Prepared for

Parsons
301 Plainfield Road, Suite 350
Syracuse, New York 13212

ONONDAGA LAKE WB-B/HB IRM OUTBOARD AREA CAP-INDUCED SETTLEMENT EVALUATION AN ADDENDUM TO THE REPORT TITLED "CAP-INDUCED SETTLEMENT EVALUATION FOR REMEDIATION AREA D"

SYRACUSE AND GEDDES, NEW YORK

Prepared by

Geosyntec consultants

engineers | scientists | innovators

1255 Roberts Boulevard, Suite 200
Kennesaw, Georgia 30144

Project Number: GJ4741

March 2012

Geosyntec consultants

TABLE OF CONTENTS

1. INTRODUCTION 1

2. SUBSURFACE CONDITIONS 1

3. MATERIAL PROPERTIES 2

4. SETTLEMENT CALCULATIONS 2
   - 4.1 Methodology 2
   - 4.2 Removal Depth and Cap Thickness 2
   - 4.3 Settlement Calculations and Results 2
   - 4.4 Cumulative Upward Consolidation Water Flow 3

LIST OF TABLES

Table 1. Summary of Material Properties used in Settlement Calculations

Table 2. Dredging and Capping Condition Combinations for the Outboard Area

LIST OF FIGURES

Figure 1. WB-B/HB Outboard Area Plan

Figure 2. Settlement Calculation Results for the 30-Year Period

Figure 3. Settlement Calculation Results for the 2-Year Period (Subarea 7 Only)

Figure 4. Calculated Cumulative Consolidation Water Flow for Subareas 1 through 8

LIST OF ATTACHMENTS

Attachment A. Subsurface Layer Thickness Contours

Attachment B. Interpretation of Consolidation Parameters of Subsurface Materials

Attachment C. Example Settlement Calculation

Geosyntec consultants

TABLE OF CONTENTS (Continued)

Attachment D. Calculated Excess Pore Water Pressure Isochrones

1. INTRODUCTION

This report was prepared as an addendum to the report titled "*Cap-Induced Settlement Evaluation for Remediation Area D*" (referred to as the RA-D Cap Settlement Report) dated March 2012. It presents the evaluation of the consolidation settlement anticipated after removal and capping in the Wastebed B/Harbor Brook (WB-B/HB) Outboard Area. Specifically, this report presents: (i) the total settlement (including the primary and the secondary settlement) at the end of 30 years after capping for the entire Outboard Area and at the end of two years after capping for the subarea with the highest estimated settlement; and (ii) the upward flow rate of consolidation water.

The Outboard Area is a 16-acre strip of land that lies between Onondaga Lake and the Wastebed B barrier wall alignment, and includes the mouth of Harbor Brook and areas of wetlands along the lake shoreline, as shown in Figure 1. The Outboard Area is part of the WB-B/HB Site, which is a subsite of the Onondaga Lake Superfund site. The remedy for this area will include removal of material above and below the water table, construction of an isolation cap, and habitat restoration. The assumptions used for the analyses presented herein are based on the minimum required sediment removal to allow cap construction and habitat restoration, as developed and documented in the main text of the *Capping, Dredging, and Habitat Design Report*.

The remainder of this report presents: (i) subsurface conditions; (ii) material properties; and (iii) settlement calculations and results for the Outboard Area.

2. SUBSURFACE CONDITIONS

Information regarding the subsurface stratigraphy in the Outboard Area was presented in two calculation packages prepared previously by Geosyntec: "*Summary of Subsurface Stratigraphy and Material Properties*" for the West Wall design (referred to as the West Wall Data Package) and "*Summary of Subsurface Stratigraphy and Material Properties*" for the East Wall design (referred to as the East Wall Data Package). For the purpose of the settlement calculations presented herein, the Outboard Area was divided into 8 subareas based on the thicknesses of the Fill, SOLW, Marl, and Silt and Clay layers. Subareas 1 through 6 are located in the outboard area near the West Wall; while Subareas 7 and 8 are located in the outboard area near the East Wall. These subareas and the selected representative thicknesses of the subsurface layers are

presented in Figure 1. The thickness contours for each of the subsurface layers in the outboard area are presented in Attachment A of this report.

3. MATERIAL PROPERTIES

Information regarding the unit weights of the subsurface materials in the Outboard Area was presented in the West Wall Data Package and the East Wall Data Package. The consolidation parameters were interpreted from the laboratory test data and presented in Attachment B of this report. Hydraulic conductivity values for SOLW, Marl, and Silt and Clay were selected from the values presented in the West Wall and East Wall Data Packages. Hydraulic conductivity value for Fill material was selected based on soil type description. The material properties used for the settlement calculations are summarized in Table 1.

4. SETTLEMENT CALCULATIONS

4.1 Methodology

The same methodology presented in the RA-D Cap Settlement Report was used in the settlement calculations presented herein.

4.2 Removal Depth and Cap Thickness

The range in removal depths and cap thicknesses assumed for this analysis are based on the design presented in the main text of the *Capping, Dredging, and Habitat Design*.

4.3 Settlement Calculations and Results

The settlement calculation results for the 30-year period are presented in Figure 2. For each subarea, calculations were performed for a combination of five removal depths (i.e., 0 ft, 3 ft, 6 ft, 9 ft, and 12 ft) and three cap thicknesses (i.e., 2 ft, 4 ft, and 6 ft). Additional settlement calculations were performed for the 2-year period after capping. Subarea 7 was selected because it has the largest calculated settlement for the 30-year period. The results for Subarea 7 for the 2-year period are presented in Figure 3.

An example calculation using an Excel® spreadsheet is included in Attachment C of this report. The Excel® spreadsheets for all the settlement calculations presented in this report are included in the attached CD.

It should be noted that the following assumptions were made in the settlement calculations:

- The SOLW, Marl, and Silt and Clay layers were assumed as one layer for the purpose of calculating the time needed to reach 90% primary consolidation because the c_v values for these three layers are similar and much smaller than that of the Fill layer.

- The Fill layer was assumed to have single drainage due to the relatively low permeability layer underneath. The combined SOLW, Marl, and Silt and Clay layer was assumed to have double drainage due to the relatively high permeability materials above (i.e., Fill) and underneath (i.e., Silt and Sand).

The settlement calculation results indicate that generally the calculated settlement increases as the removal depth decreases or the cap thickness increases. However, the calculated settlement becomes less sensitive to either the removal depth or the cap thickness when the removal depth is greater than approximately 6 ft.

4.4 Cumulative Upward Consolidation Water Flow

The same methodology presented in the RA-D Cap Settlement Report was used in the cumulative upward consolidation water flow calculations presented herein. The assumptions made in the settlement analysis were also applied to the upward water flow calculations. Calculations of the cumulative upward consolidation water flow for Subareas 1-8 were performed using the capping/dredging condition combinations summarized in Table 2, which are based on the Capping, Dredging, and Habitat Design Report. Figure 4 presents the results of these analyses. The calculated excess pore water pressure isochrones for Subareas 1 through 8 are provided in Attachment D of this report. These isochrones indicate that the excess pore water pressure in the Fill dissipates more rapidly than the pressures in the underlying layers. After most of the excess pore water pressure in the Fill has dissipated, the combined layer behaves similarly to a doubly drained layer. Subarea 4 has the highest calculated cumulative upward water flow at the end of 30 years, and hence is used for the cap modeling.

TABLES

Table 1. Summary of Material Properties used in Settlement Calculations

Area	Material	Unit Weight (pcf)	Hydraulic Conductivity (cm/s)	Recommended Consolidation Parameters			
				$C_{c\varepsilon}$	$C_{r\varepsilon}$	$C_{\alpha\varepsilon}$	c_v (ft^2/d)
Outboard Area near West Wall (Subareas 1 through 6)	Fill[1]	105	5×10^{-4}	0.061	0.006	0.0003	4.50
	SOLW	80	1×10^{-5}	0.042[2]	0.003	0.0006	0.60[3]
	Marl	101	1×10^{-6}	0.152	0.010	0.0008	0.50
	Silt and Clay	118	1×10^{-7}	0.117	0.013	0.0015	0.15
Outboard Area near East Wall (Subareas 7 and 8)	Fill	92	5×10^{-4}	0.061	0.006	0.0003	4.50
	Marl	97	1×10^{-6}	0.176	0.010	0.0030	0.25[3]
	Silt and Clay	111	1×10^{-7}	0.129	0.013	0.0015	0.15

Notes:

[1]. The consolidation parameters of Fill in the Outboard Area near the West Wall were assumed to be the same as the those near the East Wall.

[2]. The $C_{c\varepsilon}$ value of SOLW corresponds to the low stress range and takes into account the effect of overconsolidation. This was discussed in the RA-D Cap Settlement Report.

[3]. As mentioned in this report, the SOLW, Marl, and Silt and Clay layers were assumed as one layer for the purpose of calculating the time needed to reach 90% primary consolidation because the c_v values for these three layers are similar and much smaller than that of the Fill layer. In the Outboard Area near the West Wall, the c_v value of SOLW was applied to the combined layer. In the Outboard Area near the East Wall, the c_v value of Marl was applied to the combined layer.

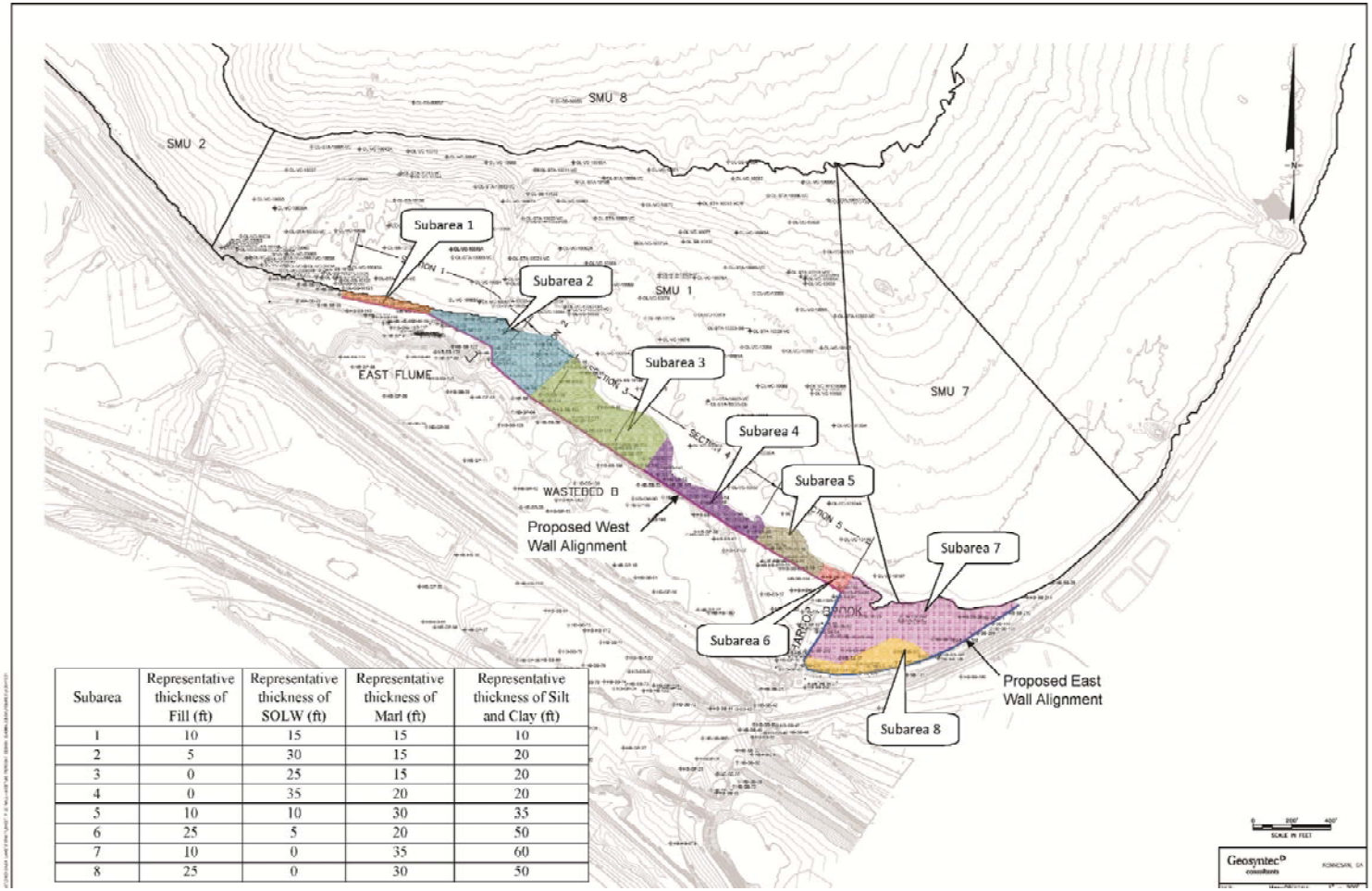
Table 2. Dredging and capping condition combinations for the Outboard Area

Subarea	Minimum Dredge Cut (ft)	Cap Thickness (ft)
1	6	4
2	9	
3	7	
4	5	
5	5	
6	5	
7	6	
8	6	

Note:

1. The combinations shown in the table were provided to Geosyntec by Parsons.

FIGURES



Subarea	Representative thickness of Fill (ft)	Representative thickness of SOLW (ft)	Representative thickness of Marl (ft)	Representative thickness of Silt and Clay (ft)
1	10	15	15	10
2	5	30	15	20
3	0	25	15	20
4	0	35	20	20
5	10	10	30	35
6	25	5	20	50
7	10	0	35	60
8	25	0	30	50

Figure 1. WB-B/HB Outboard Area Plan

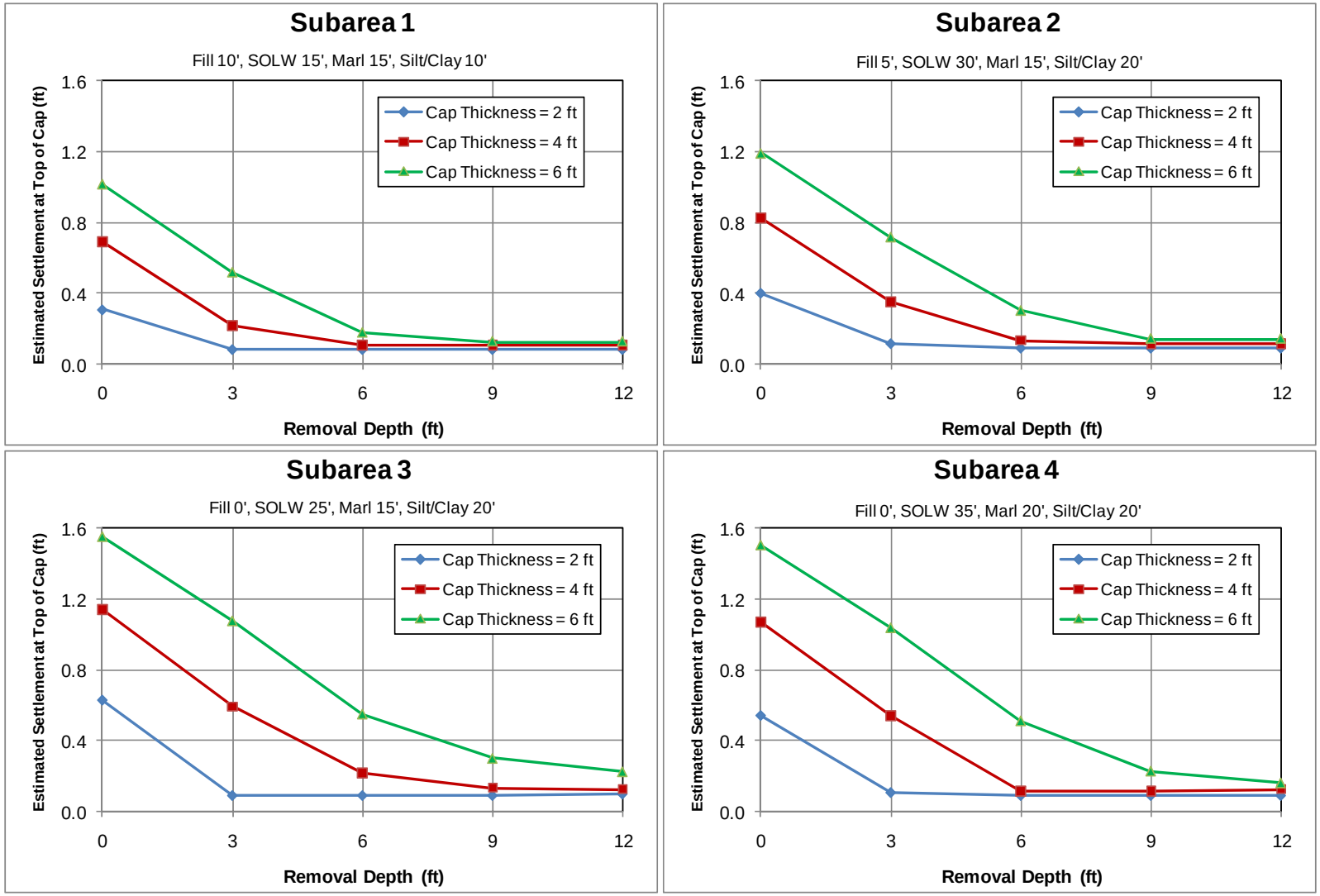


Figure 2. Settlement Calculation Results for the 30-Year Period

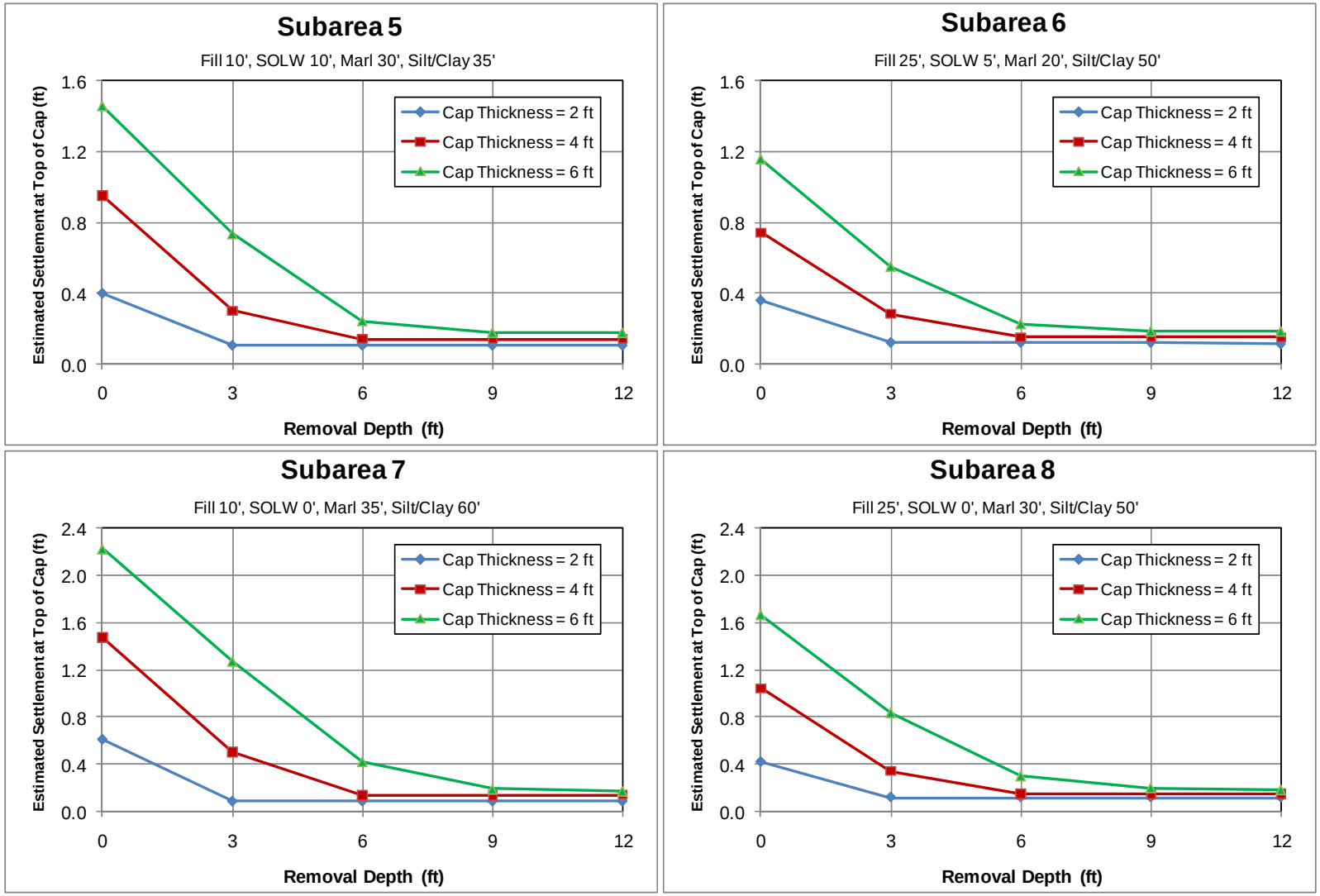


Figure 2. Settlement Calculation Results for the 30-Year Period (continued)

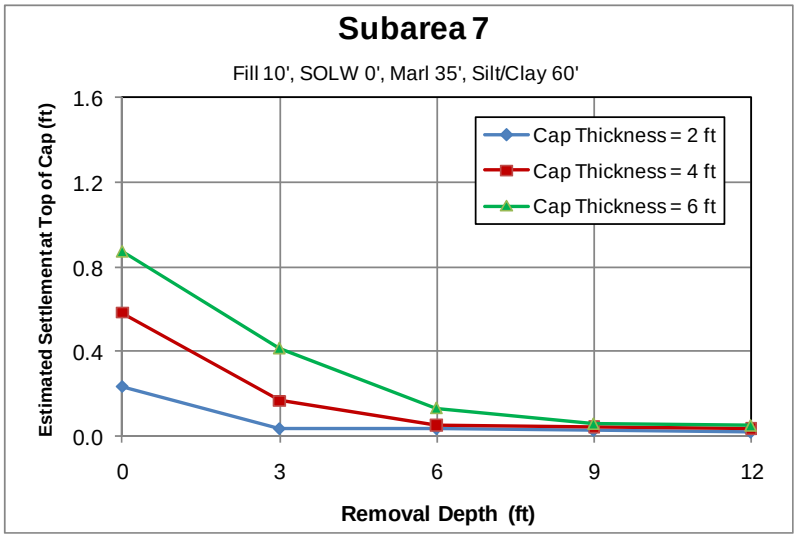


Figure 3. Settlement Calculation Results for the 2-Year Period (Subarea 7 Only)

