# E.2

# CAP SETTLEMENT RA D AND OUTBOARD

# GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

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**TITLE OF COMPUTATIONS** **CAP-INDUCED SETTLEMENT EVALUATION FOR REMEDIATION AREA D AND THE ADDENDUM**

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# CAP-INDUCED SETTLEMENT EVALUATION FOR REMEDIATION AREA D

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## 1. INTRODUCTION

This report presents calculations of the amount and rate of consolidation settlement anticipated after dredging and placement of a subaqueous cap in Remediation Area D of the Onondaga Lake Bottom Site. Specifically, this report presents: (i) the total settlement (including primary settlement and secondary settlement) at the end of 30 years after placement of the cap and at the end of two years for the area with the highest estimated settlement; and (ii) the upward flow rate of consolidation water.

Remediation Area D, which is also referred to as the In-Lake Waste Deposit (ILWD), is shown in Figure 1. Remediation Area D consists predominantly of Sediment Management Unit (SMU) 1 with limited portions of SMUs 2 and 7. The dredging plan and the maximum and minimum cap thicknesses in Remediation Area D are 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; (iii) settlement analysis; and (iv) conclusions.

## 2. SUBSURFACE CONDITIONS

Extensive pre-design investigations (PDIs) were conducted in the ILWD from 2005 to 2007 to characterize the subsurface conditions. Detailed information regarding the subsurface stratigraphy is presented in a calculation package titled "*Summary of Subsurface Stratigraphy and Material Properties*" (referred to as the ILWD Data Package) for the Stability Evaluation of the ILWD [appendix of the Capping, Dredging, and Habitat Design Report]. In summary, the subsurface stratigraphy primarily consists of the following materials: Solvay waste (SOLW), Marl, Silt and Clay, Silt and Sand, Sand and Gravel, Till, and Shale. In isolated areas of the ILWD, thin silt layers are present over the SOLW.

The subsurface profile of the ILWD was developed based on the elevations of each layer from the boring logs. As explained in the ILWD Data Package, elevations for the deeper surfaces (e.g., bottom of Silt and Clay, bottom of Silt and Sand) that are below the depth of the shallow borings were estimated based on a limited number of deeper borings in the ILWD area. The deeper layers (i.e., Silt and Sand, Sand and Gravel, Till, and Shale) were considered as incompressible layers in the settlement analysis.

For the purpose of the settlement analysis presented herein, Remediation Area D was divided into 12 areas based on the thickness of the SOLW, Marl, and Silt and Clay layers. Representative values of SOLW, Marl, and Silt and Clay thicknesses were selected for settlement analysis in each area. The thin isolated silt layers were assumed to be part of the SOLW because their impact on settlement is expected to be insignificant. The divided areas and selected layer thicknesses for the settlement analyses are presented in Figure 2. The subsurface layer thickness contours are presented in Attachment A of this report. It is noted that the selected subsurface thickness values represent a general estimation of the average thickness of each layer in a particular area. The actual subsurface layer thickness at any point within an area may be higher or lower than the selected value.

## 3. MATERIAL PROPERTIES

The material properties required for settlement analysis include: (i) unit weight of cap and subsurface materials (i.e., SOLW, Marl, and Silt and Clay); and (ii) consolidation parameters of subsurface materials. For the calculation of upward flow rate of consolidation water, the hydraulic conductivities of the subsurface materials were also needed.

Unit Weight

The unit weight of Cap material was assumed to be 120 pcf in the analysis. The unit weight of SOLW, Marl, and Silt and Clay were assumed to be 81 pcf, 98 pcf and 108 pcf, respectively, as presented in the ILWD Data Package.

Consolidation Parameters

The consolidation parameters needed for settlement analysis are: 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 consolidation test data.

Two types of consolidation tests were performed, as follows:

(i) Conventional oedometer test: The conventional oedometer test data can be used to determine all the consolidation parameters needed for settlement analyses. Tests were performed on samples of SOLW, Marl, and Silt and Clay. The test reports are included in Attachment B of this report.

(ii) Seepage-induced consolidation (SIC) test: The SIC tests were completed in general accordance with the method presented by Znidarcic, et al. (1992). The test is run on a disturbed sample that has been slurried. A load is then applied by creating a constant flow rate in the sample. Load is then increased to the maximum desired level after constant flow is reached. The change in void ratio and permeability is measured as the loads are applied. Only the compression index can be calculated based on SIC test data. For Remediation Area D, SIC tests were performed primarily on samples of SOLW. The test results are presented in Phase I and Phase II Pre-Design Investigation Data Summary Report [Parsons 2007 and 2009].

As indicated previously, both tests were performed on samples of SOLW. The rationale for interpreting the $C_{c\varepsilon}$ value of SOLW from only the conventional oedometer test results is as follows:

(i) consolidation curves from conventional oedometer tests indicate an "apparent" pre-consolidation pressure between 1,000 to 3,000 psf, as shown by the solid lines in Figure 3. The slope of the consolidation curve is flatter when the vertical effective stress is less than the "apparent" pre-consolidation pressure as compared to when the vertical effective stress is greater than the "apparent" pre-consolidation pressure. It indicates that the compressibility of SOLW under a small stress condition (i.e., less than 1,000 psf) is less than the compressibility under a higher stress condition (i.e., greater than 1,000 psf). As presented in the ILWD Data Package, the consolidated undrained triaxial tests performed for SOLW during the PDI showed higher undrained shear strength ratios under a small stress condition (i.e., less than 1,000 psf) than under higher stress conditions (i.e., greater than 1,000 psf). This is likely due to the overconsolidated condition of the samples in the lab from the presence of an "apparent" pre-consolidation pressure;

(ii) SIC tests were performed on disturbed samples, and as expected, did not indicate any "apparent" pre-consolidation pressure, as indicated by the dashed lines in Figure 3. It is believed that the disturbance of the sample in the SIC tests changed the structure of the sample, and therefore, the SIC tests did not show the "apparent" pre-consolidation pressure; and

(iii) the vertical effective stress of SOLW in the field before and after capping is less than the "apparent" pre-consolidation pressure. Therefore, the $C_{c\varepsilon}$ value of SOLW should be interpreted from the conventional oedometer test, using the portion of the consolidation curve corresponding to the potential stress condition of SOLW in the field before and after capping (i.e., from 100 to 1,000 psf).

The values interpreted from oedometer tests for $C_{c\varepsilon}$ and $C_{r\varepsilon}$ of SOLW, Marl, and Silt and Clay are presented in Tables 1 through 4. The mean values of $C_{c\varepsilon}$ and $C_{r\varepsilon}$ were used for the settlement analysis in all areas. The interpretation of $C_{\alpha\varepsilon}$ and $c_v$ for SOLW, Marl, and Silt and Clay are presented in Figures 4 through 11. The representative values were used for the settlement analysis.

For sensitivity analyses to evaluate the impact of consolidation parameter uncertainty on calculated settlement, reasonable upper and lower bound values were selected for $C_{c\varepsilon}$, $C_{r\varepsilon}$, $C_{\alpha\varepsilon}$, and $c_v$. For $C_{c\varepsilon}$ and $C_{r\varepsilon}$, the reasonable upper bound values were selected as the smaller of the calculated "mean plus standard deviation" and the maximum value, and the reasonable lower bound values were selected as the larger of the calculated "mean minus standard deviation" and the minimum value (see Tables 1 through 4). For $C_{\alpha\varepsilon}$ and $c_v$, reasonable upper and lower bound values were selected based on the variability within the stress range of interest (see Figures 4 through 11).

As presented in the ILWD Data Package, comparison of calculated in-situ vertical effective stresses and the "apparent" pre-consolidation pressures interpreted from oedometer tests indicates that Marl has an OCR of about 1.2, and Silt and Clay is normally consolidated. The analyses presented herein assumed that both Marl and Silt and Clay are normally consolidated. This assumption will lead to slightly higher total settlement estimates.

Hydraulic Conductivity

According to the calculation package titled "*Summary of Subsurface Stratigraphy and Material Properties*" (referred to as the West Wall Data Package) for the Onondaga Lake West Wall Final Design [Geosyntec 2009], the measured hydraulic conductivity of SOLW varies from $4.95 \times 10^{-6}$ cm/s to $2.78 \times 10^{-5}$ cm/s. The measured hydraulic conductivity of Silt and Clay varies from $4.9 \times 10^{-8}$ cm/s to $4.41 \times 10^{-7}$ cm/s. These values are based on hydraulic conductivity tests performed on samples of SOLW and Silt and Clay from the Wastebed B/Harbor Book (WB-B/HB) area. For the purposes of analysis presented herein, the hydraulic conductivities of SOLW and Silt and Clay were assumed as $1 \times 10^{-5}$ cm/s and $1 \times 10^{-7}$ cm/s, respectively. These values are also reasonably consistent (i.e., same order of magnitude) as the values being used in the groundwater upwelling evaluations for the ILWD. The hydraulic conductivity of Marl was assumed the same as for Silt and Clay. Hydraulic conductivities were only used for the calculation of excess pore water pressures at layer interfaces as part of the upward flow of consolidation water calculations. Hydraulic conductivity values ranging from $1 \times 10^{-7}$ cm/sec to $5 \times 10^{-5}$ cm/sec have minimum impact on the calculated amount of consolidation water because the hydraulic conductivities only affect the calculation of pore water pressure at the interface between soil layers (refer to Equation 11B presented below). The coefficient of consolidation $c_v$ has significant impact on the calculated amount of consolidation water flow at any given time. The $c_v$ is related to the hydraulic conductivity and compressibility, but was calculated directly based on consolidation tests on ILWD samples.

A summary of the material properties used in the analyses is provided in Table 5. The reasonable upper and lower bound consolidation parameters used in the sensitivity analysis are summarized in Table 6.

# 4. SETTLEMENT ANALYSIS

## 4.1 Methodology

Consolidation Settlement

Settlement of the SOLW, Marl, and Silt and Clay was calculated using equations for conventional one-dimensional (1-D) consolidation theory used in geotechnical engineering [Holtz and Kovacs, 1981]. Settlement is caused by the following mechanisms:

- primary compression of the SOLW, Marl, and Silt and Clay due to overburden loading imposed by the cap; and
- secondary compression resulting from the plastic realignment of the fabric (i.e., creep) of SOLW, Marl, and Silt and Clay under the sustained loading.

The general forms of the settlement equations are given below:

*Primary Settlement*

$$S_p = \mathrm{C}_{\mathrm{r}\varepsilon}\ \mathrm{H} \log\left(\frac{\sigma'_{vo} + \Delta\sigma'_v}{\sigma'_{vo}}\right) \text{ for } \sigma'_{vo} + \Delta\sigma'_v \le \sigma'_p \quad (1)$$

$$S_p = \mathrm{C}_{\mathrm{r}\varepsilon}\ \mathrm{H} \log\left(\frac{\sigma'_p}{\sigma'_{vo}}\right) + \mathrm{C}_{\mathrm{c}\varepsilon}\ \mathrm{H} \log\left(\frac{\sigma'_{vo} + \Delta\sigma'_v}{\sigma'_p}\right) \text{ for } \sigma'_{vo} \le \sigma'_p \text{ and } \sigma'_{vo} + \Delta\sigma'_v > \sigma'_p \quad (2A)$$

$$S_p = \mathrm{C}_{\mathrm{c}\varepsilon}\ \mathrm{H} \log\left(\frac{\sigma'_{vo} + \Delta\sigma'_v}{\sigma'_{vo}}\right) \text{ for } \sigma'_{vo} \ge \sigma'_p \quad (2B)$$

*Secondary Settlement*

$$S_s = \mathrm{C}_{\alpha\varepsilon}\ \mathrm{H} \log\left(\frac{t_2}{t_1}\right) \quad (3)$$

*Total Settlement*

$$S = S_p + S_s \quad (4)$$

Where,

$S_p$ = primary settlement;
$S_s$ = secondary settlement;
$S$ = total settlement;
$C_{c\varepsilon}$ = modified compression index;
$C_{r\varepsilon}$ = modified recompression index;
$C_{\alpha\varepsilon}$ = modified secondary compression index;
H = initial thickness of compressible layer;
$\sigma'_{vo}$ = initial effective overburden stress;
$\sigma'_p$ = preconsolidation pressure;
$\Delta\sigma'_v$ = increase in effective stress due to the loading;
$t_1$ = time for completion of primary compression; and
$t_2$ = time when settlement due to secondary compression is computed (i.e., unless stated otherwise, assumed to be 30 years for this analysis).

The following equations related to the time rate of consolidation were used to calculate $t_1$:

$$T = \frac{c_v t}{H^2_{dr}} \tag{5}$$

$$T = \frac{\pi}{4}\left(\frac{U\%}{100}\right)^2 \text{ for U < 60\%} \tag{6A}$$

$$T = 1.781 - 0.933\log(100 - U\%) \text{ for U > 60\%} \tag{6B}$$

The completion of primary compression was considered as U = 90%, in accordance with common engineering practice. Based on Equation 6B, T = 0.848 when U = 90%. Therefore, $t_1$ can be calculated using the following equation:

$$t_1 = 0.848\frac{H^2_{dr}}{c_v} \tag{7}$$

Where,

$T$ = time factor;
$c_v$ = coefficient of consolidation;
$H_{dr}$ = longest drainage path; and
$U$ = average degree of consolidation.

Upward Flow of Consolidation Water

Cumulative upward flow volume of consolidation water from SOLW, Marl, and Silt and Clay at any time can be calculated as follows for use in cap design:

$$V_t = \sum\left(\left(\frac{\mathrm{P_i}\,\%}{100}\right)\left(\frac{\mathrm{U_{i,t}}\,\%}{100}\right)\mathrm{S_{pi}} + \left(\frac{\mathrm{P_i}\,\%}{100}\right)\mathrm{S_{si,t}}\right) \tag{8}$$

Where,

$V_t$ = cumulative upward flow volume of consolidation water at time t;
$P_i$ = percentage of thickness of layer i contributing to upward flow of consolidation water;
$U_{i,t}$ = average degree of consolidation for layer i at time t;
$S_{pi}$ = ultimate primary settlement of layer i; and
$S_{si,t}$ = secondary settlement of layer i at time t. For simplicity of calculation, secondary settlement was assumed to start when U = 93% (T ≈ 1), even though in the settlement calculation presented above, U=90% was considered as the completion of primary settlement

Both P and U can be calculated from contours of excess pore water pressure variation with depth for different times (i.e., isochrones). Simpson's rule is used to calculate relative areas from contours of excess pore water pressure, which are used to estimate U at different times. The following governing equation for one-dimensional consolidation can be solved using the finite difference method (FDM) to develop isochrones.

$$\frac{\partial \mathrm{u}}{\partial \mathrm{t}} = \frac{\mathrm{k}}{\gamma_{\mathrm{w}} m_v}\frac{\partial^2 u}{\partial \mathrm{z}^2} = \mathrm{c_v}\frac{\partial^2 u}{\partial \mathrm{z}^2} \tag{9}$$

Where,

| | | |
|---|---|---|
| $u$ | = | excess pore water pressure; |
| t | = | time; |
| k | = | hydraulic conductivity; |
| $\gamma_w$ | = | unit weight of water; and |
| $m_v$ | = | coefficient of volume change. |

The FDM solution is expressed in terms of the following dimensionless (relative) parameters:

$$\bar{u} = \frac{u}{u_R} \tag{10A}$$

$$\bar{t} = \frac{t}{t_R} \tag{10B}$$

$$\bar{z} = \frac{z}{z_R} \tag{10C}$$

Where,

| | | |
|---|---|---|
| $\bar{u}$ | = | dimensionless (relative) excess pore water pressure; |
| $u_R$ | = | maximum excess pore water pressure induced by the loading; |
| $\bar{t}$ | = | dimensionless (relative) time; |
| $t_R$ | = | time for 93% consolidation, calculated as $t_R = \frac{z_R^2}{c_v}$ ; |
| $\bar{z}$ | = | relative depth; and |
| $z_R$ | = | maximum depth of all layers modeled. |

The finite difference nodes are presented in Figure 12. The FDM equations for a node in a homogeneous layer and at a layer interface are presented in Equations 11A and 11B, respectively.

$$\bar{u}_{0,\bar{t}+\Delta\bar{t}} = \frac{\Delta\bar{t}}{\left(\Delta\bar{z}\right)^2}\left(\bar{u}_{1,\bar{t}} + \bar{u}_{3,\bar{t}} - 2\bar{u}_{0,\bar{t}}\right) + \bar{u}_{0,\bar{t}} \tag{11A}$$

$$\bar{u}_{0,\bar{t}+\Delta\bar{t}} = A\frac{\Delta\bar{t}}{\left(\Delta\bar{z}\right)^2}\left(B\bar{u}_{1,\bar{t}} + C\bar{u}_{3,\bar{t}} - 2\bar{u}_{0,\bar{t}}\right) + \bar{u}_{0,\bar{t}} \qquad (11B)$$

The parameters referred to as A, B, and C can be calculated using the following equations (where $k_1$ and $k_2$ are hydraulic conductivities of the top and bottom layers, respectively, and $c_{v1}$ and $c_{v2}$ are coefficients of consolidation of the top and bottom layers, respectively):

$$A = \frac{1 + \dfrac{k_2}{k_1}}{1 + \left(\dfrac{k_2}{k_1}\right)\left(\dfrac{c_{v1}}{c_{v2}}\right)} \qquad (12A)$$

$$B = \frac{2k_1}{k_1 + k_2} \qquad (12B)$$

$$C = \frac{2k_2}{k_1 + k_2} \qquad (12C)$$

For numerical stability of the FDM implementation, the following should be satisfied:

$$\frac{\Delta\bar{t}}{\left(\Delta\bar{z}\right)^2} < 0.5 \qquad (13)$$

## 4.2 Dredge Cut Depths and Cap Thicknesses Considered

As documented in the main text of the Capping, Dredging, and Habitat Design Report, the proposed dredging depth in Remediation Area D, excluding hot spot removal, is between 0 m and 3 m (or 10 ft). The proposed cap has a thickness of approximately 3 to 4.5 ft assuming average overplacement and a maximum thickness of 5.5 ft for maximum overplacement. In the settlement analysis performed herein, dredging depths of 0 ft, 3 ft, 6 ft, and 10 ft, and cap thicknesses of 3 ft, 4 ft, and 5.5 ft were considered for each of the 12 areas identified in Figure 2.

## 4.3 Settlement Calculations

Settlement Analysis

Cap-induced settlement analyses were performed for each of the 12 areas for all combinations of the considered dredging depths and cap thicknesses. The calculated settlement includes the primary settlement and secondary settlement that will occur within 30 years of cap placement. The following assumptions were made for the purposes of the analyses presented herein:

- Both Marl and Silt and Clay were considered as one layer in the consolidation rate calculation (i.e., the average degree of consolidation at the end of 30 years and the time needed to reach 90% primary consolidation) because their $c_v$ values are comparable. The $c_v$ value of Silt and Clay was applied to this combined layer due to the relatively larger thickness of Silt and Clay compared to Marl.

- The SOLW layer was considered to be a singly drained layer. The combined Marl and Silt and Clay layer was assumed to be a doubly drained layer. The $c_v$ value of SOLW is much larger than that for the combined layer and, therefore, the excess pore water pressure in the SOLW dissipates (in the upward direction) much faster than the excess pore water pressure in the combined layer. The combined layer behaves similar to a doubly drained layer after most of the excess pore water pressure in the SOLW has dissipated. This assumption will be validated in Section 4.4.

- Secondary compression starts when 90% of the primary consolidation is reached.

The settlement calculations were performed using EXCEL® spreadsheets. An example calculation is shown in Attachment C. Analysis results are presented in Figure 13. For each area, the cap-induced settlement can be read or interpolated from the charts for a given proposed dredging depth and cap thickness that is within the range of the values evaluated.

An additional cap-induced settlement analysis was performed to evaluate the settlement that will occur within two years after cap placement. Area 3 was selected for this analysis because it is the area with the largest calculated settlement for the different combinations of dredging depth and cap thickness. The settlement analysis results for Area 3 for a 2-year period are presented in Figure 14.

Sensitivity Analysis

Sensitivity analyses were performed to evaluate the impact of variability in consolidation parameters on the calculated settlement. Analyses were performed for the condition with a 2-m (6.6 ft) dredge and 4-ft cap thickness, which represents the average dredge depth and cap thickness for Remediation Area D. The reasonable upper and lower bound values presented in Table 6 were used to calculate the potential upper bound and lower bound settlement magnitude. In the calculation of potential upper bound of settlement magnitude, Marl and Silt and Clay were considered as one layer in the consolidation rate calculation and the $c_v$ value of Silt and Clay was applied to this layer. In the calculation of potential lower bound of settlement magnitude, all of the SOLW, Marl, and Silt and Clay were assumed as one doubly drained layer for the consolidation rate calculation because the reasonable lower bound $c_v$ values of the three materials are comparable. The $c_v$ value of Silt and Clay was applied to this combined layer.

Based on settlement calculations presented in Figure 13 for a 2-m dredge and 4-ft cap thickness condition, the settlement ranges from 0.5 ft to 0.7 ft. The sensitivity analysis results indicated that the settlement in Remediation Area D may range from 0.2 ft to 1.0 ft for a 2-m dredge and 4-ft cap thickness condition.

## 4.4 Cumulative Upward Consolidation Water Flow

After cap placement, water stored in the voids of the subsurface soil will be squeezed out due to the consolidation of the subsurface soil. Part of the water will flow upward. For the purpose of the analyses presented herein, the upward flow rate of consolidation water was evaluated for the condition with a 2-m (6.6 ft) dredge and 4-ft cap thickness, which represents the average dredge depth and cap thickness for Remediation Area D. These analyses were performed using average/representative parameters. The following assumption was made for this analysis:

- Since Marl and Silt and Clay have comparable $c_v$ values, they were modeled as one layer. The $c_v$ value of Silt and Clay was applied to this combined layer. The SOLW layer was modeled separately because its $c_v$ value is much higher than the value for the Marl and Silt and Clay.

Based on this assumption, the analysis of upward flow rate of consolidation water was performed as follows:

(i) calculate the variation of excess pore water pressure with depth and time, according to the subsurface conditions and material properties; and plot the isochrones of excess pore water pressure;

(ii) based on calculated excess pore water pressures, determine the average degree of consolidation (U) of SOLW and the combined layer at different times;

(iii) based on calculated excess pore water pressures, determine the percentage of consolidation water flowing upward (P) for the SOLW and the combined layer (results indicated P is 100% for SOLW and 50% for the combined layer);

(iv) calculate the ultimate primary settlement of SOLW and upper half of the combined layer; and

(v) calculate the primary and secondary settlement of SOLW and upper half of the combined layer at selected times. The total settlement is the cumulative upward consolidation water flow at the selected times.

The calculations were performed using EXCEL® spreadsheets. An example of the calculation is shown in Attachment C. The calculated cumulative consolidation water variations with time for Areas 1 and 7 are presented in Figure 15. These two areas were selected because they have the smallest and largest calculated settlement corresponding to the condition with a 2-m dredge and 4-ft cap thickness and hence, likely to have the largest and smallest cumulative consolidation water flow, respectively. The calculated excess pore water pressure isochrones for Areas 1 and 7 are provided in Attachment D of this report. These isochrones indicated that the excess pore water pressure in SOLW dissipates much faster than in the combined layer. After most of the excess pore water pressure in the SOLW has dissipated, the combined layer behaves similar to a doubly drained layer.

## 5. CONCLUSIONS

This report presents analyses performed to calculate the amount of consolidation settlement and the upward flow rate of consolidation water that may be expected following dredging and placement of a subaqueous cap in Remediation Area D. Based on the results of the analysis, the following conclusions can be made:

- The subsurface soils are expected to undergo consolidation settlement following placement of the cap. The magnitude of settlement largely depends on the dredging depth and cap thickness. The settlement increases when dredging depth decreases or cap thickness increases.

- The subsurface profiles have limited influence on the calculated settlement. The calculated settlements in all areas are in the range of 0 to 1.5 ft for a 30-year period using average or representative consolidation/compressibility parameters. The calculated settlements are in the range of 0 to 0.7 ft for a 2-year period in the area that has the largest calculated settlement for a 30-year period (i.e., Area 3).

- The calculated consolidation settlement is not very sensitive to the consolidation or compressibility parameters. A sensitivity analysis indicates that using reasonable upper bound values for consolidation/compressibility parameters increases the maximum settlement from 0.7 ft to 1.0 ft for the case with 2-m dredging and a 4-ft cap thickness over a 30-year period.

- Upward flow of consolidation water is expected after placement of the cap. The flow rate will be highest when the cap is placed and will decrease with time. For an average condition (i.e., 2-m dredge and 4-ft cap thickness) using average or representative consolidation/compressibility values, a total cumulative consolidation water of approximately 0.4 ft to 0.5 ft is expected within 30 years of cap material placement.

