substation. The polarity of the voltage at the site indicates that the current is flowing away from the Substation at all times. This condition would tend to cause current pickup on any metallic building component at the point nearest the substation and corrosion where it discharges back into the electrolyte. (i.e. a steel sheet pile bulkhead would tend to lose wall thickness at the end of the bulkhead farthest away from the substation) The rate of metal loss would be dependent upon the actual current flow leaving the sheet pile bulkhead or the H-pile wave screen. The metal loss would be constant and occurring 24 hours a day 365 days a year. Therefore even a small amount of current can compromise a metallic structure in a relatively short time.

4.0 Stray Current Study

4.0.1 Stray Current Types

Stray current is defined by NACE International as “Current passing in an electrolyte other than where intended.”

There are two types of stray current that are normally found in urban areas, Dynamic and Static.

- Dynamic stray current is characterized by widely fluctuating current flows and their associated voltage changes in the earth electrolyte. This is typically the result of the operation of DC transit systems, welding operations, DC controlled motors etc. Note that the actual current flow cannot be measured, however, the resulting voltage changes (gradients) in the earth electrolyte can be monitored and conclusions on current flow drawn based on the magnitude of the voltage changes.

- Static stray current is characterized by steady state sources of current such as cathodic protection systems, railroad signaling systems, battery charging and other steady state DC electrical current sources. The “off hours” of a transit system may also be a source of static stray current since the lines remain energized with some equipment still in standby operation although at a reduced level.

4.0.2 Survey Equipment

The survey was conducted utilizing an array of paired Copper/Copper-Sulfate ($Cu/CuSO_4$) reference electrodes and multi-channel digital recording voltmeters. The reference electrodes were each calibrated to a tolerance of ±2 millivolts prior to beginning the survey. The calibration insured that the results of the voltage survey are not influenced in any way due to variations in the electrodes. The reference electrodes were also tested at the completion of the survey to ensure that they remained calibrated throughout the duration of the survey. The reference electrodes provide a reproducible contact with the soil electrolyte and complete the measuring circuit when in contact with the soil. D1 Data Loggers manufactured by Tinker and Rasor, Inc. were programmed to sample at a rate of approximately 1 reading per second and record each reading.

4.0.3 Survey Methods

The survey consisted of burying six reference electrodes at selected locations around the site. Wires were installed between each of the electrodes and terminated at a central location. The reference electrodes were wired into the four recording voltmeters. See Figure 2 for the relative placement of the electrodes. The units were then stored on site in a secure location and allowed to run for a period of 18 hours. The location of the reference electrodes was selected based on the general layout of the proposed new bulkheads and oriented so that the polarity of paired electrodes would indicate a direction of current flow (Voltage Gradient). The location of each electrode is shown in Figure 2. A seventh reference electrode was installed on the northernmost H-pile on the wave screen. This electrode was a Silver/SilverChloride (AG/AGCL) and is the standard electrode for testing in brackish water or seawater. The AG/AGCL electrode monitored the potential of the H-pile for the same period to see if the voltage changes in the area caused any effects on in place steel structures. In this case, the potential changes on the H-pile correlated with activity in the ground.

The existing bulkheads were not tested since they are not electrically continuous and would not provide data that would be usable for a structure with any length in the ground. The only structure that fit the profile of long and electrically continuous was the 60 foot section of wave screen that was interconnected by the waler.

Electrode Polarity:

Unit 653 06/13/11
6(+) to 1(-) Green
5(+) to 6(-) Red

Unit 654 06/14/11
Ag/AgCl Ref. (+) to H-pile (-) Green
1(+) to 5 (-) Red

Unit 655 06/14/11
3(+) to 1(-) Green
1(+) to 2 (-) Red

Unit 656 06/14/11
5(+) to 2(-) Green
2(+) to 4(-) Red

.

Figure 2 – General Test Plan with Reference Locations

4.0.4 Conclusions

1. The level of dynamic stray voltage activity at different points on the property can be fairly substantial. Along Croton Beach Road it can vary by over .5 volts along shore, and up to .25 volts in front of the Clubhouse.

2. The level of static stray current is moderate, and is flowing away from the substation. It has the potential to cause deterioration of metallic underground structures over a period of time.