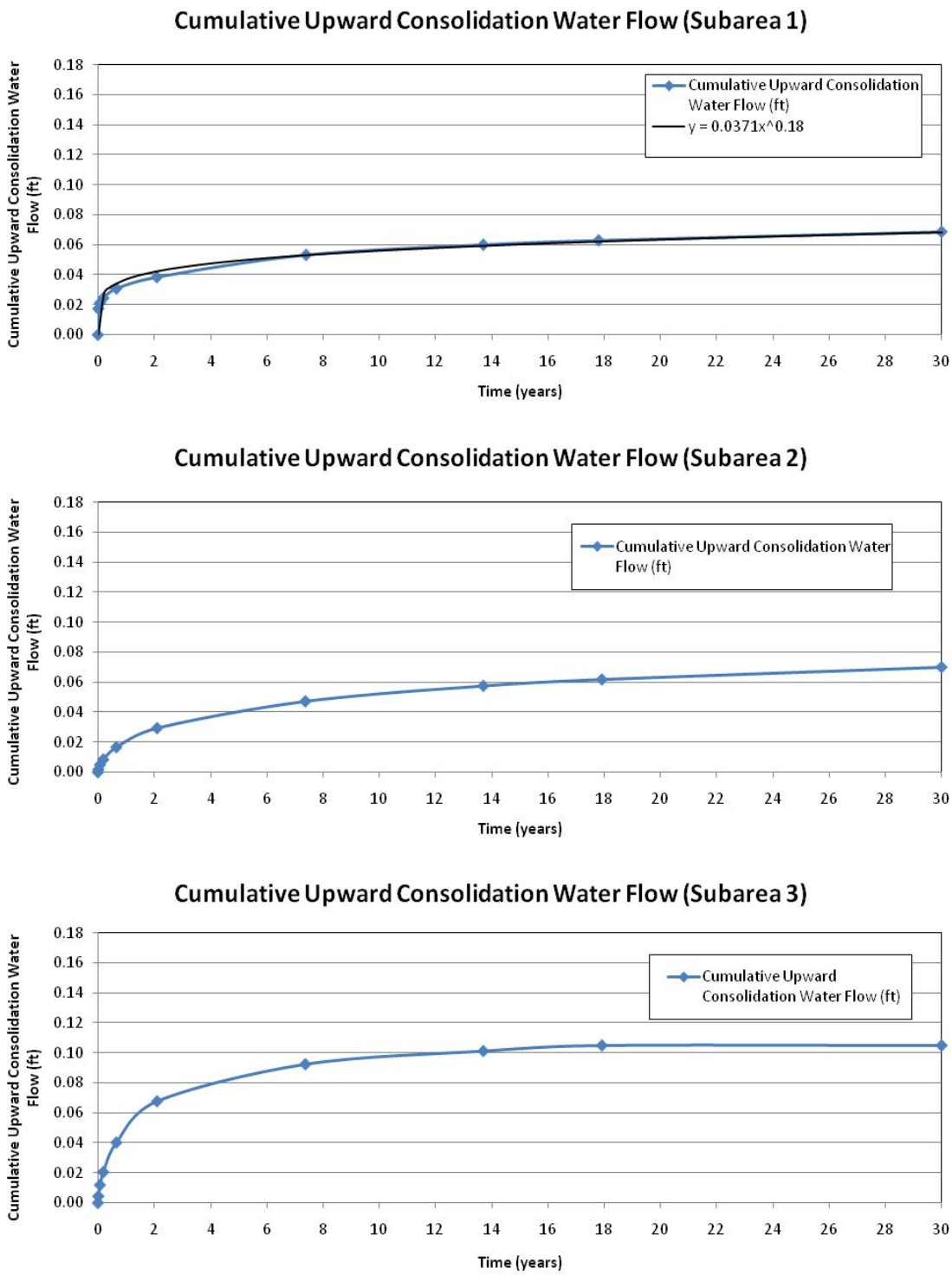
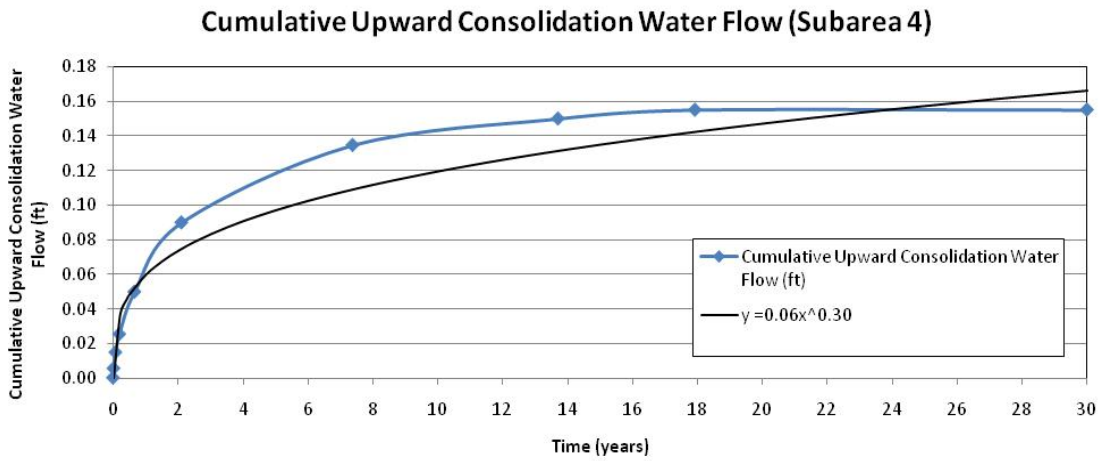
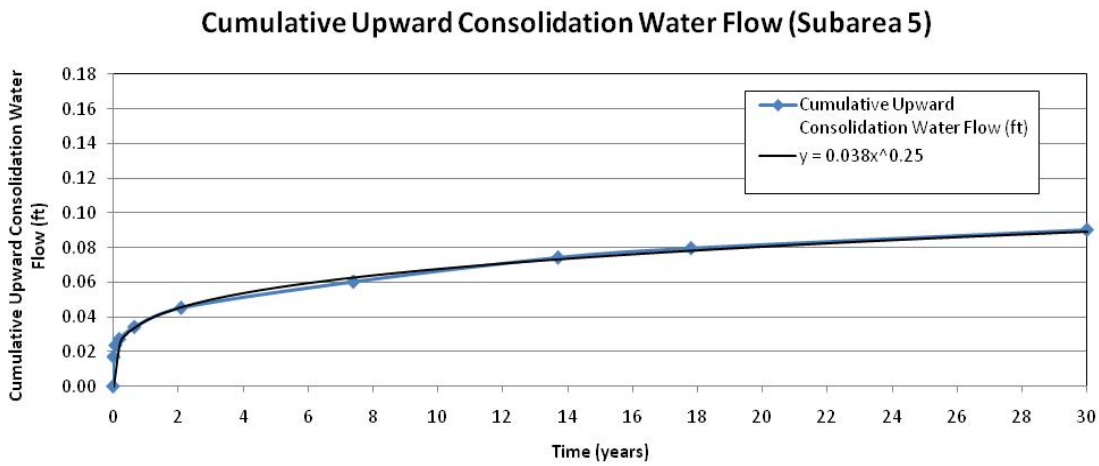


Figure 4. Calculated Cumulative Consolidation Water Flow for Subareas 1 through 8





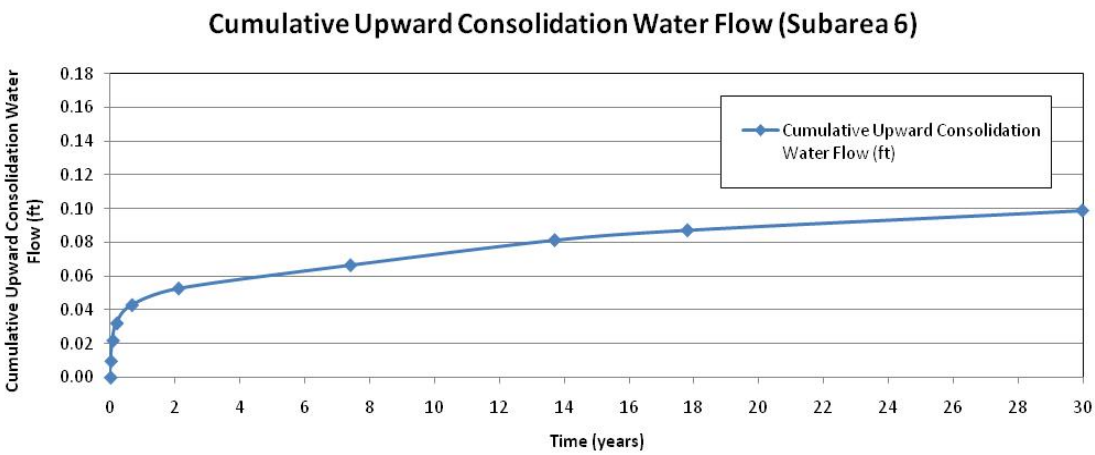
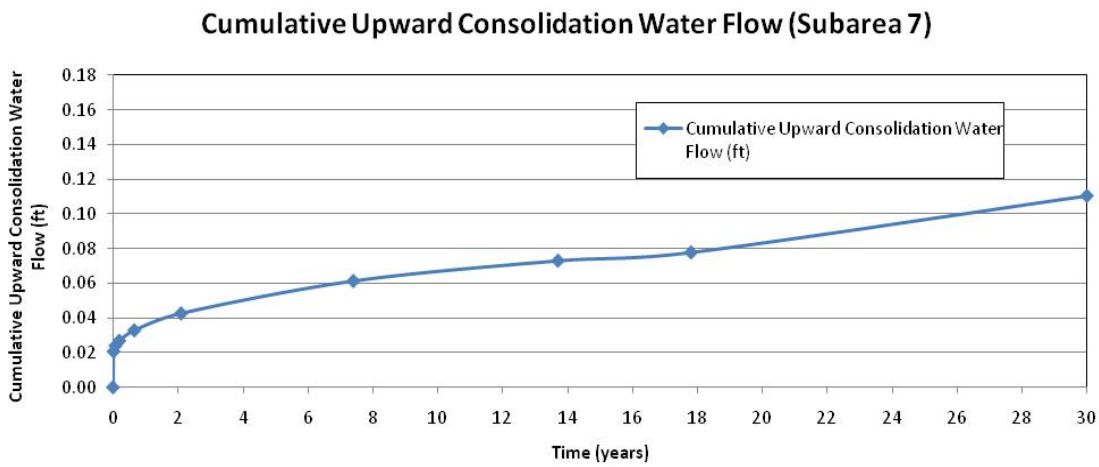


Figure 4. Calculated Cumulative Consolidation Water Flow for Subareas 1 through 8 (Continued)

Note: For Subarea 4, curve fit was selected to achieve the optimum fit for the maximum rate of upward water flow based on recommendations of the cap modelers.



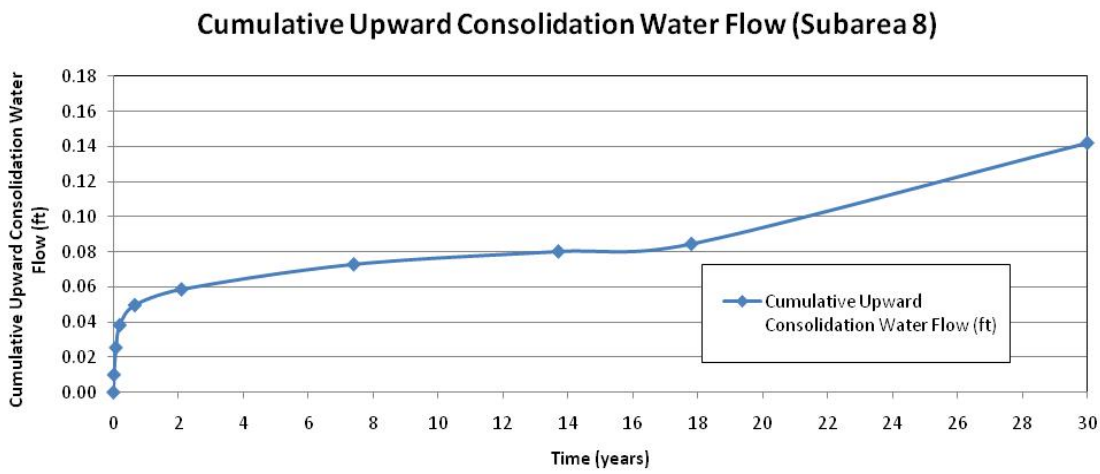


Figure 4. Calculated Cumulative Consolidation Water Flow for Subareas 1 through 8 (Continued)

Note: For Subareas 7 and 8, material properties of Marl were used for the bottom layer due to the absence of SOLW (see Table 1), and hence resulted in slightly different shaped curves as compared to the other subareas.

ATTACHMENT A

SUBSURFACE LAYER THICKNESS CONTOURS

(WB-B/HB OUTBOARD AREA)

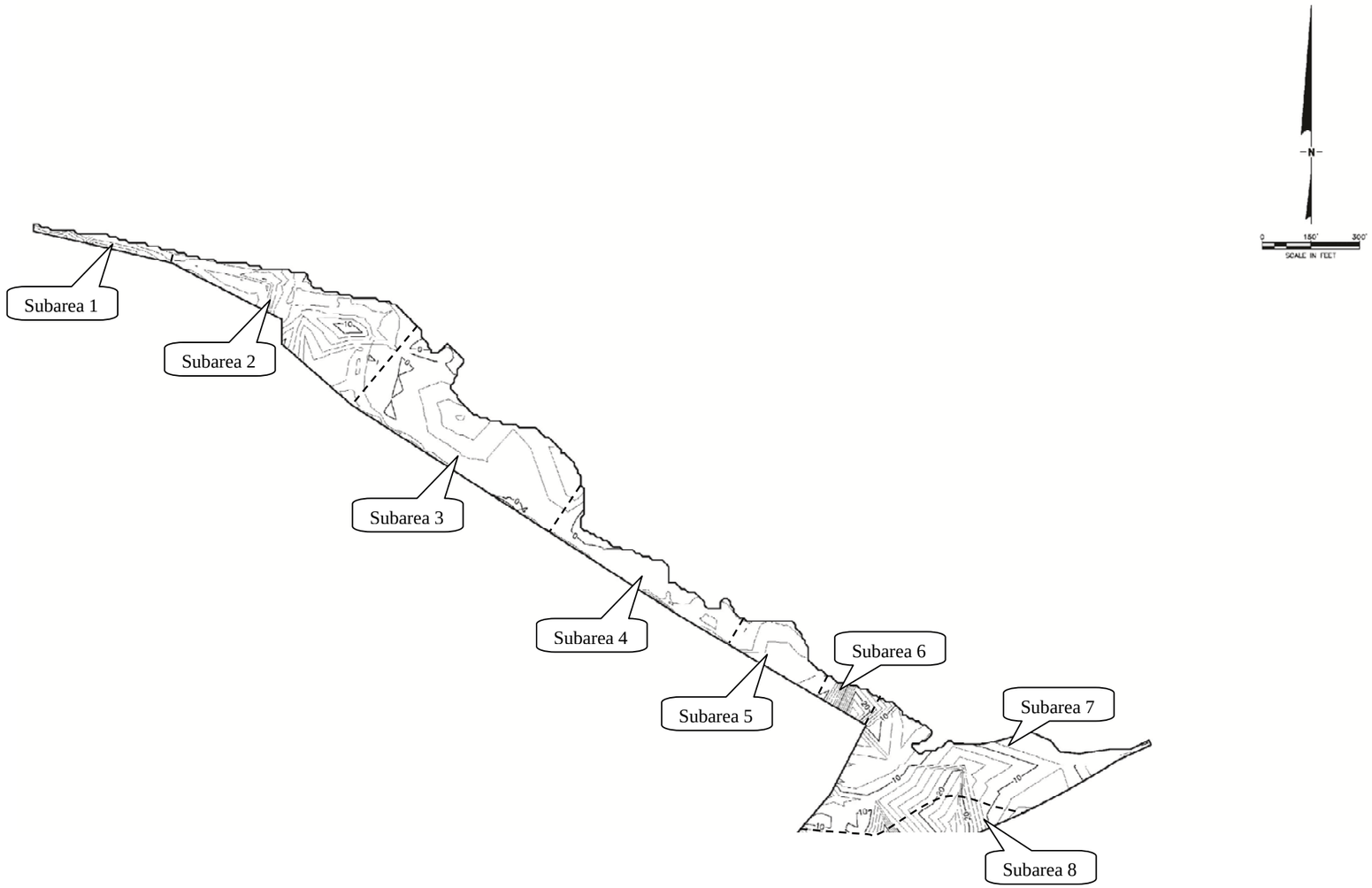


Figure A-1. Thickness of Fill in WB-B/HB Outboard Area

Note:

1. The subsurface thickness contours were developed based on the elevations of each layer interpreted from the available boring logs. This note applies to all the other figures included in this attachment.

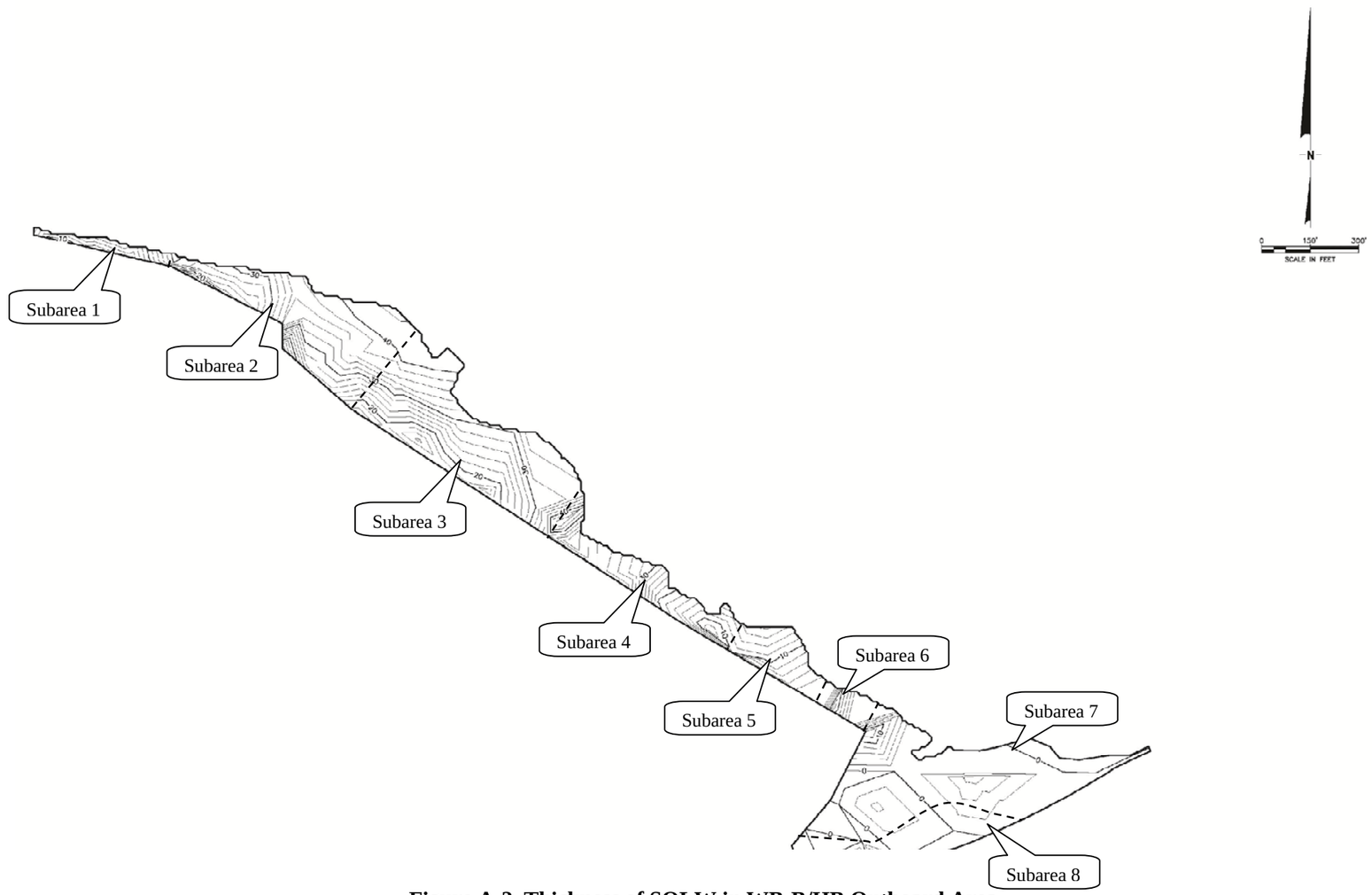


Figure A-2. Thickness of SOLW in WB-B/HB Outboard Area

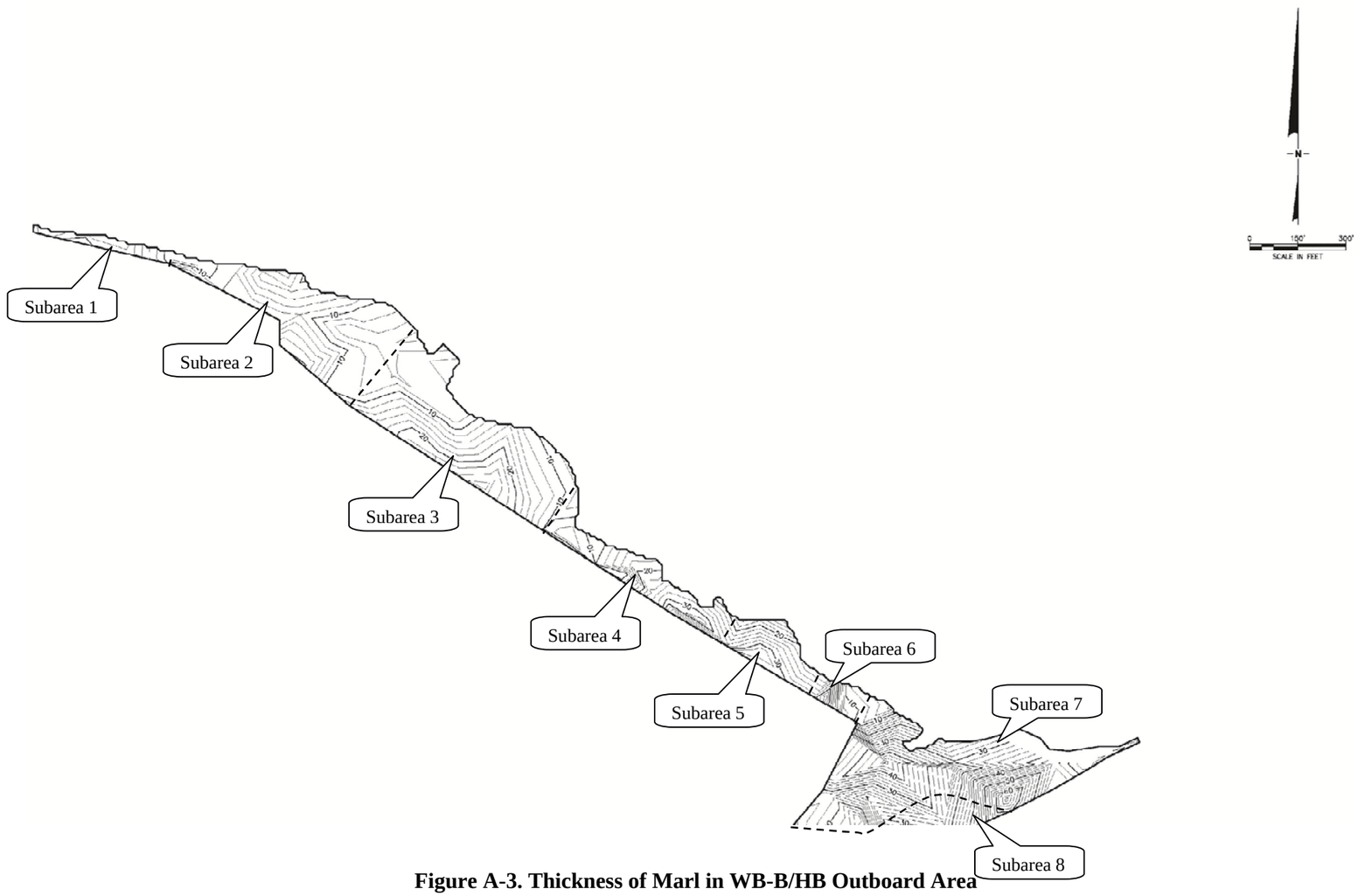


Figure A-3. Thickness of Marl in WB-B/HB Outboard Area

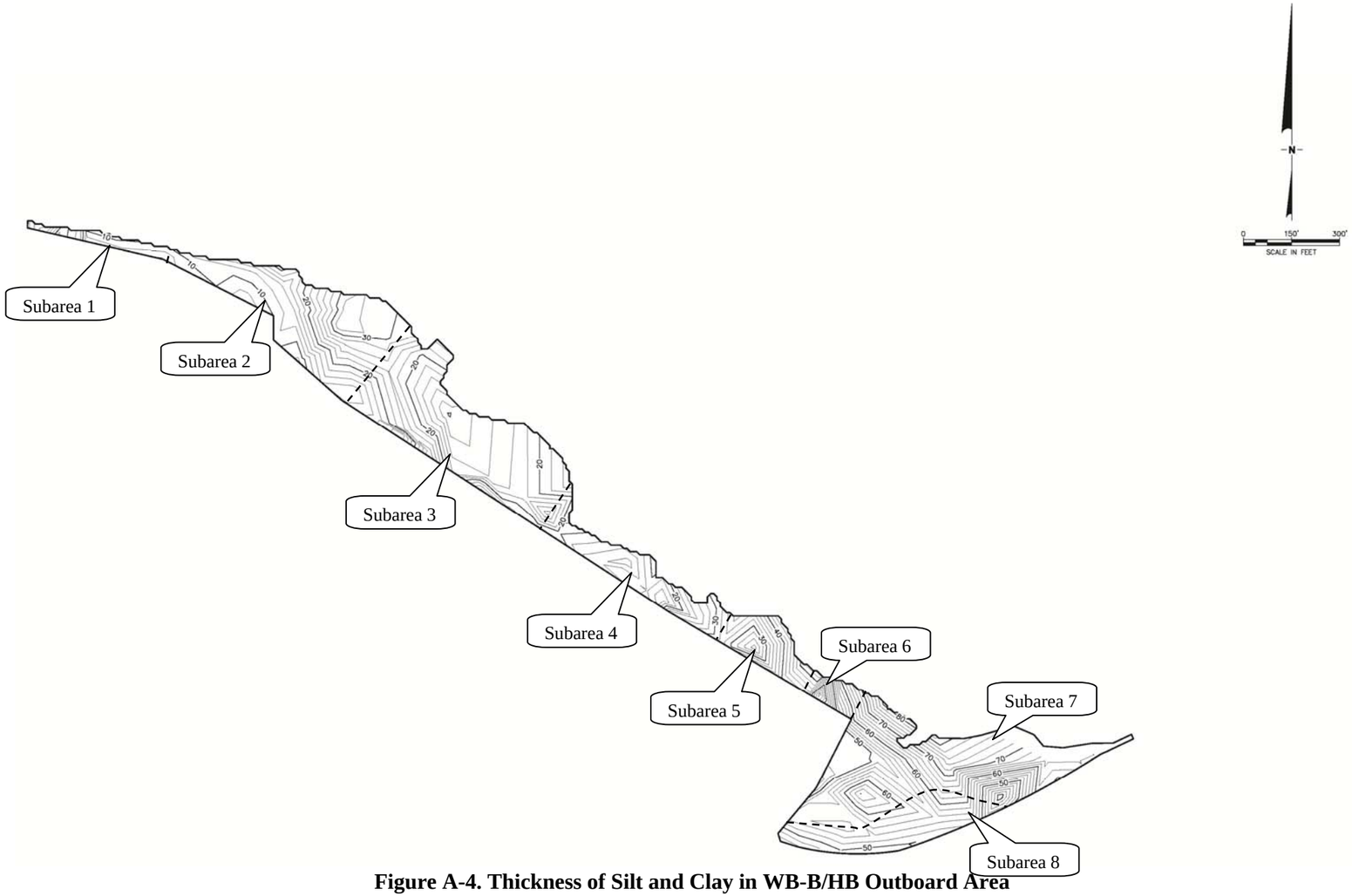


Figure A-4. Thickness of Silt and Clay in WB-B/HB Outboard Area

Note:

1. Thickness of Silt and Clay was estimated based on a limited number of deep borings that penetrated the Silt and Clay layer.