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# TABLES

**Table 1. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ from Oedometer Tests for SOLW.**

| Sample Location ID | Depth (ft) | Initial Void Ratio $e_0$ | $C_c$ | $C_r$ | $C_{c\varepsilon}$ [1] | $C_{r\varepsilon}$ [1] |
|---|---|---|---|---|---|---|
| OL-STA-10025 | 7-9 | 4.53 | 0.18 | 0.02 | 0.033 | 0.0038 |
| OL-STA-10026 | 7-9 | 3.17 | 0.14 | 0.03 | 0.033 | 0.0065 |
| OL-STA-10019 | 12.5-14.5 | 4.24 | 0.02 | 0.01 | 0.004 | 0.0023 |
| OL-STA-10023 | 13-15 | 3.38 | 0.17 | 0.02 | 0.039 | 0.0054 |
| OL-STA-10024 | 15-17 | 3.08 | 0.16 | 0.02 | 0.039 | 0.0047 |
| OL-STA-10024 | 30-32 | 4.93 | 0.10 | 0.03 | 0.016 | 0.0054 |
| OL-STA-10014 | 34.5-36.5 | 3.05 | 0.19 | 0.01 | 0.047 | 0.0036 |
| | | | | Mean Value | 0.030 | 0.0045 |
| | | | | Maximum Value | 0.047 | 0.0065 |
| | | | | Minimum Value | 0.004 | 0.0023 |
| | | | | Standard Deviation | 0.015 | 0.0014 |
| | | | | Mean plus Standard Deviation | 0.045 | 0.0031 |
| | | | | Mean minus Standard Deviation | 0.015 | 0.0059 |

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 $C_{r\varepsilon} = C_r / (1+e_0)$.

[2]. $C_c$ and $C_{c\varepsilon}$ values correspond to low stress range only.

**Table 2. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ from Oedometer Tests for Marl.**

| Sample Location ID | Depth (ft) | Initial Void Ratio $e_0$ | $C_c$ | $C_r$ | $C_{c\varepsilon}$ [1] | $C_{r\varepsilon}$ [1] |
|---|---|---|---|---|---|---|
| OL-STA-20001 | 20-22 | 1.87 | 0.37 | 0.02 | 0.127 | 0.0082 |
| OL-STA-20007 | 23-25 | 1.89 | 0.41 | 0.03 | 0.142 | 0.0113 |
| OL-STA-20004 | 36.6-38.6 | 0.90 | 0.16 | 0.02 | 0.083 | 0.0103 |
| | | | | Mean Value | 0.117 | 0.0099 |
| | | | | Maximum Value | 0.142 | 0.0110 |
| | | | | Minimum Value | 0.083 | 0.0080 |
| | | | | Standard Deviation | 0.031 | 0.0016 |
| | | | | Mean plus Standard Deviation | 0.148 | 0.0115 |
| | | | | Mean minus Standard Deviation | 0.087 | 0.0083 |

Note:

[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 $C_{r\varepsilon} = C_r / (1+e_0)$.

**Table 3. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ from Oedometer Tests for Silt and Clay in SMU 1.**

| Sample Location ID | Depth (ft) | Initial Void Ratio $e_0$ | $C_c$ | $C_r$ | $C_{c\varepsilon}$ [1] | $C_{r\varepsilon}$ [1] |
|---|---|---|---|---|---|---|
| OL-STA-10013 | 41-43 | 1.60 | 0.51 | 0.06 | 0.195 | 0.0228 |
| OL-STA-10018 | 48-50 | 1.06 | 0.36 | 0.03 | 0.175 | 0.0151 |
| OL-STA-10023 | 50-52 | 1.94 | 0.73 | 0.07 | 0.248 | 0.0255 |
| OL-STA-10026 | 50-52 | 1.99 | 0.69 | 0.09 | 0.229 | 0.0297 |
| OL-STA-10025 | 52-54 | 1.88 | 0.65 | 0.08 | 0.227 | 0.0295 |
| OL-STA-10022 | 64-66 | 1.85 | 0.70 | 0.06 | 0.246 | 0.0212 |
| OL-STA-10024 | 64-66 | 1.81 | 0.57 | 0.09 | 0.204 | 0.0330 |
| OL-STA-10017 | 28-30 | 2.74 | 0.94 | 0.13 | 0.252 | 0.0353 |
| OL-STA-10108 | 64-66 | 1.91 | 0.74 | 0.06 | 0.254 | 0.0206 |
| OL-STA-10108 | 68-70 | 1.86 | 0.58 | 0.05 | 0.203 | 0.0175 |
| Mean Value | | | | | 0.223 | 0.0250 |
| Maximum Value | | | | | 0.254 | 0.0353 |
| Minimum Value | | | | | 0.175 | 0.0151 |
| Standard Deviation | | | | | 0.028 | 0.0067 |
| Mean plus Standard Deviation | | | | | 0.251 | 0.0317 |
| Mean minus Standard Deviation | | | | | 0.196 | 0.0183 |

Note:

[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 $C_{r\varepsilon} = C_r / (1+e_0)$.

**Table 4. $C_{c\varepsilon}$ and $C_{r\varepsilon}$ from Oedometer Tests for Silt and Clay in SMU 2.**

| Sample Location ID | Depth (ft) | Initial Void Ratio $e_0$ | $C_c$ | $C_r$ | $C_{c\varepsilon}$ [1] | $C_{r\varepsilon}$ [1] |
|---|---|---|---|---|---|---|
| OL-STA-20007 | 38.6-40.6 | 1.33 | 0.49 | 0.05 | 0.210 | 0.0222 |
| OL-STA-20001 | 44.9-46.9 | 0.95 | 0.26 | 0.04 | 0.134 | 0.0223 |
| OL-STA-20018 | 47-49 | 0.91 | 0.23 | 0.02 | 0.119 | 0.0090 |
| Mean Value | | | | | 0.154 | 0.0179 |
| Maximum Value | | | | | 0.210 | 0.022 |
| Minimum Value | | | | | 0.119 | 0.009 |
| Standard Deviation | | | | | 0.049 | 0.0076 |
| Mean plus Standard Deviation | | | | | 0.203 | 0.0255 |
| Mean minus Standard Deviation | | | | | 0.106 | 0.0102 |

Note:

[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 $C_{r\varepsilon} = C_r / (1+e_0)$.

**Table 5. Summary of the Material Properties used in Analysis.**

| Materials | Unit Weight (pcf) | Consolidation Parameters | | | | Hydraulic Conductivity (cm/s) |
|---|---|---|---|---|---|---|
| | | $C_{c\varepsilon}$ | $C_{r\varepsilon}$ | $C_{\alpha\varepsilon}$ | $c_v$ ($ft^2$/d) | |
| Cap | 120 | N/A | N/A | N/A | N/A | N/A |
| SOLW | 81 | 0.030[1] | 0.0045 | 0.0011 | 3.500 | $1\times10^{-5}$ |
| Marl | 98 | 0.117 | 0.0099 | 0.0050 | 0.090 (SMU 1)<br>0.100 (SMU 2)[2] | $1\times10^{-7}$ |
| Silt and Clay (SMU 1) | 108 | 0.223 | 0.0250 | 0.0100 | 0.090 | $1\times10^{-7}$ |
| Silt and Clay (SMU 2) | 108 | 0.154 | 0.0179 | 0.0050 | 0.100 | $1\times10^{-7}$ |

Notes:

[1]. $C_{c\varepsilon}$ value corresponds to low stress range only.

[2]. The interpreted $c_v$ of Marl is 0.135 $ft^2$/d as presented in Figure 9. However, for the purpose of analysis, the $c_v$ of Marl was assumed to be the same as Silt and Clay (i.e., 0.09 and 0.1 $ft^2$/d in SMUs 1 and 2, respectively) in settlement calculations, as presented in Section 4.3.

**Table 6. Selected Reasonable Upper and Lower Bound Values for Consolidation Parameters.**

| Material | $C_{c\varepsilon}$ | $C_{r\varepsilon}$ | $C_{\alpha\varepsilon}$ | $c_v$ ($ft^2/d$) |
|---|---|---|---|---|
| Selected Reasonable Upper Bound Values | | | | |
| SOLW | 0.045 | 0.0059 | 0.0030 | 7.000 |
| Marl | 0.142 | 0.0110 | 0.0080 | 0.130 (SMU 1)<br>0.230 (SMU 2)[1] |
| Silt and Clay (SMU 1) | 0.251 | 0.0317 | 0.0130 | 0.130 |
| Silt and Clay (SMU 2) | 0.203 | 0.0220 | 0.0070 | 0.230 |
| Selected Reasonable Lower Bound Values | | | | |
| SOLW | 0.015 | 0.0031 | 0.0003 | 0.050[2] |
| Marl | 0.087 | 0.0083 | 0.0025 | 0.050[2] |
| Silt and Clay (SMU 1) | 0.196 | 0.0183 | 0.0070 | 0.050 |
| Silt and Clay (SMU 2) | 0.119 | 0.0102 | 0.0040 | 0.050 |

Notes:

[1]. The interpreted reasonable upper bound value of $c_v$ of Marl is 0.15 $ft^2/d$, as presented in Figure 9. However, for the purpose of analysis, the reasonable upper bound value of $c_v$ of Marl was assumed the same as Silt and Clay (i.e., 0.13 and 0.23 $ft^2/d$ in SMUs 1 and 2, respectively) in the settlement calculations, as presented in Section 4.3.

[2]. The interpreted reasonable lower bound values of $c_v$ of SOLW and Marl are 0.1 and 0.12 $ft^2/d$, respectively, as presented in Figures 8 and 9. However, for the purpose of analysis, the reasonable lower bound values of $c_v$ of SOLW and Marl were assumed the same as Silt and Clay (i.e., 0.05 $ft^2/d$) in the settlement calculations, as presented in Section 4.3.

# FIGURES

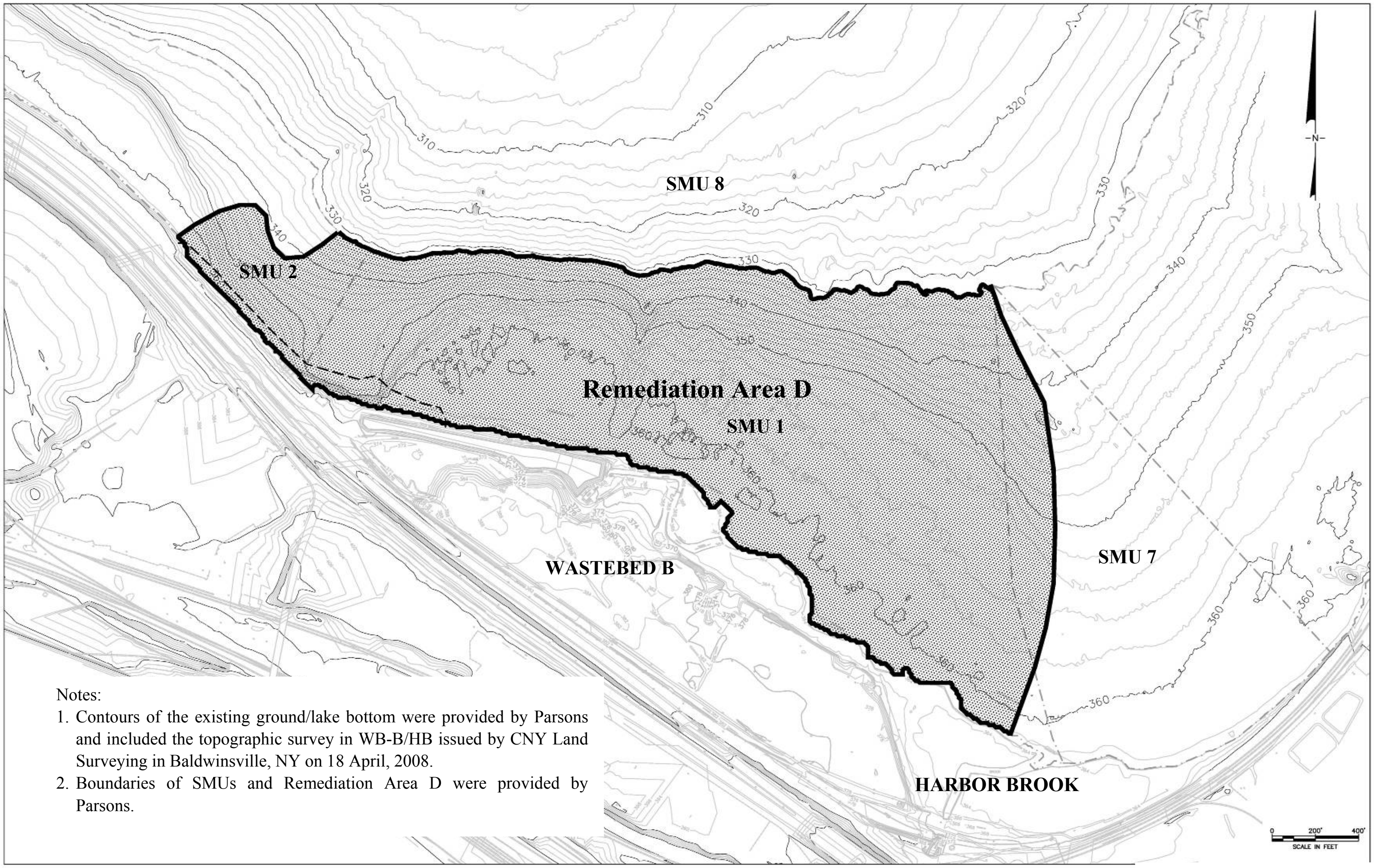
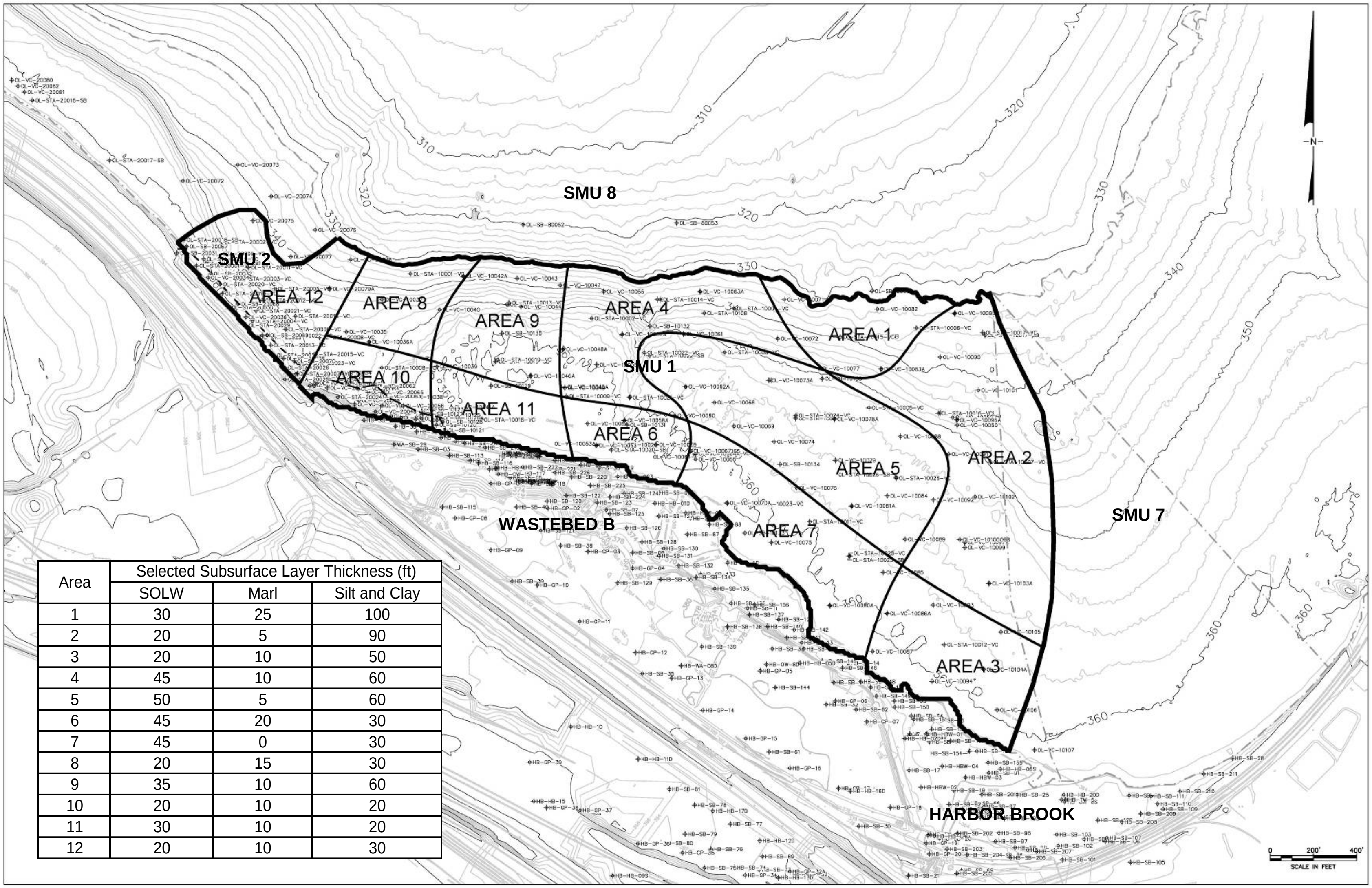



**Figure 1. Remediation Area D.**




| Area | Selected Subsurface Layer Thickness (ft) | | |
|---|---|---|---|
| | SOLW | Marl | Silt and Clay |
| 1 | 30 | 25 | 100 |
| 2 | 20 | 5 | 90 |
| 3 | 20 | 10 | 50 |
| 4 | 45 | 10 | 60 |
| 5 | 50 | 5 | 60 |
| 6 | 45 | 20 | 30 |
| 7 | 45 | 0 | 30 |
| 8 | 20 | 15 | 30 |
| 9 | 35 | 10 | 60 |
| 10 | 20 | 10 | 20 |
| 11 | 30 | 10 | 20 |
| 12 | 20 | 10 | 30 |

**Figure 2. Areas and Subsurface Layer Thicknesses.**

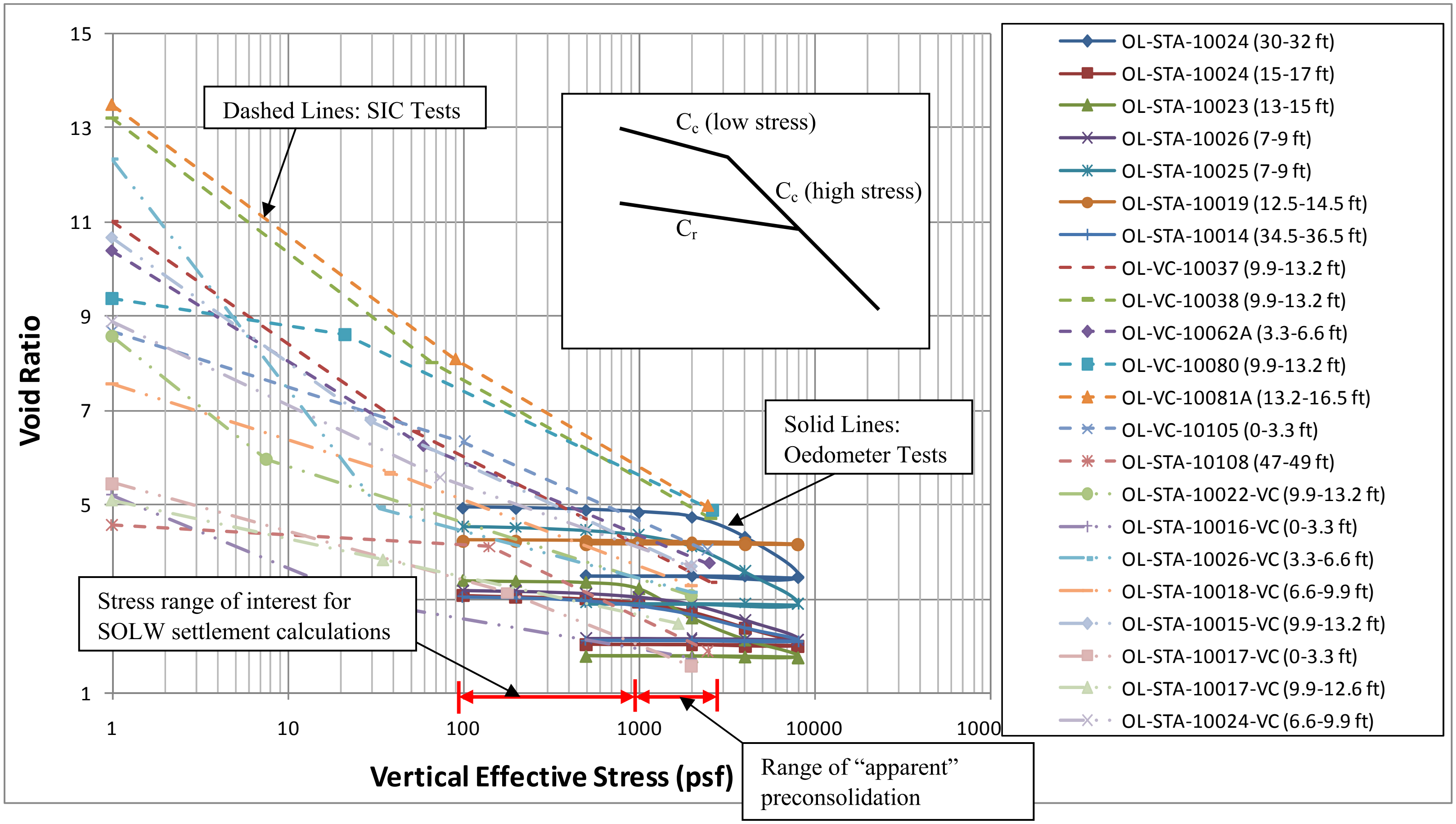



**Figure 3. Comparison of Results from Conventional Oedometer Tests and SIC Tests.**

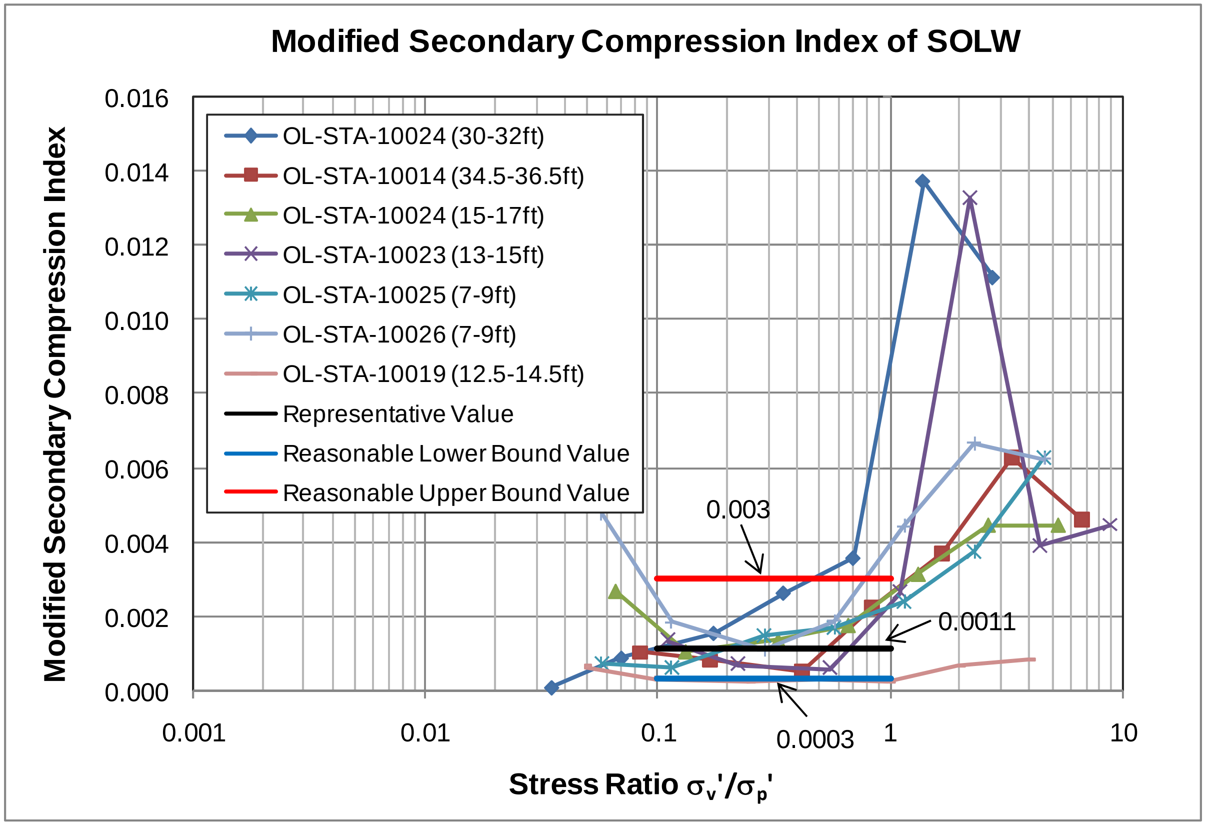



**Figure 4. Interpretation of Modified Secondary Compression Index for SOLW.**

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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.