3. Stray current will flow through the proposed sheet piles, and any other below grade metallic components, creating a voltage gradient across each structure. The closer the component is to the substation, the larger the voltage gradient can become and the higher amount of metal loss that can be expected.

4. Mitigation of stray current damage typically involves the use of cathodic protection or in some cases an actual hardwire bond back to the source. Bonding to the source is not an option in this case.

5. Design considerations such as isolating the tiebacks from both the new bulkhead and the old bulkhead, continuity bonding, coating all underground metallic structures, and the addition of an impressed current cathodic protection system should be considered. These measures will minimize or eliminate the effects of the stray current activity in the area.

6. The wave screen pilings are presently being influenced by stray currents. The 150-200 mV depression observed overnight indicates a relatively severe exposure For about 4-5 hours per day.

4.0.5 Recommendations

1. Provide a dielectric coating (coal tar epoxy- minimum) on all buried or submerged surfaces including below the mud line if possible. This would include the land side of the sheet pile bulkhead and tie-backs if possible.

2. Provide continuity bonding between all sheet piles and appurtenances that will be submerged or buried.

   Note: Continuity bonding can be accomplished by a steel channel pile cap, welded strap, or welded pile connections, or a welded waler system.

3. Electrically isolate the tiebacks from the sheet pile bulkhead and provide spacing and/or isolation sleeves to prevent contact between the tiebacks and the old bulkhead.

4. Avoid electrical connections on the bulkhead that interconnect with the power neutral grounding system. (i.e conduits, lighting mounts, electrical service panels, etc.)

5. Install a potentially controlled Impressed Current Cathodic Protection (ICCP) System that will provide both mitigation of any stray current activity and also provide general corrosion protection for the submerged areas of the bulkhead and the wave screen pilings.

   Note: If more than one bulkhead is installed at this location in the future they will each require their own ICCP system.

   Note: Cathodic Protection will only provide protection to the submerged or buried surfaces of the bulkheads including some of the intertidal zone. It does not provide additional protection to steel surfaces located above the water line or not electrically connected to the system.

6. Install permanent reference electrodes at intervals along the land side of the new bulkhead to monitor voltage activity.

7. If any new bulkheads or additions are made to this facility in the future, cathodic protection for both the land and water side surfaces of the new structures should be considered in the design. The closer to the substation that any new facilities are located the more likely that stray current will cause problems.

4.0.6 Discussion

The stray current activity at the Croton Yacht Club is moderate to severe, which is typical for a location as proximal to the Metro-North rail system as this site. The brackish/seawater in the Hudson River also contributes to the activity at this location because it provides a low resistance earth path near the substation. The polarity of the test results show that static stray current is flowing away from the substation. The static stray current is a cause of concern; with the constant flow of current in that direction, current will also flow along the new bulkhead and discharge as it reaches the northern end of the structure. The constant discharge of current on the north end of the structure will increase the rate of corrosion in that area. It is not possible to predict the corrosion rate before the bulkhead is installed, only that the potential for increased corrosion exists.

The level of static stray current present typically indicates discontinuities on the track bonding and cable associated with the rail system. It can also be the product of a general deterioration or increased resistance in the Metro-north ground path. The static stray current is a byproduct of the Metro-north system operation in general and there is little that can be done by Metro-north to mitigate the issue. The fact that the substation is near the end of the electrified service area is likely contributing to the general stray current activity at this facility.

The mitigation of stray current effects typically involves a multi-level approach during the design of a facility; Continuity, Coating and Cathodic Protection. By integrating these three items most of the negative effects on a structure can be removed.

<u>Continuity:</u> Bonds the structure together so that it can be evaluated and controlled as a single unit.
<u>Coating:</u> Increases the resistance to earth of the structure as a whole and reduces the amount of surface that can pick up current flowing in the earth. The better the coating the less current that will get onto the structure.
<u>Cathodic Protection</u>: Offsets the effects of stray current by providing an opposing current to the stray current that is trying to leave the structure. It reduces the net current flow off of the structure to zero. It has the additional benefit of providing a net current flow onto the structure that provides protection from the normal corrosion of steel in the earth electrolyte.