ATTACHMENT B

INTERPRETATION OF CONSOLIDATION PARAMETERS OF SUBSURFACE MATERIALS

(WB-B/HB OUTBOARD AREA)

This attachment presents the interpretation of the consolidation parameters that were used for the cap-induced settlement calculations for the WB-B/HB outboard area near the West and East Walls. The consolidation parameters include the modified compression index ($C_{c\varepsilon}$), modified recompression index ($C_{r\varepsilon}$), modified secondary compression index ($C_{\alpha\varepsilon}$), and coefficient of consolidation (C_v). These parameters were interpreted from the available laboratory consolidation test data.

The interpreted values for $C_{c\varepsilon}$ and $C_{r\varepsilon}$ of SOLW, Marl, and Silt and Clay are presented in Tables B-1 through B-6. The recommended consolidation parameters (i.e., mean values) are summarized in Table B-7. The interpretation of $C_{\alpha\varepsilon}$ and C_v for SOLW, Marl, and Silt and Clay are presented in Figures B-1 through B-12. The selected representative values shown on these figures were used for the settlement calculations.

Table B-1. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ for SOLW in Outboard Area near West Wall

Sample Location ID	Depth (ft)	Initial Void Ratio e_0	C_c [2]	C_r	$C_{c\varepsilon}$ [1,2]	$C_{r\varepsilon}$ [1]
HB-SB-02	10-12	3.16	0.04	0.01	0.010	0.002
HB-SB-18	10-12	1.72	0.18	0.01	0.065	0.004
HB-SB-126	5-7	3.07	0.21	0.02	0.051	0.004
HB-SB-143	22-24	3.73	0.20	0.01	0.043	0.002
				Mean Value	0.042	0.003
				Maximum Value	0.065	0.004
				Minimum Value	0.010	0.002
				Standard Deviation	0.023	0.001
				Mean plus Standard Deviation	0.066	0.004
				Mean minus Standard Deviation	0.019	0.002

Notes:

[1]. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ are modified compression index and recompression index, respectively. They are calculated as follows: $C_{c\varepsilon} = C_c / (1+e_0)$ and $C_{r\varepsilon} = C_r / (1+e_0)$. This note also applies to Tables B-2 through B-6.

[2]. C_c and $C_{c\varepsilon}$ values of SOLW correspond to the low stress range, as discussed in the RA-D Cap Settlement Report.

Table B-2. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ for Marl in Outboard Area near West Wall

Sample Location ID	Depth (ft)	Initial Void Ratio e_0	C_c	C_r	$C_{c\varepsilon}$	$C_{r\varepsilon}$
HB-SB-01	20-22	1.62	0.31	0.01	0.118	0.004
HB-SB-15	24-26	1.57	0.33	0.04	0.129	0.016
HB-SB-126	36-38	2.56	0.83	0.02	0.233	0.006
HB-SB-143	42-44	1.08	0.27	0.03	0.129	0.015
				Mean Value	0.152	0.010
				Maximum Value	0.233	0.016
				Minimum Value	0.118	0.004
				Standard Deviation	0.054	0.006
				Mean plus Standard Deviation	0.206	0.016
				Mean minus Standard Deviation	0.098	0.004

Table B-3. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ for Silt and Clay in Outboard Area near West Wall

Sample Location ID	Depth (ft)	Initial Void Ratio e_0	C_c	C_r	$C_{c\varepsilon}$	$C_{r\varepsilon}$
HB-SB-09	38-40	0.58	0.07	0.01	0.044	0.006
HB-SB-15	40-42	0.87	0.15	0.01	0.080	0.005
HB-SB-01	44-46	0.89	0.28	0.03	0.148	0.016
HB-SB-27	54-56	1.29	0.26	0.02	0.114	0.009
HB-SB-25	62-64	1.20	0.47	0.03	0.214	0.014
HB-SB-126	48-50	0.84	0.18	0.04	0.101	0.019
HB-SB-143	64-66	0.92	0.22	0.05	0.116	0.024
				Mean Value	0.117	0.013
				Maximum Value	0.214	0.024
				Minimum Value	0.044	0.005
				Standard Deviation	0.054	0.007
				Mean plus Standard Deviation	0.170	0.020
				Mean minus Standard Deviation	0.063	0.006

Table B-4. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ for Fill in Outboard Area near East Wall

Sample Location ID	Depth (ft)	Initial Void Ratio e_0	C_c	C_r	$C_{c\varepsilon}$	$C_{r\varepsilon}$
HB-SB-202	5-7	0.86	0.11	0.01	0.061	0.006
				Mean Value	0.061	0.006

Table B-5. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ for Marl in Outboard Area near East Wall

Sample Location ID	Depth (ft)	Initial Void Ratio e_0	C_c	C_r	$C_{c\varepsilon}$	$C_{r\varepsilon}$
HB-SB-209	34-36	1.61	0.51	0.05	0.194	0.020
HB-SB-97	24-26	2.38	0.76	0.04	0.224	0.013
HB-SB-102	40-42	1.56	0.38	0.03	0.150	0.011
HB-SB-107	14-16	2.56	0.71	0.01	0.199	0.004
HB-SB-20	22-24	1.54	0.29	0.01	0.114	0.004
Mean Value					0.176	0.010
Maximum Value					0.224	0.020
Minimum Value					0.114	0.004
Standard Deviation					0.044	0.007
Mean plus Standard Deviation					0.220	0.017
Mean minus Standard Deviation					0.132	0.004

Table B-6. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ for Silt and Clay in Outboard Area near East Wall

Sample Location ID	Depth (ft)	Initial Void Ratio e_0	C_c	C_r	$C_{c\varepsilon}$	$C_{r\varepsilon}$
HB-SB-97	60-62	0.74	0.11	0.01	0.066	0.008
HB-SB-102	54-56	2.14	0.57	0.05	0.183	0.017
HB-SB-104	76-78	0.94	0.27	0.03	0.138	0.015
				Mean Value	0.129	0.013
				Maximum Value	0.183	0.017
				Minimum Value	0.066	0.008
				Standard Deviation	0.059	0.004
				Mean plus Standard Deviation	0.188	0.018
				Mean minus Standard Deviation	0.070	0.009

Table B-7. Summary of Recommended Consolidation Parameters for Settlement Calculations

Area	Material	Recommended Consolidation Parameters			
		$C_{c\varepsilon}$	$C_{r\varepsilon}$	$C_{\alpha\varepsilon}$	c_v (ft^2/d)
Outboard Area near West Wall	SOLW	0.042[1]	0.003	0.0006	0.60
	Marl	0.152	0.010	0.0008	0.50
	Silt and Clay	0.117	0.013	0.0015	0.15
Outboard Area near East Wall	Fill	0.061	0.006	0.0003	4.50
	Marl	0.176	0.010	0.0030	0.25
	Silt and Clay	0.129	0.013	0.0015	0.15

Note:

1. The $C_{c\varepsilon}$ value of SOLW corresponds to the low stress range, as discussed in the RA-D Cap Settlement Report..

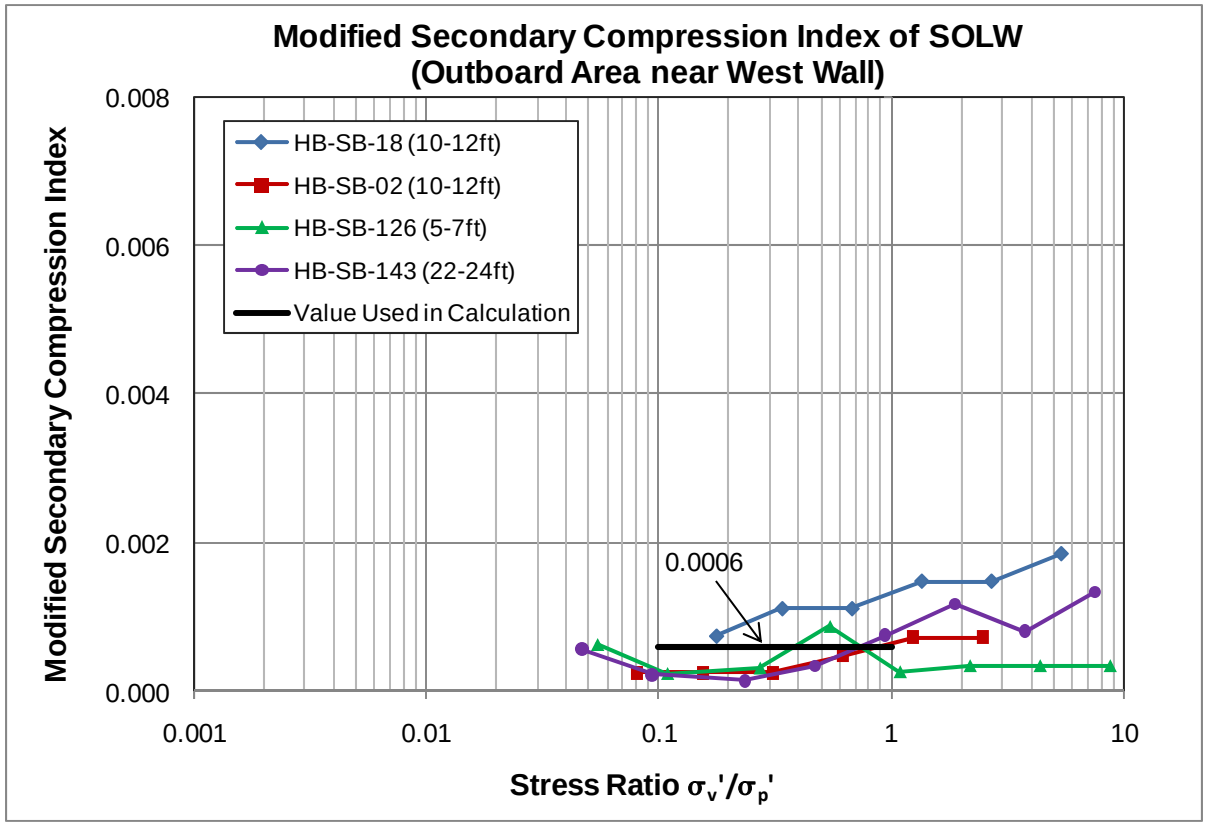


Figure B-1. Interpretation of Modified Secondary Compression Index for SOLW (Outboard Area near West Wall)

Note:
The ratio of σ_v'/σ_p' of SOLW in the field before and after capping was estimated to be between 0.1 and 1 according to the assumed subsurface layer thicknesses.

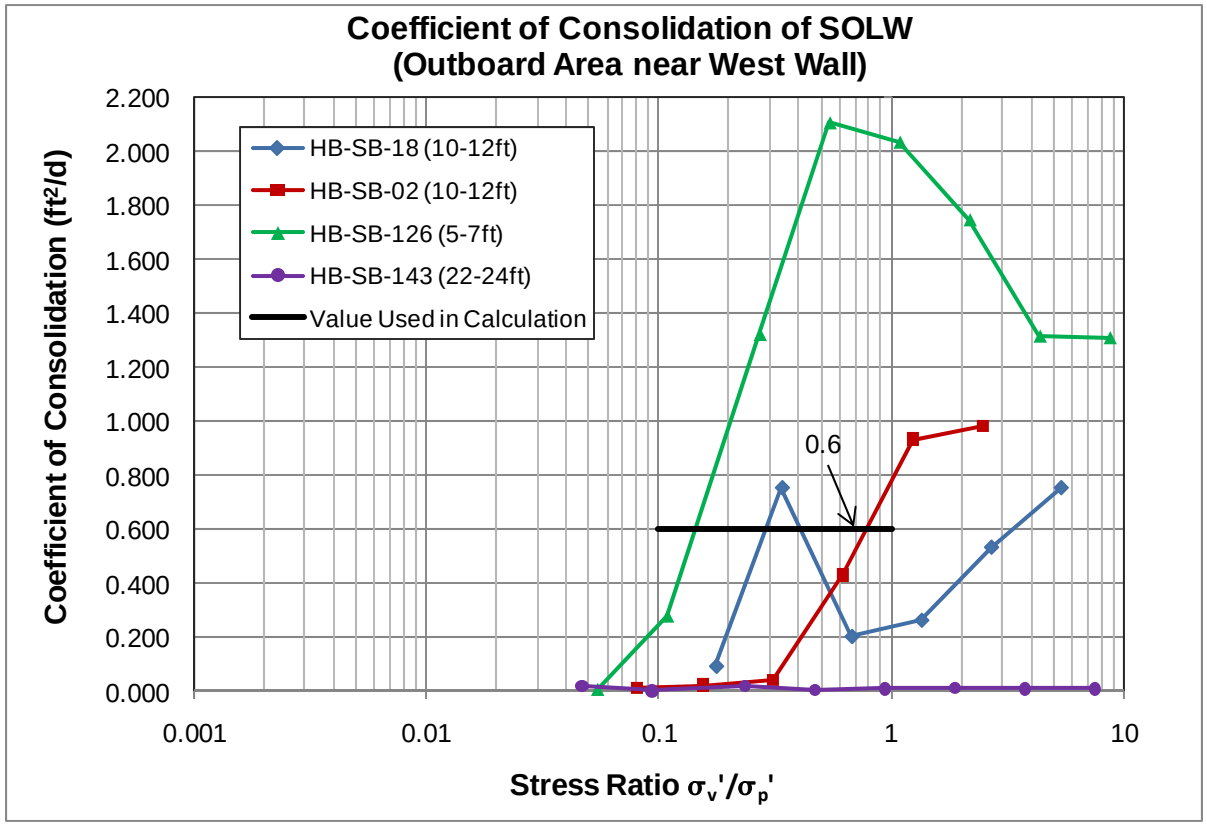


Figure B-2. Interpretation of Coefficient of Consolidation for SOLW
(Outboard Area near West Wall)

Note:
The ratio of σ_v'/σ_p' of SOLW in the field before and after capping was estimated to be between 0.1 and 1 according to the assumed subsurface layer thicknesses.

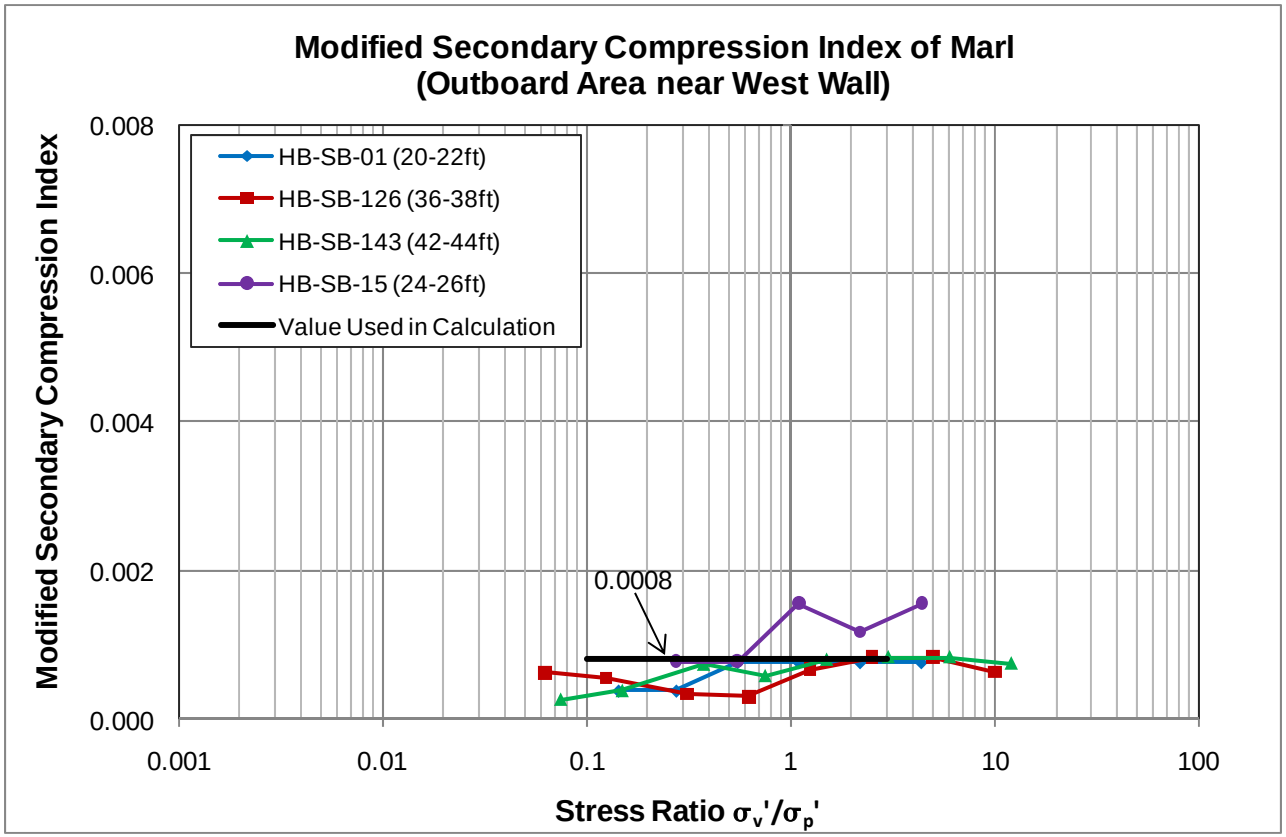


Figure B-3. Interpretation of Modified Secondary Compression Index for Marl (Outboard Area near West Wall)

Note:
The ratio of σ_v'/σ_p' of Marl in the field before and after capping was estimated to be between 0.1 and 3 according to the assumed subsurface layer thicknesses.

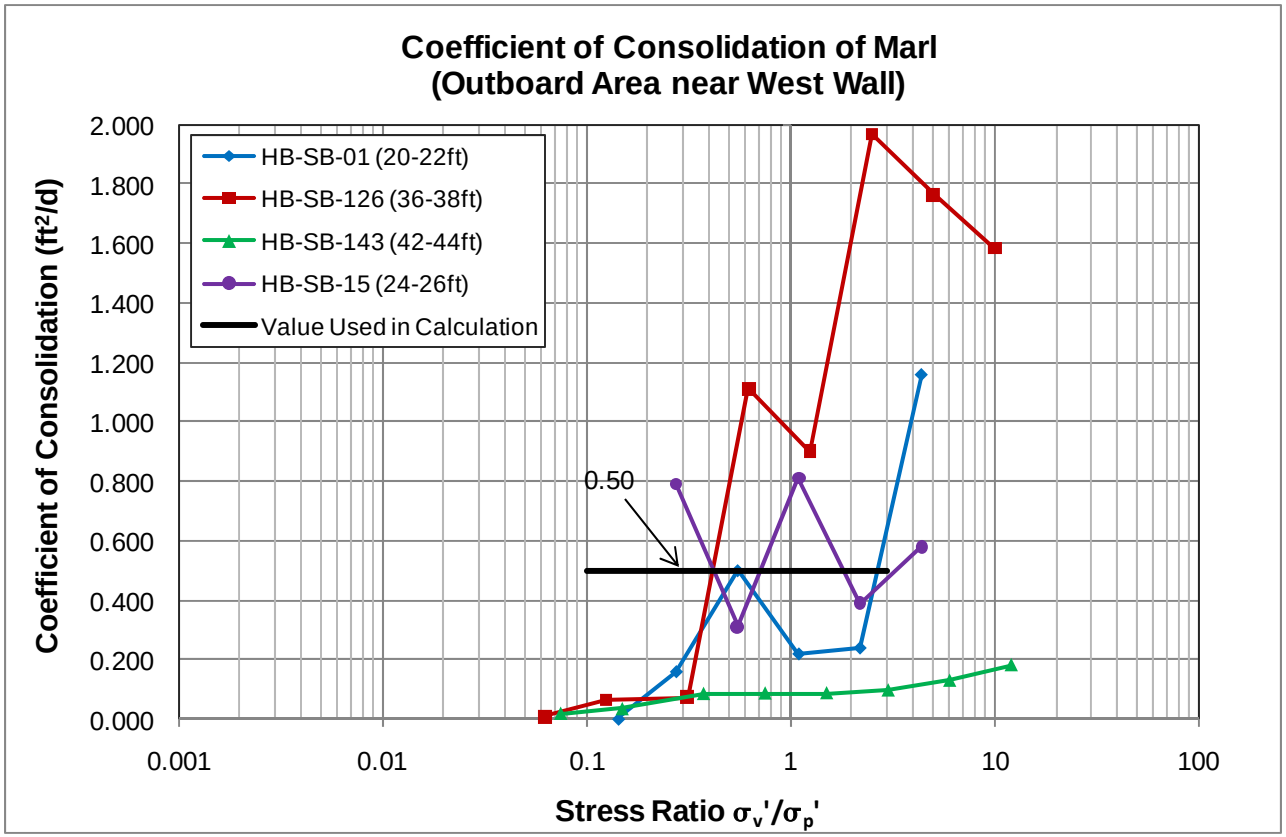


Figure B-4. Interpretation of Coefficient of Consolidation for Marl
(Outboard Area near West Wall)

Note:
The ratio of σ_v'/σ_p' of Marl in the field before and after capping was estimated to be between 0.1 and 3 according to the assumed subsurface layer thicknesses.

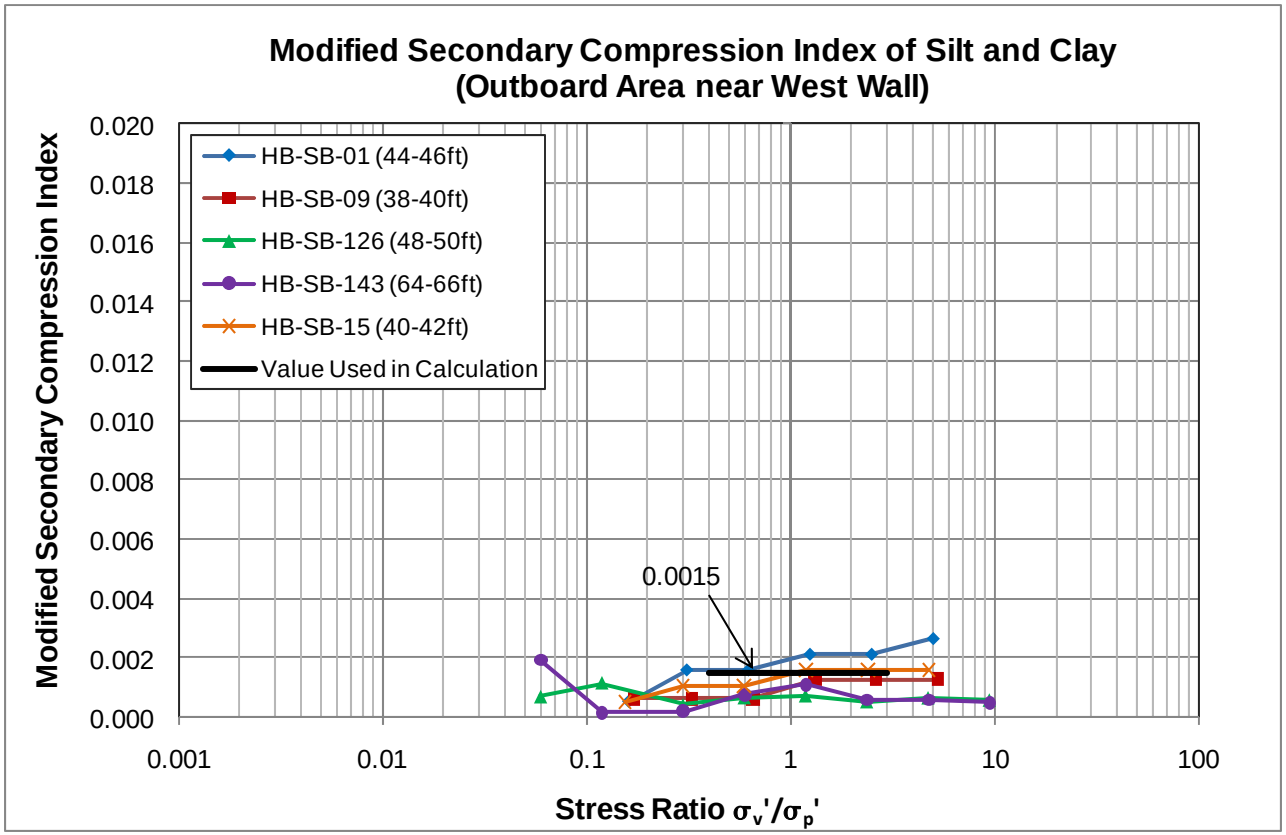


Figure B-5. Interpretation of Modified Secondary Compression Index for Silt and Clay (Outboard Area near West Wall)

Note:
The ratio of σ_v'/σ_p' of Silt and Clay in the field before and after capping was estimated to be between 0.4 and 2 according to the assumed subsurface layer thicknesses.