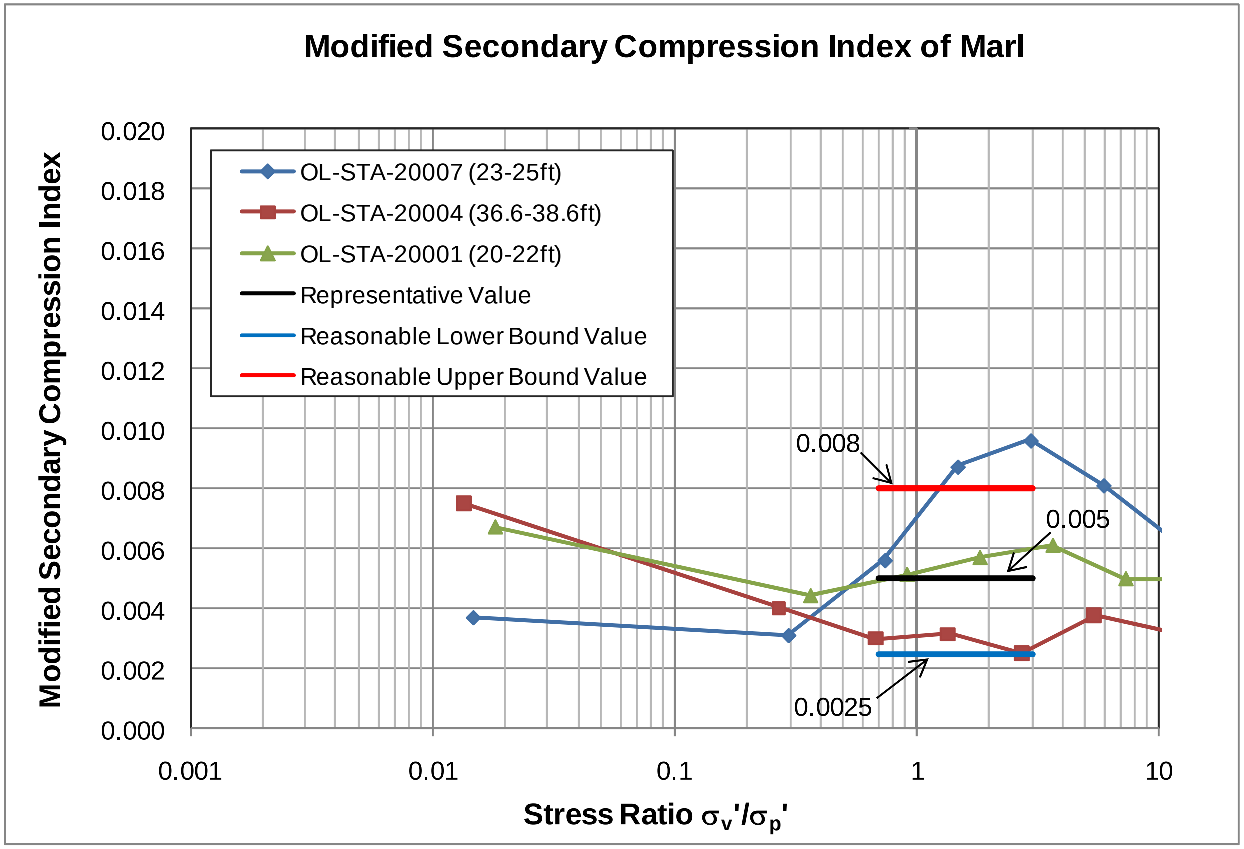



**Figure 5. Interpretation of Modified Secondary Compression Index for Marl.**

Note:

The ratio of $\sigma_v'/\sigma_p'$ of Marl in the field before and after capping was estimated to be between 0.7 and 3 according to the assumed subsurface layer thicknesses.

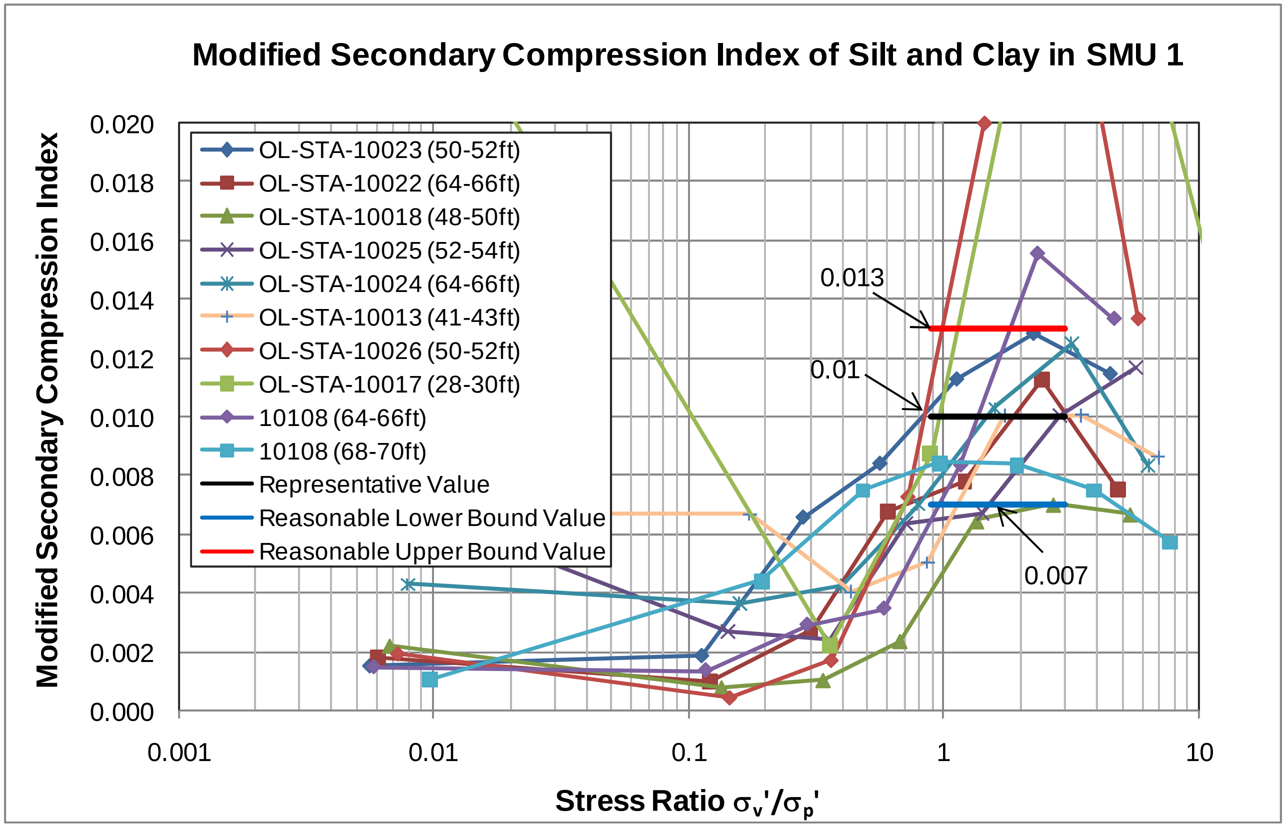



**Figure 6. Interpretation of Modified Secondary Compression Index for Silt and Clay in SMU 1.**

Note:

The ratio of $\sigma_v'/\sigma_p'$ of Silt and Clay in the field before and after capping was estimated to be between 0.9 and 3 according to the assumed subsurface layer thicknesses.

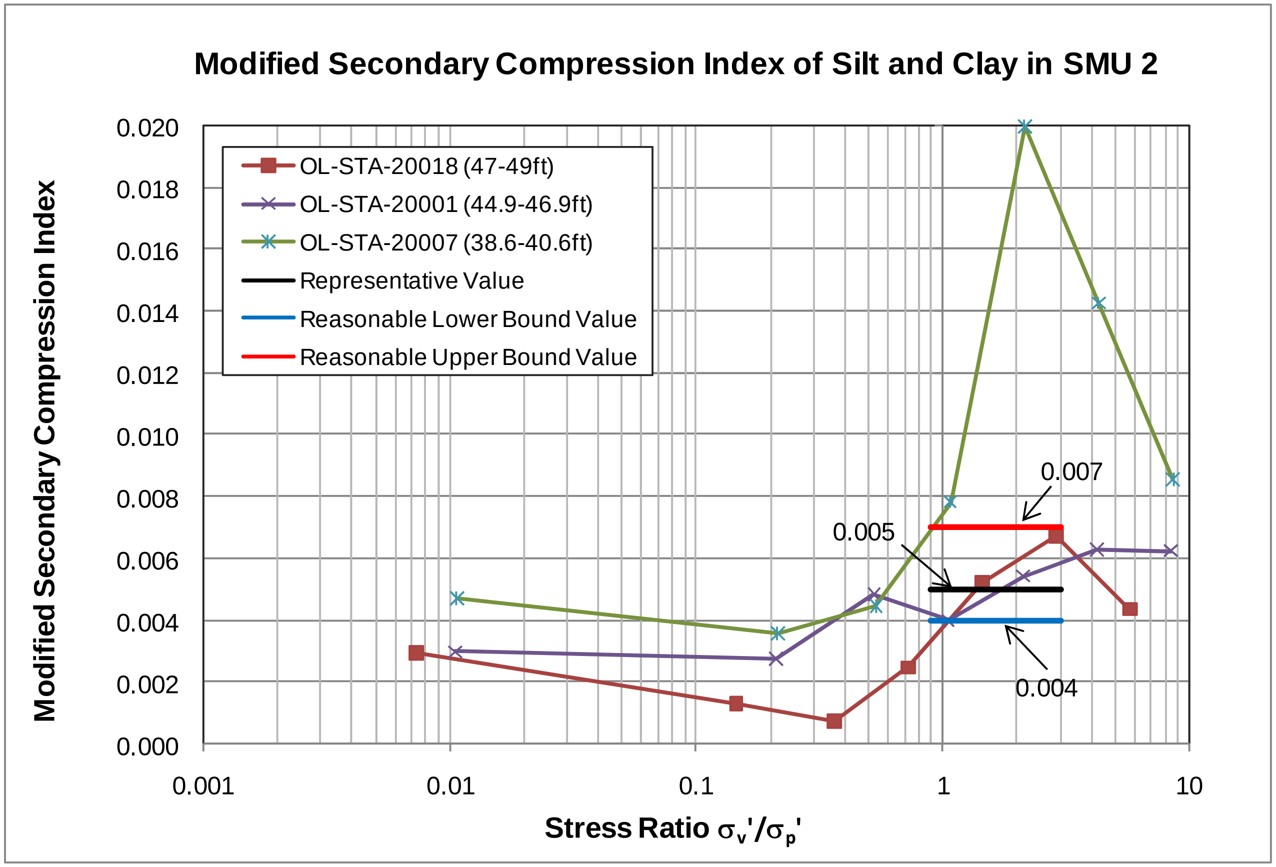



**Figure 7. Interpretation of Modified Secondary Compression Index for Silt and Clay in SMU 2.**

Note:

The ratio of $\sigma_v'/\sigma_p'$ of Silt and Clay in the field before and after capping was estimated to be between 0.9 and 3 according to the assumed subsurface layer thicknesses.

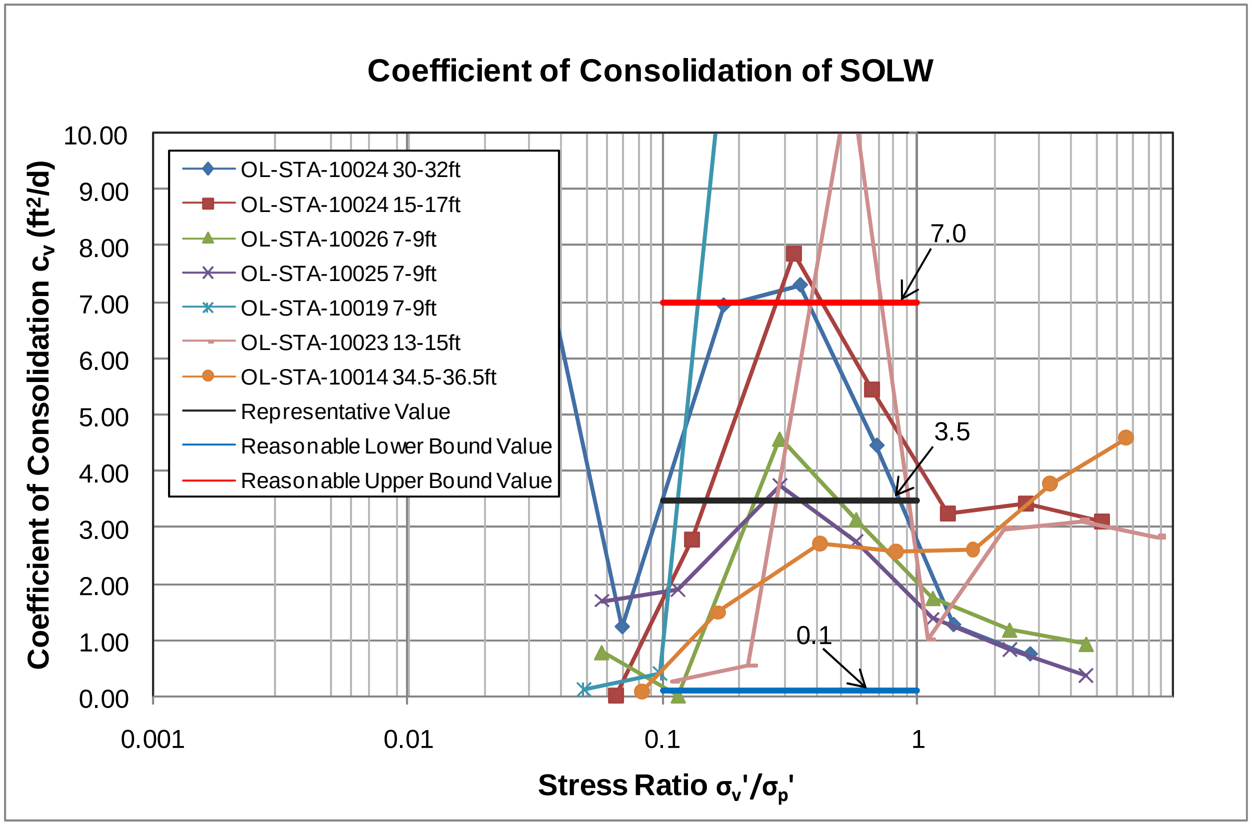



**Figure 8. Interpretation of Coefficient of Consolidation Index for SOLW.**

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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.

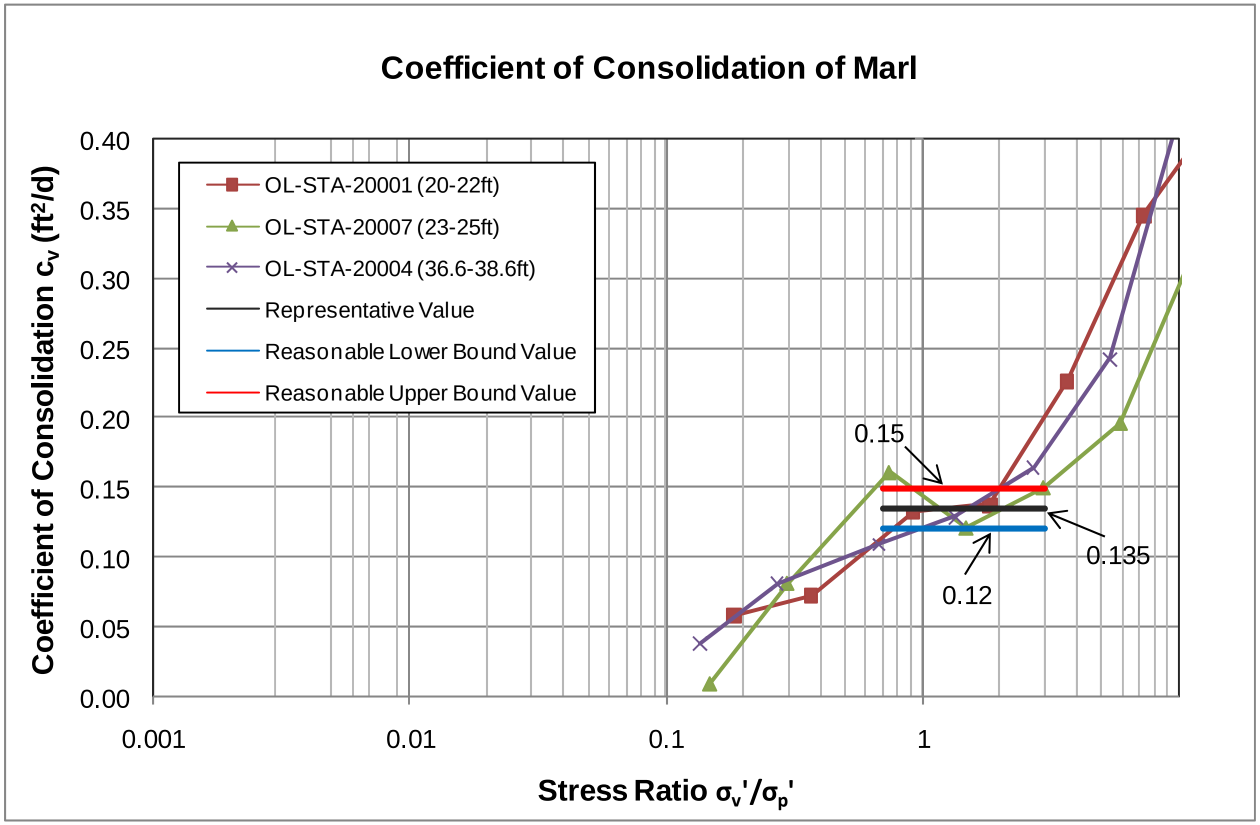



**Figure 9. Interpretation of Coefficient of Consolidation Index for Marl.**

Note:

The ratio of $\sigma_v'/\sigma_p'$ of Marl in the field before and after capping was estimated to be between 0.7 and 3 according to the assumed subsurface layer thicknesses.

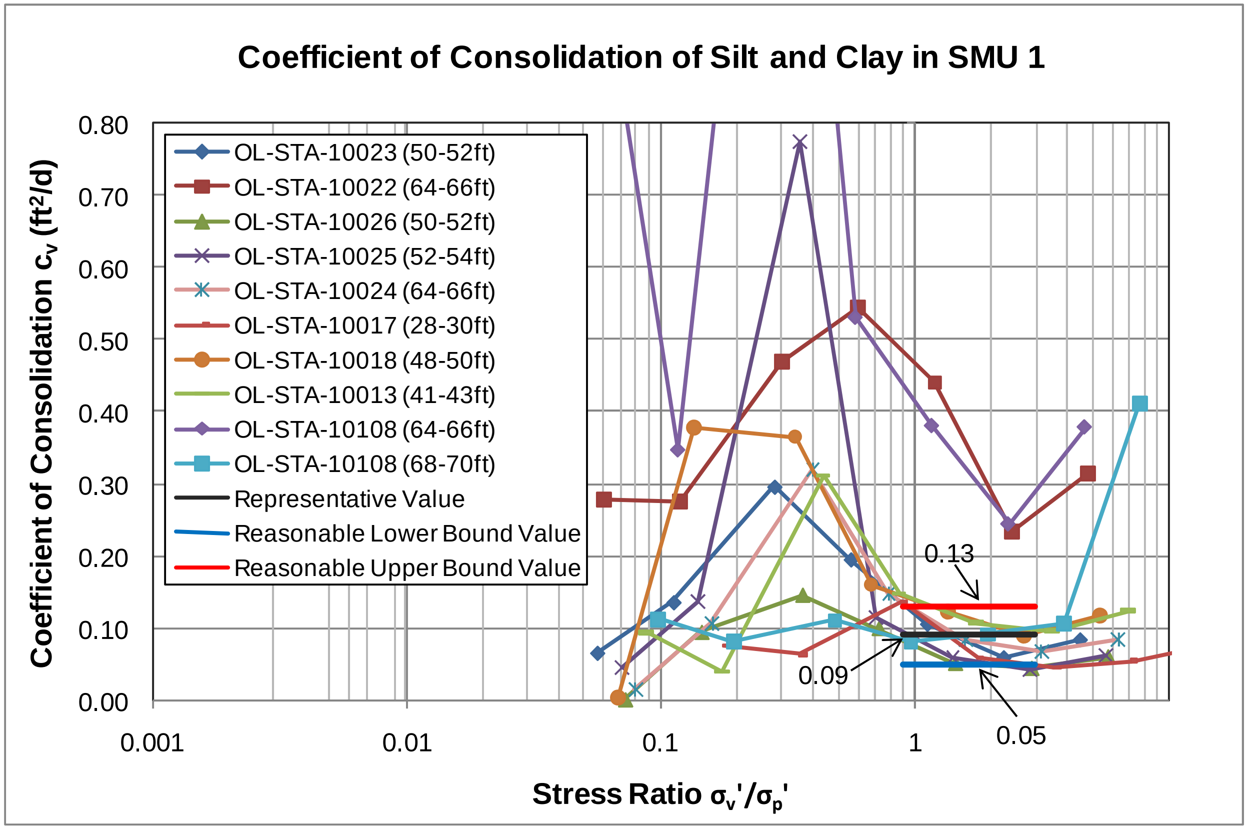



**Figure 10. Interpretation of Coefficient of Consolidation Index for Silt and Clay in SMU 1.**

Note:

The ratio of $\sigma_v'/\sigma_p'$ of Silt and Clay in the field before and after capping was estimated to be between 0.9 and 3 according to the assumed subsurface layer thicknesses.

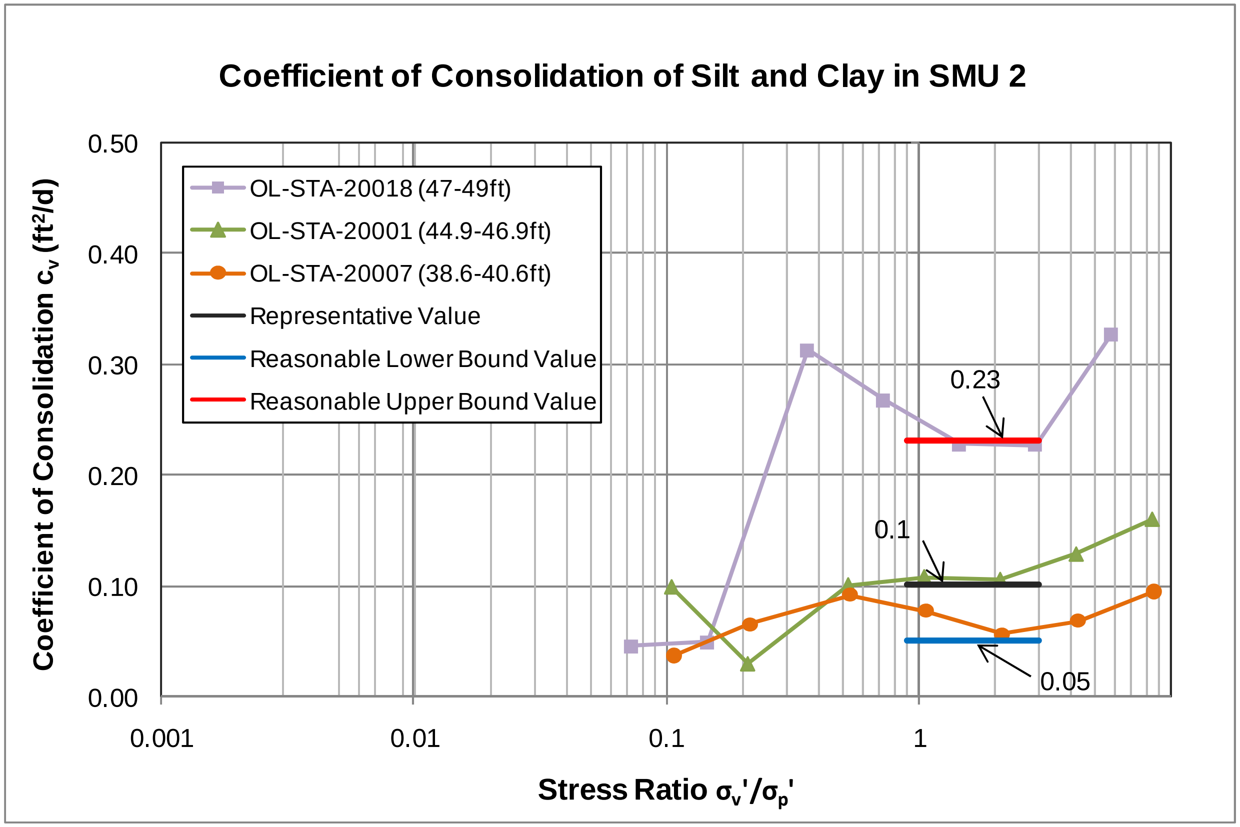
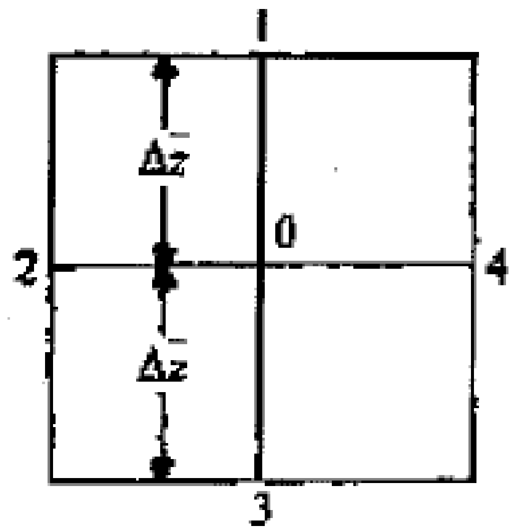


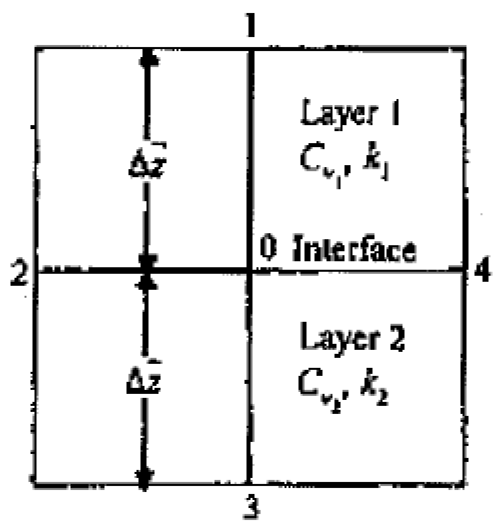

**Figure 11. Interpretation of Coefficient of Consolidation Index for Silt and Clay in SMU 2.**

Note:

The ratio of $\sigma_v'/\sigma_p'$ of Silt and Clay in field before and after capping was estimated to be between 0.9 and 3 according to the assumed subsurface layer thicknesses.