The wave screen piles near shore (approximately 60 feet of which are bonded together) are already being affected by stray current in the area. Current is likely being picked up on each bent and is being discharged near the north end of the screen. For potentials on a bare structure to be depressed 150-200 mV, it takes a significant amount of current being discharged. When current is discharged it takes a small amount of metal with it. A typical corrosion rate for steel in seawater is 20 lbs per amp per year. We do not know how much current is being discharged, but it is certain that if the wave screen waler system is completed without any type of mitigation in place, the northern piles will fail prematurely at this location.

5.0 References

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Roberge, R.R. Handbook of Corrosion Engineering, New York, McGraw-Hill, 1999

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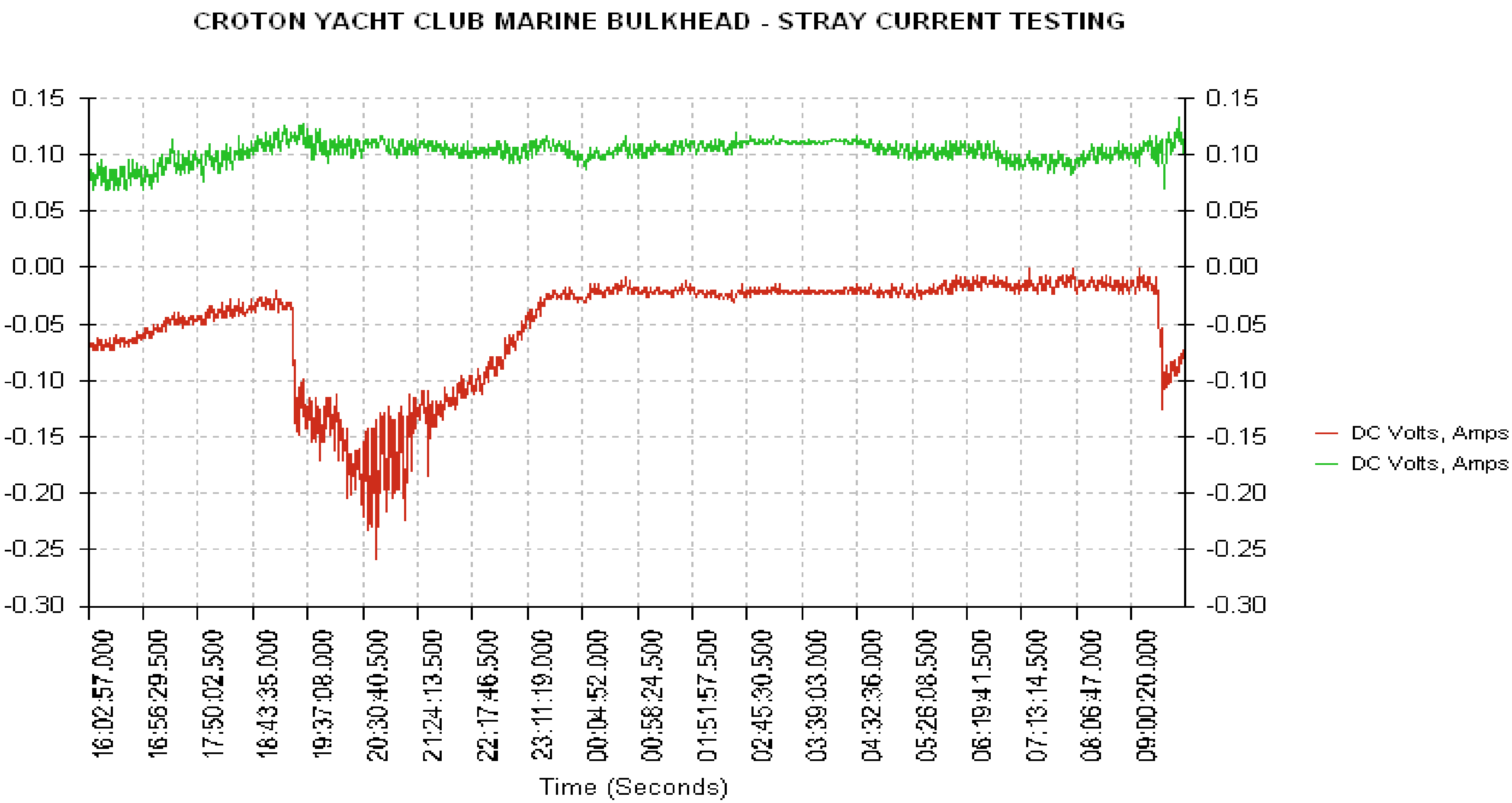
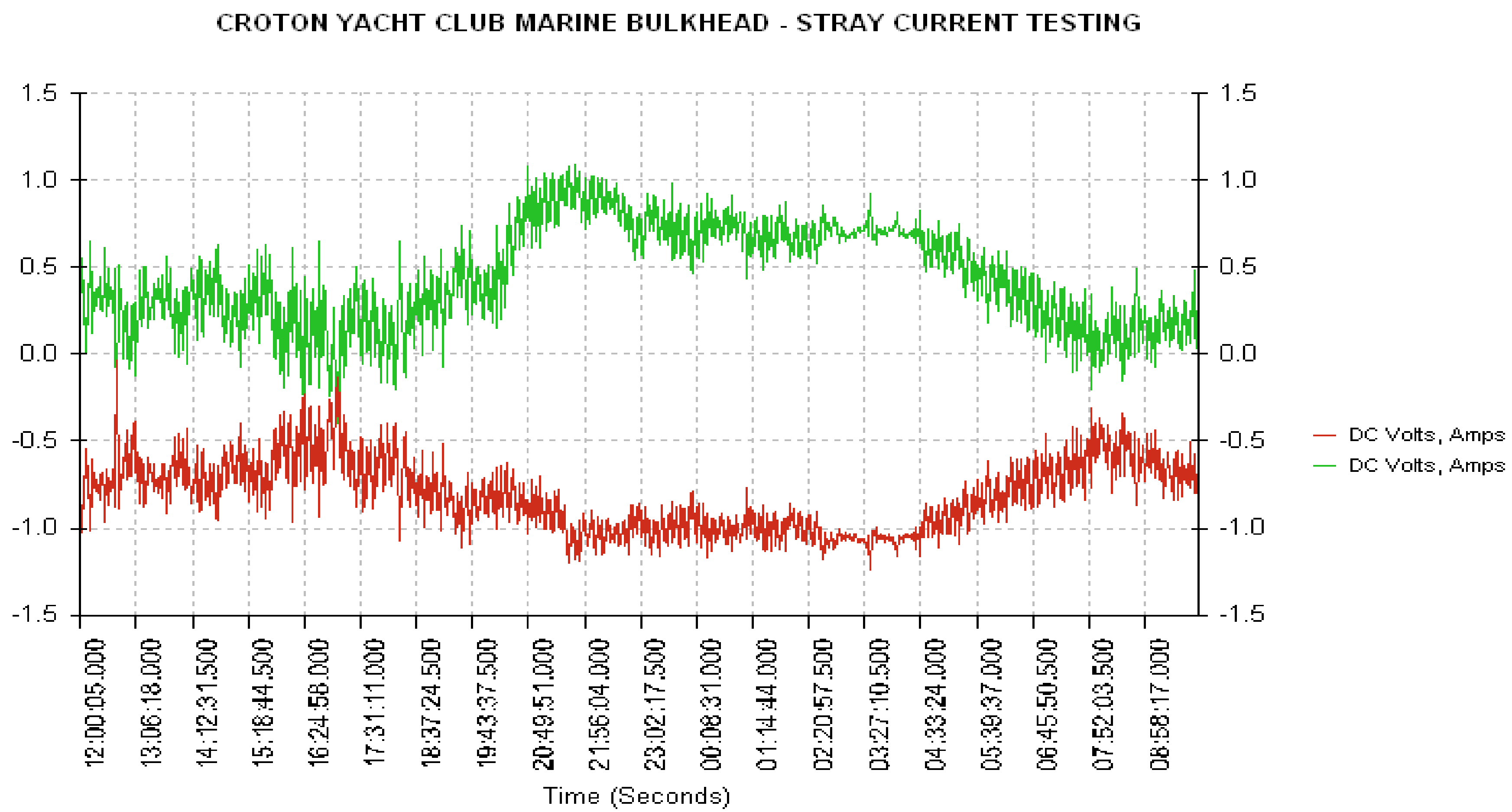
APPENDIX I