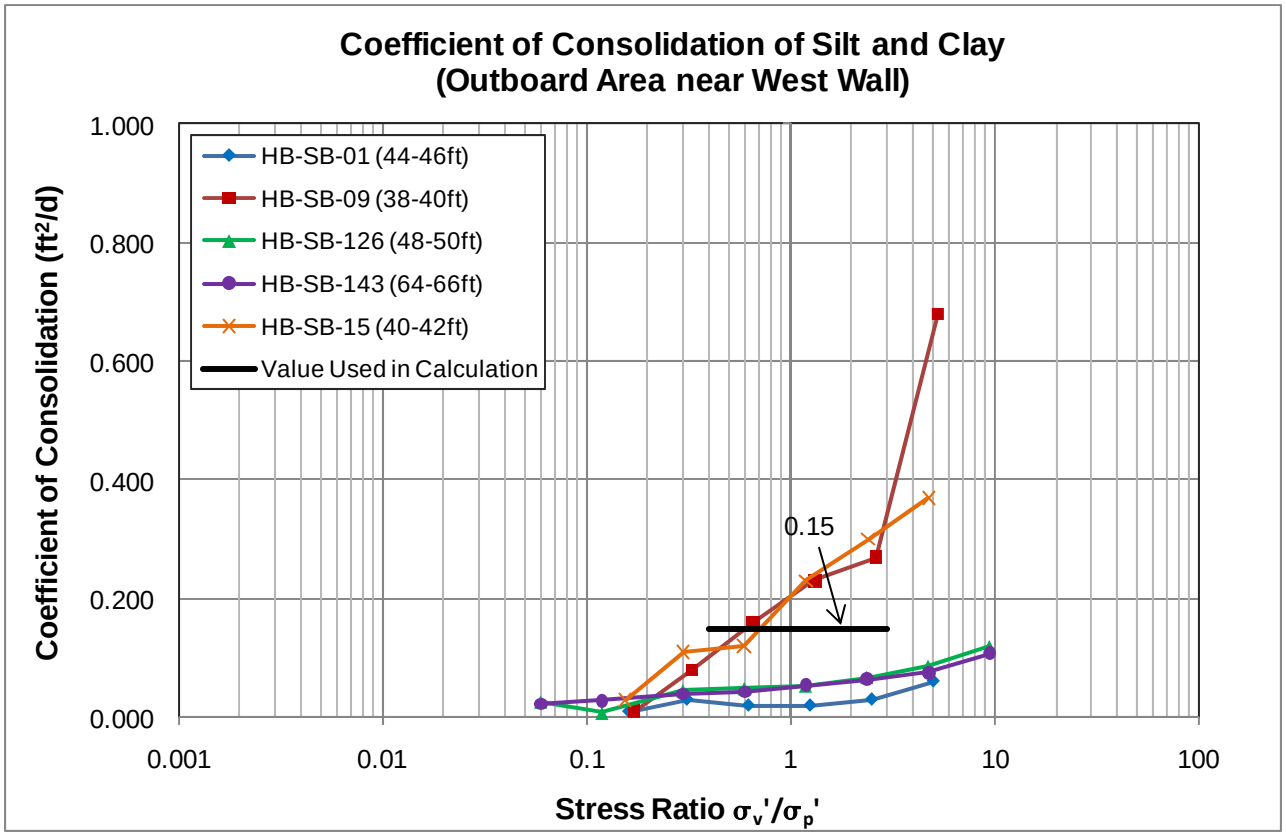


Figure B-6. Interpretation of Coefficient of Consolidation for Silt and Clay
(Outboard Area near West Wall)

Note:
The ratio of σ_v'/σ_p' of Silt and Clay in the field before and after capping was estimated to be between 0.4 and 2 according to the assumed subsurface layer thicknesses.

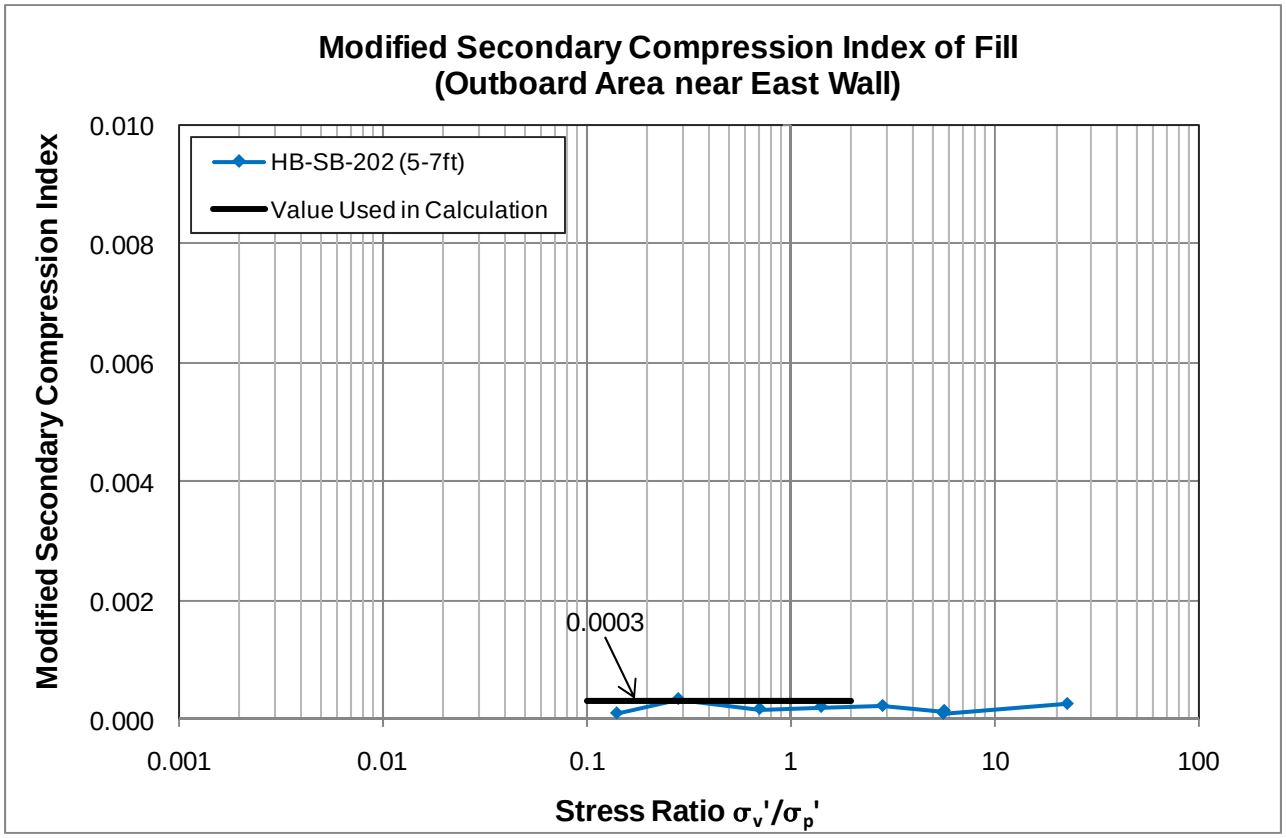


Figure B-7. Interpretation of Modified Secondary Compression Index for Fill (Outboard Area near East Wall)

Note:
The ratio of σ_v'/σ_p' of Fill in the field before and after capping was estimated to be between 0.1 and 2 according to the assumed subsurface layer thicknesses.

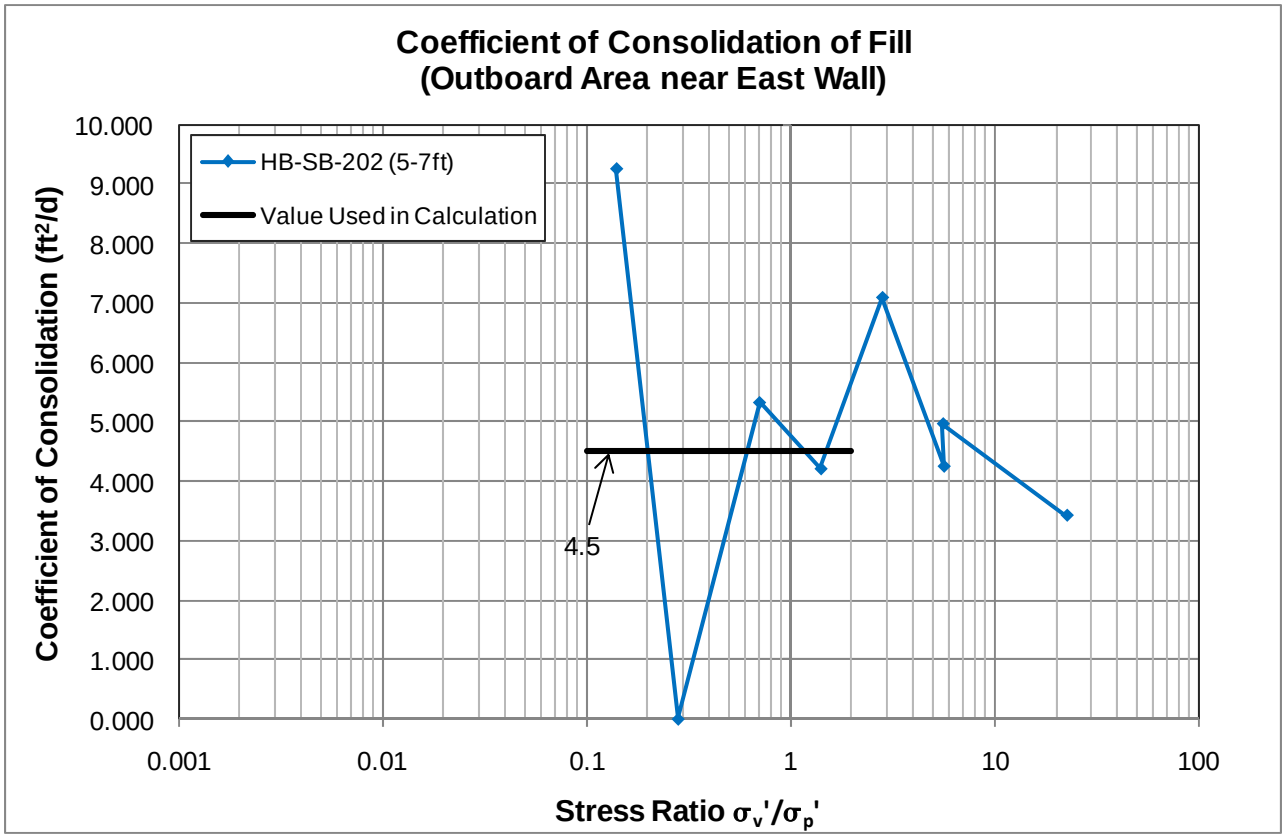


Figure B-8. Interpretation of Coefficient of Consolidation for Fill
(Outboard Area near East Wall)

Note:
The ratio of σ_v'/σ_p' of Fill in the field before and after capping was estimated to be between 0.1 and 2 according to the assumed subsurface layer thicknesses.

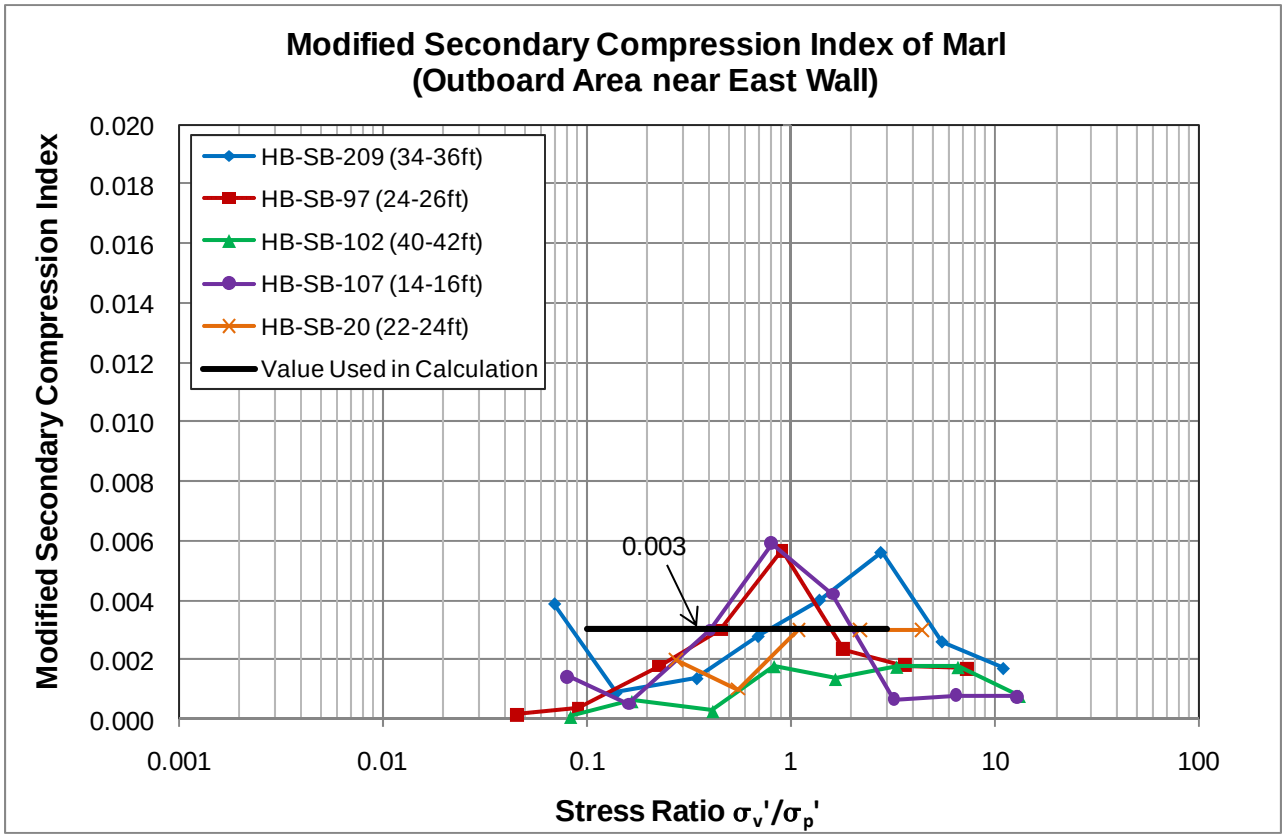


Figure B-9. Interpretation of Modified Secondary Compression Index for Marl (Outboard Area near East Wall)

Note:
The ratio of σ_v'/σ_p' of Marl in the field before and after capping was estimated to be between 0.1 and 3 according to the assumed subsurface layer thicknesses.

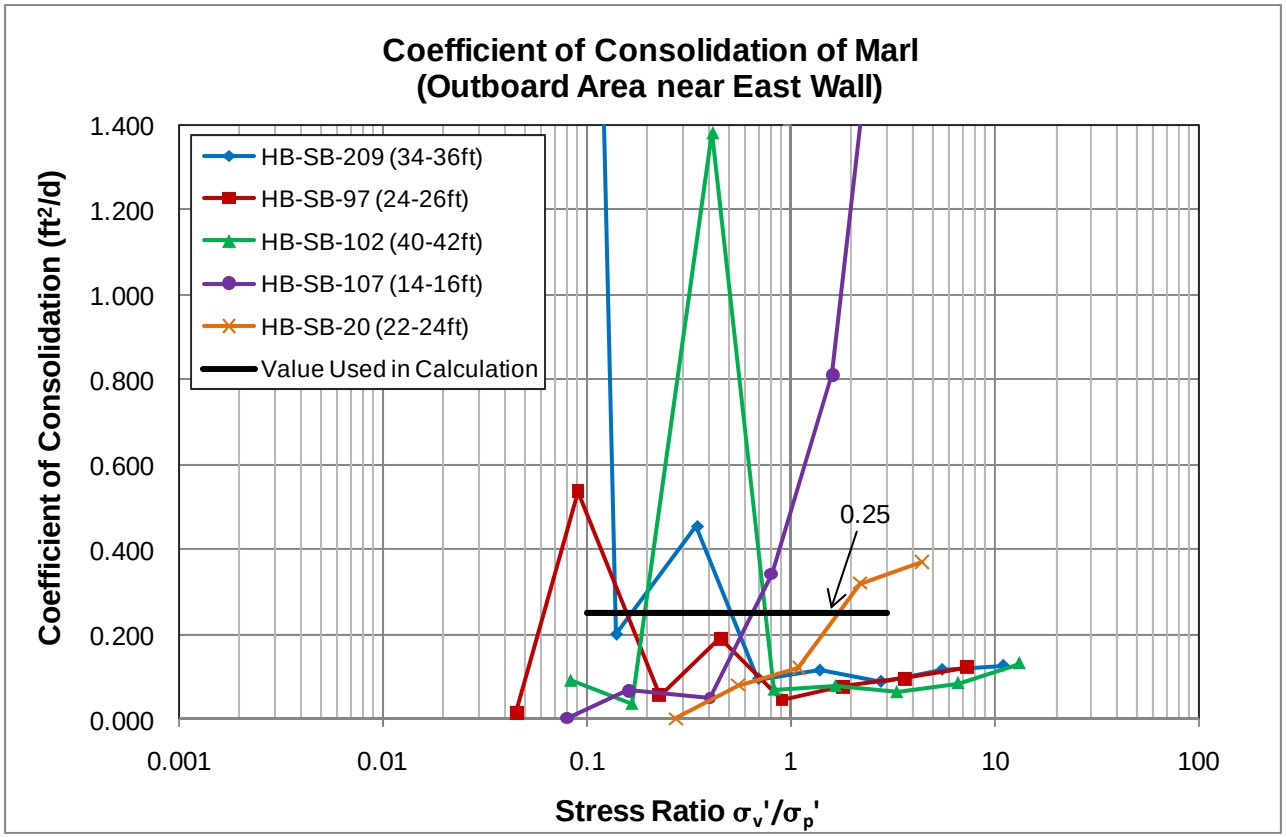


Figure B-10. Interpretation of Coefficient of Consolidation for Marl
(Outboard Area near East Wall)

Note:
The ratio of σ_v'/σ_p' of Marl in the field before and after capping was estimated to be between 0.1 and 3 according to the assumed subsurface layer thicknesses.

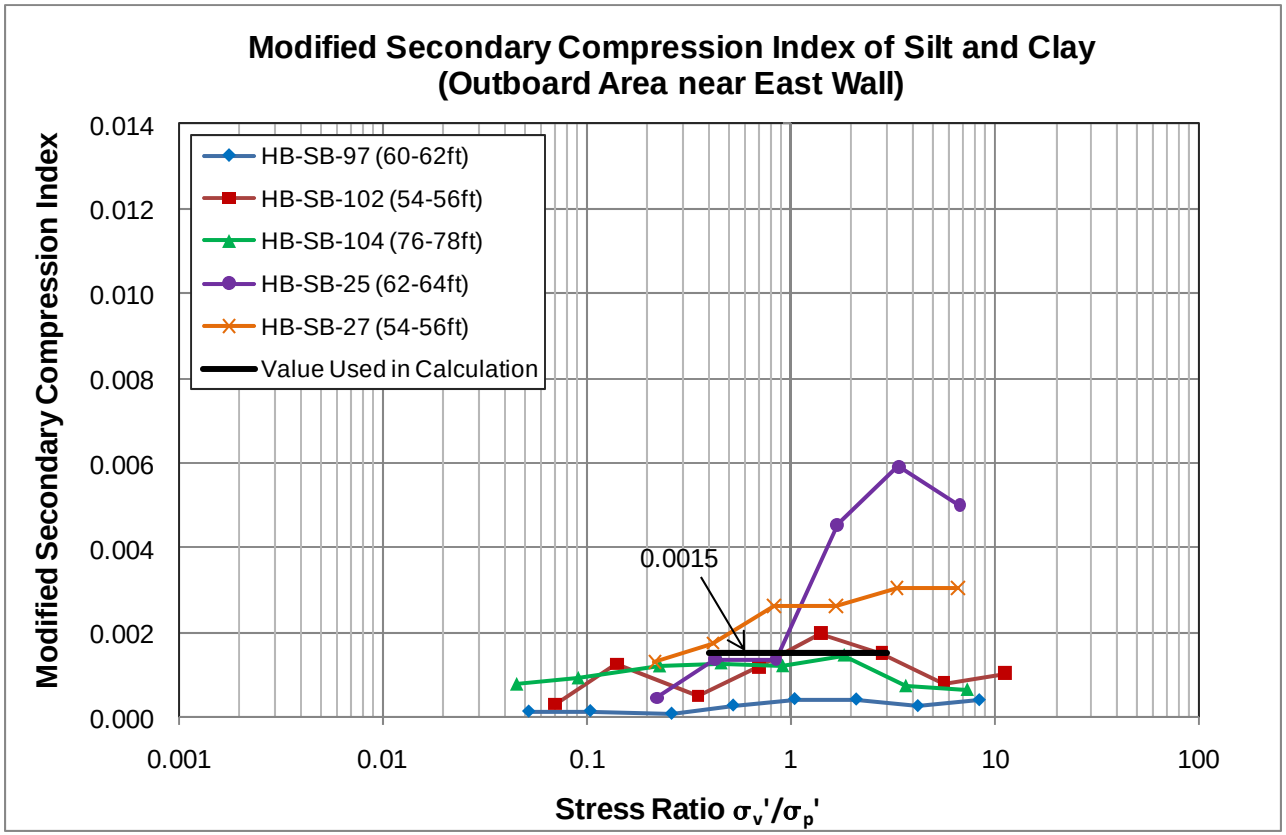


Figure B-11. Interpretation of Modified Secondary Compression Index for Silt and Clay (Outboard Area near East Wall)

Note:
The ratio of σ_v'/σ_p' of Silt and Clay in the field before and after capping was estimated to be between 0.4 and 3 according to the assumed subsurface layer thicknesses.

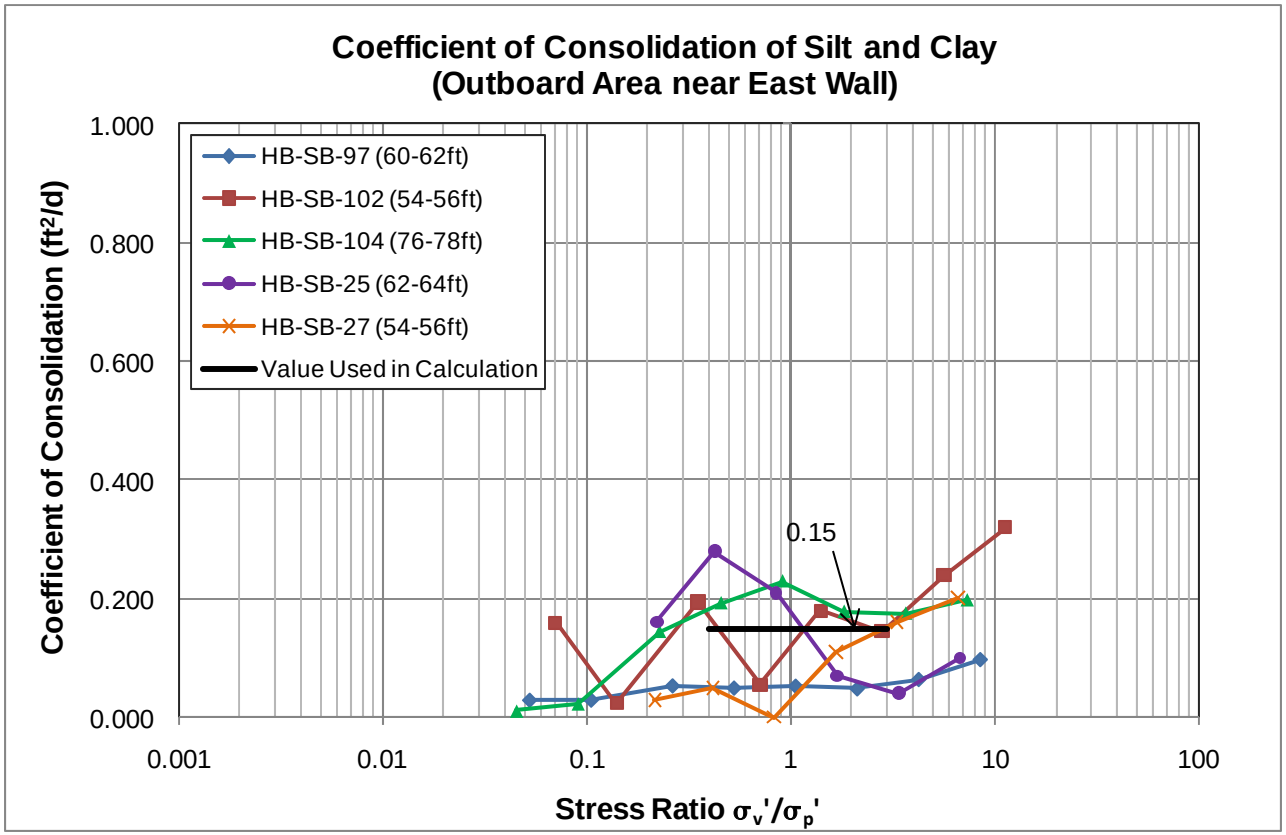


Figure B-12. Interpretation of Coefficient of Consolidation for Silt and Clay (Outboard Area near East Wall)

Note:
The ratio of σ_v'/σ_p' of Silt and Clay in the field before and after capping was estimated to be between 0.4 and 3 according to the assumed subsurface layer thicknesses.