(a)




(b)

**Figure 12. Finite difference method based numerical solution for the 1-D consolidation equation: (a) for nodes within homogeneous layers; and (b) for interface node between 2 layers. Note that the consolidation water flow direction is vertical. (source: Das, 2008)**

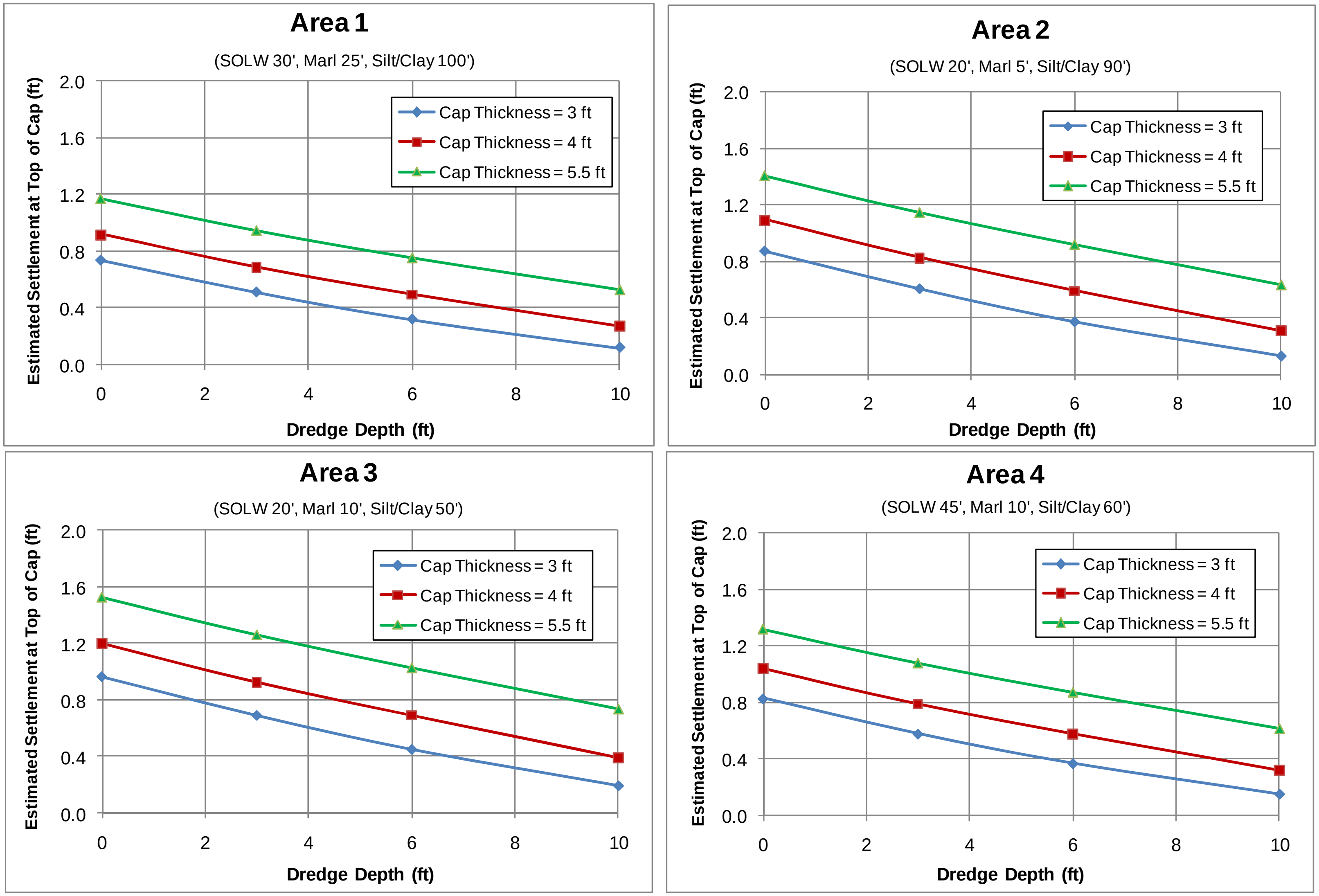



**Figure 13. Settlement Analysis Results for Areas 1 to 12 for 30-Year Period.**

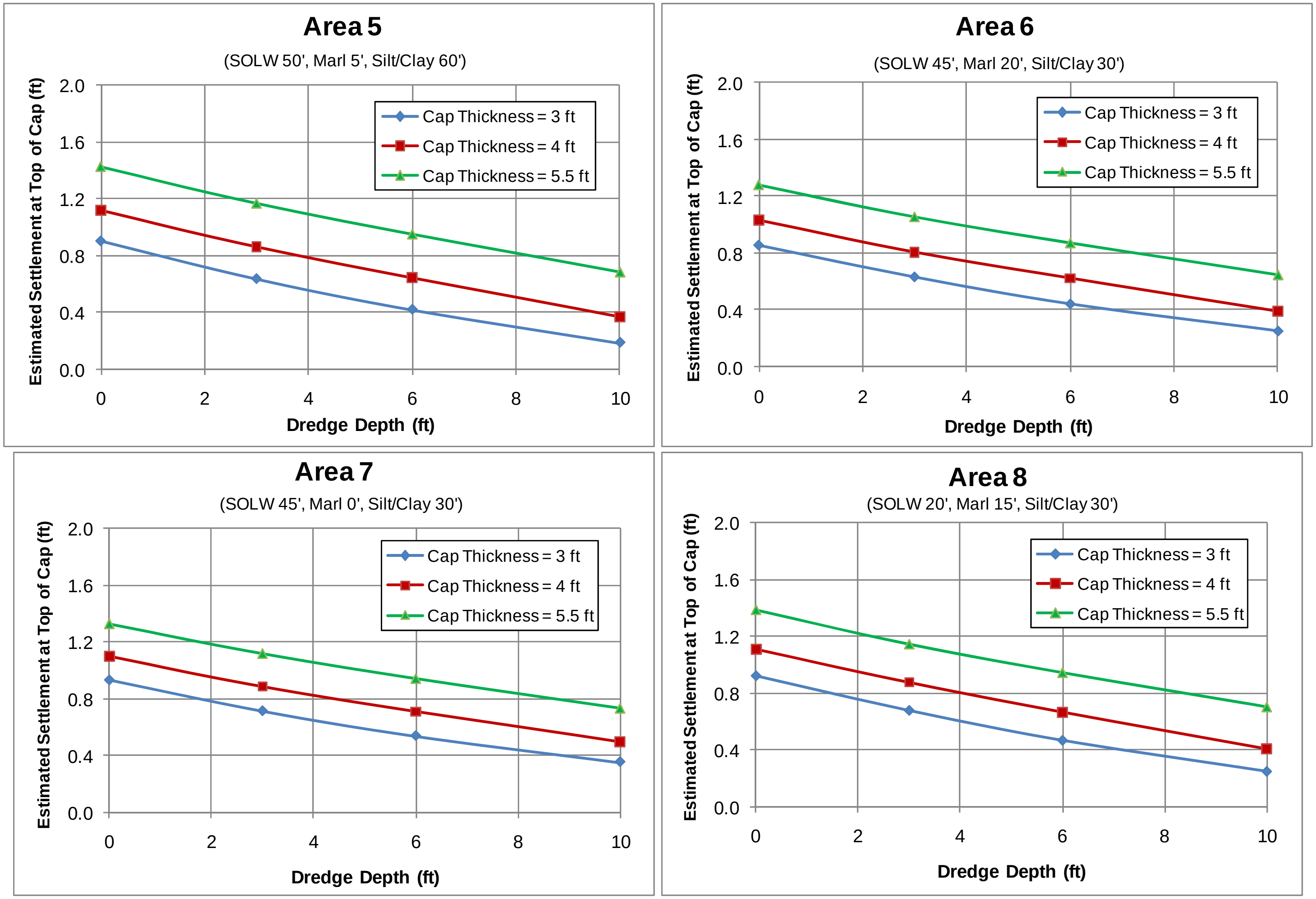



**Figure 13. Settlement Analysis Results for Areas 1 to 12 for 30-Year Period (continued).**

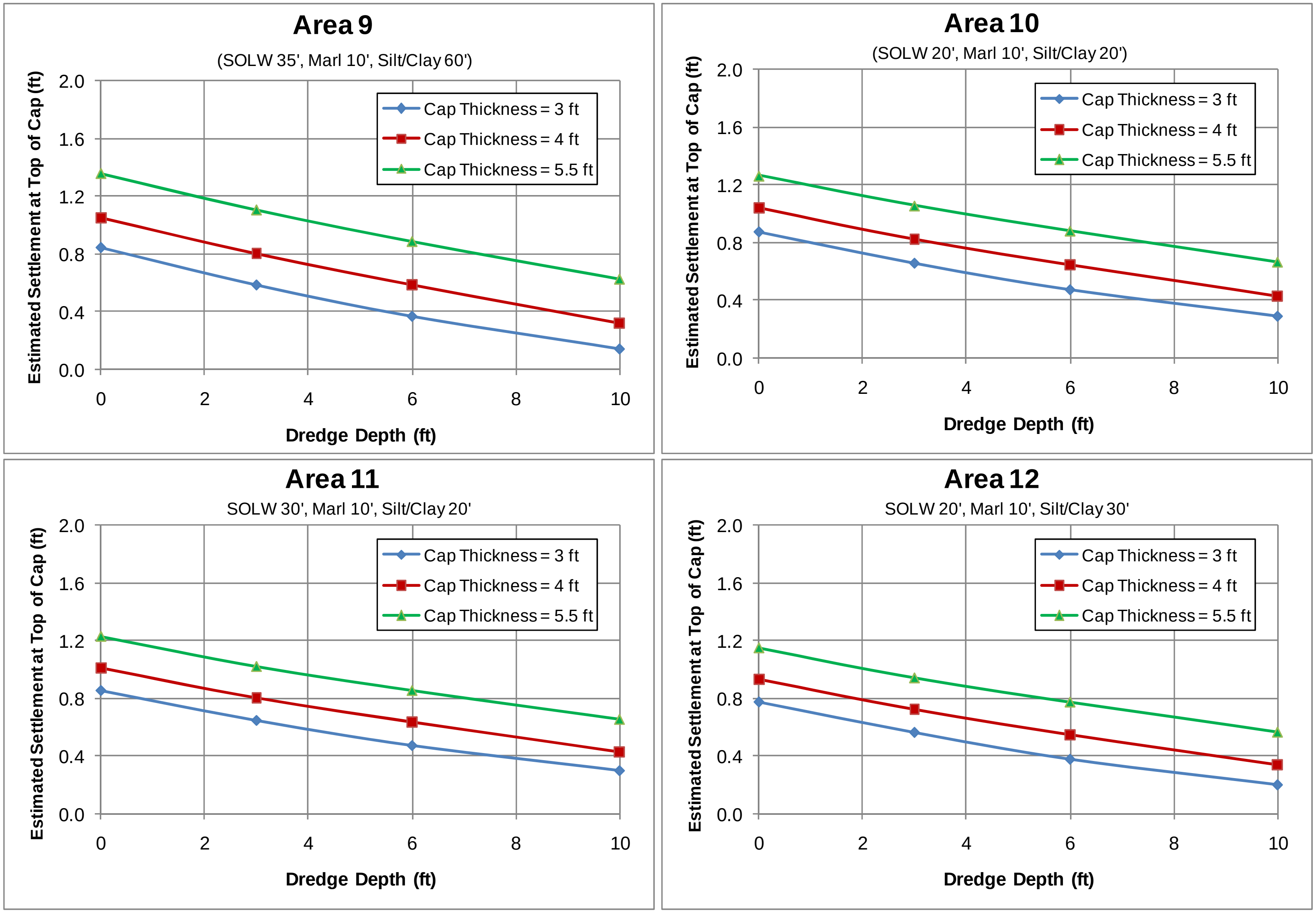



**Figure 13. Settlement Analysis Results for Areas 1 to 12 for 30-Year Period (continued).**

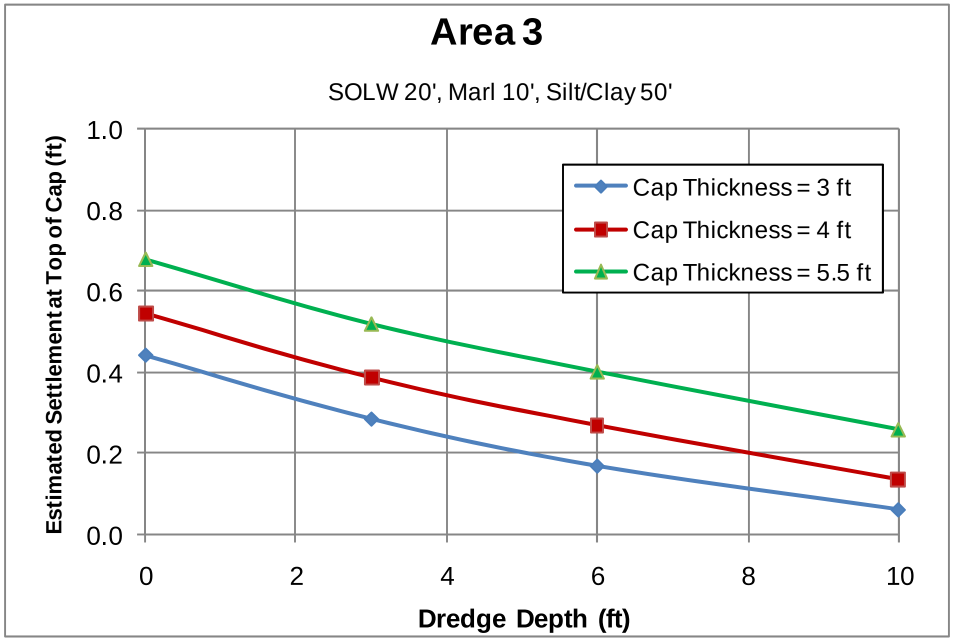



**Figure 14. Settlement Analysis Results for Area 3 for 2-Year Period.**

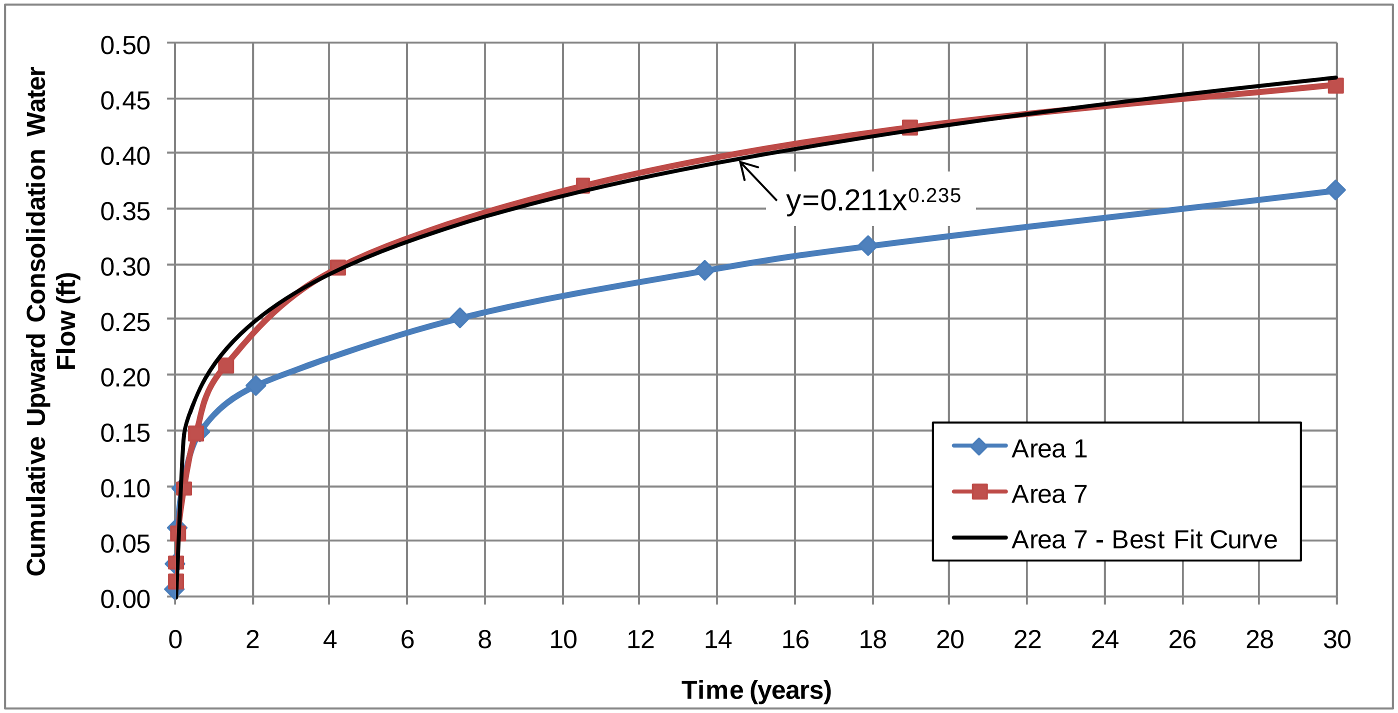



**Figure 15. Calculated Cumulative Consolidation Water Flow.**

Note:

Calculations were performed for 2 m dredge and 4 ft thick cap.

# ATTACHMENT A

# SUBSURFACE LAYER THICKNESS CONTOURS

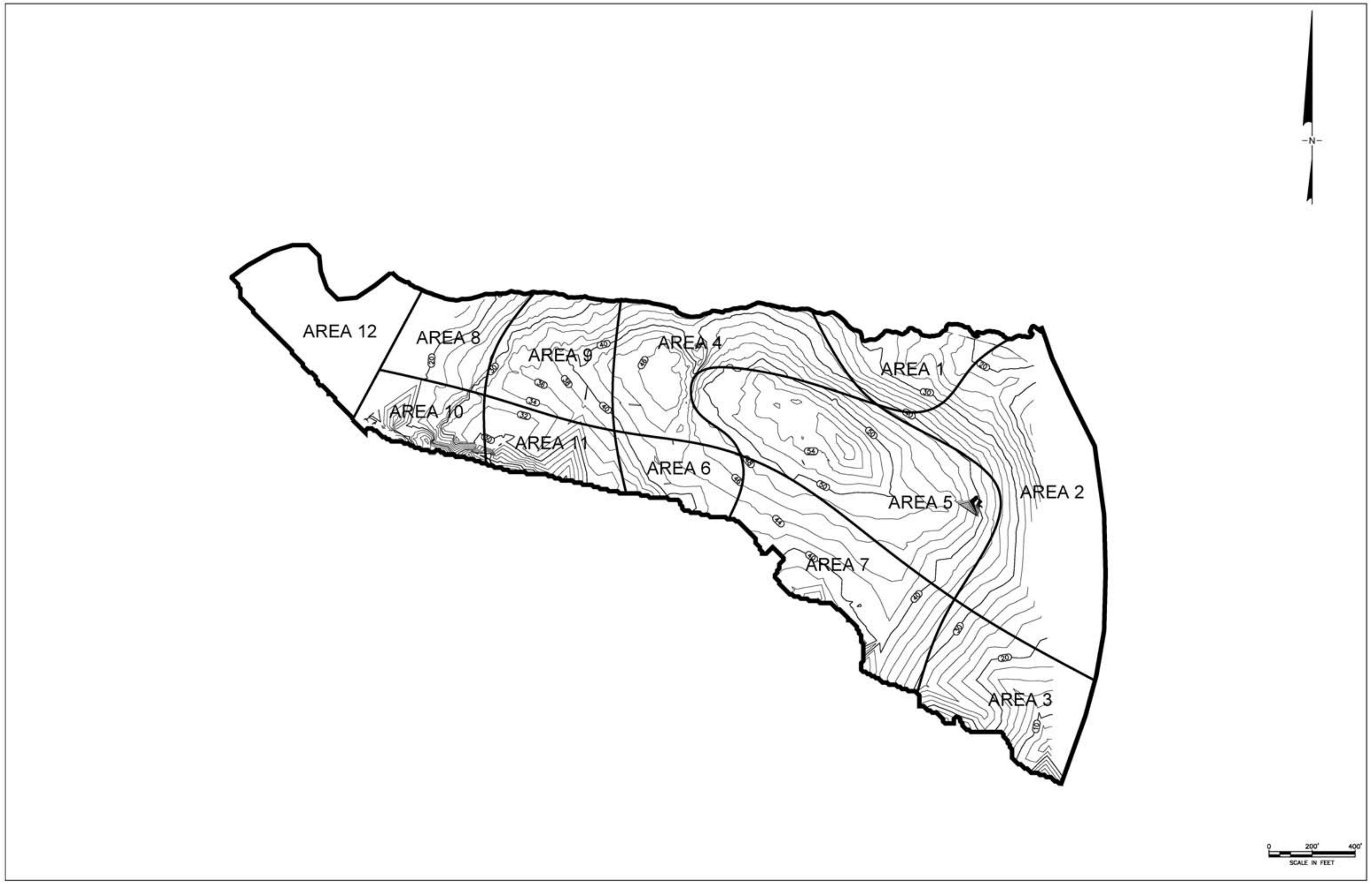



**Figure A1. The Thickness of SOLW in Remediation Area D**

Note:

1. The subsurface thickness contours were developed based on the elevations of each layer from the boring logs provided by Parsons, as presented in Section 2.
2. The subsurface thickness in the area that is not covered by the contours presented in this figure was estimated based on boring logs provided by Parsons.

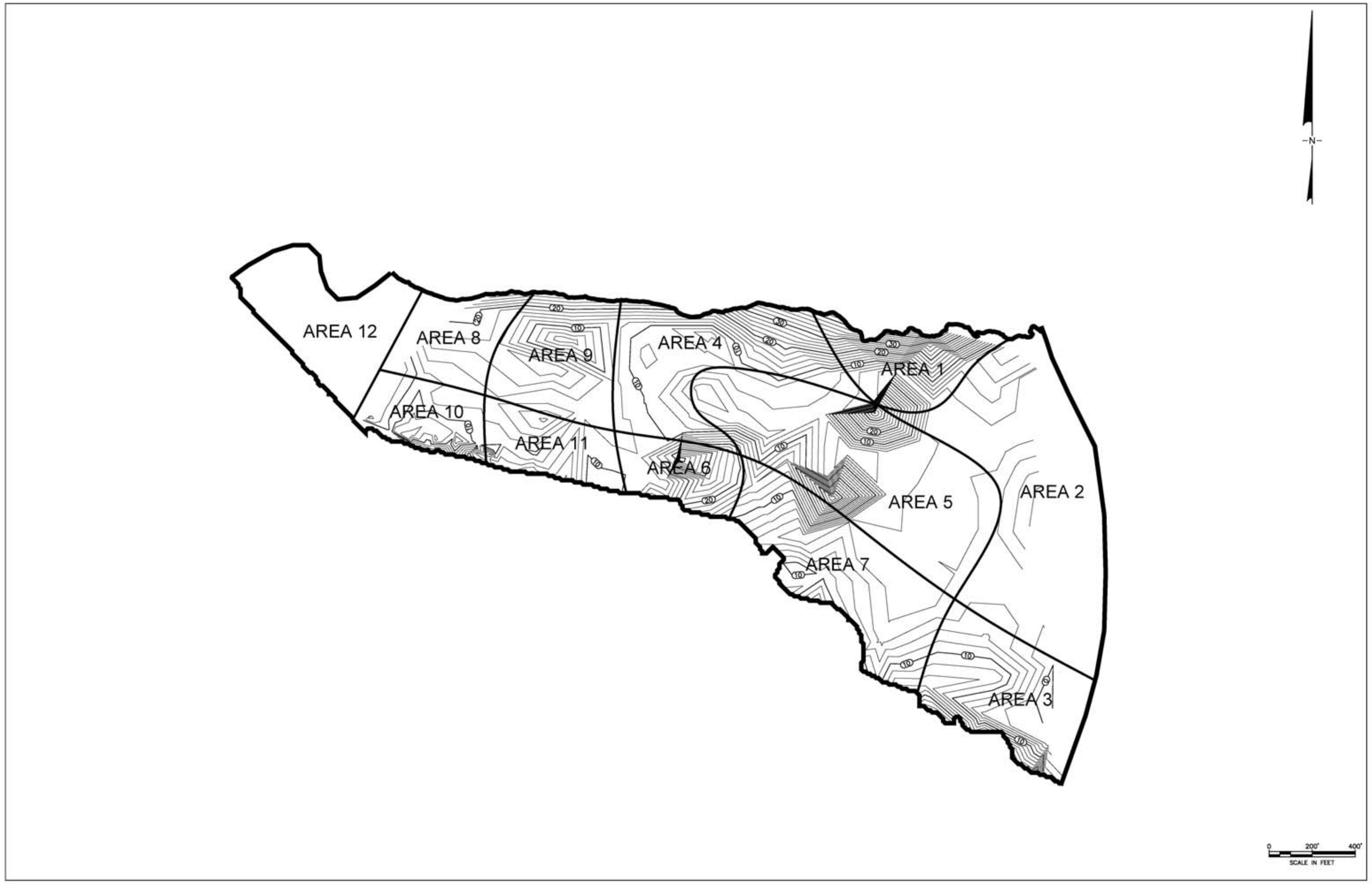



**Figure A2. The Thickness of Marl in Remediation Area D**

Note:

1. The subsurface thickness contours were developed based on the elevations of each layer from the boring logs provided by Parsons, as presented in Section 2.
2. The subsurface thickness in the area that is not covered by the contours presented in this figure was estimated based on boring logs provided by Parsons.