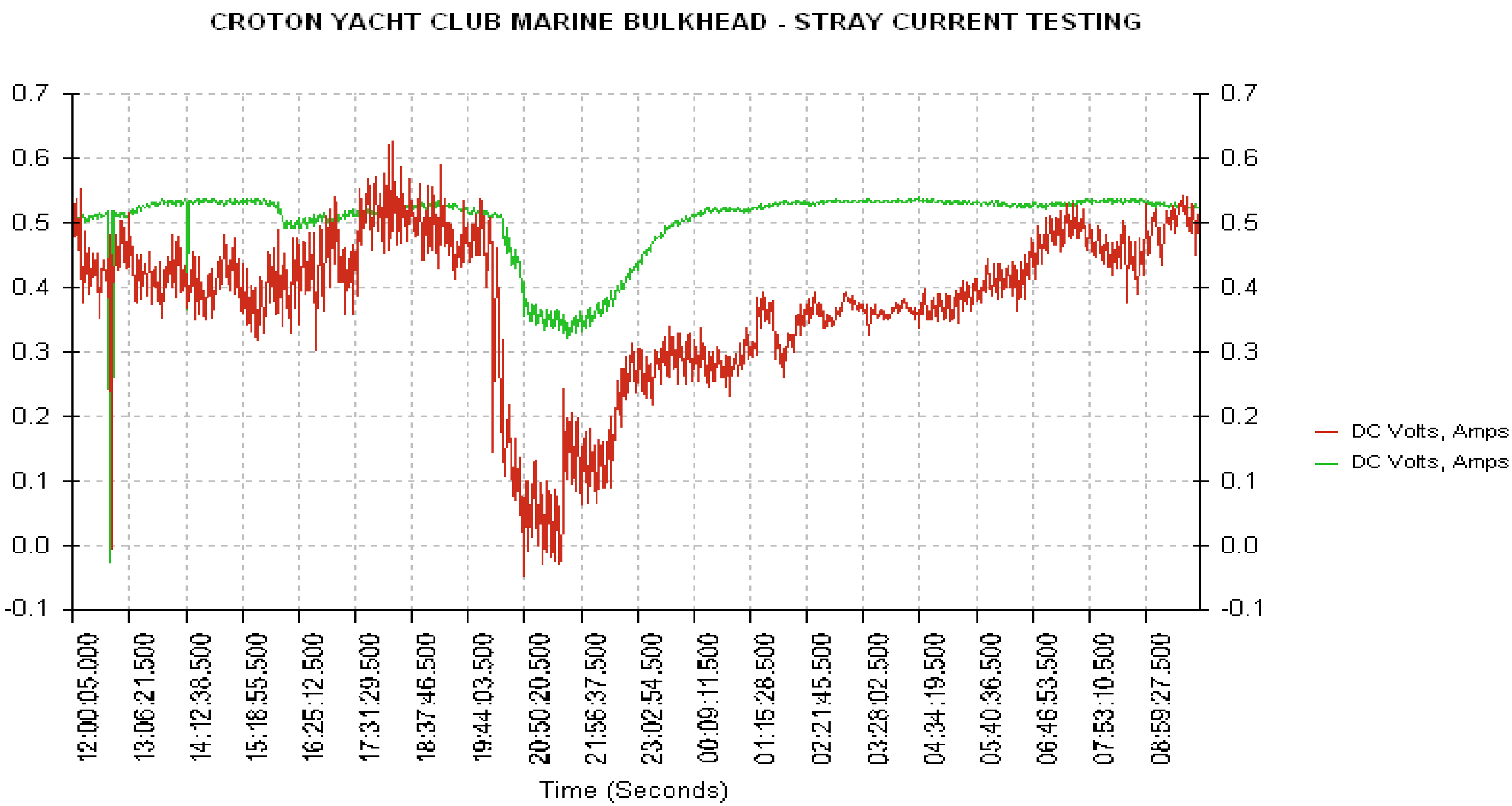
Graphs of Field Data Recordings



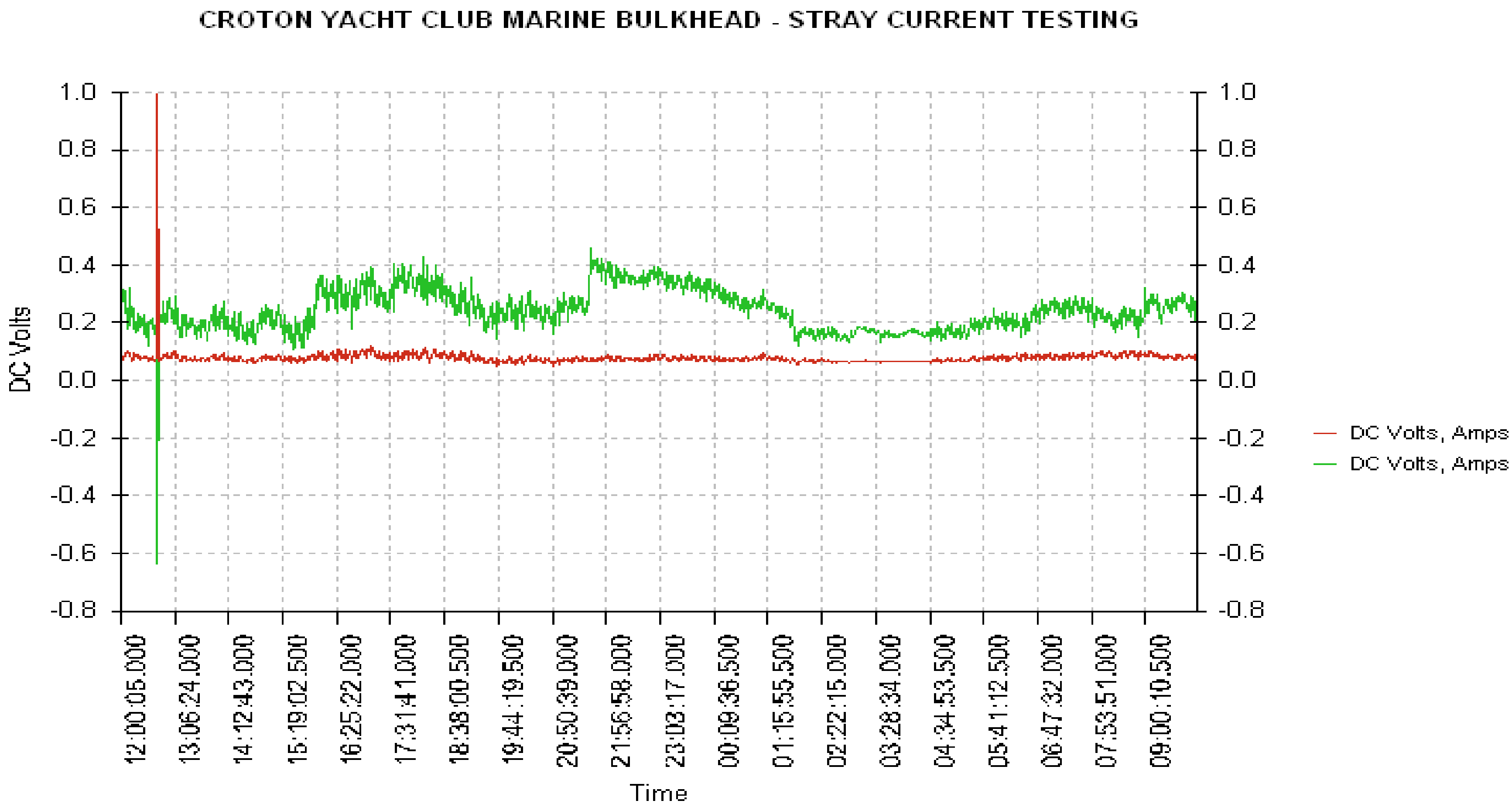
Unit: H&M 653 s/n: 02896-E20 FIGURE 3 6/13/2011 Red 1(+) - 2(-) Green 1(-) - 3(+)



Unit: H&M 653 s/n: 02896-E20 FIGURE 4 6/13/2011 Red 5(+) - 6(-) Green 6(+) - 1(-)



Unit: H&M 654 s/n: 02856-E20 FIGURE 5 6/14/2011 Red 1(+) - 5(-) Green AG/AGCL(+) - Structure(-)



Unit: H&M 656 s/n: 02943-E20 FIGURE 6 6/14/2011 Red 2(+) - 4(-) Green 5(+) - 2(-)