ATTACHMENT C

EXAMPLE SETTLEMENT CALCULATION

(For Subarea 7 with 3 ft removal and 4 ft thick cap)

An Example of Settlement Calculation

Input:

Removal Depth	3	ft
Consider Total Settlement	30	years
Groundwater Table	1	ft, bgs

Soil Layers	Thickness (ft)	Unit Weight (pcf)	OCR	$C_{c\varepsilon}$	$C_{r\varepsilon}$	C_{α}	Coef. of Con. c_v (ft^2/d)	Time of 90% primary con. (years)	t2/t1 for Secondary Con.	# of Sublayers
Cap	4	120								
Fill	10	92	2	0.061	0.0060	0.0003	4.500	0.1	1185.9	4
SOLW	0	88	1	0.042	0.0030	0.0006	0.250	21.0	1.4	0
Marl	35	97	1.2	0.176	0.0100	0.0030	0.250	21.0	1.4	14
Silt/Clay	60	111	1	0.129	0.0130	0.0015	0.250	21.0	1.4	12
Water		62.4								

Note: 1. Assume secondary consolidation starts at the time when 90% of primary consolidation have occurred.

Calculated Settlement (ft):

	Primary Settlement	Secondary Settlement	Total Settlement
Fill	0.016	0.006	0.023
SOLW	0.000	0.000	0.000
Marl	0.194	0.015	0.210
Silt/Clay	0.256	0.013	0.270
Total	0.47	0.03	**0.50**

= 6.0 in

Total Primary	0.016		Total Primary	0.000
Total Secondary	0.006		Total Secondary	0.000
Total	0.023		Total	0.000
Calculation for Fill			Calculation for SOLW	
Layer No.	1		Layer No.	1
Layer Thickness, m / ft	1.75		Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	0.875		Midpoint Depth from T. of SLOW/Removal Bot, m/ft	5E-11
Midpoint Depth from Ori Ground Surface, m/ft	3.875		Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	177.1		Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	25.9		Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	131.5		Final Effective Stress, KPa/psf	562.4
OCR	2		OCR	1
Preconsolidation Pressure, KPa/psf	354.2		Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061		Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.006		Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003		Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1185.9		ratio of t2 / t1	1.4
Settlements			Settlements	
Primary Settlement, (m / ft)	0.007		Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.002		Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.009		Total Settlement (m / ft)	0.000
Layer No.	2		Layer No.	2
Layer Thickness, m / ft	1.75		Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	2.625		Midpoint Depth from T. of SLOW/Removal Bot, m/ft	1.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	5.625		Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	228.9		Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	77.7		Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	183.3		Final Effective Stress, KPa/psf	562.4
OCR	2		OCR	1
Preconsolidation Pressure, KPa/psf	457.8		Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061		Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.006		Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003		Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1185.9		ratio of t2 / t1	1.4
Settlements			Settlements	
Primary Settlement, (m / ft)	0.004		Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.002		Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.006		Total Settlement (m / ft)	0.000
Layer No.	3		Layer No.	3
Layer Thickness, m / ft	1.75		Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	4.375		Midpoint Depth from T. of SLOW/Removal Bot, m/ft	2.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	7.375		Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	280.7		Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	129.5		Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	235.1		Final Effective Stress, KPa/psf	562.4
OCR	2		OCR	1
Preconsolidation Pressure, KPa/psf	561.4		Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061		Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.006		Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003		Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1185.9		ratio of t2 / t1	1.4
Settlements			Settlements	
Primary Settlement, (m / ft)	0.003		Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.002		Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.004		Total Settlement (m / ft)	0.000

Layer No.	4
Layer Thickness, m / ft	1.75
Midpoint Depth from Removal Bot, m/ft	6.125
Midpoint Depth from Ori Ground Surface, m/ft	9.125
Effective Stress Before Removal, KPa/psf	332.5
Initial Effective Stress, KPa/psf	181.3
Final Effective Stress, KPa/psf	286.9
OCR	2
Preconsolidation Pressure, KPa/psf	665
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.002
Secondary Settlement (m / ft)	0.002
Total Settlement (m / ft)	0.004

Layer No.	4
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	3.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	5
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	4.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	1.332E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	5
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	4.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	6
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	5.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	1.628E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	6
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	5.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	7
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	6.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	1.924E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	7
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	6.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	8
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	7.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	2.22E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	8
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	7.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	9
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	8.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	2.516E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	9
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	8.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	10
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	9.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	2.812E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	10
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	9.5E-10
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	11
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	1.05E-09
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	3.108E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	11
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	1.05E-09
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	12
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	1.15E-09
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	3.404E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	12
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	1.15E-09
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	13
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	1.25E-09
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	3.7E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	13
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	1.25E-09
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	14
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	1.35E-09
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	3.996E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	14
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	1.35E-09
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	15
Layer Thickness, m / ft	1E-10
Midpoint Depth from Removal Bot, m/ft	1.45E-09
Midpoint Depth from Ori Ground Surface, m/ft	3
Effective Stress Before Removal, KPa/psf	151.2
Initial Effective Stress, KPa/psf	4.292E-08
Final Effective Stress, KPa/psf	105.6
OCR	2
Preconsolidation Pressure, KPa/psf	302.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.061
Modified Recompression Index, $C_{r\varepsilon}$	0.006
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0003
ratio of t2 / t1	1185.9
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	15
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of SLOW/Removal Bot, m/ft	1.45E-09
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1
Preconsolidation Pressure, KPa/psf	358.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.042
Modified Recompression Index, $C_{r\varepsilon}$	0.003
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0006
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Total Primary	0.194		Total Primary	0.256
Total Secondary	0.015		Total Secondary	0.013
Total	0.210		Total	0.270
Calculation for Marl			Calculation for Silt and Clay	
Layer No.	1		Layer No.	1
Layer Thickness, m / ft	2.5		Layer Thickness, m / ft	5
Midpoint Depth from T. of Marl/Removal Bot, m/f	1.25		Midpoint Depth from T. of Silt/Clay, m/ft	2.5
Midpoint Depth from Ori Ground Surface, m/ft	11.25		Midpoint Depth from Ori Ground Surface, m/ft	47.5
Effective Stress Before Removal, KPa/psf	401.65		Effective Stress Before Removal, KPa/psf	1690.9
Initial Effective Stress, KPa/psf	250.45		Initial Effective Stress, KPa/psf	1539.7
Final Effective Stress, KPa/psf	605.65		Final Effective Stress, KPa/psf	1894.9
OCR	1.2		OCR	1
Preconsolidation Pressure, KPa/psf	481.98		Preconsolidation Pressure, KPa/psf	1690.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176		Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.01		Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003		Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4		ratio of t2 / t1	1.4
Settlements			Settlements	
Primary Settlement, (m / ft)	0.051		Primary Settlement, (m / ft)	0.035
Secondary Settlement (m / ft)	0.001		Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.052		Total Settlement (m / ft)	0.036
Layer No.	2		Layer No.	2
Layer Thickness, m / ft	2.5		Layer Thickness, m / ft	5
Midpoint Depth from T. of Marl/Removal Bot, m/f	3.75		Midpoint Depth from T. of Silt/Clay, m/ft	7.5
Midpoint Depth from Ori Ground Surface, m/ft	13.75		Midpoint Depth from Ori Ground Surface, m/ft	52.5
Effective Stress Before Removal, KPa/psf	488.15		Effective Stress Before Removal, KPa/psf	1933.9
Initial Effective Stress, KPa/psf	336.95		Initial Effective Stress, KPa/psf	1782.7
Final Effective Stress, KPa/psf	692.15		Final Effective Stress, KPa/psf	2137.9
OCR	1.2		OCR	1
Preconsolidation Pressure, KPa/psf	585.78		Preconsolidation Pressure, KPa/psf	1933.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176		Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.01		Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003		Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4		ratio of t2 / t1	1.4
Settlements			Settlements	
Primary Settlement, (m / ft)	0.038		Primary Settlement, (m / ft)	0.030
Secondary Settlement (m / ft)	0.001		Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.039		Total Settlement (m / ft)	0.031
Layer No.	3		Layer No.	3
Layer Thickness, m / ft	2.5		Layer Thickness, m / ft	5
Midpoint Depth from T. of Marl/Removal Bot, m/f	6.25		Midpoint Depth from T. of Silt/Clay, m/ft	12.5
Midpoint Depth from Ori Ground Surface, m/ft	16.25		Midpoint Depth from Ori Ground Surface, m/ft	57.5
Effective Stress Before Removal, KPa/psf	574.65		Effective Stress Before Removal, KPa/psf	2176.9
Initial Effective Stress, KPa/psf	423.45		Initial Effective Stress, KPa/psf	2025.7
Final Effective Stress, KPa/psf	778.65		Final Effective Stress, KPa/psf	2380.9
OCR	1.2		OCR	1
Preconsolidation Pressure, KPa/psf	689.58		Preconsolidation Pressure, KPa/psf	2176.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176		Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.01		Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003		Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4		ratio of t2 / t1	1.4
Settlements			Settlements	
Primary Settlement, (m / ft)	0.029		Primary Settlement, (m / ft)	0.027
Secondary Settlement (m / ft)	0.001		Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.030		Total Settlement (m / ft)	0.028

Layer No.	4
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	8.75
Midpoint Depth from Ori Ground Surface, m/ft	18.75
Effective Stress Before Removal, KPa/psf	661.15
Initial Effective Stress, KPa/psf	509.95
Final Effective Stress, KPa/psf	865.15
OCR	1.2
Preconsolidation Pressure, KPa/psf	793.38
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.021
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.022

Layer No.	4
Layer Thickness, m / ft	5
Midpoint Depth from T. of Silt/Clay, m/ft	17.5
Midpoint Depth from Ori Ground Surface, m/ft	62.5
Effective Stress Before Removal, KPa/psf	2419.9
Initial Effective Stress, KPa/psf	2268.7
Final Effective Stress, KPa/psf	2623.9
OCR	1
Preconsolidation Pressure, KPa/psf	2419.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.024
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.026

Layer No.	5
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	11.25
Midpoint Depth from Ori Ground Surface, m/ft	21.25
Effective Stress Before Removal, KPa/psf	747.65
Initial Effective Stress, KPa/psf	596.45
Final Effective Stress, KPa/psf	951.65
OCR	1.2
Preconsolidation Pressure, KPa/psf	897.18
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.016
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.017

Layer No.	5
Layer Thickness, m / ft	5
Midpoint Depth from T. of Silt/Clay, m/ft	22.5
Midpoint Depth from Ori Ground Surface, m/ft	67.5
Effective Stress Before Removal, KPa/psf	2662.9
Initial Effective Stress, KPa/psf	2511.7
Final Effective Stress, KPa/psf	2866.9
OCR	1
Preconsolidation Pressure, KPa/psf	2662.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.022
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.023

Layer No.	6
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	13.75
Midpoint Depth from Ori Ground Surface, m/ft	23.75
Effective Stress Before Removal, KPa/psf	834.15
Initial Effective Stress, KPa/psf	682.95
Final Effective Stress, KPa/psf	1038.15
OCR	1.2
Preconsolidation Pressure, KPa/psf	1000.98
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.011
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.012

Layer No.	6
Layer Thickness, m / ft	5
Midpoint Depth from T. of Silt/Clay, m/ft	27.5
Midpoint Depth from Ori Ground Surface, m/ft	72.5
Effective Stress Before Removal, KPa/psf	2905.9
Initial Effective Stress, KPa/psf	2754.7
Final Effective Stress, KPa/psf	3109.9
OCR	1
Preconsolidation Pressure, KPa/psf	2905.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.021
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.022

Layer No.	7
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	16.25
Midpoint Depth from Ori Ground Surface, m/ft	26.25
Effective Stress Before Removal, KPa/psf	920.65
Initial Effective Stress, KPa/psf	769.45
Final Effective Stress, KPa/psf	1124.65
OCR	1.2
Preconsolidation Pressure, KPa/psf	1104.78
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.007
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.008

Layer No.	7
Layer Thickness, m / ft	5
Midpoint Depth from T. of Silt/Clay, m/ft	32.5
Midpoint Depth from Ori Ground Surface, m/ft	77.5
Effective Stress Before Removal, KPa/psf	3148.9
Initial Effective Stress, KPa/psf	2997.7
Final Effective Stress, KPa/psf	3352.9
OCR	1
Preconsolidation Pressure, KPa/psf	3148.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.019
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.020

Layer No.	8
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	18.75
Midpoint Depth from Ori Ground Surface, m/ft	28.75
Effective Stress Before Removal, KPa/psf	1007.15
Initial Effective Stress, KPa/psf	855.95
Final Effective Stress, KPa/psf	1211.15
OCR	1.2
Preconsolidation Pressure, KPa/psf	1208.58
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.004
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.005

Layer No.	8
Layer Thickness, m / ft	5
Midpoint Depth from T. of Silt/Clay, m/ft	37.5
Midpoint Depth from Ori Ground Surface, m/ft	82.5
Effective Stress Before Removal, KPa/psf	3391.9
Initial Effective Stress, KPa/psf	3240.7
Final Effective Stress, KPa/psf	3595.9
OCR	1
Preconsolidation Pressure, KPa/psf	3391.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.018
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.019

Layer No.	9
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	21.25
Midpoint Depth from Ori Ground Surface, m/ft	31.25
Effective Stress Before Removal, KPa/psf	1093.65
Initial Effective Stress, KPa/psf	942.45
Final Effective Stress, KPa/psf	1297.65
OCR	1.2
Preconsolidation Pressure, KPa/psf	1312.38
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.003
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.005

Layer No.	9
Layer Thickness, m / ft	5
Midpoint Depth from T. of Silt/Clay, m/ft	42.5
Midpoint Depth from Ori Ground Surface, m/ft	87.5
Effective Stress Before Removal, KPa/psf	3634.9
Initial Effective Stress, KPa/psf	3483.7
Final Effective Stress, KPa/psf	3838.9
OCR	1
Preconsolidation Pressure, KPa/psf	3634.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.016
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.018

Layer No.	10
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	23.75
Midpoint Depth from Ori Ground Surface, m/ft	33.75
Effective Stress Before Removal, KPa/psf	1180.15
Initial Effective Stress, KPa/psf	1028.95
Final Effective Stress, KPa/psf	1384.15
OCR	1.2
Preconsolidation Pressure, KPa/psf	1416.18
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.003
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.004

Layer No.	10
Layer Thickness, m / ft	5
Midpoint Depth from T. of Silt/Clay, m/ft	47.5
Midpoint Depth from Ori Ground Surface, m/ft	92.5
Effective Stress Before Removal, KPa/psf	3877.9
Initial Effective Stress, KPa/psf	3726.7
Final Effective Stress, KPa/psf	4081.9
OCR	1
Preconsolidation Pressure, KPa/psf	3877.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.015
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.017

Layer No.	11
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	26.25
Midpoint Depth from Ori Ground Surface, m/ft	36.25
Effective Stress Before Removal, KPa/psf	1266.65
Initial Effective Stress, KPa/psf	1115.45
Final Effective Stress, KPa/psf	1470.65
OCR	1.2
Preconsolidation Pressure, KPa/psf	1519.98
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.003
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.004

Layer No.	11
Layer Thickness, m / ft	5
Midpoint Depth from T. of Silt/Clay, m/ft	52.5
Midpoint Depth from Ori Ground Surface, m/ft	97.5
Effective Stress Before Removal, KPa/psf	4120.9
Initial Effective Stress, KPa/psf	3969.7
Final Effective Stress, KPa/psf	4324.9
OCR	1
Preconsolidation Pressure, KPa/psf	4120.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.015
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.016

Layer No.	12
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	28.75
Midpoint Depth from Ori Ground Surface, m/ft	38.75
Effective Stress Before Removal, KPa/psf	1353.15
Initial Effective Stress, KPa/psf	1201.95
Final Effective Stress, KPa/psf	1557.15
OCR	1.2
Preconsolidation Pressure, KPa/psf	1623.78
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.003
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.004

Layer No.	12
Layer Thickness, m / ft	5
Midpoint Depth from T. of Silt/Clay, m/ft	57.5
Midpoint Depth from Ori Ground Surface, m/ft	102.5
Effective Stress Before Removal, KPa/psf	4363.9
Initial Effective Stress, KPa/psf	4212.7
Final Effective Stress, KPa/psf	4567.9
OCR	1
Preconsolidation Pressure, KPa/psf	4363.9
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.014
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.015

Layer No.	13
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	31.25
Midpoint Depth from Ori Ground Surface, m/ft	41.25
Effective Stress Before Removal, KPa/psf	1439.65
Initial Effective Stress, KPa/psf	1288.45
Final Effective Stress, KPa/psf	1643.65
OCR	1.2
Preconsolidation Pressure, KPa/psf	1727.58
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.003
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.004

Layer No.	13
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of Silt/Clay, m/ft	1.25E-09
Midpoint Depth from Ori Ground Surface, m/ft	45
Effective Stress Before Removal, KPa/psf	1569.4
Initial Effective Stress, KPa/psf	1418.2
Final Effective Stress, KPa/psf	1773.4
OCR	1
Preconsolidation Pressure, KPa/psf	1569.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	14
Layer Thickness, m / ft	2.5
Midpoint Depth from T. of Marl/Removal Bot, m/f	33.75
Midpoint Depth from Ori Ground Surface, m/ft	43.75
Effective Stress Before Removal, KPa/psf	1526.15
Initial Effective Stress, KPa/psf	1374.95
Final Effective Stress, KPa/psf	1730.15
OCR	1.2
Preconsolidation Pressure, KPa/psf	1831.38
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.002
Secondary Settlement (m / ft)	0.001
Total Settlement (m / ft)	0.004

Layer No.	14
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of Silt/Clay, m/ft	1.35E-09
Midpoint Depth from Ori Ground Surface, m/ft	45
Effective Stress Before Removal, KPa/psf	1569.4
Initial Effective Stress, KPa/psf	1418.2
Final Effective Stress, KPa/psf	1773.4
OCR	1
Preconsolidation Pressure, KPa/psf	1569.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	15
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of Marl/Removal Bot, m/f	1.45E-09
Midpoint Depth from Ori Ground Surface, m/ft	10
Effective Stress Before Removal, KPa/psf	358.4
Initial Effective Stress, KPa/psf	207.2
Final Effective Stress, KPa/psf	562.4
OCR	1.2
Preconsolidation Pressure, KPa/psf	430.08
Modified Primary Compression Index, $C_{c\varepsilon}$	0.176
Modified Recompression Index, $C_{r\varepsilon}$	0.01
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.003
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

Layer No.	15
Layer Thickness, m / ft	1E-10
Midpoint Depth from T. of Silt/Clay, m/ft	1.45E-09
Midpoint Depth from Ori Ground Surface, m/ft	45
Effective Stress Before Removal, KPa/psf	1569.4
Initial Effective Stress, KPa/psf	1418.2
Final Effective Stress, KPa/psf	1773.4
OCR	1
Preconsolidation Pressure, KPa/psf	1569.4
Modified Primary Compression Index, $C_{c\varepsilon}$	0.129
Modified Recompression Index, $C_{r\varepsilon}$	0.013
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.0015
ratio of t2 / t1	1.4
Settlements	
Primary Settlement, (m / ft)	0.000
Secondary Settlement (m / ft)	0.000
Total Settlement (m / ft)	0.000

An Example Calculation of Upward Cumulative Consolidation Water Flow (For Subarea 7 with 6 ft of removal and 4 ft thick cap)

Loading

Cap thickness =	4	ft
Cap unit weight =	120	psf
Load =	230.4	psf

Properties

	Bottom Layer	Top Layer			
Type	MARL	Fill			
k =	1.0E-06	5.00E-04	cm/s	Fill/MARL Interface	
	1.8E-02	9.1E+00	ft/d	A=	0.967197
Cv =	0.25	4.5	ft2/d	B=	2.00E+00
H =	94	4	ft	C =	3.99E-03
$C\alpha\varepsilon$ =	0.0030	0.0003			
t(U=93%) =	8836	4	days		
	24.2	0.0	years		

Reference Values

zR =	98.0	98.0	ft
uR =	2.30	2.30	psf
tR =	38416	2134	days
	105	6	years

Time Step

Select δt to ensure convergence of solution

	δt =	0.0010	0.0010	years
		0	0	days
	δt-bar =	9.50E-06	1.71E-04	
	δz =	2	2	ft
	δz-bar =	0.02	0.02	
bar	$\delta t_1/(\delta z)^2$ =	0.02	0.41	should be less than 0.5

Note: For Subareas 1 through 6, SOLW properties were assumed for the bottom layer; for Subareas 7 and 8, MARL properties were assumed. See Table 1 for details.