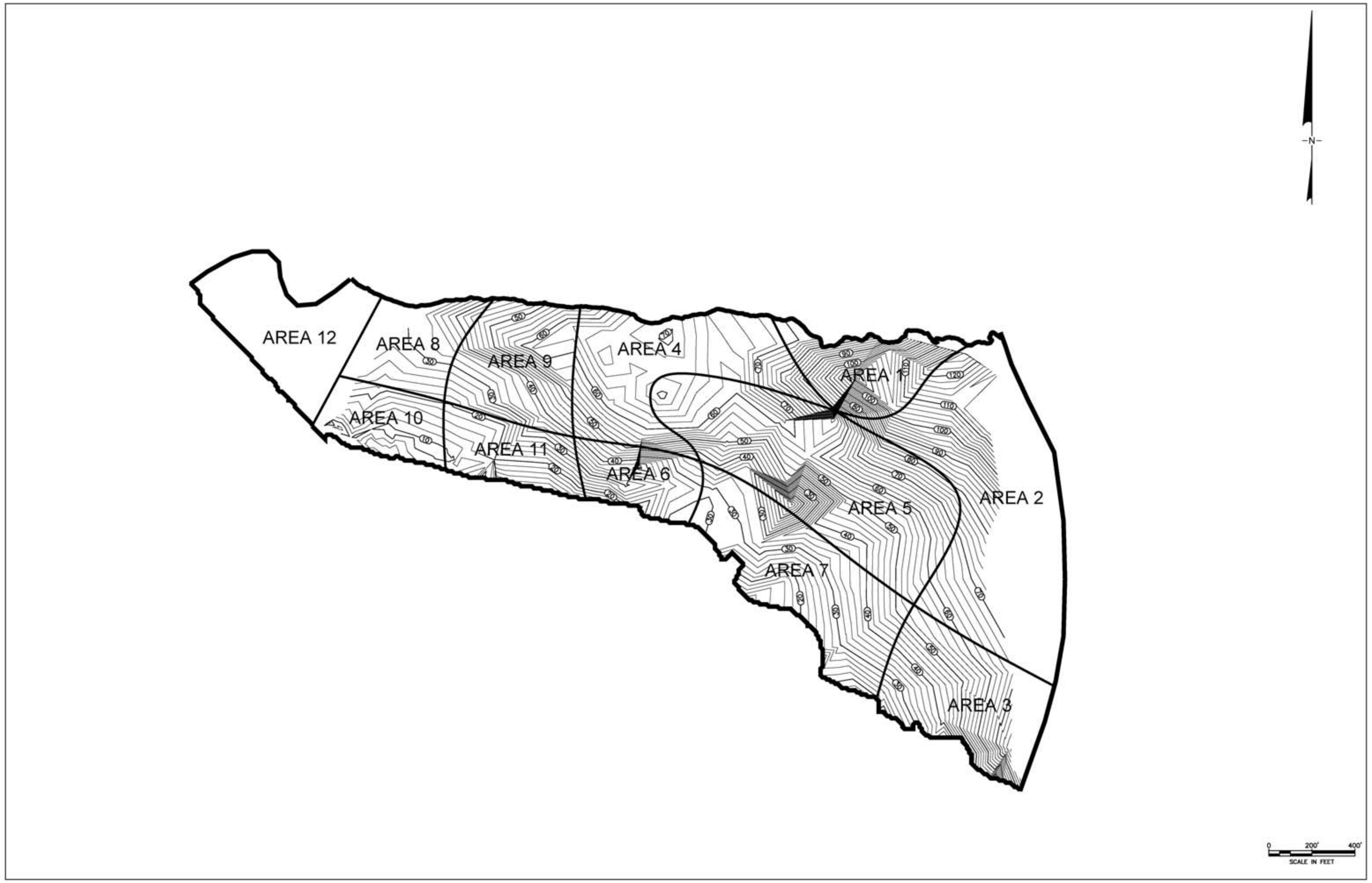



**Figure A3. The Thickness of Silt and Clay in Remediation Area D**

Note:

1. The subsurface thickness contours were developed based on the elevations of each layer from the boring logs provided by Parsons. The bottom of Silt and Clay was below the depth of the shallow borings and was developed based on a limited number of borings that went to deeper depths in the ILWD, as presented in Section 2.
2. The subsurface thickness in the area that is not covered by the contours presented in this figure was estimated based on boring logs provided by Parsons.

# ATTACHMENT B

# CONVENTIONAL OEDOMETER TEST RESULTS SUMMARY

## Summary of Consolidation Test Data – Phase I PDI

| Location ID | Field Sample ID | Depth (ft) | Average Depth (ft) | Compression Index (Cc) | Recompression Index (Cr) | Initial Void Ratio ($e_o$) | Initial Water Content (%) | Preconsolidation Pressure (tsf) |
|---|---|---|---|---|---|---|---|---|
| OL-STA-10013 | OL-0110-05 | 41-43 | 42 | 0.51 | 0.06 | 1.60 | 57.6 | 0.6 |
| OL-STA-10014 | OL-0110-08 | 34.5-36.5 | 35.5 | 0.94 | 0.01 | 3.05 | 113.1 | 0.6 |
| OL-STA-10017 | OL-0110-20 | 28-30 | 29 | 0.94 | 0.13 | 2.74 | 103.7 | 0.3 |
| OL-STA-10018 | OL-0110-27 | 48-50 | 49 | 0.36 | 0.03 | 1.06 | 36.5 | 0.7 |
| OL-STA-10019 | OL-0110-30 | 12.5-14.5 | 13.5 | 0.08 | 0.01 | 4.24 | 148.7 | 1.0 |
| OL-STA-10022 | OL-0110-49 | 64-66 | 65 | 0.70 | 0.06 | 1.85 | 67.2 | 0.8 |
| OL-STA-10023 | OL-0052-06 | 13-15 | 14 | 1.59 | 0.02 | 3.38 | 142.2 | 0.5 |
| OL-STA-10023 | OL-0052-04 | 50-52 | 51 | 0.73 | 0.07 | 1.94 | 72.5 | 0.9 |
| OL-STA-10024 | OL-0052-07 | 15-17 | 16 | 1.18 | 0.02 | 3.08 | 120.9 | 0.8 |
| OL-STA-10024 | OL-0052-09 | 30-32 | 31 | 2.84 | 0.03 | 4.93 | 180.0 | 1.4 |
| OL-STA-10024 | OL-0052-12 | 64-66 | 65 | 0.57 | 0.09 | 1.81 | 63.4 | 0.6 |
| OL-STA-10025 | OL-0052-13 | 7-9 | 8 | 2.04 | 0.02 | 4.53 | 183.6 | 0.9 |
| OL-STA-10025 | OL-0052-16 | 52-54 | 53 | 0.65 | 0.08 | 1.88 | 70.3 | 0.7 |
| OL-STA-10026 | OL-0052-19 | 7-9 | 8 | 1.22 | 0.03 | 3.17 | 105.7 | 0.9 |
| OL-STA-10026 | OL-0052-22 | 50-52 | 51 | 0.69 | 0.09 | 1.99 | 76.5 | 0.7 |
| OL-STA-20001 | OL-0072-07 | 20-22 | 21 | 0.37 | 0.02 | 1.87 | 64.2 | 0.3 |
| OL-STA-20001 | OL-0072-09 | 44.9-46.9 | 45.9 | 0.26 | 0.04 | 0.95 | 32.7 | 0.5 |
| OL-STA-20004 | OL-0072-01 | 12-14 | 13 | 0.72 | 0.01 | 2.91 | 102.3 | 0.3 |
| OL-STA-20004 | OL-0072-02 | 36.6-38.6 | 37.6 | 0.16 | 0.02 | 0.90 | 31.4 | 0.4 |
| OL-STA-20007 | OL-0072-04 | 23-25 | 24 | 0.41 | 0.03 | 1.89 | 65.8 | 0.3 |
| OL-STA-20007 | OL-0072-05 | 38.6-40.6 | 39.6 | 0.49 | 0.05 | 1.33 | 48.6 | 0.5 |
| OL-STA-20016 | OL-0110-52 | 27-29 | 28 | 0.19 | 0.04 | 0.89 | 30.9 | 0.4 |
| OL-STA-20017 | OL-0110-57 | 10-12 | 11 | 0.51 | 0.01 | 1.42 | 37.2 | 0.4 |
| OL-STA-20017 | OL-0110-59 | 42-44 | 43 | 0.22 | 0.03 | 0.87 | 31.1 | 0.6 |
| OL-STA-20018 | OL-0110-55 | 47-49 | 48 | 0.23 | 0.02 | 0.91 | 32.7 | 0.7 |

## Summary of Consolidation Test Data – Phase II PDI

| Location ID | Field Sample ID | Depth (ft) | Average Depth (ft) | Compression Index ($C_c$) | Recompression Index ($C_r$) | Modified Compression Index ($C_{c\varepsilon}$) | Modified Recompression Index ($C_{r\varepsilon}$) | Initial Void Ratio ($e_o$) | Initial Water Content (%) | Preconsolidation Pressure (psf) |
|---|---|---|---|---|---|---|---|---|---|---|
| OL-STA-10108 | OL-0267-01 | 64-66 | 65 | 0.74 | 0.06 | 0.25 | 0.02 | 1.91 | 70.8 | 1702 |
| OL-STA-10108 | OL-0267-02 | 68-70 | 69 | 0.58 | 0.05 | 0.20 | 0.02 | 1.86 | 65.3 | 1032 (disturbed sample) |

Notes:

1. The Cc values of SOLW in this table correspond to high stress (i.e., >1000 psf) range and were not used in analysis.
2. The modified compression index $C_{c\varepsilon}$ and recompression index $C_{r\varepsilon}$ are calculated as follows: $C_{c\varepsilon} = C_c / (1+e_0)$ and $C_{r\varepsilon} = C_r / (1+e_0)$.
3. These summary tables were provided to Geosyntec by Parsons.

# ATTACHMENT C

# EXAMPLES OF CALCULATIONS

(For Area 7 with 2 m dredge and 4 ft thick cap)

# An Example of Settlement Calculations

Input:

Dredging Depth 6.6 ft

Consider Total Settlement in 30 years

| Soil Layers | Thickness (ft) | Unit Weight (pcf) | OCR | $C_{c\varepsilon}$ | $C_{r\varepsilon}$ | $C_{\alpha}$ | Coef. of Con. $c_v$ ($ft^2/d$) | Time of 90% primary con. (years) | t2/t1 for Secondary Con. | # of Sublayers |
|---|---|---|---|---|---|---|---|---|---|---|
| Cap | 4 | 120 | | | | | | | | |
| SOLW | 45 | 81 | 1 | 0.030 | 0.0045 | 0.0011 | 3.500 | 1.3 | 22.3 | 18 |
| Marl | 0 | 98 | 1 | 0.117 | 0.0099 | 0.0050 | 0.090 | 5.8 | 5.2 | 0 |
| Silt/Clay | 30 | 108 | 1 | 0.223 | 0.0250 | 0.0100 | 0.090 | 5.8 | 5.2 | 6 |
| Water | | 62.4 | | | | | | | | |

Calculated Settlement (ft):

| | Primary Settlement | Secondary Settlement | Total Settlement |
|---|---|---|---|
| SOLW | 0.158 | 0.057 | 0.215 |
| Marl | 0.000 | 0.000 | 0.000 |
| Silt/Clay | 0.242 | 0.215 | 0.457 |
| Total | 0.40 | 0.27 | **0.67** |

Calculation for SOLW

| Layer No. | 1 | Layer No. | 5 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.1333333 | Layer Thickness, m / ft | 2.1333333 |
| Midpoint Depth from Dredge Bot, m/ft | 1.0666667 | Midpoint Depth from Dredge Bot, m/ft | 9.6 |
| Effective Stress Before Dredging, KPa/psf | 142.6 | Effective Stress Before Dredging, KPa/psf | 301.32 |
| Initial Effective Stress, KPa/psf | 19.84 | Initial Effective Stress, KPa/psf | 178.56 |
| Final Effective Stress, KPa/psf | 250.24 | Final Effective Stress, KPa/psf | 408.96 |
| OCR | 1 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 142.6 | Preconsolidation Pressure, KPa/psf | 301.32 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 | Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 | Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 | Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 |
| ratio of t2 / t1 | 22.3 | ratio of t2 / t1 | 22.3 |
| Settlements | | Settlements | |
| Primary Settlement, (m / ft) | 0.024 | Primary Settlement, (m / ft) | 0.011 |
| Secondary Settlement (m / ft) | 0.003 | Secondary Settlement (m / ft) | 0.003 |
| Total Settlement (m / ft) | 0.027 | Total Settlement (m / ft) | 0.014 |

| Layer No. | 2 | Layer No. | 6 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.1333333 | Layer Thickness, m / ft | 2.1333333 |
| Midpoint Depth from Dredge Bot, m/ft | 3.2 | Midpoint Depth from Dredge Bot, m/ft | 11.733333 |
| Effective Stress Before Dredging, KPa/psf | 182.28 | Effective Stress Before Dredging, KPa/psf | 341 |
| Initial Effective Stress, KPa/psf | 59.52 | Initial Effective Stress, KPa/psf | 218.24 |
| Final Effective Stress, KPa/psf | 289.92 | Final Effective Stress, KPa/psf | 448.64 |
| OCR | 1 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 182.28 | Preconsolidation Pressure, KPa/psf | 341 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 | Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 | Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 | Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 |
| ratio of t2 / t1 | 22.3 | ratio of t2 / t1 | 22.3 |
| Settlements | | Settlements | |
| Primary Settlement, (m / ft) | 0.018 | Primary Settlement, (m / ft) | 0.009 |
| Secondary Settlement (m / ft) | 0.003 | Secondary Settlement (m / ft) | 0.003 |
| Total Settlement (m / ft) | 0.021 | Total Settlement (m / ft) | 0.013 |

| Layer No. | 3 | Layer No. | 7 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.1333333 | Layer Thickness, m / ft | 2.1333333 |
| Midpoint Depth from Dredge Bot, m/ft | 5.3333333 | Midpoint Depth from Dredge Bot, m/ft | 13.866667 |
| Effective Stress Before Dredging, KPa/psf | 221.96 | Effective Stress Before Dredging, KPa/psf | 380.68 |
| Initial Effective Stress, KPa/psf | 99.2 | Initial Effective Stress, KPa/psf | 257.92 |
| Final Effective Stress, KPa/psf | 329.6 | Final Effective Stress, KPa/psf | 488.32 |
| OCR | 1 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 221.96 | Preconsolidation Pressure, KPa/psf | 380.68 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 | Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 | Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 | Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 |
| ratio of t2 / t1 | 22.3 | ratio of t2 / t1 | 22.3 |
| Settlements | | Settlements | |
| Primary Settlement, (m / ft) | 0.014 | Primary Settlement, (m / ft) | 0.009 |
| Secondary Settlement (m / ft) | 0.003 | Secondary Settlement (m / ft) | 0.003 |
| Total Settlement (m / ft) | 0.018 | Total Settlement (m / ft) | 0.012 |

| Layer No. | 4 | Layer No. | 8 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.1333333 | Layer Thickness, m / ft | 2.1333333 |
| Midpoint Depth from Dredge Bot, m/ft | 7.4666667 | Midpoint Depth from Dredge Bot, m/ft | 16 |
| Effective Stress Before Dredging, KPa/psf | 261.64 | Effective Stress Before Dredging, KPa/psf | 420.36 |
| Initial Effective Stress, KPa/psf | 138.88 | Initial Effective Stress, KPa/psf | 297.6 |
| Final Effective Stress, KPa/psf | 369.28 | Final Effective Stress, KPa/psf | 528 |
| OCR | 1 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 261.64 | Preconsolidation Pressure, KPa/psf | 420.36 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 | Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 | Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 | Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 |
| ratio of t2 / t1 | 22.3 | ratio of t2 / t1 | 22.3 |
| Settlements | | Settlements | |
| Primary Settlement, (m / ft) | 0.012 | Primary Settlement, (m / ft) | 0.008 |
| Secondary Settlement (m / ft) | 0.003 | Secondary Settlement (m / ft) | 0.003 |
| Total Settlement (m / ft) | 0.015 | Total Settlement (m / ft) | 0.011 |

| Layer No. | 9 | Layer No. | 14 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.1333333 | Layer Thickness, m / ft | 2.1333333 |
| Midpoint Depth from Dredge Bot, m/ft | 18.133333 | Midpoint Depth from Dredge Bot, m/ft | 28.8 |
| Effective Stress Before Dredging, KPa/psf | 460.04 | Effective Stress Before Dredging, KPa/psf | 658.44 |
| Initial Effective Stress, KPa/psf | 337.28 | Initial Effective Stress, KPa/psf | 535.68 |
| Final Effective Stress, KPa/psf | 567.68 | Final Effective Stress, KPa/psf | 766.08 |
| OCR | 1 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 460.04 | Preconsolidation Pressure, KPa/psf | 658.44 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 | Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 | Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 | Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 |
| ratio of t2 / t1 | 22.3 | ratio of t2 / t1 | 22.3 |
| Settlements | | Settlements | |
| Primary Settlement, (m / ft) | 0.007 | Primary Settlement, (m / ft) | 0.005 |
| Secondary Settlement (m / ft) | 0.003 | Secondary Settlement (m / ft) | 0.003 |
| Total Settlement (m / ft) | 0.010 | Total Settlement (m / ft) | 0.008 |

| Layer No. | 10 | Layer No. | 15 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.1333333 | Layer Thickness, m / ft | 2.1333333 |
| Midpoint Depth from Dredge Bot, m/ft | 20.266667 | Midpoint Depth from Dredge Bot, m/ft | 30.933333 |
| Effective Stress Before Dredging, KPa/psf | 499.72 | Effective Stress Before Dredging, KPa/psf | 698.12 |
| Initial Effective Stress, KPa/psf | 376.96 | Initial Effective Stress, KPa/psf | 575.36 |
| Final Effective Stress, KPa/psf | 607.36 | Final Effective Stress, KPa/psf | 805.76 |
| OCR | 1 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 499.72 | Preconsolidation Pressure, KPa/psf | 698.12 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 | Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 | Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 | Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 |
| ratio of t2 / t1 | 22.3 | ratio of t2 / t1 | 22.3 |
| Settlements | | Settlements | |
| Primary Settlement, (m / ft) | 0.007 | Primary Settlement, (m / ft) | 0.005 |
| Secondary Settlement (m / ft) | 0.003 | Secondary Settlement (m / ft) | 0.003 |
| Total Settlement (m / ft) | 0.010 | Total Settlement (m / ft) | 0.008 |

| Layer No. | 11 | Layer No. | 16 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.1333333 | Layer Thickness, m / ft | 2.1333333 |
| Midpoint Depth from Dredge Bot, m/ft | 22.4 | Midpoint Depth from Dredge Bot, m/ft | 33.066667 |
| Effective Stress Before Dredging, KPa/psf | 539.4 | Effective Stress Before Dredging, KPa/psf | 737.8 |
| Initial Effective Stress, KPa/psf | 416.64 | Initial Effective Stress, KPa/psf | 615.04 |
| Final Effective Stress, KPa/psf | 647.04 | Final Effective Stress, KPa/psf | 845.44 |
| OCR | 1 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 539.4 | Preconsolidation Pressure, KPa/psf | 737.8 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 | Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 | Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 | Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 |
| ratio of t2 / t1 | 22.3 | ratio of t2 / t1 | 22.3 |
| Settlements | | Settlements | |
| Primary Settlement, (m / ft) | 0.006 | Primary Settlement, (m / ft) | 0.005 |
| Secondary Settlement (m / ft) | 0.003 | Secondary Settlement (m / ft) | 0.003 |
| Total Settlement (m / ft) | 0.009 | Total Settlement (m / ft) | 0.008 |

| Layer No. | 12 | Layer No. | 17 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.1333333 | Layer Thickness, m / ft | 2.1333333 |
| Midpoint Depth from Dredge Bot, m/ft | 24.533333 | Midpoint Depth from Dredge Bot, m/ft | 35.2 |
| Effective Stress Before Dredging, KPa/psf | 579.08 | Effective Stress Before Dredging, KPa/psf | 777.48 |
| Initial Effective Stress, KPa/psf | 456.32 | Initial Effective Stress, KPa/psf | 654.72 |
| Final Effective Stress, KPa/psf | 686.72 | Final Effective Stress, KPa/psf | 885.12 |
| OCR | 1 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 579.08 | Preconsolidation Pressure, KPa/psf | 777.48 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 | Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 | Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 | Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 |
| ratio of t2 / t1 | 22.3 | ratio of t2 / t1 | 22.3 |
| Settlements | | Settlements | |
| Primary Settlement, (m / ft) | 0.006 | Primary Settlement, (m / ft) | 0.004 |
| Secondary Settlement (m / ft) | 0.003 | Secondary Settlement (m / ft) | 0.003 |
| Total Settlement (m / ft) | 0.009 | Total Settlement (m / ft) | 0.007 |

| Layer No. | 13 | Layer No. | 18 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.1333333 | Layer Thickness, m / ft | 2.1333333 |
| Midpoint Depth from Dredge Bot, m/ft | 26.666667 | Midpoint Depth from Dredge Bot, m/ft | 37.333333 |
| Effective Stress Before Dredging, KPa/psf | 618.76 | Effective Stress Before Dredging, KPa/psf | 817.16 |
| Initial Effective Stress, KPa/psf | 496 | Initial Effective Stress, KPa/psf | 694.4 |
| Final Effective Stress, KPa/psf | 726.4 | Final Effective Stress, KPa/psf | 924.8 |
| OCR | 1 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 618.76 | Preconsolidation Pressure, KPa/psf | 817.16 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 | Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.03 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 | Modified Recompression Index, $C_{r\varepsilon}$ | 0.0045 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 | Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.0011 |
| ratio of t2 / t1 | 22.3 | ratio of t2 / t1 | 22.3 |
| Settlements | | Settlements | |
| Primary Settlement, (m / ft) | 0.005 | Primary Settlement, (m / ft) | 0.004 |
| Secondary Settlement (m / ft) | 0.003 | Secondary Settlement (m / ft) | 0.003 |
| Total Settlement (m / ft) | 0.009 | Total Settlement (m / ft) | 0.007 |

Calculation for Silt and Clay

| Layer No. | 1 |
|---|---|
| Layer Thickness, m / ft | 5 |
| Midpoint Depth from Top of Silt/Clay, m/ft | 2.5 |
| Effective Stress Before Dredging, KPa/psf | 951 |
| Initial Effective Stress, KPa/psf | 828.24 |
| Final Effective Stress, KPa/psf | 1058.64 |
| OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 951 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.223 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.025 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.01 |
| ratio of t2 / t1 | 5.2 |
| Settlements | |
| Primary Settlement, (m / ft) | 0.059 |
| Secondary Settlement (m / ft) | 0.036 |
| Total Settlement (m / ft) | 0.095 |

| Layer No. | 2 |
|---|---|
| Layer Thickness, m / ft | 5 |
| Midpoint Depth from Top of Silt/Clay, m/ft | 7.5 |
| Effective Stress Before Dredging, KPa/psf | 1179 |
| Initial Effective Stress, KPa/psf | 1056.24 |
| Final Effective Stress, KPa/psf | 1286.64 |
| OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1179 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.223 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.025 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.01 |
| ratio of t2 / t1 | 5.2 |
| Settlements | |
| Primary Settlement, (m / ft) | 0.048 |
| Secondary Settlement (m / ft) | 0.036 |
| Total Settlement (m / ft) | 0.084 |

| Layer No. | 3 |
|---|---|
| Layer Thickness, m / ft | 5 |
| Midpoint Depth from Top of Silt/Clay, m/ft | 12.5 |
| Effective Stress Before Dredging, KPa/psf | 1407 |
| Initial Effective Stress, KPa/psf | 1284.24 |
| Final Effective Stress, KPa/psf | 1514.64 |
| OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1407 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.223 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.025 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.01 |
| ratio of t2 / t1 | 5.2 |
| Settlements | |
| Primary Settlement, (m / ft) | 0.041 |
| Secondary Settlement (m / ft) | 0.036 |
| Total Settlement (m / ft) | 0.076 |

| Layer No. | 4 |
|---|---|
| Layer Thickness, m / ft | 5 |
| Midpoint Depth from Top of Silt/Clay, m/ft | 17.5 |
| Effective Stress Before Dredging, KPa/psf | 1635 |
| Initial Effective Stress, KPa/psf | 1512.24 |
| Final Effective Stress, KPa/psf | 1742.64 |
| OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1635 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.223 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.025 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.01 |
| ratio of t2 / t1 | 5.2 |
| Settlements | |
| Primary Settlement, (m / ft) | 0.035 |
| Secondary Settlement (m / ft) | 0.036 |
| Total Settlement (m / ft) | 0.071 |

| Layer No. | 5 |
|---|---|
| Layer Thickness, m / ft | 5 |
| Midpoint Depth from Top of Silt/Clay, m/ft | 22.5 |
| Effective Stress Before Dredging, KPa/psf | 1863 |
| Initial Effective Stress, KPa/psf | 1740.24 |
| Final Effective Stress, KPa/psf | 1970.64 |
| OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1863 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.223 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.025 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.01 |
| ratio of t2 / t1 | 5.2 |
| Settlements | |
| Primary Settlement, (m / ft) | 0.031 |
| Secondary Settlement (m / ft) | 0.036 |
| Total Settlement (m / ft) | 0.067 |

| Layer No. | 6 |
|---|---|
| Layer Thickness, m / ft | 5 |
| Midpoint Depth from Top of Silt/Clay, m/ft | 27.5 |
| Effective Stress Before Dredging, KPa/psf | 2091 |
| Initial Effective Stress, KPa/psf | 1968.24 |
| Final Effective Stress, KPa/psf | 2198.64 |
| OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 2091 |
| Modified Primary Compression Index, $C_{c\varepsilon}$ | 0.223 |
| Modified Recompression Index, $C_{r\varepsilon}$ | 0.025 |
| Modified Secondary Compression Index, $C_{\alpha\varepsilon}$ | 0.01 |
| ratio of t2 / t1 | 5.2 |
| Settlements | |
| Primary Settlement, (m / ft) | 0.028 |
| Secondary Settlement (m / ft) | 0.036 |
| Total Settlement (m / ft) | 0.063 |

# An Example Calculation of
# Upward Cumulative Consolidation Water Flow

**Loading**

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

**Properties**

| | Top Layer | Bottom Layer | | | |
|---|---|---|---|---|---|
| Type | SOLW | Silt and Clay | | | |
| k = | 1.0E-05 | 1.0E-07 | cm/s | A = | 0.7272 |
| | 1.8E-01 | 1.8E-03 | ft/d | B = | 2.0E+00 |
| Cv = | 3.50 | 0.09 | ft2/d | C = | 2.0E-02 |
| H = | 39 | 30 | ft | | |
| $C\alpha\varepsilon$ = | 0.0011 | 0.0100 | | | |
| t90 = | 435 | 2500 | days | | |
| | 1.2 | 6.8 | years | | |

**Reference Values**

| | | | |
|---|---|---|---|
| zR = | 69.0 | 69.0 | ft |
| uR = | 2.30 | 2.30 | psf |
| tR = | 1360 | 52900 | days |
| | 4 | 145 | years |

**Time Step**

Select $\delta t$ to ensure convergence of solution

| | | | | |
|---|---|---|---|---|
| | $\delta t$ = | 0.0030 | 0.0030 | years |
| | | 1 | 1 | days |
| | $\delta t$-bar = | 8.05E-04 | 2.07E-05 | |
| | $\delta z$ = | 3 | 3 | ft |
| | $\delta z$-bar = | 0.04 | 0.04 | |
| bar | $\delta t_1/(\delta z)^2$ = | 0.43 | 0.01 | should be less than 0.5 |

**U-bar values**

| Z (ft) | z-bar | s1 | s2 | s3 | s4 | s5 | s6 | s7 | s8 | s9 | s10 | s10 | s10 | s10 | s10 | s10 | s10 | s10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | t (years) | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 |
| | t (days) | 0 | 1 | 2 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 18 |
| | t-bar | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0.0 | 100 | 57 | 51 | 42 | 39 | 35 | 33 | 30 | 29 | 27 | 26 | 25 | 24 | 23 | 22 | 22 | 21 |
| 6 | 0.1 | 100 | 100 | 82 | 76 | 69 | 65 | 60 | 57 | 54 | 52 | 49 | 48 | 46 | 44 | 43 | 42 | 41 |
| 9 | 0.1 | 100 | 100 | 100 | 92 | 89 | 84 | 80 | 77 | 74 | 71 | 68 | 66 | 64 | 62 | 61 | 59 | 58 |
| 12 | 0.2 | 100 | 100 | 100 | 100 | 97 | 95 | 92 | 89 | 87 | 84 | 82 | 80 | 78 | 76 | 75 | 73 | 71 |
| 15 | 0.2 | 100 | 100 | 100 | 100 | 100 | 99 | 98 | 96 | 94 | 93 | 91 | 89 | 88 | 86 | 85 | 83 | 82 |
| 18 | 0.3 | 100 | 100 | 100 | 100 | 100 | 100 | 99 | 99 | 98 | 97 | 96 | 95 | 94 | 93 | 92 | 90 | 89 |
| 21 | 0.3 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 99 | 99 | 99 | 98 | 97 | 96 | 96 | 95 | 94 |
| 24 | 0.3 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 99 | 99 | 98 | 98 | 98 | 97 |
| 27 | 0.4 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 99 | 99 | 99 | 99 |
| 30 | 0.4 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 99 |
| 33 | 0.5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 36 | 0.5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 39 | 0.6 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 42 | 0.6 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 45 | 0.7 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 | 0.7 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 51 | 0.7 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 54 | 0.8 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 57 | 0.8 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 60 | 0.9 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 63 | 0.9 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 99 | 99 | 99 | 99 | 99 | 99 |
| 66 | 1.0 | 100 | 99 | 98 | 97 | 96 | 95 | 94 | 93 | 92 | 91 | 90 | 89 | 88 | 87 | 87 | 86 | 85 |
| 69 | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Top Layer** | | | | | | | | | | | | | | | | | |
| Initial Area = | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 | 3900 |
| Current Area = | 3700 | 3530 | 3468 | 3392 | 3342 | 3288 | 3244 | 3201 | 3162 | 3124 | 3090 | 3056 | 3024 | 2993 | 2963 | 2935 | 2907 |
| U-ave= | 5% | 9% | 11% | 13% | 14% | 16% | 17% | 18% | 19% | 20% | 21% | 22% | 22% | 23% | 24% | 25% | 25% |
| Final primary settlement (ft) = | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| Current primary settlement (ft) = | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| Current secondary settlement (ft) = | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Current total settlement (ft) = | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| **Bottom Layer** | | | | | | | | | | | | | | | | | |
| Initial Area = | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| Current Area = | 2900 | 2896 | 2891 | 2887 | 2883 | 2879 | 2875 | 2871 | 2867 | 2863 | 2859 | 2855 | 2852 | 2848 | 2845 | 2841 | 2837 |
| U-ave= | 3% | 3% | 4% | 4% | 4% | 4% | 4% | 4% | 4% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% |
| Final primary settlement (ft) = | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Current primary settlement (ft) = | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Current secondary settlement (ft) = | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Current total settlement (ft) = | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| **Total** | | | | | | | | | | | | | | | | | |
| Total current settlement (ft) = | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 |

Note: Due to the limited paper size, only part of the calculation sheet is shown here.

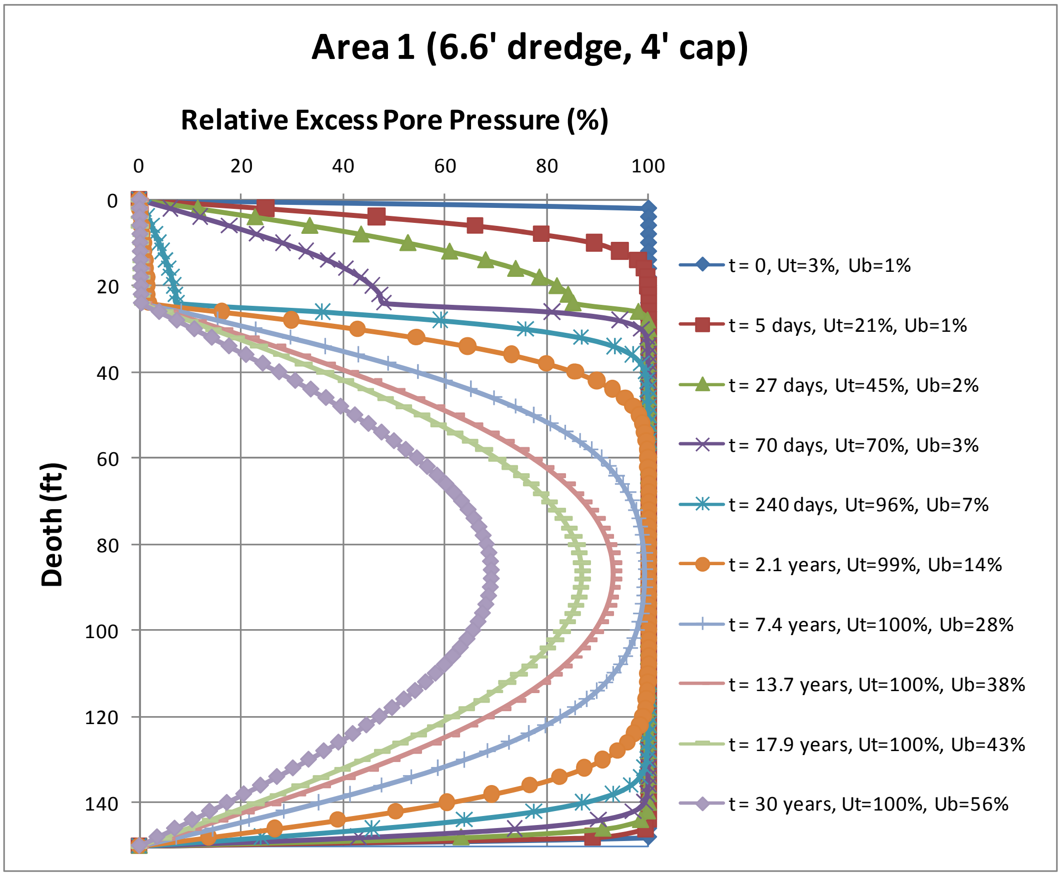
**U bar and settlement results summary**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Uave top | 5% | 16% | 30% | 51% | 73% | 93% | 99% | 100% | 100% | 100% |
| Uave bot | 3% | 4% | 6% | 12% | 22% | 41% | 79% | 98% | 100% | 100% |
| t (years) | 0.00 | 0.02 | 0.07 | 0.23 | 0.54 | 1.29 | 4.21 | 10.54 | 18.97 | 30.00 |
| t (days) | 0.00 | 5.48 | 25.19 | 82.13 | 196.01 | 469.75 | 1536.29 | 3845.64 | 6924.78 | 10950.00 |
| Z (ft) | t = 0, Ut=5%, Ub= | t = 5 days, Ut=16%, Ub | t = 25 days, Ut=30%, Ub=6 | t = 82 days, Ut= | t = 196 days, U | t = 1.3 years, U | t = 4.2 years, U | t = 10.5 years, U | t = 19.0 years, U | t = 30 years, Ut=100%, Ub=100% |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 100 | 35 | 18 | 10 | 5 | 1 | 0 | 0 | 0 | 0 |
| 6 | 100 | 65 | 34 | 20 | 10 | 3 | 0 | 0 | 0 | 0 |
| 9 | 100 | 84 | 50 | 29 | 15 | 4 | 0 | 0 | 0 | 0 |
| 12 | 100 | 95 | 63 | 38 | 20 | 5 | 1 | 0 | 0 | 0 |
| 15 | 100 | 99 | 74 | 46 | 25 | 7 | 1 | 0 | 0 | 0 |
| 18 | 100 | 100 | 82 | 54 | 29 | 8 | 1 | 0 | 0 | 0 |
| 21 | 100 | 100 | 88 | 60 | 33 | 9 | 1 | 0 | 0 | 0 |
| 24 | 100 | 100 | 93 | 66 | 36 | 10 | 1 | 0 | 0 | 0 |
| 27 | 100 | 100 | 96 | 71 | 39 | 11 | 1 | 0 | 0 | 0 |
| 30 | 100 | 100 | 98 | 75 | 41 | 12 | 1 | 0 | 0 | 0 |
| 33 | 100 | 100 | 99 | 78 | 43 | 12 | 1 | 0 | 0 | 0 |
| 36 | 100 | 100 | 99 | 80 | 45 | 13 | 1 | 0 | 0 | 0 |
| 39 | 100 | 100 | 100 | 81 | 45 | 13 | 2 | 0 | 0 | 0 |
| 42 | 100 | 100 | 100 | 96 | 77 | 43 | 12 | 1 | 0 | 0 |
| 45 | 100 | 100 | 100 | 99 | 92 | 66 | 20 | 2 | 0 | 0 |
| 48 | 100 | 100 | 100 | 100 | 98 | 79 | 27 | 3 | 0 | 0 |
| 51 | 100 | 100 | 100 | 100 | 99 | 86 | 32 | 3 | 0 | 0 |
| 54 | 100 | 100 | 100 | 100 | 98 | 85 | 33 | 4 | 0 | 0 |
| 57 | 100 | 100 | 100 | 99 | 95 | 79 | 31 | 3 | 0 | 0 |
| 60 | 100 | 100 | 100 | 97 | 86 | 67 | 26 | 3 | 0 | 0 |
| 63 | 100 | 100 | 98 | 87 | 69 | 48 | 19 | 2 | 0 | 0 |
| 66 | 100 | 95 | 80 | 57 | 39 | 26 | 10 | 1 | 0 | 0 |
| 69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cumulative Upward Consc | 0.01 | 0.03 | 0.06 | 0.10 | 0.15 | 0.21 | 0.30 | 0.37 | 0.42 | 0.46 |

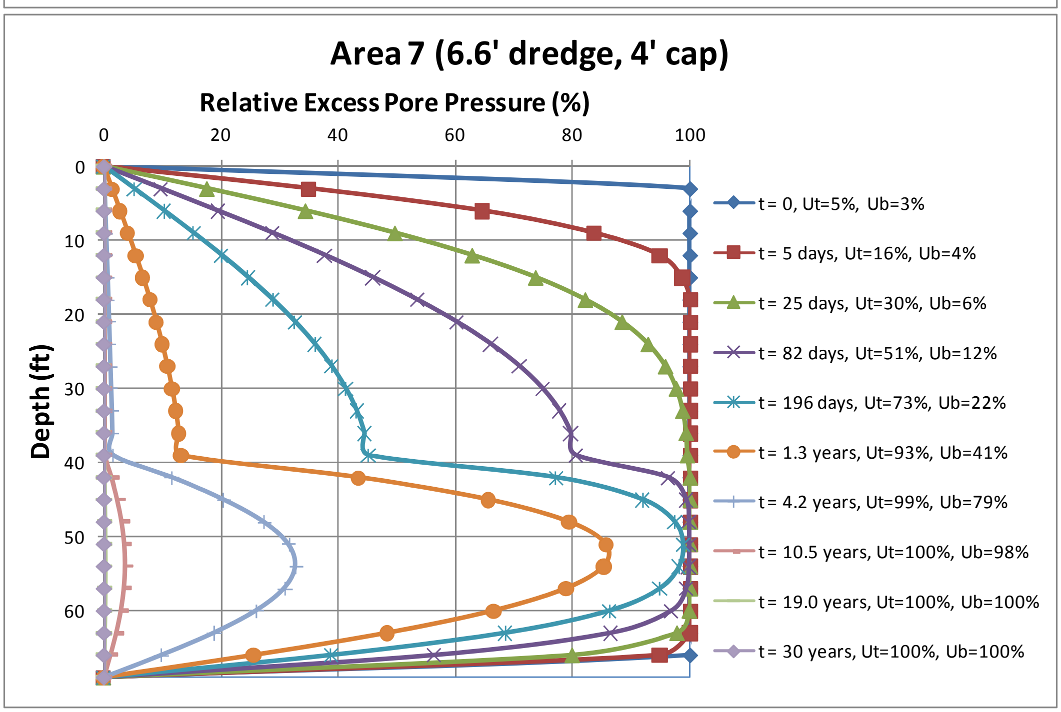
# ATTACHMENT D

# CALCULATED EXCESS PORE WATER PRESSURE ISOCHRONES

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



Area 1 (6.6' dredge, 4' cap)
Relative Excess Pore Pressure (%)
0
20
40
60
80
100
Deoth (ft)
0
20
40
60
80
100
120
140
t= 0, Ut=3%, Ub=1%
t= 5 days, Ut=21%, Ub=1%
t= 27 days, Ut=45%, Ub=2%
t= 70 days, Ut=70%, Ub=3%
t= 240 days, Ut=96%, Ub=7%
t= 2.1 years, Ut=99%, Ub=14%
t= 7.4 years, Ut=100%, Ub=28%
t= 13.7 years, Ut=100%, Ub=38%
t= 17.9 years, Ut=100%, Ub=43%
t= 30 years, Ut=100%, Ub=56%

Area 7 (6.6' dredge, 4' cap)
Relative Excess Pore Pressure (%)
0
20
40
60
80
100
Depth (ft)
0
10
20
30
40
50
60
t= 0, Ut=5%, Ub=3%
t= 5 days, Ut=16%, Ub=4%
t= 25 days, Ut=30%, Ub=6%
t= 82 days, Ut=51%, Ub=12%
t= 196 days, Ut=73%, Ub=22%
t= 1.3 years, Ut=93%, Ub=41%
t= 4.2 years, Ut=99%, Ub=79%
t= 10.5 years, Ut=100%, Ub=98%
t= 19.0 years, Ut=100%, Ub=100%
t= 30 years, Ut=100%, Ub=100%

*Prepared for*

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# 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"

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Project Number: GJ4741

January 2011

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# LIST OF ATTACHMENTS

## 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 January 2011. 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 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.

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. Based on the wetland restoration concepts advanced as part of the *Draft Habitat Plan* (Parsons, 2009), it is anticipated that 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*.

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. 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.

# TABLES

Table 1. Summary of Material Properties used in Settlement Calculations

| Area | Material | Unit Weight (pcf) | 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 | 0.061 | 0.006 | 0.0003 | 4.50 |
| | SOLW | 80 | 0.042[2] | 0.003 | 0.0006 | 0.60[3] |
| | Marl | 101 | 0.152 | 0.010 | 0.0008 | 0.50 |
| | Silt and Clay | 118 | 0.117 | 0.013 | 0.0015 | 0.15 |
| Outboard Area near East Wall (Subareas 7 and 8) | Fill | 92 | 0.061 | 0.006 | 0.0003 | 4.50 |
| | Marl | 97 | 0.176 | 0.010 | 0.0030 | 0.25[3] |
| | Silt and Clay | 111 | 0.129 | 0.013 | 0.0015 | 0.15 |

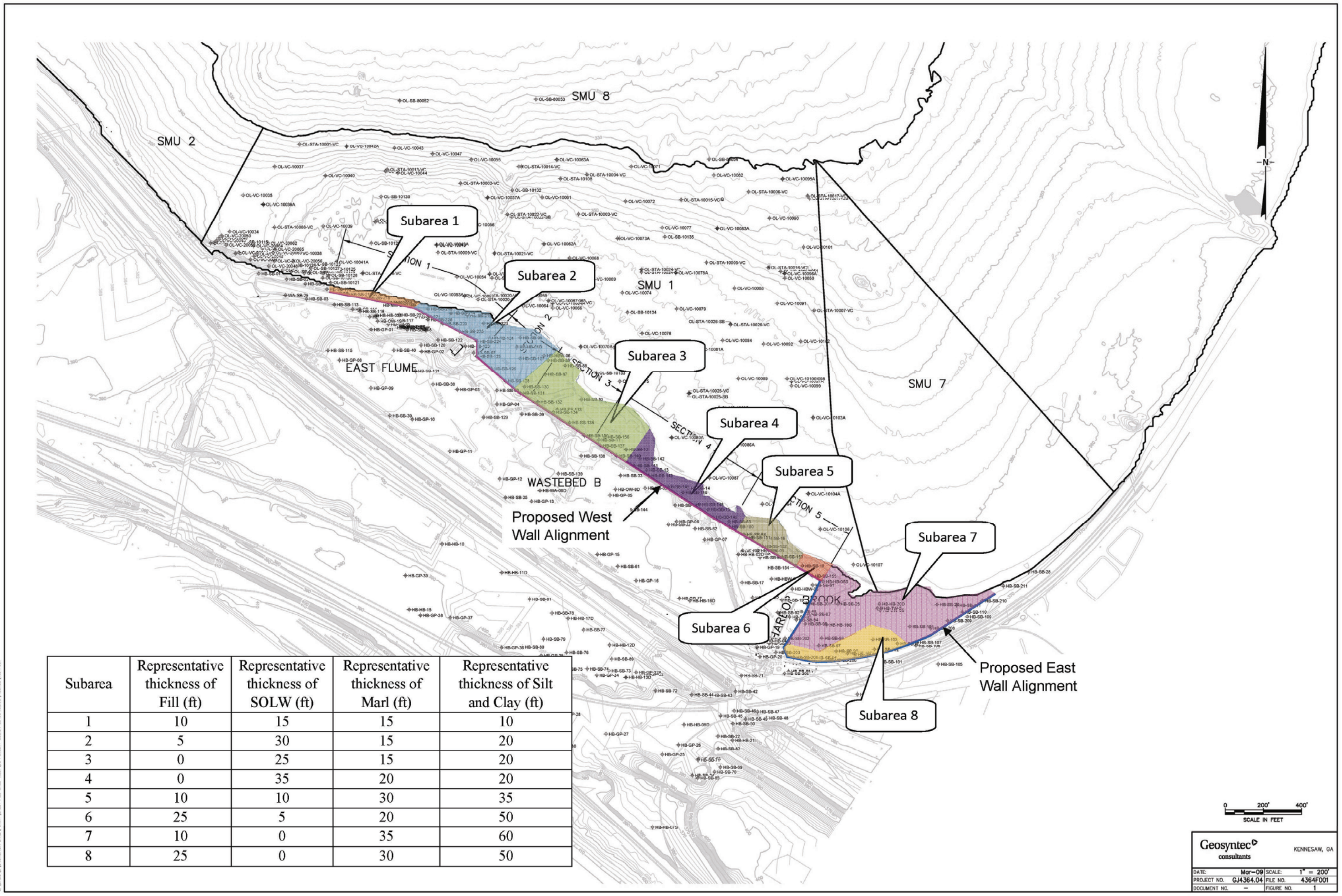
Notes:

[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.