		U-bar values					
	t (years)	0.00	0.00	0.00	0.00	0.00	0.01
	t (days)	0	0	1	1	1	2
	t-bar	0.00	0.00	0.00	0.00	0.00	0.00
Z (ft)	z-bar	s1	s2	s3	s4	s5	s6
0	0.0	0	0	0	0	0	0
2	0.0	100	59	52	37	29	22
4	0.0	100	100	67	55	41	32
6	0.1	100	100	100	99	98	97
8	0.1	100	100	100	100	100	100
10	0.1	100	100	100	100	100	100
12	0.1	100	100	100	100	100	100
14	0.1	100	100	100	100	100	100
16	0.2	100	100	100	100	100	100
18	0.2	100	100	100	100	100	100
20	0.2	100	100	100	100	100	100
22	0.2	100	100	100	100	100	100
24	0.2	100	100	100	100	100	100
26	0.3	100	100	100	100	100	100
28	0.3	100	100	100	100	100	100
30	0.3	100	100	100	100	100	100
32	0.3	100	100	100	100	100	100
34	0.3	100	100	100	100	100	100
36	0.4	100	100	100	100	100	100
38	0.4	100	100	100	100	100	100
40	0.4	100	100	100	100	100	100
42	0.4	100	100	100	100	100	100
44	0.4	100	100	100	100	100	100
46	0.5	100	100	100	100	100	100
48	0.5	100	100	100	100	100	100
50	0.5	100	100	100	100	100	100
52	0.5	100	100	100	100	100	100
54	0.6	100	100	100	100	100	100
56	0.6	100	100	100	100	100	100
58	0.6	100	100	100	100	100	100
60	0.6	100	100	100	100	100	100
62	0.6	100	100	100	100	100	100
64	0.7	100	100	100	100	100	100
66	0.7	100	100	100	100	100	100
68	0.7	100	100	100	100	100	100
70	0.7	100	100	100	100	100	100
72	0.7	100	100	100	100	100	100
74	0.8	100	100	100	100	100	100
76	0.8	100	100	100	100	100	100
78	0.8	100	100	100	100	100	100
80	0.8	100	100	100	100	100	100
82	0.8	100	100	100	100	100	100
84	0.9	100	100	100	100	100	100
86	0.9	100	100	100	100	100	100
88	0.9	100	100	100	100	100	100
90	0.9	100	100	100	100	100	100
92	0.9	100	100	100	100	100	100
94	1.0	100	100	100	100	100	100
96	1.0	100	98	96	93	91	90
98	1.0	0	0	0	0	0	0
Top Layer	ıitial Area =	400	400	400	400	400	400
	Current Area=	400	304	183	135	105	80
	U-ave=	0%	24%	54%	66%	74%	80%
	Final primary settlement (ft) =	0.019	0.02	0.02	0.02	0.02	0.02
	Current primary settlement (ft) =	0.00	0.00	0.01	0.01	0.01	0.02
	Current secondary settlement (ft) =	0.00	0.00	0.00	0.00	0.00	0.00
	Current total settlement (ft) =	0.00	0.00	0.01	0.01	0.01	0.02
Bottom Layer	ıitial Area =	9400	9400	9400	9400	9400	9400
	Current Area=	9400	9264	9239	9226	9210	9198
	U-ave=	0%	1%	2%	2%	2%	2%
	Final primary settlement (ft) =	0.063	0.06	0.06	0.06	0.06	0.06
	Current primary settlement (ft) =	0.00	0.00	0.00	0.00	0.00	0.00
	Current secondary settlement (ft) =	0.00	0.00	0.00	0.00	0.00	0.00
	Current total settlement (ft) =	0.00	0.00	0.00	0.00	0.00	0.00
	Total current settlement (ft) =	0.00	0.01	0.01	0.01	0.02	0.02

Note: Due to the limited paper size, only a portion of the calculation is shown above

U bar and settlement results summary

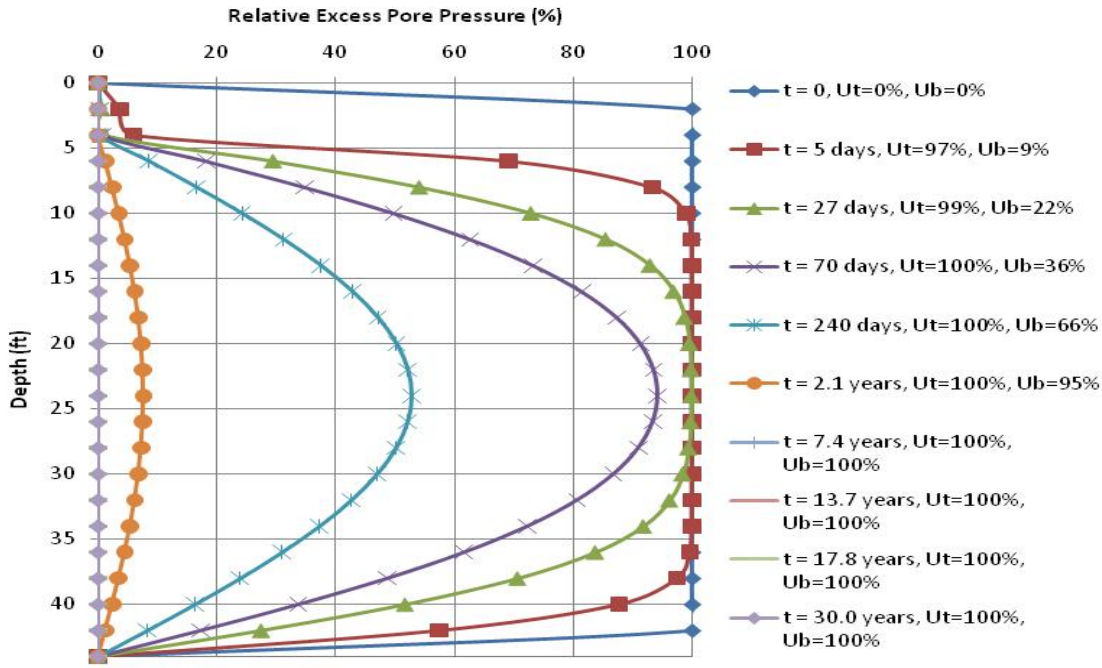
Uave top		0%	98%	100%	100%	100%	100%	100%	100%	100%	100%
Uave bot		0%	3%	6%	10%	19%	33%	62%	80%	87%	97%
t (years)		0.00	0.01	0.07	0.19	0.66	2.10	7.40	13.70	17.80	30.00
t (days)		0.00	5.11	27.01	70.08	239.81	765.04	2701.37	5001.96	6498.09	10948.91
Z (ft)		t = 0, Ut=0%, Ul t = 5 days, Ut=98%, l t = 27 days, Ut=100%, l t = 70 days, U t = 240 days, t = 2.1 years, t = 7.4 years, t = 13.7 years t = 17.8 years t = 30.0 years								
	0	0	0	0	0	0	0	0	0	0	0
	2	100	2	0	0	0	0	0	0	0	0
	4	100	3	0	0	0	0	0	0	0	0
	6	100	83	43	27	15	8	4	2	1	0
	8	100	98	74	51	29	16	8	4	3	1
	10	100	100	90	70	42	24	12	6	4	1
	12	100	100	97	83	54	32	16	8	5	1
	14	100	100	99	91	64	39	20	10	7	2
	16	100	100	100	96	73	46	23	12	8	2
	18	100	100	100	98	80	53	27	14	9	2
	20	100	100	100	99	86	59	31	16	11	3
	22	100	100	100	100	90	64	34	18	12	3
	24	100	100	100	100	93	69	37	20	13	3
	26	100	100	100	100	96	74	40	21	14	3
	28	100	100	100	100	97	78	43	23	15	4
	30	100	100	100	100	98	82	46	24	16	4
	32	100	100	100	100	99	85	48	25	17	4
	34	100	100	100	100	99	87	51	27	17	4
	36	100	100	100	100	100	90	53	28	18	4
	38	100	100	100	100	100	92	54	29	19	5
	40	100	100	100	100	100	93	56	29	19	5
	42	100	100	100	100	100	94	57	30	20	5
	44	100	100	100	100	100	95	58	31	20	5
	46	100	100	100	100	100	96	59	31	20	5
	48	100	100	100	100	100	96	60	31	21	5
	50	100	100	100	100	100	97	60	31	21	5
	52	100	100	100	100	100	97	60	31	21	5
	54	100	100	100	100	100	96	60	31	21	5
	56	100	100	100	100	100	96	59	31	20	5
	58	100	100	100	100	100	95	58	31	20	4
	60	100	100	100	100	100	94	57	30	20	4
	62	100	100	100	100	100	93	56	29	19	4
	64	100	100	100	100	100	92	54	29	18	4
	66	100	100	100	100	100	90	53	28	18	4
	68	100	100	100	100	99	87	50	27	17	4
	70	100	100	100	100	99	85	48	25	16	3
	72	100	100	100	100	98	82	46	24	15	3
	74	100	100	100	100	97	78	43	23	13	3
	76	100	100	100	100	95	74	40	21	12	2
	78	100	100	100	100	93	69	37	20	11	2
	80	100	100	100	100	90	64	34	18	9	2
	82	100	100	100	99	86	59	31	16	8	1
	84	100	100	100	98	80	53	27	14	7	1
	86	100	100	100	95	73	46	23	12	6	1
	88	100	100	99	91	64	39	20	10	5	1
	90	100	100	96	82	54	32	16	8	4	1
	92	100	100	89	69	42	24	12	6	3	1
	94	100	97	72	50	29	16	8	4	2	0
	96	100	76	42	27	15	8	4	2	1	0
	98	0	0	0	0	0	0	0	0	0	0
Cumulative Upward Cor		0.00	0.021	0.024	0.027	0.033	0.043	0.061	0.073	0.078	0.111

ATTACHMENT D

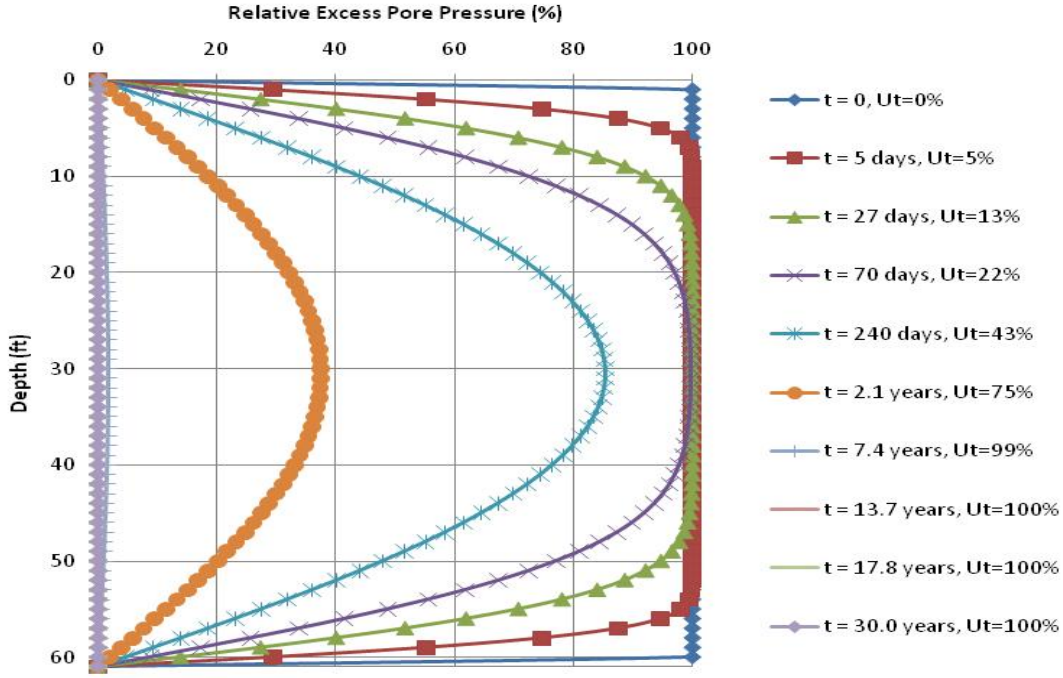
CALCULATED EXCESS PORE WATER PRESSURE ISOCHRONES

Note:
In the charts presented herein, Ut = the average degree of consolidation of top layer (i.e., Fill); Ub = the average degree of consolidation of bottom layer (i.e., SOLW + Marl + Silt and Clay).

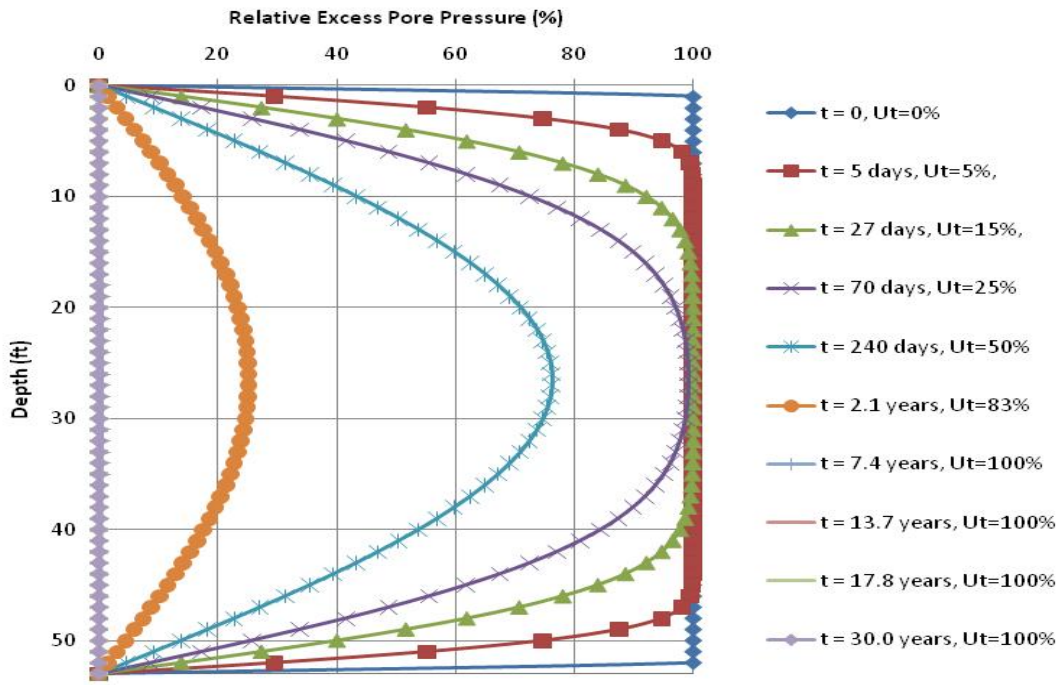
Subarea 1 (6' dredge, 4' cap)



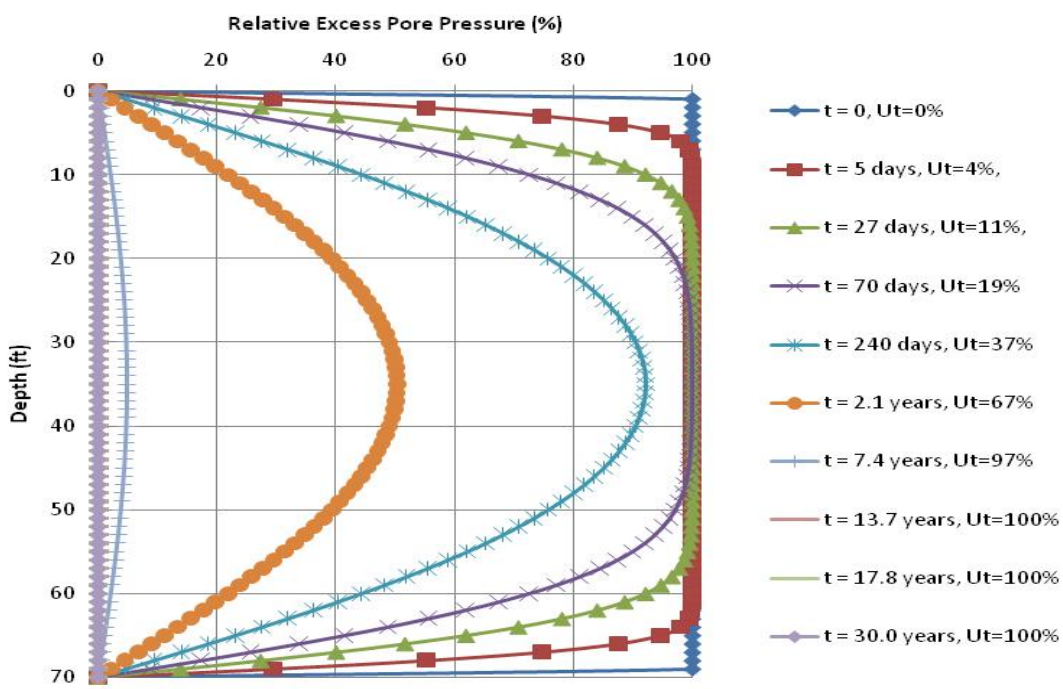
Subarea 2 (9' dredge, 4' cap)



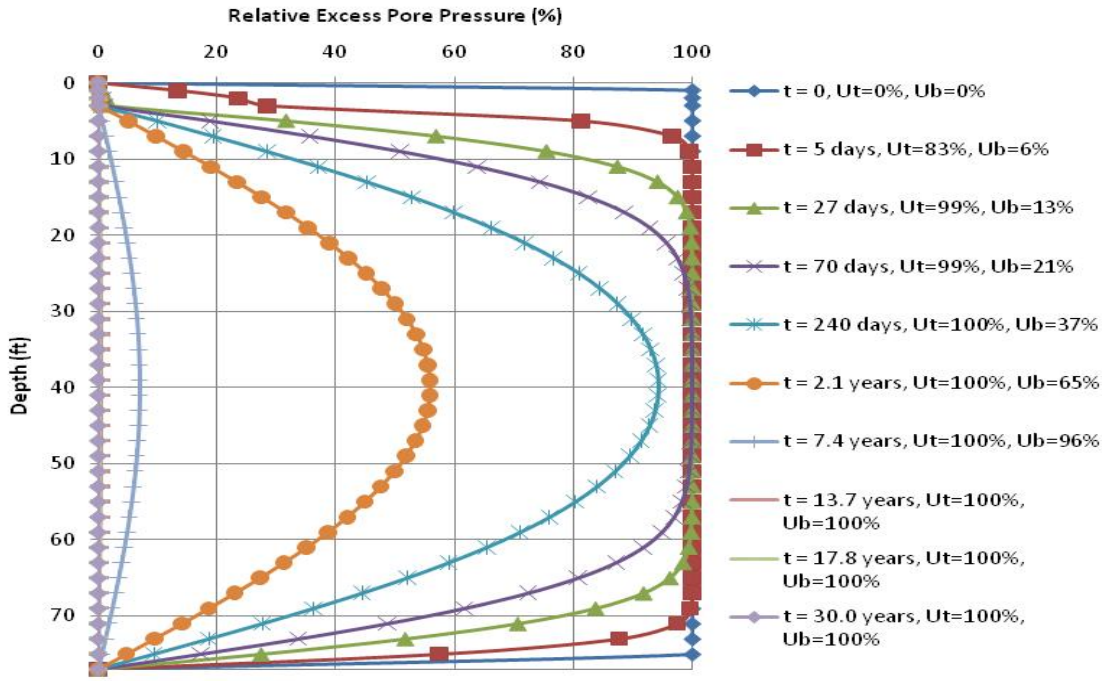
Subarea 3 (7' dredge, 4' cap)



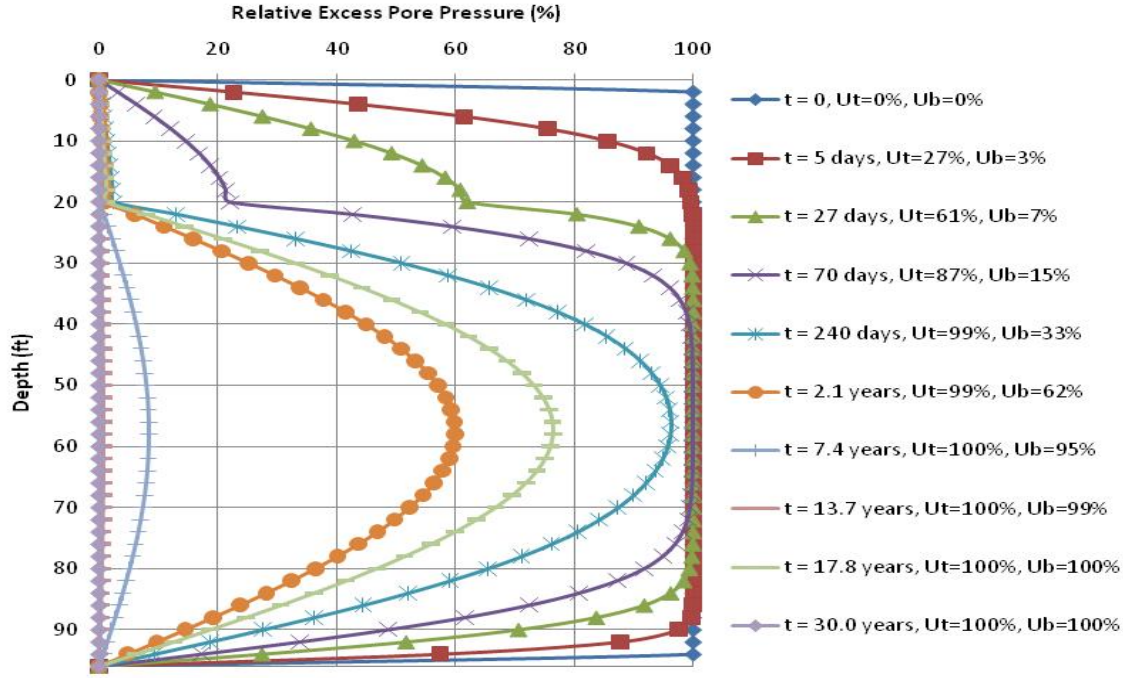
Subarea 4 (5' dredge, 4' cap)



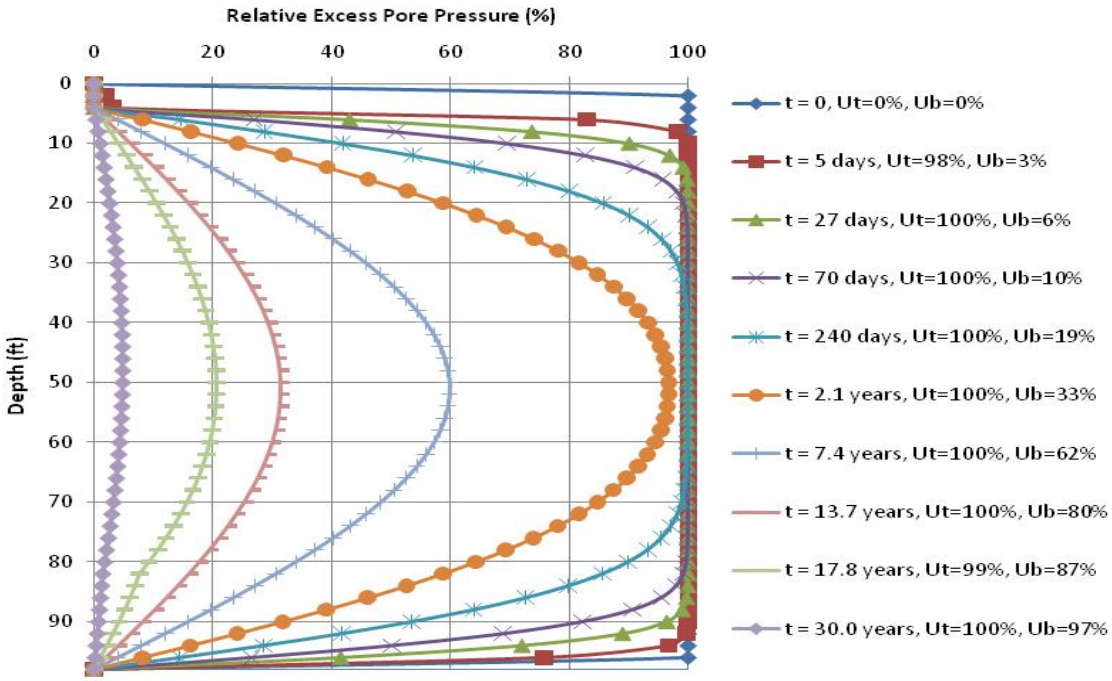
Subarea 5 (5' dredge, 4' cap)



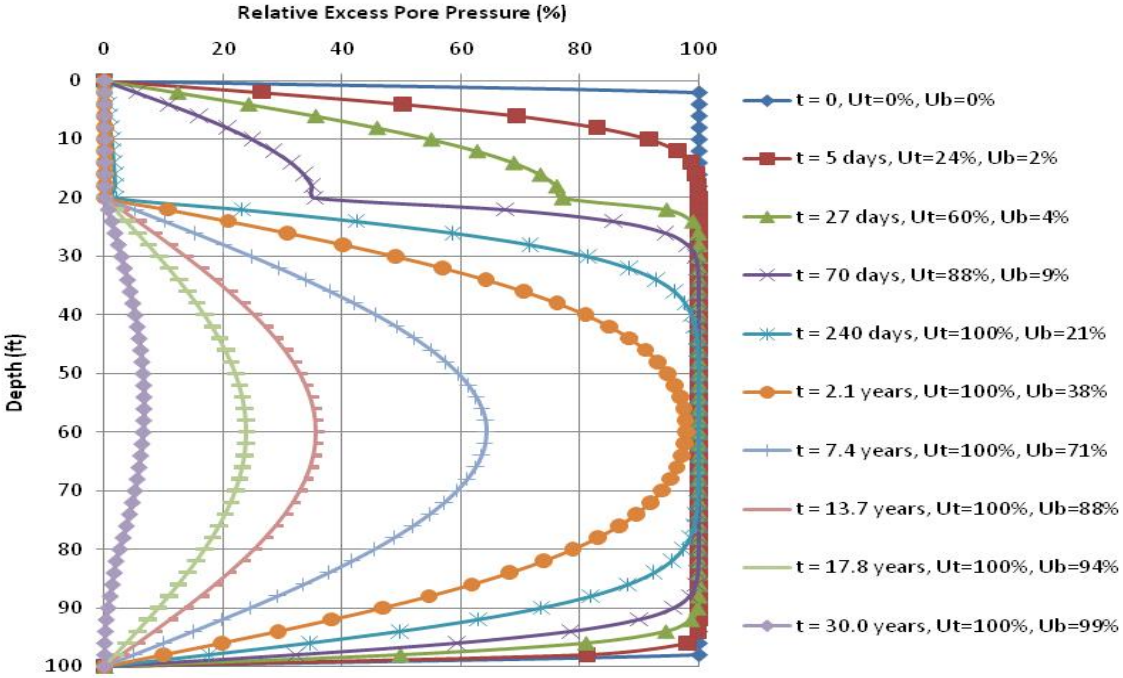
Subarea 6 (5' dredge, 4' cap)



Subarea 7 (6' dredge, 4' cap)



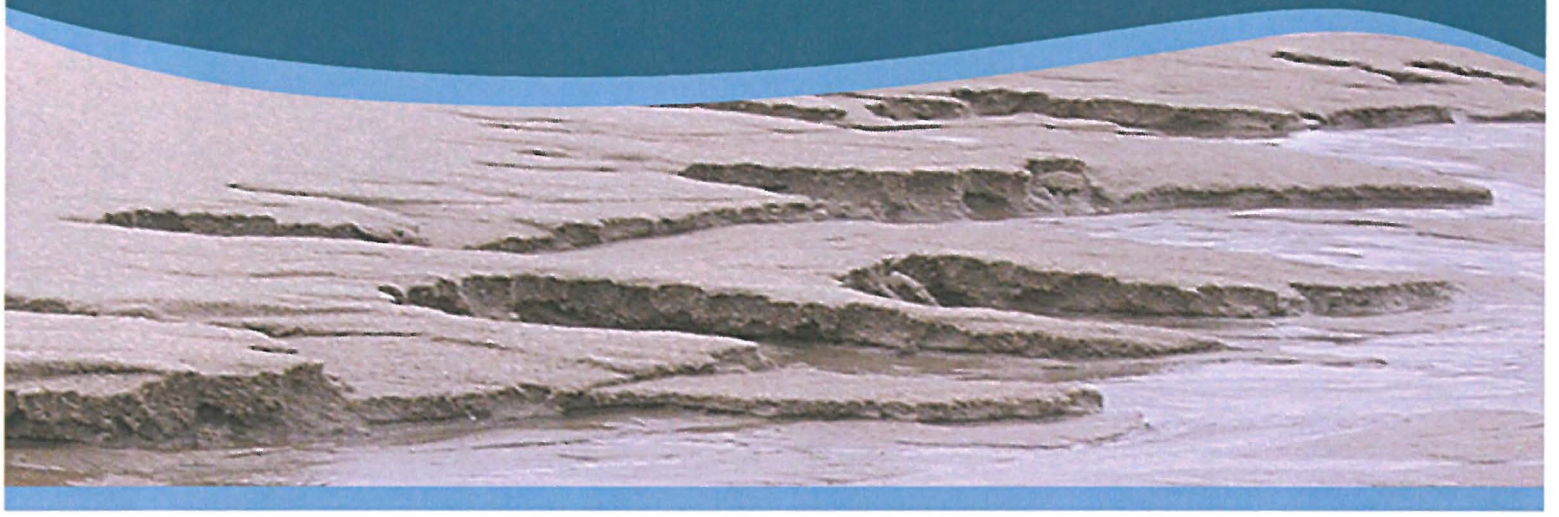
Subarea 8 (6' dredge, 4' cap)



APPENDIX F

DREDGE AND CAP DESIGN PLANS

REPORT



DREDGE PLAN DEVELOPMENT APPENDIX

ONONDAGA LAKE

Prepared for

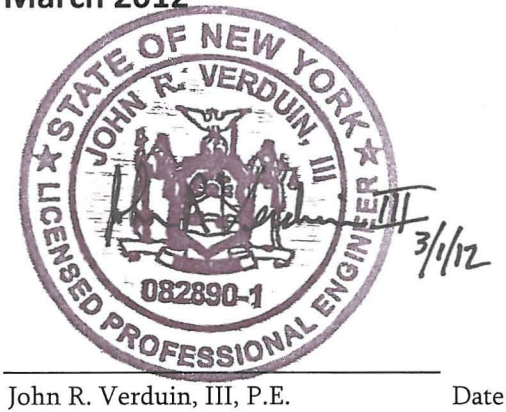
Honeywell

Prepared by

Anchor QEA, LLC

Parsons

March 2012



John R. Verduin, III, P.E. Date: March 1, 2012
New York State Professional Engineer
License No. 082890-01

It is a violation of law for any person, unless he is acting under the direction of a licensed professional engineer, to alter this item in any way. If this item bearing the seal of an engineer is altered, the altering engineer shall affix to this item his seal and the notation "altered by" followed by his signature and the date of such alteration, and a specific description of the alteration.