# 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

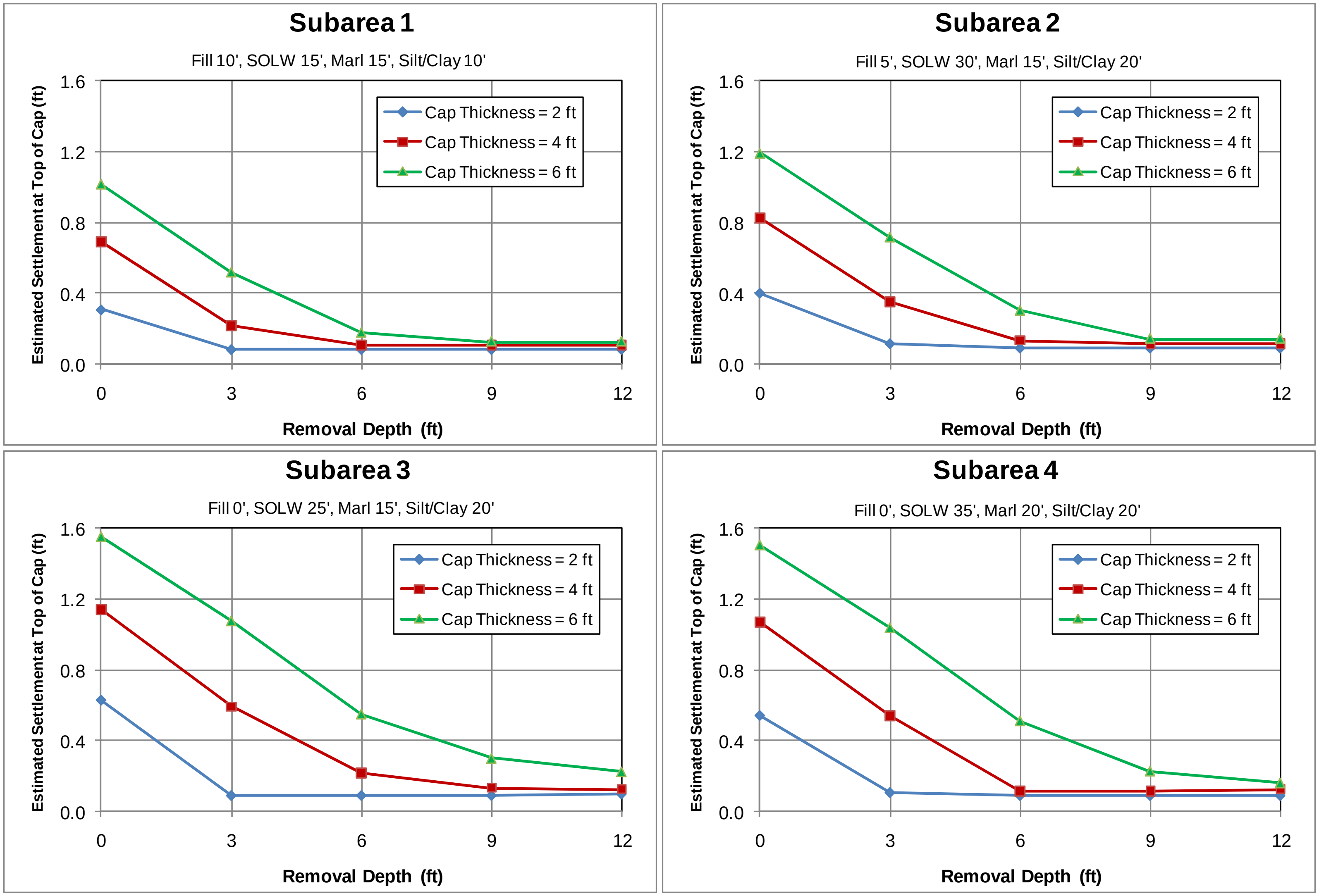



Figure 2. Settlement Calculation Results for the 30-Year Period

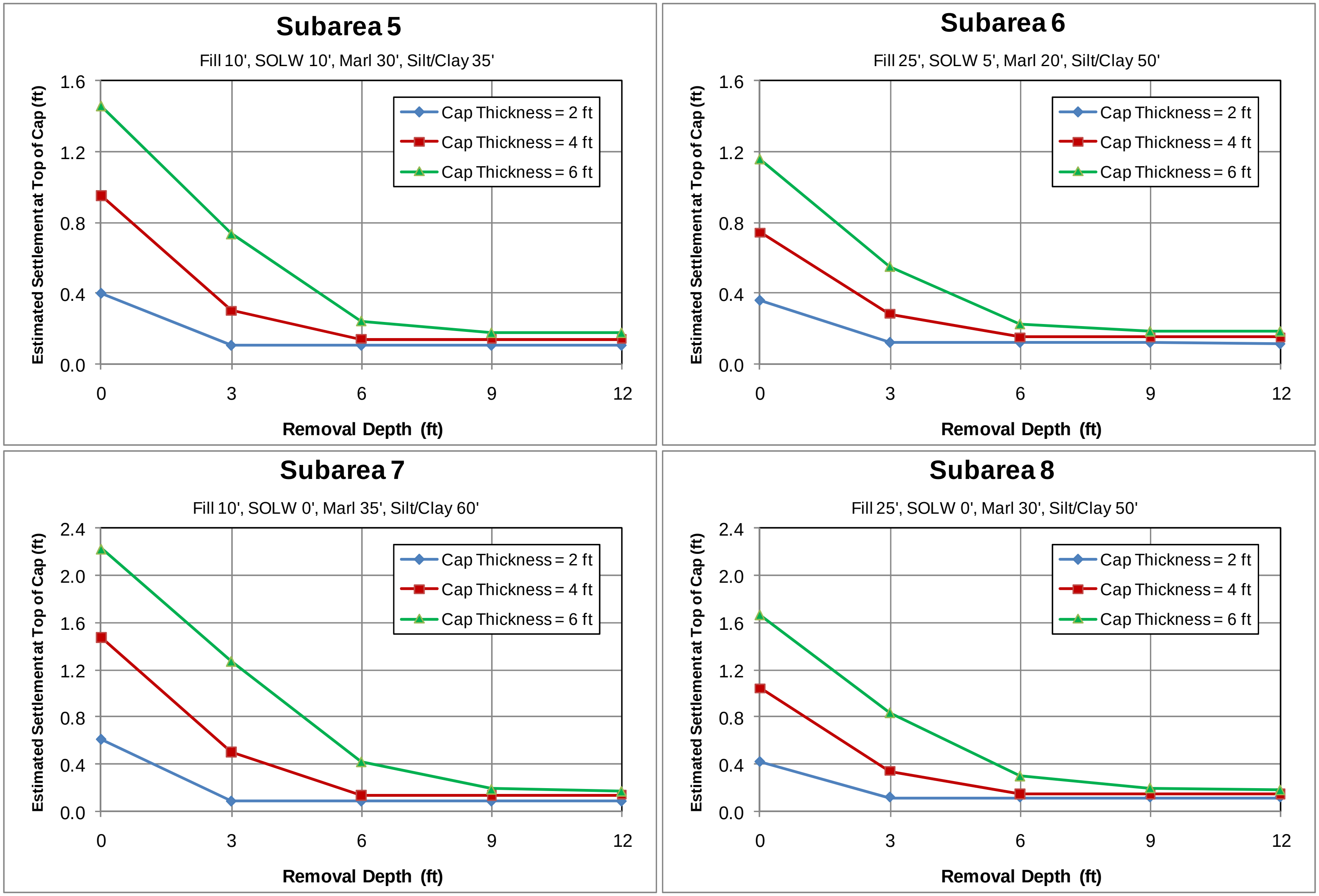



Figure 2. Settlement Calculation Results for the 30-Year Period (continued)

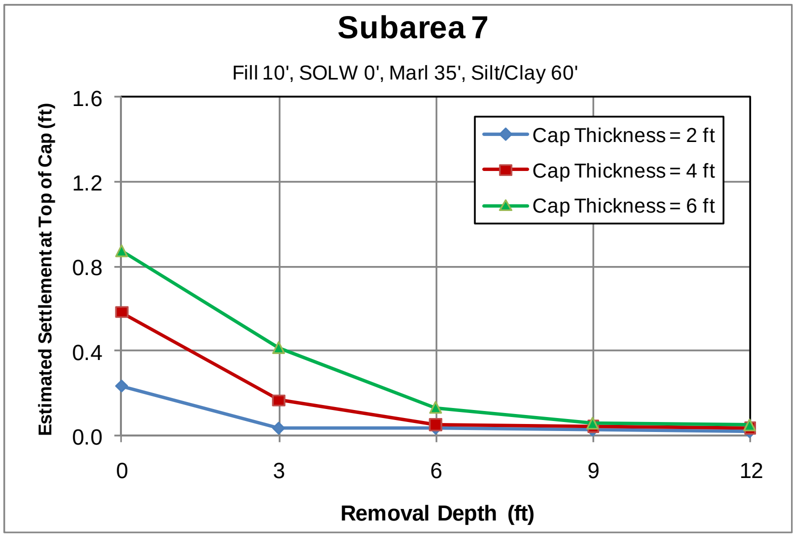



Figure 3. Settlement Calculation Results for the 2-Year Period (Subarea 7 Only)

# ATTACHMENT A

# SUBSURFACE LAYER THICKNESS CONTOURS

## (WB-B/HB OUTBOARD AREA)

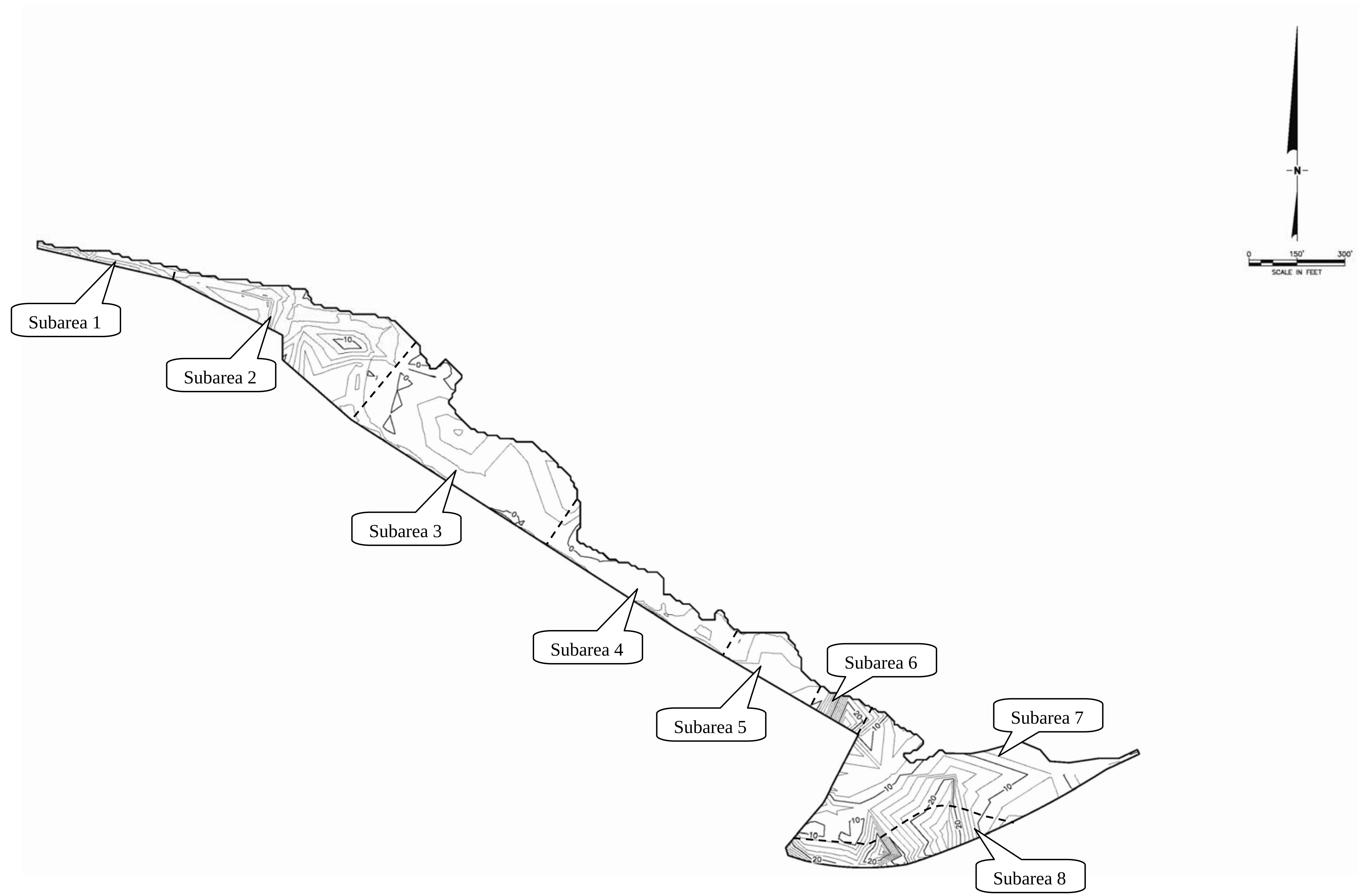



**Figure A-1. Thickness of Fill in WB-B/HB Outboard Area**

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.

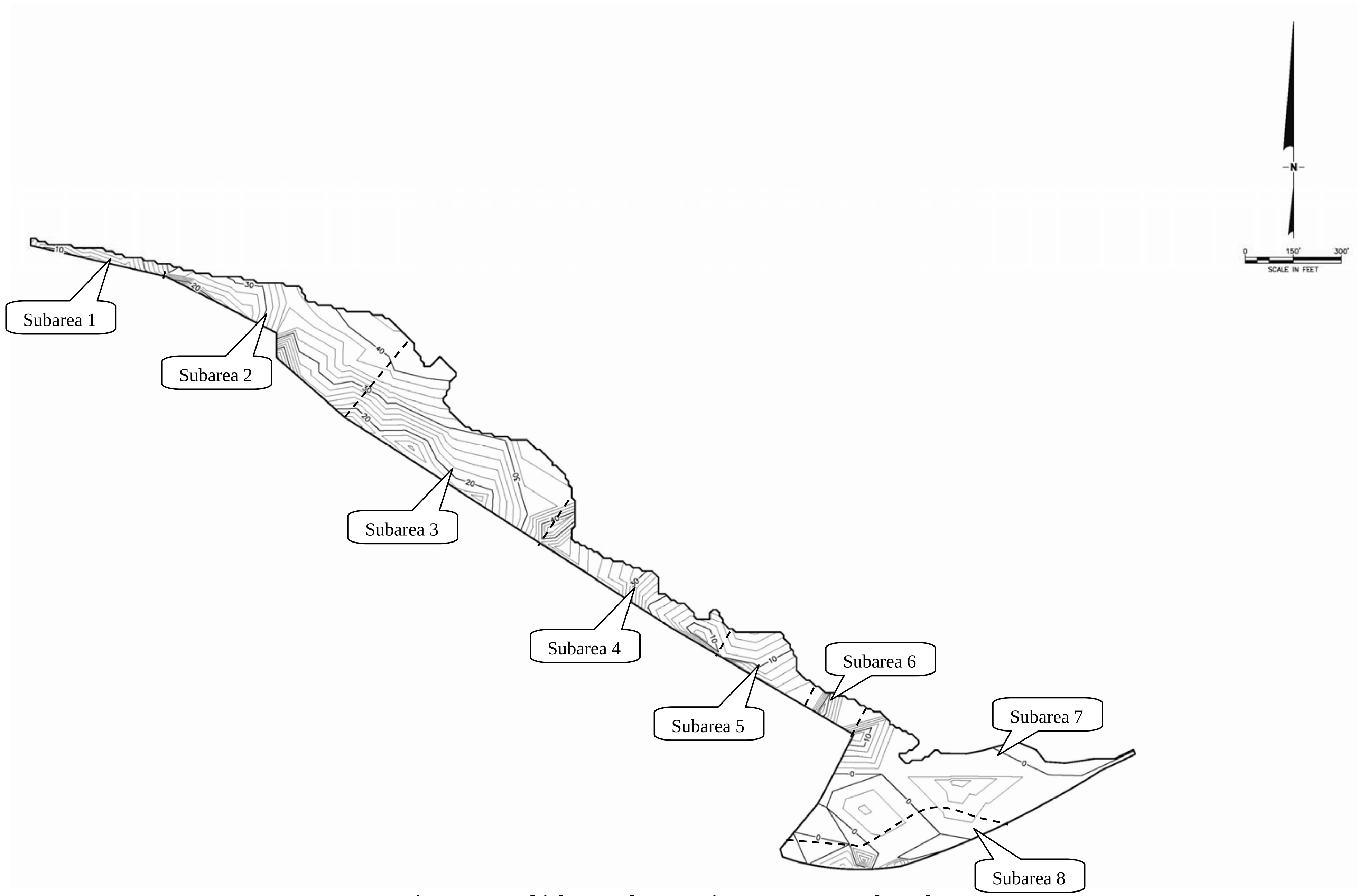



**Figure A-2. Thickness of SOLW in WB-B/HB Outboard Area**

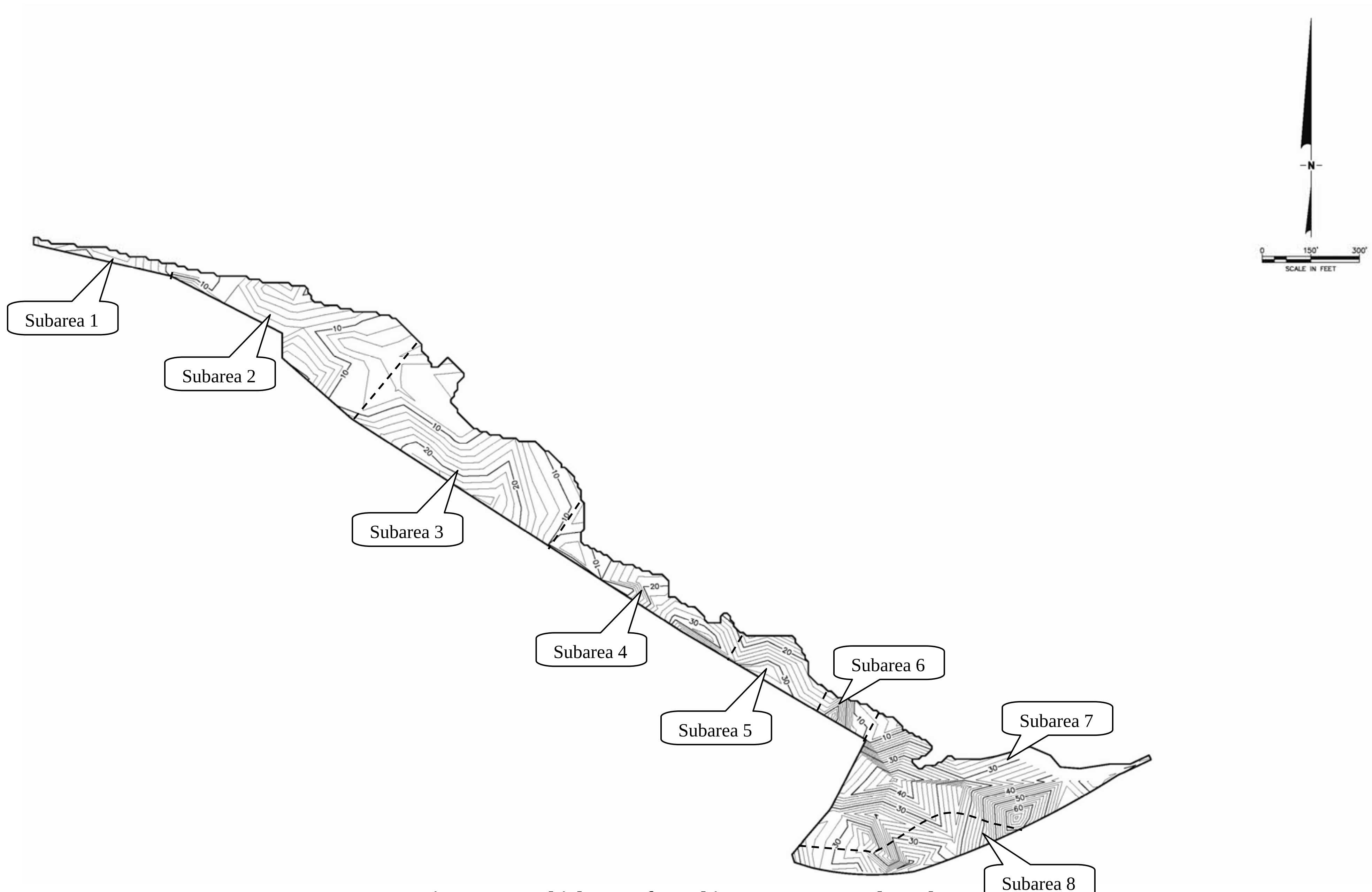



**Figure A-3. Thickness of Marl in WB-B/HB Outboard Area**

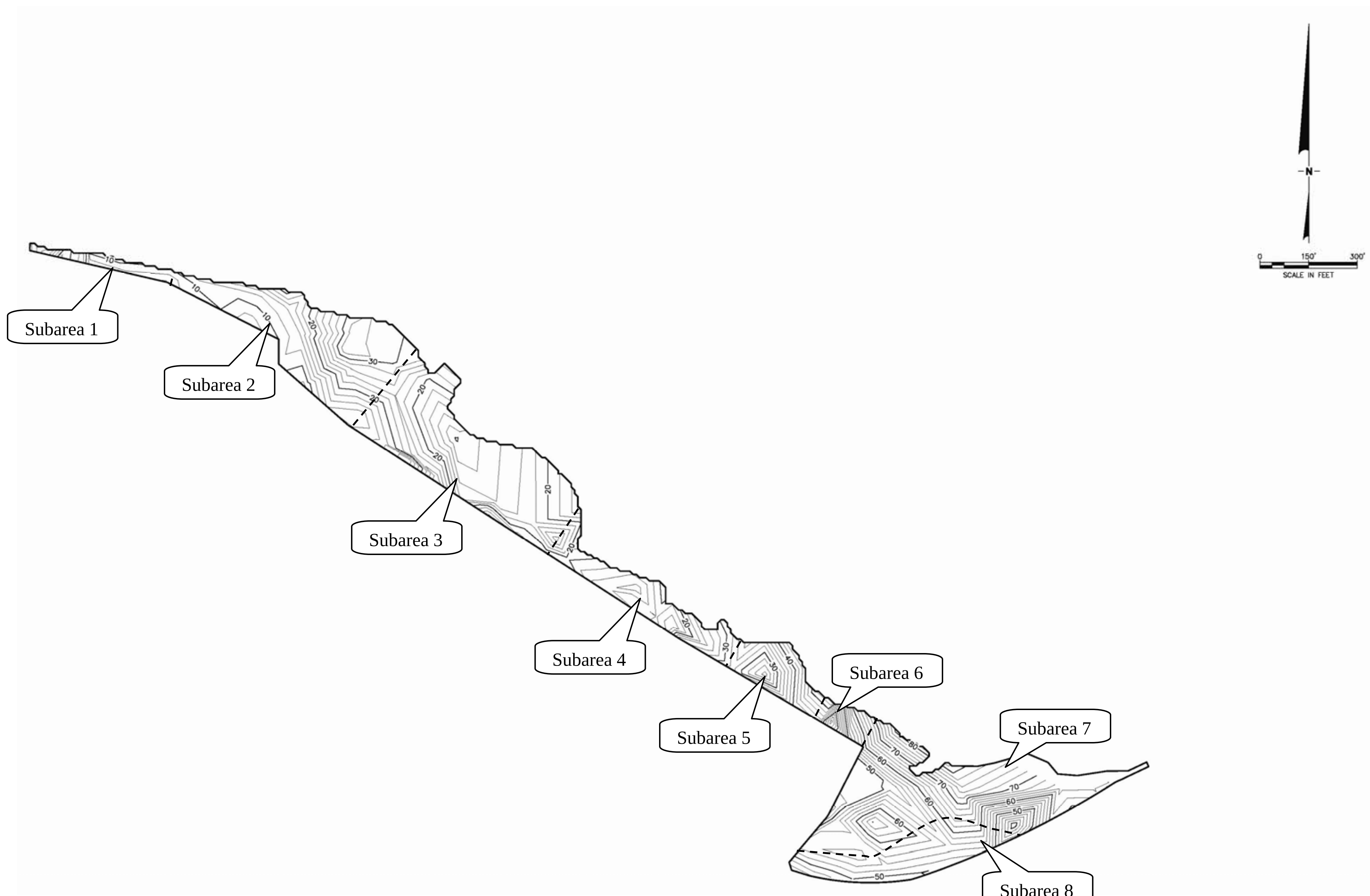



**Figure A-4. Thickness of Silt and Clay in WB-B/HB Outboard Area**

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..

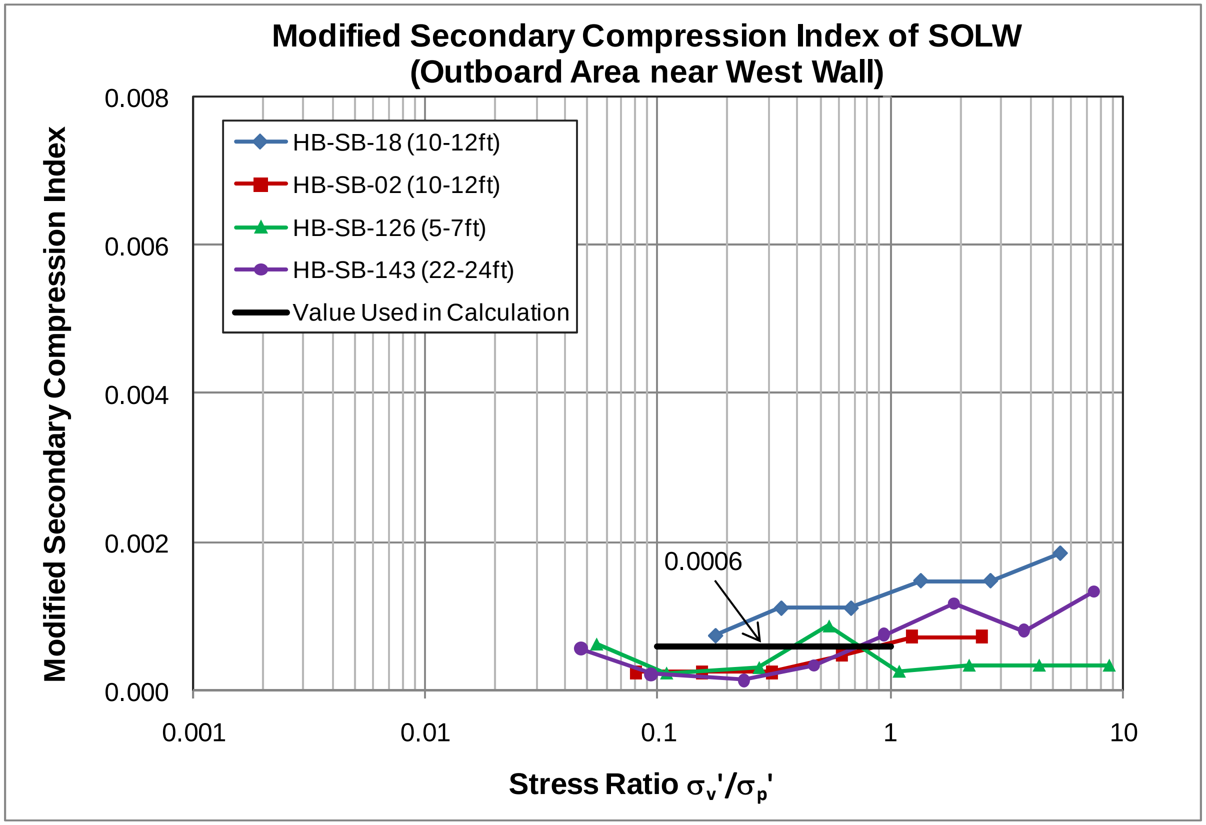



Figure B-1. Interpretation of Modified Secondary Compression Index for SOLW
(Outboard Area near West Wall)

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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.