DREDGE AND CAP DESIGN APPENDIX
ONONDAGA LAKE

Prepared for

Honeywell
PARSONS

Prepared by

Anchor QEA, LLC
290 Elwood Davis Road
Suite 340
Liverpool, New York 13088

March 2012

TABLE OF CONTENTS

1 INTRODUCTION.....1

2 DEVELOPMENT OF DREDGING AND CAPPING BOUNDARIES 2

3 DEVELOPMENT OF DREDGE PRISM AND CAP DESIGN.....5

3.1 General Dredge Prism and Capping Thickness Development Assumptions and Procedures . 9

3.2 Remediation Area-specific Dredge Prism and Cap Design Development 12

3.2.1 Remediation Area A and Ninemile Creek Spits..... 14

3.2.2 Remediation Area B and Wastebed 1-8 Connected Wetland 16

3.2.3 Remediation Area C 16

3.2.4 Remediation Area D 18

3.2.5 Remediation Area E..... 21

3.2.6 Remediation Area F 24

3.2.7 Outboard Area 24

4 REFERENCES 26

List of Tables

Table 1 Summary of Lake Surface Area Gains and Loses

Table 2 Summary of Cap Thicknesses and Dredge Volume - Remediation Area A (SMU 4)

Table 3 Summary of Cap Thicknesses and Dredge Volume - Remediation Area B (SMU 3)

Table 4 Summary of Cap Thicknesses and Dredge Volume - Remediation Area C (SMU 2)

Table 5 Summary of Cap Thicknesses and Dredge Volume - Remediation Area D (SMU 7, 12 [ILWD])

Table 6 Summary of Cap Thicknesses and Dredge Volume - Remediation Area E (SMU 6/7)

Table 7 Summary of Cap Thicknesses - Remediation Area F (SMU 5)

Table 8 Summary of Cap Thicknesses and Dredge Volume - Outboard Area

List of Attachments

Attachment A Onondaga Lake Capping, Dredging, Habitat and Profundal Zone (SMU 8) Final Design – Dredging and Capping Plans

LIST OF ACRONYMS AND ABBREVIATIONS

BSQV	bioaccumulation-based sediment quality value
Civil 3D	Auto Desk's Civil 3D software
CQAP	Construction Quality Assurance Plan
H:V	horizontal to vertical
ILWD	in-lake waste deposit
IRM	Interim Remedial Measure
Lake	Onondaga Lake
lbs/ft^2	pounds per square foot
Metro	Metropolitan Syracuse Wastewater Treatment Plant
mg/kg	milligrams per kilogram
MNR	monitored natural recovery
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NYSCC	New York State Canal Corporation
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
PDI	pre-design investigation
PECQ	probable effects concentration quotient
ROD	Record of Decision

SMU	Sediment Management Unit
TIN	triangulated irregular network
WB	Wastebed
WBB/HB	Wastebed B/Harbor Brook

1 INTRODUCTION

This report describes the basis of design and procedures used to define the dredge prism (i.e., horizontal and vertical extents of required dredging) and capping areas for the Onondaga Lake (Lake) remediation project. The Dredging Plan drawings presented herein consist of the dredge prisms and capping areas for remediation areas A, B, C, D, E, F, Ninemile Creek Spits, Wastebed (WB) 1-8 connected wetland and the Wastebed B/Harbor Brook (WBB/HB) Outboard Area. A summary description of these areas is provided below (see Drawing D-1 for remediation area locations):

- Remediation Area A and Ninemile Creek Spits – Mouth of Ninemile Creek (Sediment Management Unit [SMU] 4 and adjacent impacted areas in SMU 3 and SMU 5) plus the Ninemile Creek Spits
- Remediation Area B and WB 1-8 Connected Wetland – Adjacent to WB 1-8 (SMU 3) plus the WB 1-8 connected wetland
- Remediation Area C – Offshore of the New York State Department of Transportation (NYSDOT) Turnaround Area and the Willis/Semet Interim Remedial Measure (IRM) barrier wall exclusive of in-lake waste deposit (ILWD) (SMU 2 exclusive of the ILWD)
- Remediation Area D – ILWD (SMU 1 and adjacent portions of SMU 2 and SMU 7 where ILWD is present)
- Remediation Area E – Southwestern end of the Lake (SMU 6 and SMU 7 exclusive of the ILWD)
- Remediation Area F – Small areas of impacted sediment north of Remediation Area A and on northern shore (SMU 5)
- WBB/HB Outboard Area – Mouth of Harbor Brook and region between the barrier wall and Remediation Area D and Remediation Area E

The remainder of this report is organized as follows:

- Section 2 – Development of dredging and capping boundaries
- Section 3 – Development of the dredge prism and cap design (including both general assumptions and procedures as well as remediation area-specific assumptions)

2 DEVELOPMENT OF DREDGING AND CAPPING BOUNDARIES

The lateral extents of the remediation areas (including both dredging and capping remedial actions) were established using data obtained from individual cores (Parsons 2007, 2008, 2009a, 2011a, 2011b, 2012). Specifically, the remediation area boundaries in non-ILWD areas (outside of Remediation Area D) in waters less than 20 feet (6 meters) were drawn from core to core based on the analytical results from pre-design investigation (PDI) sampling locations (Phases I through VII) where the sediment cleanup criteria (i.e., mean probable effects concentration quotient [PECQ] of less than 1 and a mercury concentration of less than 2.2 milligrams per kilogram [mg/kg]) were not exceeded at any depth. Remediation area boundaries between 20 feet (6 meters) and 30 feet (9 meters) were drawn from core to core where the sediment cleanup criteria were not exceeded in the top 1 foot of sediment. Due to the depth of overlying water in these areas, existing sediments are stable even under a 100-year storm event in water depths from 20 to 30 feet (6 to 9 meters) in Remediation Area A, Remediation Area B, Remediation Area C, Remediation Area D, and Remediation Area F, and would be expected to see only minor disturbances in Remediation Area E, as documented in Appendix D. This demonstrates that deeper impacted sediments would not be exposed even under extreme events (e.g., 100-year storm). Therefore, determination of remediation area boundaries in these deep water areas is appropriate based on consideration of the top 1 foot of sediment. These areas are also net depositional, as discussed in Section 4.1.7 of the Final Design Report; therefore, the thickness of clean surface sediments in these areas will increase over time. In Remediation Area D, boundaries in the 20 ft. (6 meters) and 30 ft. (9 meters) water depth were drawn from point to point based on sampling locations where the sediment cleanup criteria were not exceeded at any depth. Section 3 and Appendix A of the Final Design Report provide additional details pertaining to development of the remediation area boundaries.

Within the remediation areas, the remedy was subdivided into two categories:

1. Elevation-based dredging, which will be followed by capping
2. Capping without prior dredging to isolate impacted sediments (i.e., “capping only”)

Elevation-based dredging will be performed in select areas to prevent loss of Lake surface area after the cap is placed and/or to meet a specific post-capping elevation based on habitat considerations. In

addition, elevation-based dredging will be performed in Remediation Area D to achieve the 2-meter average removal and 1-meter hot spot removals as specified in the Record of Decision (ROD).

In most areas of the Lake, sufficient dredging will be completed up to the shoreline (surface elevation of 362.5 feet) to ensure placement of the full-thickness cap all the way to the shoreline or to the edge of the wetland being restored. As a result, the removal prisms typically extend inland of the shoreline in order to accommodate suitable dredge cut slopes; however, this is not feasible along certain portions of the shoreline due to limitations such as potential impacts to shoreline utilities or structures or stability considerations, resulting in minor losses of lake surface area. These losses are more than offset by localized gains in Lake surface area resulting in the other shoreline completion areas. Table 1 presents a summary of Lake surface area "gains" and "losses" as a result of the dredging and capping activities.

Table 1
Summary of Lake Surface Area Gains and Losses

Remediation Area	Gains	Losses
A	0.2 acres	
B	0.1 acres	0.1 acres
C	0.3 acres	0.7 acres
D		
E	0.3 acres	
F		
Total	0.9 acres	0.8 acres

Furthermore, elevation-based dredging will be performed in Remediation Area D to achieve the 2-meter average removal and 1-meter hot spot removal specified in the ROD.

3 DEVELOPMENT OF DREDGE PRISM AND CAP DESIGN

The lateral and vertical extents of elevation-based dredging areas in remediation areas A, B, C, E, Ninemile Creek Spits, WBB/HB Outboard Area, and WB 1-8 connected wetlands are largely driven by habitat considerations. The Draft Remedial Design Elements for Habitat Restoration (Parsons 2009b; Habitat Plan) identifies 14 habitat modules targeted for inclusion in the restoration of the Lake and adjacent shoreline. Habitat modules are areas with specific physical characteristics suitable for various representative species, and are defined by three basic habitat parameters: water depth, substrate type, and water energy as described in the Habitat Plan. Habitat modules presented in the Habitat Plan (including module name, target water depth, and substrate type) within the Lake are summarized below (Parsons 2009c).

- Module 1 – Deep water (20 to 30 feet water depth). Sand substrate. Low to medium energy.
- Module 2A – Mid-water depth (7 to 20 feet). Sand/fine gravel substrate. Low to medium energy.
- Module 2B – Mid-water depth (7 to 20 feet). Coarse gravel/gravely cobble substrate. High energy.
- Module 3A – Shallow water (2 to 7 feet). Sand/fine gravel substrate. Low energy.
- Module 3B – Shallow water (2 to 7 feet). Sand/coarse gravel substrate. High energy.
- Module 4A – Floating aquatics wetland (1 to 3 feet). Organics/fines/sand substrate. Very low energy.
- Module 5A – Non-persistent emergent wetland (0.5 to 2 feet). Organics/fines/sand substrate. Low energy.
- Module 5B – Shoreline shallows/limited emergent wetland (0.5 to 2 feet). Gravel substrate. High energy.
- Module 6A – Persistent emergent wetland (1 foot above water to 1 foot deep). Organics/fines/sand substrate. Low energy.
- Module 6B – On shore to shallows/limited emergent wetland (1 foot above water to 1 foot deep). Coarse gravel/sand substrate. High energy.
- Module 8A – Shoreline/riparian areas/successional fields (greater than 1 foot above water). Topsoil/sand substrate. Low energy.
- Module 8B – Shoreline/riparian areas/shrub-scrub or forested (greater than 1 foot above water). Topsoil/sand substrate. High energy.

- Module 9A – Inland wetlands not associated with the Lake/emergent wetland (water level varies). Topsoil/sand substrate. Low energy.
- Module 9B – Inland wetlands not associated with the Lake/forested wetland (water level varies). Topsoil/sand substrate. High energy.

The vertical extent of dredging (e.g., dredging elevation [E]) was computed for the elevation-based dredging areas using the equation below.

$$E = WL - T_c - WD + \Delta H$$

Each of the equation parameters is described below.

- **Project water level (WL)** – The project water level was set at 362.5 feet North American Vertical Datum of 1988 (NAVD88) to meet habitat objectives focused on the sensitivity of plant communities in the nearshore areas of the Lake. This elevation of 362.5 feet NAVD88 was selected for the design, as it represents the average lake level during the aquatic plant growing season (see Section 3.3 of the Draft Final Design Report).
- **Estimated cap thickness (T_c)** – The estimated cap thickness consists of the sum of the minimum thicknesses for up to four layers of the cap (i.e., mixing layer, chemical isolation layer, erosion protection layer, and habitat layer), plus an over-placement allowance for each layer (tables 2 through 8). For the estimated dredge areas to be completed in 2012, the maximum anticipated capping over-placement was assumed for each cap layer within habitat modules 5 and 6 (i.e., modules containing sensitive aquatic vegetation dependent on a tight water depth tolerance) in portions of Remediation Areas C and D. These areas will be used to demonstrate the remedial contractor's cap placement abilities. For the remainder of the remediation areas to be completed after 2012, the mean capping over-placement was assumed to account for the remedial contractor's anticipated ability to meet such tolerances based on demonstrated cap placement experience at other sites (see Section 4.3.4 of Final Design Report). Verification of construction tolerances during the first year of capping in portions of Remediation Area C and Remediation Area D will be used to confirm that mean over-placement design in habitat modules 5 and 6 is appropriate. The capping over-placement will be further evaluated as part of an adaptive management program throughout the remedy.

The four cap layers are described below:

- Mixing layer thickness is conservatively assumed to be 0.25 feet (see Section 4.1 of the Final Design Report).
- Chemical isolation layer thickness is a minimum of 1 foot (in accordance with the ROD). In some portions of the Lake, cap amendments including pH amendment (e.g., siderite) and/or activated carbon will be integrated into the caps to meet ROD objectives, as detailed in Appendix B and Section 4.1.4 of the Final Design Report. With the exception of caps over certain utilities and cultural resources, and portions of the Outboard Area, the chemical isolation layer will be placed completely below an elevation of 360.5 feet NAVD88 to protect against ice scour.
- Erosion protection layer thickness is sized according to the results of Appendix D of the Final Design Report. The minimum stable particle size and thickness are typically based on the wind-induced waves during a 100-year event. The minimum erosion protection layer thickness will be 1 foot within the Lake and 4.5 inches (0.375 feet) in the adjacent Ninemile Creek spits, WB 1-8 connected wetland, and WBB/HB Outboard Area.
- To prevent loss of protectiveness due to ice scour, a minimum thickness of 0.5 feet of erosion protection material will be below an elevation of 360.5 feet NAVD88 in the Lake and the adjacent Ninemile Creek Spits and WB 1-8 connected wetland. With the exception of caps over certain utilities and cultural resources, and portions of the Outboard Area, the minimum 0.5 feet of erosion protection material below elevation 360.5 feet was not considered a requirement due to the following:

    - Transitioning into the wetlands that are above Lake surface; therefore, not practical to meet
    - The Outboard Area will be vegetated and will have a minimum of 2 feet of erosion protection/habitat material overlying the chemical isolation layer; therefore, providing significant buffering from any ice scour
    - Ice evaluation is conservative; the potential for impact due to ice scour is low and will be addressed, if necessary, as part of Cap Monitoring and Maintenance Plan

- Habitat layer thickness is based on a minimum habitat layer for a specific water depth, as defined in the Habitat Plan and Section 4.3 of the Final Design Report.

- **Target water depth (WD)** – In general, the target post-capping water depth in areas within the lake that will be dredged was assumed to be the shallowest water depth within a habitat module (excluding habitat module 6 where the water depth was set to zero), as defined in the Habitat Plan, and summarized in tables 1 through 6. The target water depth was assumed to be the shallowest target water depth in the module to minimize the effect of settlement on changing the habitat module, while still resulting in a post-construction elevation that will be within the targeted habitat range for that module immediately following cap placement. For example, Module 5A has a target water depth ranging from 0.5 to 2 feet (tables 1 through 6). The dredging elevation was developed based on the shallowest water depth in this habitat module (0.5 feet). The post-capping water depths for the Ninemile Creek Spits, WBB/HB Outboard Area, and WB 1-8 connected wetlands were also developed based on habitat considerations, as detailed in Section 4.3.5 of the Design Report.
- **Settlement (ΔH)** – Settlement refers to the compressing of sediments due to an increase in the stress (i.e., the added weight of a cap) on those sediments. The change in stress is a function of the thickness/load removed by initial dredging (if any) and the thickness/load of the applied cap. If the sediment is subjected to a net increase in stress/load (e.g., the increase in load resulting from the placement of the cap more than offsets the reduction in load from the removal of dredge material), some settlement could occur. The amount and rate of settlement are dependent on the compressibility and permeability of the sediments. For fine-grained sediments like those in the Lake, this settlement typically occurs over a period of several months to many years and will gradually slow over time. Appendix E of the Final Design Report provides additional details of long-term settlement predictions. Although settlement was accounted for in estimating long-term, post-construction surface elevations for habitat planning, it was assumed to be zero ($\Delta H = 0$) when determining dredging elevations. This way, dredge depths could be planned deep enough to meet habitat elevation goals, without relying on predicted settlements. When incorporating predicted settlement, portions of the habitat module would attain average or deeper water depths.

Cross-sections in remediation areas A, B, C, D, E, Ninemile Creek Spits, WBB/HB, and WB 1-8 illustrate the development of the dredging elevation by including the existing ground surface, removal limit, and proposed cap elevations at construction (see Dredging and Capping Plan). Based

on anticipated over-placement tolerances, and taking into consideration over-dredging that will likely occur in order to achieve required minimum dredge cuts, the required shown cap surface and minimum dredge cuts for shallow water modules 5 and 6 anticipated to be dredged in the first dredging season are based on total cap thicknesses inclusive of maximum cap over-placements. This applies to portions of Remediation Areas C and D. It is anticipated that this is a conservative approach and that the first year of construction will demonstrate that target cap elevations can be met based on dredge cuts developed using average over-placements for each layer. Therefore, dredge cuts developed for the areas anticipated to be dredged in subsequent dredging season are based on total cap thicknesses inclusive of mean over-placements for each cap layer. Modifications to the dredge prisms for subsequent years will be made as necessary based on the results of the first year, subject to NYSDEC approval.

In general, the elevation post-construction for all habitat modules deeper than 3 feet will reflect a mean cap thickness following construction, prior to the effects of settlement. During construction of the shallow water caps (habitat modules with the tightest acceptance criteria [6, 5, and 4]), if the final elevation is below the acceptable lower limit, the thickness of the final habitat layer will be increased such that the final elevation of the cap surface is within the elevation targeted for the given habitat module.

3.1 General Dredge Prism and Capping Thickness Development Assumptions and Procedures

In addition to defining the lateral and vertical extents of the dredge prism, general assumptions or procedures that were globally applied during dredge prism development include the following:

- **Project datum** – Horizontal survey information is referenced to the New York State Plane Feet North American Datum of 1983 (NAD83), Central Zone. All elevations are referenced to the NAVD88.
- **Shoreline** – The project boundary along the shoreline was defined by the project water level of 362.5 feet NAVD88.
- **Bathymetry (e.g., existing ground)** – A bathymetric survey was conducted by CR

Environmental, Inc. in 2005 and is documented in *Lake Phase I Pre-design Investigation Geophysical Survey Report* (CR Environmental, Inc. 2007). This bathymetric survey formed the basis of the existing bathymetry presented in the dredge plans. An additional bathymetric and topographic nearshore survey was completed in July 2011 by Thew Associates, PLLC, in the area along the CSX Railroad within Remediation Area E.

- **Transition between shoreline and dredging** – Sufficient dredging will typically be completed up to the shoreline to allow placement of the cap without losing lake surface area (see drawing D-31). In areas not contiguous with adjacent wetland remediation, the dredge prism was designed with a 5 horizontal to 1 vertical (5H:1V) slope from the bottom of the dredge cut (e.g., toe of slope) to the daylight line along the upland of the shoreline. Minor exceptions to this approach are identified under the discussion pertaining to individual remediation areas. Nearshore geotechnical data, including in situ vane shear testing and laboratory strength testing, was collected as part of the Phase V PDI. These Phase V data indicate that steeper slopes (steeper than 5H:1V) may be stable in some shoreline areas; therefore, additional evaluations and/or adaptive management may be used during construction to refine shoreline dredge slopes such that they are stable, yet minimize upland disturbance.
- **Transition between dredging elevations/cuts** – A slope of 5H:1V was designed to transition between two different target dredging elevations/cuts (see drawing D-31).
- **Transition between elevation-based dredging areas and sediments outside remediation area boundary** – In areas where elevation-based dredging is planned away from the shoreline, the bottom of the dredging prism was set at the required elevation along the remediation area boundary (see drawing D-31). The slope of the dredge cut was extended into the sediment outside of the remediation area boundary.
- **Transition between elevation-based dredging and cap-only areas** – In areas where the elevation-based dredging boundary is planned to abut a cap-only boundary, the dredge prism was set at the required elevation within the elevation-based dredging area, and the slope of the dredge cut was extended into the cap-only area (see drawing D-31).
- **Minimum dredge cut** – A minimum dredge cut of 0.5 feet was used within the dredge prism to maintain efficient production rates and minimize low solids contents in the dredge slurry.

In addition to defining the specific thickness of the caps, general assumptions or procedures that were globally applied during the capping cross section development include the following:

- **Transition between shoreline and cap** – As described above, sufficient dredging will typically be completed up to the shoreline to allow placement of the cap without losing lake surface area (see drawing D-31). The full cap thickness will be placed from the lake to the shoreline (defined as 362.5 feet NAVD88). At the dredge slope, the erosion protection layer will extend up the dredge slope to protect the exposed slope from erosive forces (see drawing D-31). In select areas (e.g., contiguous with wetland remediation and near the NYSDOT Turnaround Area), a modified shoreline transition will be necessary. These shoreline transitions are discussed in Section 3.2 under each remediation area.
- **Transition between capping elevations** – A slope of 5H:1V was designed to transition between two different target capping elevations/cap thicknesses.
- **Transition between capping areas and sediments outside remediation area boundary** – In areas where capping is planned away from the shoreline (e.g., junction between remediation area and SMU-8), the full cap thickness was applied along the remediation area boundary and sloped at 5H:1V into the adjacent sediments.

The in situ dredged material volume associated with the design of the dredge prism was calculated using Auto Desk's Civil 3D software (Civil 3D). A three-dimensional surface was created in AutoCAD v. 2011 for both the existing bathymetry and the required dredge prism, accounting for design side slopes. These surfaces each consisted of a set of contiguous, non-overlapping triangles known as a triangulated irregular network (TIN). Using Civil 3D, the volume between these two TINs was calculated to represent the required dredge volume.

An allowable over-dredge surface was developed by lowering the required dredge prism by 0.5 feet in elevation, and over-dredge allowance volume was computed using this surface for remediation areas A, B, C, and E. The dredging elevation in water depths less than 3 feet in Remediation Area D is also based on a minimum required elevation to achieve a target post-capping water depth; therefore, an estimated removal volume associated with over-dredging is included for this area. However, the overall dredge plan in the ILWD is based on the ROD-required removal volume equal to an average

of 2 meters, plus hot spots. Therefore, the removal in the remainder of the ILWD will be to the specified target elevation plus or minus 0.5 feet such that the final removal volume achieves the ROD-specified goal of a volume equal to a 2-meter average removal, plus the volume of hot spots. Details regarding how achievement of the 2-meter average removal will be ensured during construction (i.e., that the amount of overcut is equal to or greater than the amount of undercut within each SMU portion of the ILWD) will be provided in the Construction Quality Assurance Plan (CQAP).

Target post-capping elevations in the adjacent wetlands being dredged as part of the Lake remediation (Ninemile Creek Spits, WB 1-8, and WBB/HB) were not developed as maximum elevations; rather, they were developed as the ideal elevations with some expectation of variability around these elevations. Therefore, post-capping target elevations will be met in these areas plus or minus 6 inches. Thus, the target dredge elevations were established based on an assumption of mean over-placement of each cap layer, and the dredging will be specified to meet target dredge cuts plus or minus 6 inches. As a result, no over-dredging is included in these areas.

3.2 Remediation Area-specific Dredge Prism and Cap Design Development

In addition to the general assumptions and procedures outlined above, each remediation area contained dredge and cap design nuances (e.g., dredge cut thickness, habitat considerations) that are specific to that remediation area. In light of the complex design, tables 1 through 6 were developed in conjunction with the habitat work group as a tool to guide the dredging and capping design for each remediation area. Each remediation area-specific table includes the following:

- Targeted habitat modules
- Location inside or outside of the surf zone (as defined as the approximate depth of the breaking wave during a 100-year event [see Appendix D of the Final Design Report])
- Proposed remediation (elevation-based dredging, or capping only)
- Chemical isolation components, including a mixing layer, chemical isolation layer including pH and/or activated carbon amendments where indicated, an assumed mean over-placement allowance (maximum over-placement allowance for habitat modules 5 and 6 in portions of

Remediation Area C and Remediation Area D scheduled for dredging in 2012), and the mean total layer thickness (maximum total layer thickness for habitat modules 5 and 6 in portions of Remediation Area C and Remediation Area D scheduled for dredging in 2012)

- Erosion protection/habitat layer components, including a minimum erosion protection/habitat layer based on the results of Appendix D of the Final Design Report (excluding the adjacent wetland areas described below), an assumed mean over-placement allowance (maximum over-placement allowance for habitat modules 5 and 6 in portions of Remediation Area C and Remediation Area D scheduled for dredging in 2012), and the mean total layer thickness (maximum total layer thickness for habitat modules 5 and 6 in portions of Remediation Area C and Remediation Area D scheduled for dredging in 2012). Due to cap design requirements, the minimum erosion protection/habitat layer thickness was set at 1 foot in all areas excluding the adjacent wetland areas (Ninemile Creek Spits, WB 1-8 connected wetlands, and WBB/HB Outboard Area) where a minimum erosion protection layer was set at 4.5 inches (0.375 feet) and a minimum habitat layer was set at 19.5 inches (1.625 feet). For the wetland areas, the dredge elevations are based on the total thickness with combined average over-placements of 23 inches for the habitat substrate and 9 inches for the erosion protection substrate (along with the thicknesses of the mixing and isolation layers with average over-placements) to achieve the post-capping target elevations for the wetlands (with up to 1 m additional removals in the Outboard Area hot spots).
- Additional habitat layer components, including a dedicated minimum habitat layer (in addition to the erosion protection layer), an assumed mean over-placement allowance, and the mean total layer thickness
- Total minimum cap thickness
- Assumed total mean over-placement allowance for all layers
- Total mean cap thickness
- Assumed total maximum over-placement allowance for all layers
- Total maximum cap thickness
- Top of cap elevation
- Water depth from cap surface
- Dredging volume computations including total area, dredge volume based on the dredge prism, over-dredge volume estimate (assuming 6 inches across the total dredge area excluding Remediation Area D and the adjacent wetlands discussed above), and total dredge volume

The dredge depths were largely developed to achieve the desired post-construction habitat objectives and elevations. It is Honeywell's objective to continually monitor the progress of the construction, allowing continued project implementation enhancement on cap and dredge tolerances. This continuous monitoring can lead to design assumption revisions, allowing the project construction schedule and final effectiveness to be optimized. As such, adaptive management will be used during the remedial construction to refine components of the dredge prism design with an overall objective of continuous optimization of the project.

An area-by-area summary of unique dredge prism components is provided below.

3.2.1 Remediation Area A and Ninemile Creek Spits

Remediation Area A is approximately 86 acres and is located off the mouth of Ninemile Creek (drawings D-2 to D-3 and D-13 to D-15 show plan views and cross-sections of Remediation Area A). Remediation Area A contains both elevation-based dredging and capping-only areas. Additionally, the dredge prism for the adjacent spits along the mouth of Ninemile Creek and the removal of the connected emergent wetlands have been integrated into the Remediation Area A dredge prism.

Remediation Area A contains four habitat modules (modules 6A, 5A, 4A, and 3A) where elevation-based dredging will occur near the shoreline. Target dredge elevations were assigned based on target water depths, presence of amended cap material, and mean cap thickness, as shown in Table 2.

Dredge prism design along the SYW 10 wetland west of Ninemile Creek and along a small portion of the steep bank east of Ninemile Creek allows for a 1-foot dredge depth at the shoreline, and extends to mean cap thickness at a 5H:1V into the Lake (see Drawing D-31). The dredge cut rises at a 5H:1V from the shoreline into SYW 10. This design provides for minimizing the disturbance of the SYW 10

mature forested wetland by the dredge. The groundwater collection trench will be located outside of the eastern half of Remediation Area A along the shoreline dredge boundary.

Three unique capping situations occur within or near Remediation Area A: 1) the shoreline transition near SYW 10 wetland and the steep bank east of Ninemile Creek; 2) shoreline stabilization/enhancement; and 3) offset of capping/shoreline stabilization area near cultural resources. As described above, the dredge prism design along the SYW 10 wetland west of Ninemile Creek and along the steep bank east of Ninemile Creek allows for a 1-foot dredge depth at the shoreline. The cap transitions in these areas differ from the typical shoreline transition, whereas the erosion protection layer extends up the slope with a minimum 1-foot erosion protection layer at the shoreline rather than a full cap (see drawing D-31). The modified shoreline transition is located primarily within the restored wetland, and includes a habitat layer thickness of at least 1 ft. over the entire area except for approximately 0.05 acres.

Additionally, material will be placed along a portion of the surf zone of SMU 3 to address erosion of Solvay waste material along the shoreline of WB 1-8. Shoreline stabilization material consisting of a graded, bank-run gravel material will be placed at an average thickness of approximately 1.5 feet from existing elevation 365 feet to 362.5 feet (upland from the shoreline). Shoreline stabilization material consisting of coarse gravel will be placed at an average thickness of approximately 6 inches from elevation 362.5 feet to 360 feet (within the lake). Drawing D-32 depicts the shoreline stabilization features.

Four cultural resources were identified within the northern basin of the lake: two resources within Remediation Area A and two resources between Remediation Areas A and B. As described in Section 7.3 of the Final Design Report, a 10-foot offset where capping will not occur has been incorporated near cultural resources A-20 (rock scow) and A-22 (Pleasant View Resort Pier). Two identical spud barges, A17-1 and A17-2, are located between Remediation Areas A and B within the shoreline stabilization area. To avoid impacts to the spud barges, the shoreline stabilization will be completed up to these features, but not within their bounds.

3.2.2 Remediation Area B and Wastebed 1-8 Connected Wetland

Remediation Area B is approximately 19 acres and is located offshore of WB 1-8 (drawings D-4 and D-16 show plan views and cross-sections of Remediation Area B). Within Remediation Area B, there are two elevation-based dredging areas (Module 5B and Module 3A) where elevation-based dredging will occur near the shoreline. The target dredge elevations are shown in Table 3.

Nearshore sediment dredging in this area is relatively shallow, and no sensitive structures are located along the shoreline. However, as discussed in Section 3.4 of the Final Design Report, a groundwater collection trench will be installed along the shoreline as part of the WB 1-8 IRM. The groundwater collection trench will be located outside of the Remediation Area B dredge boundary.

The removal prism for the WB 1-8 connected wetland area was developed adjacent to the Remediation Area B dredge prism and alongside the IRM collection trench. Material above and below the water table within the connected wetland area will be removed as part of the Lake design.

Similar to Remediation Area A, shoreline stabilization/enhancement material will be placed along a portion of the surf zone of SMUs 3 and 4 to address erosion of Solvay waste material along the shoreline of WB 1-8.

3.2.3 Remediation Area C

Remediation Area C is approximately 24 acres and is located offshore of the NYSDOT Turnaround Area and the Willis/Semet IRM barrier wall exclusive of ILWD (drawings D-5 and D-17 to D-18 show plan views and cross-sections of Remediation Area C). Remediation Area C contains three habitat modules (modules 6B, 5B, and 3B) where elevation-based dredging will occur near the shoreline. Target dredge elevations were assigned based on target water depths and maximum cap thickness for habitat modules 5B and 6B to be dredged in 2012 as shown in Table 4. All areas

scheduled for dredging to occur after 2012 were designed based on target water depths and mean cap thickness.

Shoreline stability in this area is of particular concern due to the proximity of shoreline utilities and existing steep slopes. The dredge prism along the shoreline east of the NYSDOT Turnaround Area was modified to prevent impacting the existing utilities and barrier wall along the shoreline. A 10-foot offset (daylight slope of dredge cut was moved 10 feet outboard of existing shoreline) was incorporated into the design for the length of shoreline where a force-main parallels the shoreline. A barrier wall is present for a portion of this length. In this area, the cap will be placed such that the full cap thickness is placed over the dredge slope and existing ground (see Drawing D-17, Section 13).

The NYSDOT Turnaround Area is located on top of hard slag waste material, which was deposited in the Lake by industrial processes not associated with Honeywell or its predecessors. Removal of shoreline material is not included due to the extremely hard nature of this material and to facilitate future development of this area as a boat launch. Since the NYSDOT Turnaround Area has a steep slope (on the order of 2H:1V) present on the northeastern side, a modified cap will be placed over the steep slope. The modified cap includes a chemical isolation layer that extends to the shoreline, as well as an armor layer over the whole slope. The armor stone will extend from elevation 362.5 feet down to the base of the steep slope at approximately elevation 340 feet and include an armor stone toe berm as depicted on Drawing D-32.

East of the NYSDOT Turnaround Area, the post-capping water depth was developed specifically to facilitate recreational boat traffic in the vicinity of the future boat launch. Additionally, the stone size of the erosion protection layer was increased from fine gravel (suitable for protection from wind-wave forces) to coarse gravel taking into consideration the potential for significant boat traffic in this area.

Three active outfalls discharge near the proposed capping areas within Remediation Area C. These outfalls include the Tributary 5A outlet, Westside Pumping Station outlet, and the former I-690 outfall. Proposed dredging and capping occurs outside of the delineated scour pads (see Drawing D-5); however, dredging and capping activities near these active outfalls will be executed such that they do not impact the active outfalls. An appropriate offset from these outfalls will be established to prevent damage during construction in conjunction with the construction contractor and the New York State Department of Environmental Conservation (NYSDEC) based on field conditions and observations. Scour protection at the outfalls will be replaced in-kind, as necessary (see Drawing D-32).

As with remediation areas A and B, shoreline stabilization/enhancement material will be placed along a portion of the surf zone of SMU 3 to address erosion of Solvay waste material along the shoreline of WB 1-8. The dredge and cap boundary was adjusted to accommodate the groundwater collection trench located west of the NYSDOT Turnaround Area along WB 1-8 where the trench is near the proposed inland wetland.

3.2.4 Remediation Area D

Remediation Area D is approximately 99 acres and is comprised of SMU 1 and the ILWD portions of SMUs 2 and 7 (see drawings D-6 to D-8 and D-19 to D-22). The dredging requirements in Remediation Area D are based on the ROD-required, 2-meter-average dredge cut within former SMUs 1, 2, and 7. Additional dredging (beyond the 2-meter average dredge cut) of 3.3 feet (1 meter) is proposed at seven hot spot locations (A through G) where remaining sediment concentrations exceeded the ROD-specified hot spot criteria in the 1-meter interval below the initial dredge depth. The details pertaining to the development of the general dredge depths in each SMU and hot spot areas is presented in Appendix G of the Final Design Report. Remediation Area D contains three habitat modules (modules 6A, 5A, and 3B) where elevation-based dredging will occur near the shoreline. Table 5 presents the targeted habitat modules that will be incorporated into the dredge prism.

The shoreline of the western third of Remediation Area D consists of the exposed sheetpile barrier wall installed in 2008 as part of the Willis/Semet IRM. Dredging design and implementation in this area will consider potential stability issues associated with the wall, as well as ensure dredging operations and shoreline support activities do not subject the sheetpile wall to excessive stress and compromise structural integrity that could lead to potential damage and safety risks. The dredge prism for Remediation Area D will include a 10-foot offset along the barrier wall, with a 5H:1V slope extending from the toe of the dredge prism up to the barrier wall.

In addition to the dredging offset near the barrier, dredging offsets will also occur near utilities. There are seven utilities present within Remediation Area D. Section 7.2 of the Final Design Report provides detailed descriptions of these utilities and how they are incorporated into the dredging and capping design. A summary of dredging and capping offsets and design modifications are provided herein.

- Two cooling water intakes (84-inch-diameter and 72-inch-diameter pipes) are located in the SMU 2 portion of Remediation Area D (Drawing D-5). Sufficient dredging will be completed over these pipelines in the nearshore area to allow cap placement without loss of lake surface area. Once outside of the dredging zone, a 10-foot offset was applied to the two cooling water intakes.
- Three water inlet pipes (42-, 30-, and 16-inch diameter) are located near the western boundary of SMU 1 within Remediation Area D (Drawing D-6). These pipelines are believed to be below the bottom of the dredge cut or only slightly extend into the dredge area and, therefore, will not impact dredging activities.
- A 60-inch diameter diffuser pipeline bisects the middle of SMU 1 within Remediation Area D (Drawing D-6). The pipeline originally lay on the lake bottom; however, it is currently under the sediment from the shoreline to approximately 500 feet offshore. The remaining section of pipeline and diffuser (which runs perpendicular to the pipe) rises above the sediment, with the diffuser portion of the pipeline pile-supported on a structure of unknown detail and condition. To avoid undermining and potential collapse of the pipeline, the dredge cut adjacent to the pipe will be offset by 10 feet.
- The Metropolitan Syracuse Wastewater Treatment Plant (Metro) Deepwater Outfall (72-inch outer diameter) is located at the edge of SMU 7 within Remediation Area D (Drawing D-9).

To avoid having an adverse effect on the pipeline and outfall, a buffer zone will be established such that dredging will be offset approximately 25 feet from the outfall and pipeline. The final approach for capping of the area over the pipeline is currently under development and will be included in a design addendum subsequent to the Final Design.

The remaining valve structure components associated with the 72-inch cooling water intake will be left in place. This structure is comprised of heavy gauge metal and is not expected to represent a potential contaminant pathway. In order to provide an extra level of conservatism, a modified cap design, including an additional 1-ft. thickness of chemical isolation material, will be placed above and around this valve structure. The area of this modified cap will be 25 ft. x 25 ft., and is shown on Drawing D-5.

Two active outfalls discharge onto the proposed dredging and capping areas within Remediation Area D. These outfalls include the 48-inch stormwater outlet and Metro deepwater outfall (see Section 3.2.5 for further details). Based on a scour protection assessment presented in Appendix D of the Final Design Report, a scour pad will be incorporated into the cap near the 48-inch stormwater outlet and will be constructed as shown in the typical detail of the outfall scour protection on Drawing D-32. The scour protection will be constructed with the NYSDOT Standard Specification for Medium Stone Filling.

Adjacent to Remediation Area D are two additional capping areas: Remediation Area D addendum area and the SMU 8 thin layer cap area. The Remediation Area D addendum area is approximately 6 acres and will receive a cap consistent in composition as the Remediation Area D habitat module 1 cap (see Table 5).

A thin-layer cap will be placed in portions of SMU 8 (15 acres) adjacent to Remediation Area D. Thin-layer capping is required in areas of SMU 8 where the mean PECQ exceeds 1 in the top 4 centimeters , and where monitored natural recovery (MNR) is not predicted to meet the mercury

criteria required by the ROD (probably effects concentration of 2.2 mg/kg at each location, and bioaccumulation-based sediment quality value (BSQV) of 0.8 mg/kg on an area-wide basis) within 10 years following the completion of upland source control and dredging and capping in the littoral zone. The minimum thickness of the thin-layer cap is 4 cm (approximately 2 inches). Based on constructability considerations, the mean thickness of the thin-layer cap with over-placement will be approximately 5 inches.

3.2.5 Remediation Area E

Remediation Area E is approximately 183 acres and is located at the southwestern end of the lake (drawings D-8 to D-11 and D-22 to D-29 show plan views and cross-sections of Remediation Area E). Remediation Area E contains three habitat modules (modules 6B, 5B, and 3B) where elevation-based dredging will occur near the shoreline. Target dredge elevations were assigned based on target water depths and mean cap thickness, as shown in Table 6.

A fourth elevation-based dredging area has been designed for the navigation channel that extends from Onondaga Creek into the Lake (see Drawing D-10). The navigation channel is authorized by the State of New York. Based on information from the New York State Canal Corporation (NYSCC), the dredge prism was developed with a post-capping water depth of 16 feet (an authorized depth of 14 feet plus 2 feet below authorized dredge depth to prevent dredge-induced damage to the cap associated with future navigational dredging), and a 5H:1V side slope. An erosion protection layer consisting of 3-inch stone with a minimum erosion layer thickness of 1 foot was assumed for two purposes: 1) the larger stone will serve as an indicator layer for future navigational dredging; and 2) to protect the side slopes inside the surf zone (e.g., approximately 7 feet). As the habitat substrate is also gravely cobble in the channel, the total thickness of the erosion/habitat layer in the channel is 1 foot. Although the bottom of the channel is outside of the surf zone, a portion of the side slopes is subjected to erosive wind-wave forces within the surf zone; therefore, the larger stone size to resist wind-waves was applied to the entire channel. The dredge and cap design within the in-lake portion of the channel will be reviewed with NYSCC and any required modifications will be addressed in a Design Addendum subject to NYSDEC approval.

The shoreline adjacent to the southern portion of Remediation Area E is dominated by an active rail line, which is directly adjacent to the shoreline. Design and implementation of dredging and capping (9 acres out of the 183 acres within Remediation Area E) in this area will consider potential stability limitations associated with the presence of the rail line. A 150-foot offset from the shoreline was incorporated into the dredge prism design for this Final Design to indicate the area that is being evaluated due to the potential stability concerns in this area during dredging. Capping and dredging plans will be developed for this area as part of a design addendum subsequent to the Final Design.

Similar to Remediation Area D, a thin-layer cap will be placed in portions (12 acres) of SMU 8 adjacent to Remediation Area E (see drawings D-10 and D-11).

Remediation Area E also contains the deepwater outfall owned by Metro (see drawing D-9). This pipe passes through Remediation Area E (including the 150-foot shoreline stability area where the remedial design approach has not been determined) and discharges at the boundary between remediation areas D and E. To avoid having an adverse effect on the pipeline and outfall, a buffer zone will be established such that dredging will be offset approximately 25 feet from the outfall and pipeline. The final approach for capping of the area over the pipeline and adjacent to its discharge, including any consideration of potential scour, is currently under development and will be included in a design addendum subsequent to the Final Design.

Also located in Remediation Area E are the Metro storm water discharge and shoreline treated effluent outfall. These utilities are located in the area impacted by potential stability concerns due to the shoreline railroad tracks in this area, and the remedial approach in this area is under development. The remedial approach in the vicinity of these utilities will be determined following determination of the overall remedial approach in this area.

The final utility is an 8-inch-diameter cast-iron pipe previously owned by Sun Oil and abandoned in the early 1900s (see Drawings D-8 and D-9). Visual inspection of the pipeline in 2011, indicated the pipeline was disintegrating and in poor condition (see Section 7.2.2.12 of the Final Design Report). As the pipeline is relatively small and is on or near the sediment surface, it will be removed prior to any dredging or capping activities.

As described in Section 7.3 of the Final Design Report, the Syracuse Maritime Historic District is a proposed National Register district located almost entirely within Remediation Area E and is composed of 16 cultural resource targets. The 16 targets were broken into three groups: wooden watercrafts, marine structures, and rock mounds and piles. Descriptions of these targets are provided in Section 7.3; revisions to dredging and/or capping associated with these targets are described below.

- **Wooden watercrafts:** Seven wooden watercraft (A3, A4-1, A4-2, A12, A35, A53, and A55) were identified within the Syracuse Maritime Historic District (see Drawings D-9, D-10, and D-11). To avoid adverse effect on the vessel remnants, a 25-foot offset where dredging will not occur will be placed around these wooden watercrafts. A modified cap will be placed over the targets. The modified cap for Remediation Area E cultural resources will be made up of a minimum 1-foot chemical isolation layer consisting of gravelly sand (including granular activated carbon [GAC] where required) and a minimum 1-foot habitat/erosion protection layer consisting of gravelly cobble. Using these minimum thicknesses, and including a 3-inch mixing layer and average capping over-placements, an average 3-foot cap will be placed over these targets. A typical modified cap for Remediation Area E cultural resources is provided in Drawing D-32.
- **Marine infrastructure:** Six areas of marine infrastructure include: A1/A2 (Salina Pier), A38 (iron pier), A45 (concrete breakwater), A7 (piling clumps), A72 (piling clumps), and A73 (bulkhead). To avoid an adverse effect on the piers, dredging will be offset 25 feet from targets A1/A2 and A38 (see Drawing D-11). The modified cap for Remediation Area E cultural resources will be installed over the offset area and pier remnants, where possible. Anomaly A45, a concrete breakwater, is situated southeast of the entrance to the Syracuse Inner Harbor (see Drawing D-9). Sediments will be dredged to within approximately 10 feet of the breakwater and a modified cap for Remediation Area E cultural resources will be placed over the area. Two sets of piling clumps (A7 and A72) and a bulkhead consisting of 7

pilings (A73) are located entirely within the dredge and cap zone. The bulkhead A73 will be removed prior to dredging/capping. The fate of the piling will be addressed in a Design Addendum subject to NYSDEC approval.

- **Rock mounds and piles:** Three rock mounds and piles, A34, A75, and A76, are located within or near Remediation Area E (see Drawings D-10 and D-11). The rock mound and piles appear to lack intentional design and have limited research potential. Targets A34 and A75 lie entirely within the dredge and cap zone. Given their limited historical significance and research potential, these features will be removed prior to capping. A76 is adjacent to but just outside the remediation area boundary. This rock pile will be marked and a work zone buffer will be established around it to ensure it is not adversely impacted by vicinity construction activities.

A buried wooden canal boat (A33) is also located within Remediation Area E outside of the Syracuse Maritime Historic District in the cap-only area. To avoid adverse effect on the vessel remnants and because this feature is in an area where concentrations are relatively low, this area will remain uncapped (with a 25-foot buffer), as it will likely meet criteria in the future via natural recovery processes (particularly burial) and will present minimal environmental risk in the interim.

3.2.6 Remediation Area F

Remediation Area F is approximately 0.6 acres and comprises two small areas of impacted sediment north of Remediation Area A (Drawings D-12 show plan view of Remediation Area F). These impacted areas are located in SMU 5. Remediation Area F contains two habitat modules (5A and 3A) where capping will occur. The mean cap thickness for habitat modules 5A and 3A are shown in Table 7.

3.2.7 Outboard Area

The WBB/HB Outboard Area is approximately 16 acres and is located at the southwestern end of the Lake between the Willis/Semet IRM barrier wall and remediation areas D and E (drawings D-6 and

D-8 and D-19 to D-23 show plan views and cross-sections of Outboard Area). The Outboard Area contains four habitat modules (modules 9B, 6A, 5A, and 3A) where elevation-based dredging will occur throughout. Target dredge elevations were assigned based on habitat considerations to promote pike spawning assuming mean cap thicknesses, as shown in Table 8.

Additional dredging (beyond the target dredge elevations to meet habitat objectives) of 3.3 feet (1 meter) is proposed at six hot spot locations (OB1 through OB6) where remaining sediment concentrations exceeded the ROD-specified hot spot criteria. Hot spots OB4 and OB6 will be backfilled following dredging to achieve required elevations for Habitat Module 9B. Additional material will also be place in hot spots OB1 and OB2 to transition from 1 foot of material over the barrier wall into the hot spot (see Sections 20 and 22 on Drawing D-20).

4 REFERENCES

CR Environmental, Inc., 2007. *Onondaga Lake Phase I Pre-design Investigation Geophysical Survey Report*. Prepared for Honeywell.

Parsons, 2007. *Onondaga Lake Pre-Design Investigation: Phase I Data Summary Report.* Prepared for Honeywell, Morristown, NJ. May 2007.

Parsons, 2008. *Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report.* Prepared for Honeywell, Morristown, NJ. Draft August 2008.

Parsons, 2009a. *Onondaga Lake Pre-Design Investigation: DRAFT Phase III Data Summary Report.* Prepared for Honeywell, Morristown, New Jersey and Syracuse, New York. Draft April 2009.

Parsons, 2009b. *Draft Remedial Design Elements for Habitat Restoration*. Prepared for Honeywell, Morristown, New Jersey and Syracuse, New York. Draft June 2009.

Parsons, 2011a. *Onondaga Lake Pre-Design Investigation Phase IV Data Summary Report*. Prepared for Honeywell, Morristown, New Jersey, and Syracuse, New York. January 2011.

Parsons, 2011b. *Onondaga Lake Pre-Design Investigation: Phase VI Data Summary Report*. Prepared for Honeywell, Syracuse, New York. January 2011.

Parsons, 2012. *Onondaga Lake Pre-Design Investigation: Phase VII Data Summary Report*. Prepared for Honeywell, Syracuse, New York. March 2012.