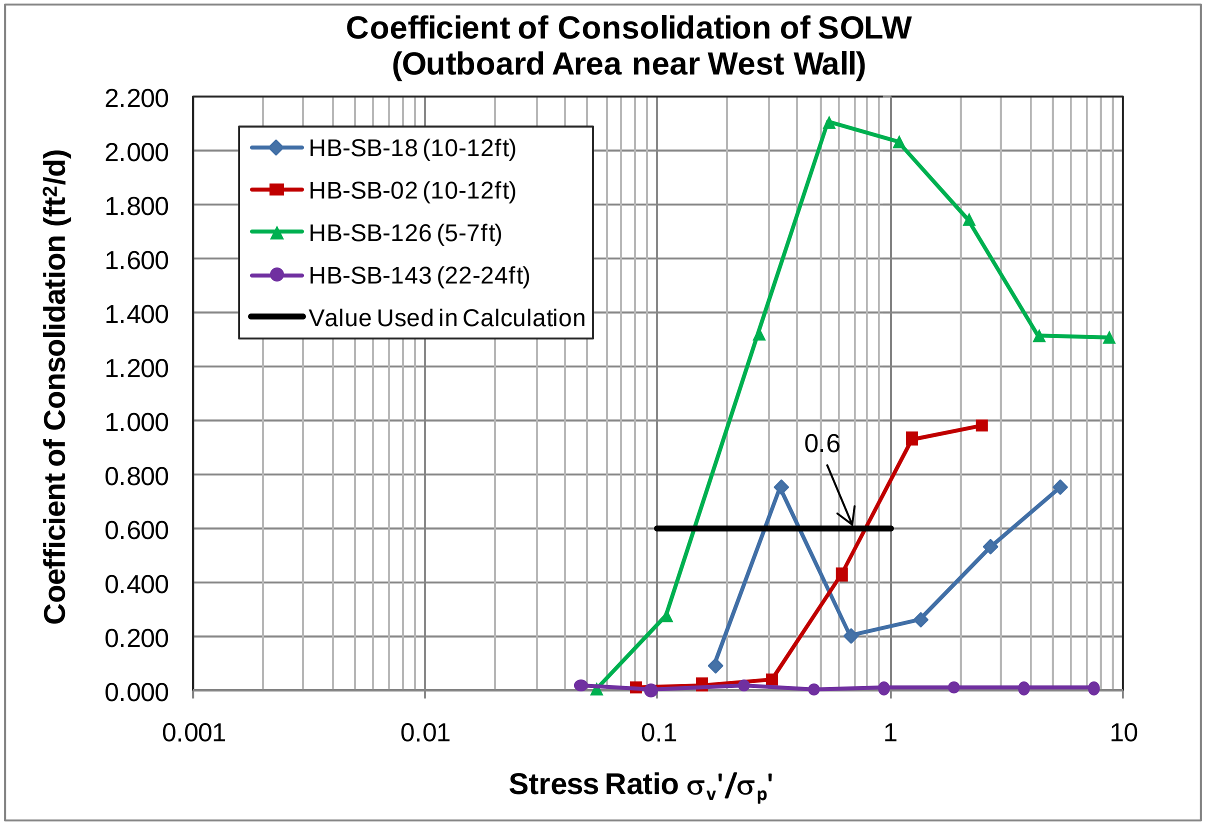



Figure B-2. Interpretation of Coefficient of Consolidation for SOLW
(Outboard Area near West Wall)

Note:
The ratio of $\sigma_v'/\sigma_p'$ 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.

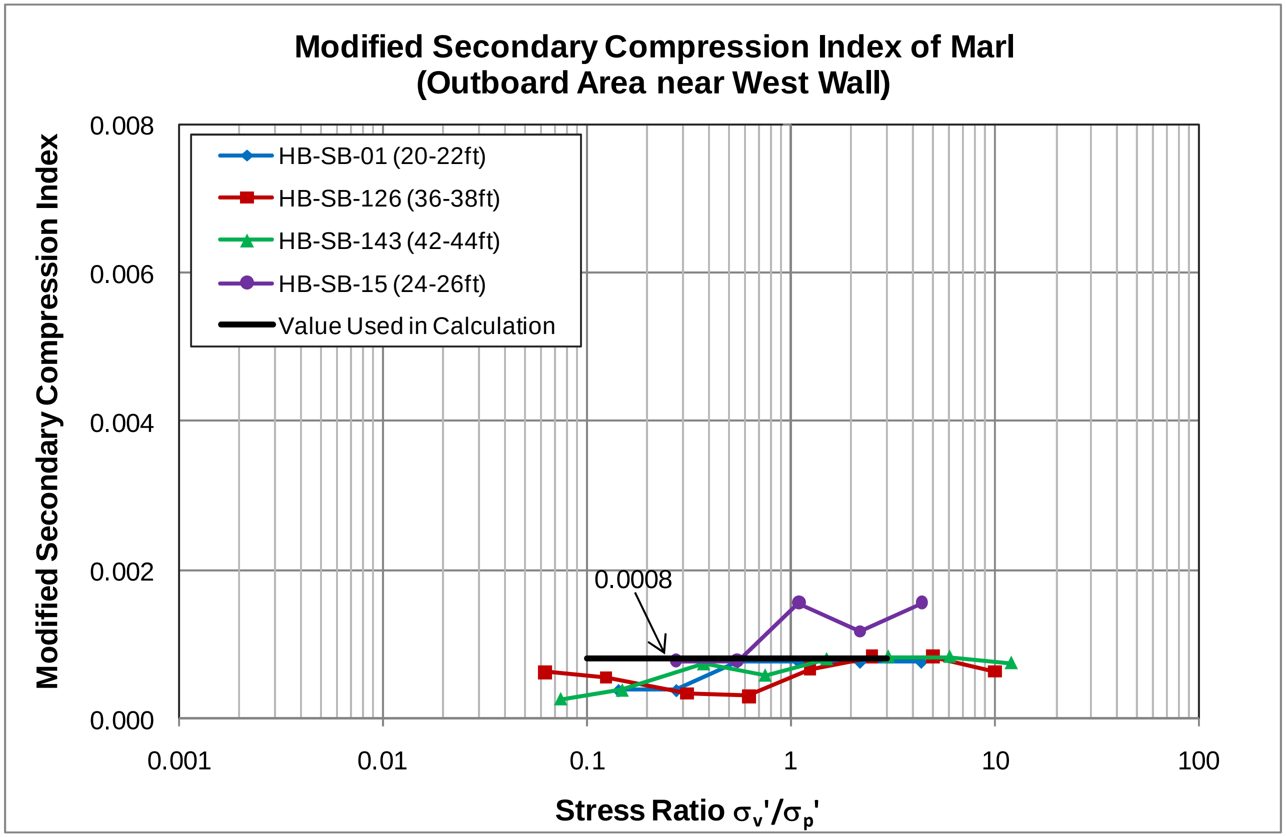



Figure B-3. Interpretation of Modified Secondary Compression Index for Marl
(Outboard Area near West Wall)

Note:
The ratio of $\sigma_v'/\sigma_p'$ 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.

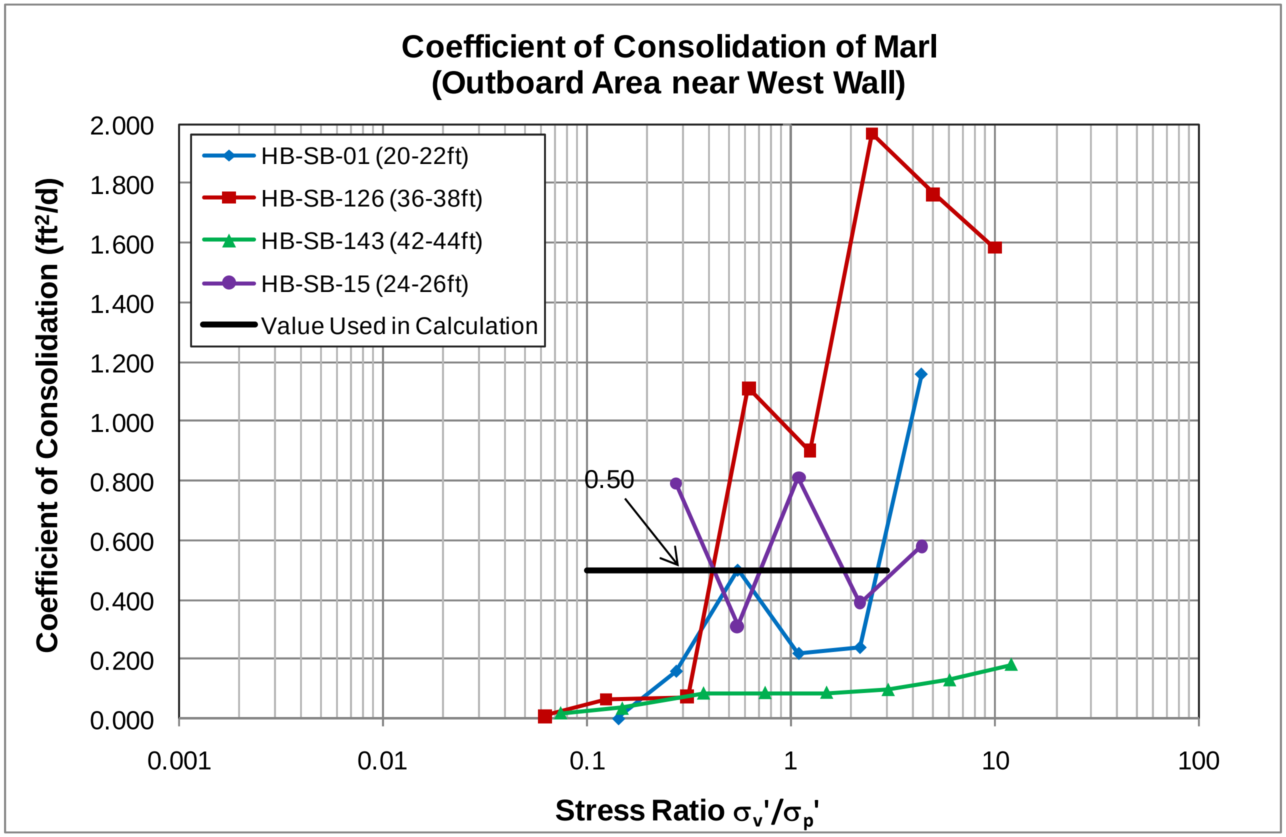



Figure B-4. Interpretation of Coefficient of Consolidation for Marl
(Outboard Area near West Wall)

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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.

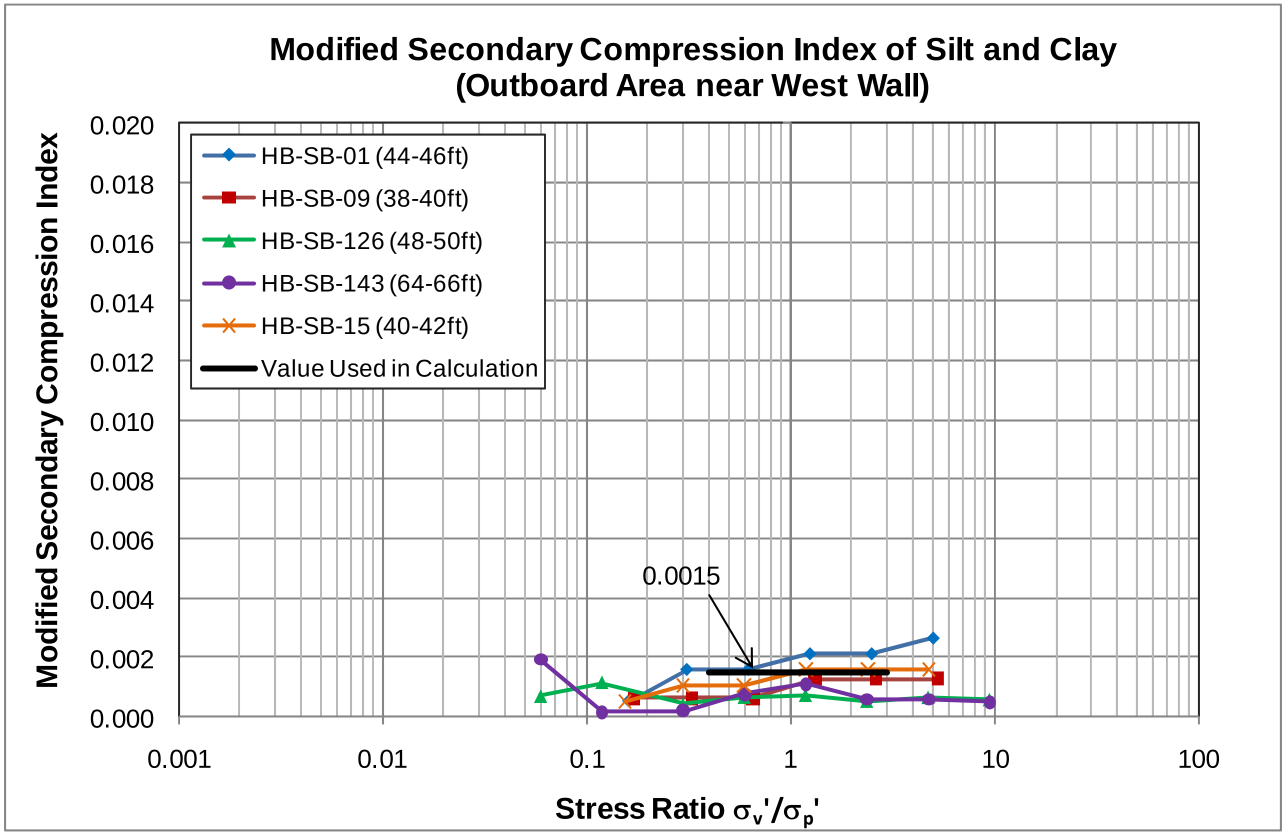



Figure B-5. Interpretation of Modified Secondary Compression Index for Silt and Clay (Outboard Area near West Wall)

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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.

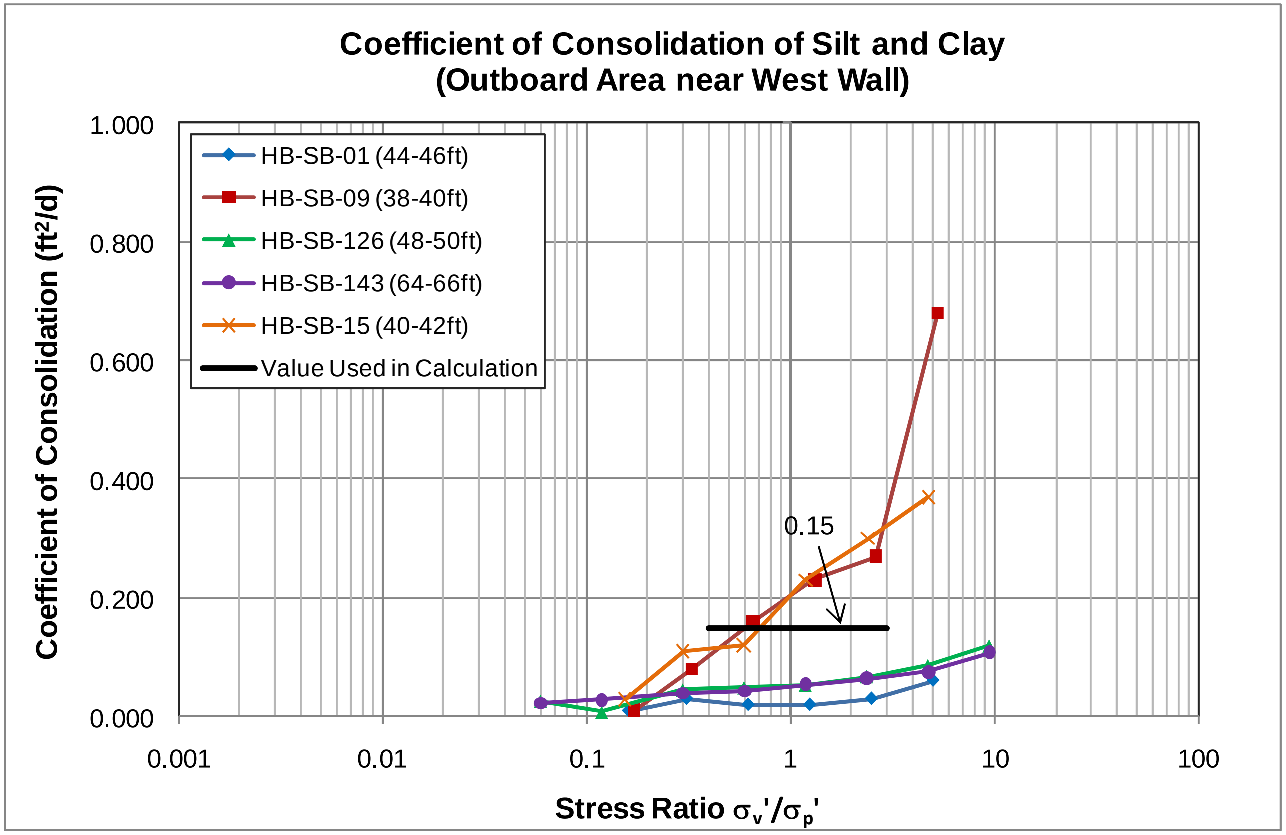



Figure B-6. Interpretation of Coefficient of Consolidation for Silt and Clay
(Outboard Area near West Wall)

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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.

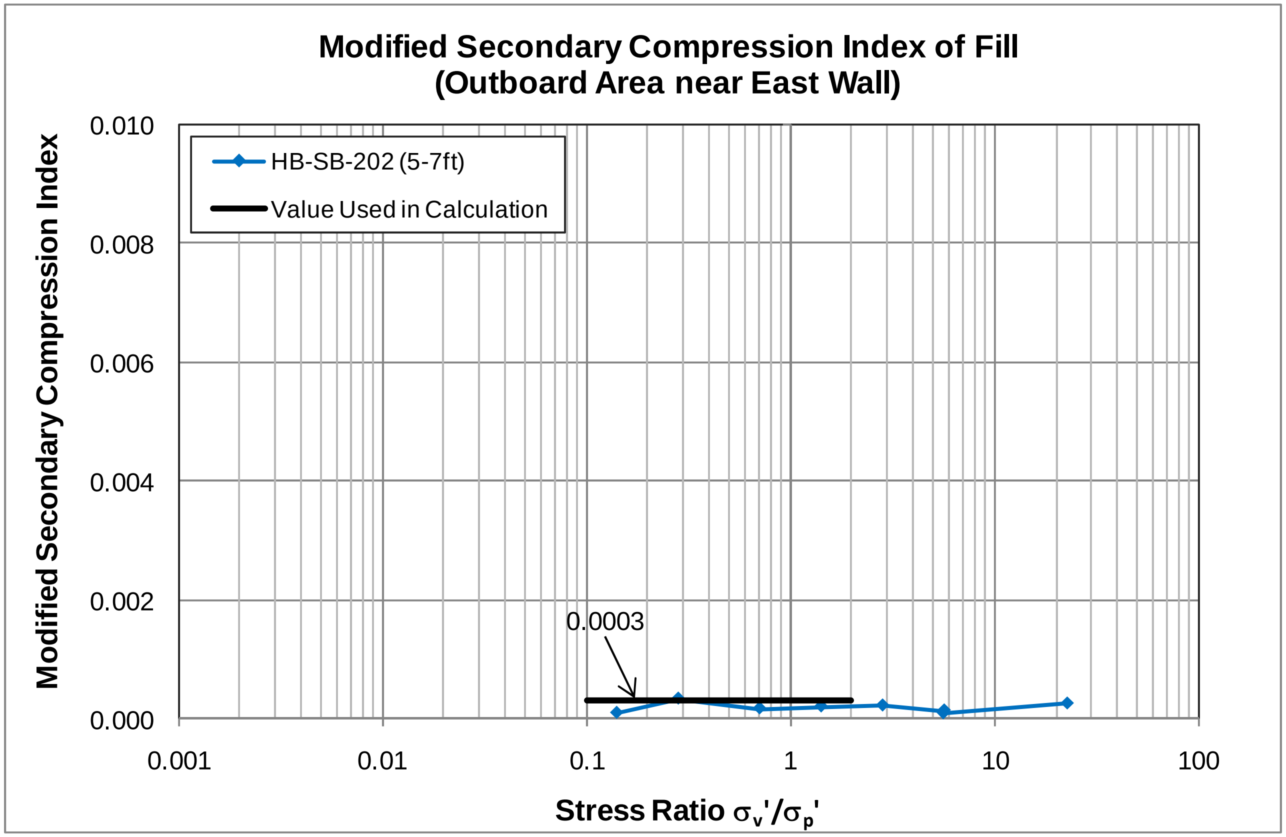



Figure B-7. Interpretation of Modified Secondary Compression Index for Fill
(Outboard Area near East Wall)

Note:
The ratio of $\sigma_v'/\sigma_p'$ 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.

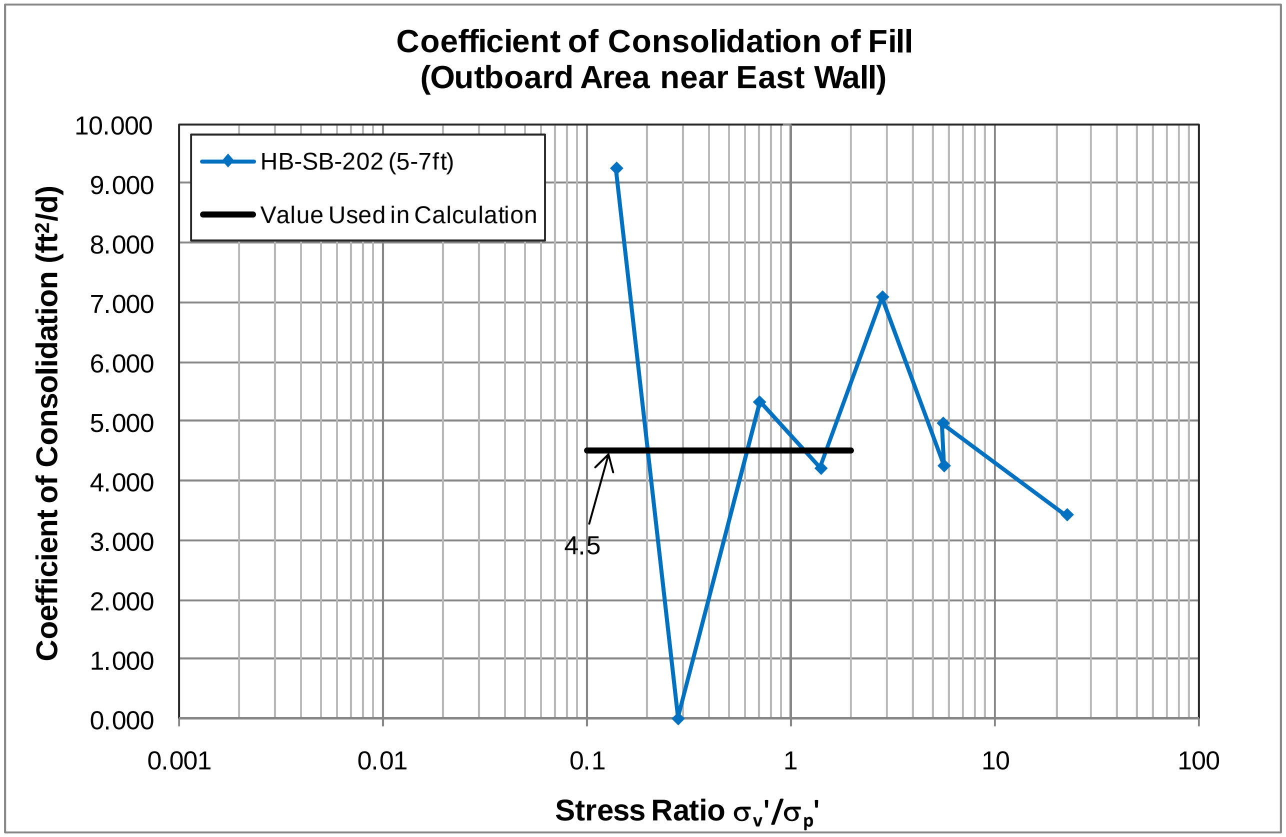


Figure B-8. Interpretation of Coefficient of Consolidation for Fill
(Outboard Area near East Wall)

Note:
The ratio of $\sigma_v'/\sigma_p'$ 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.

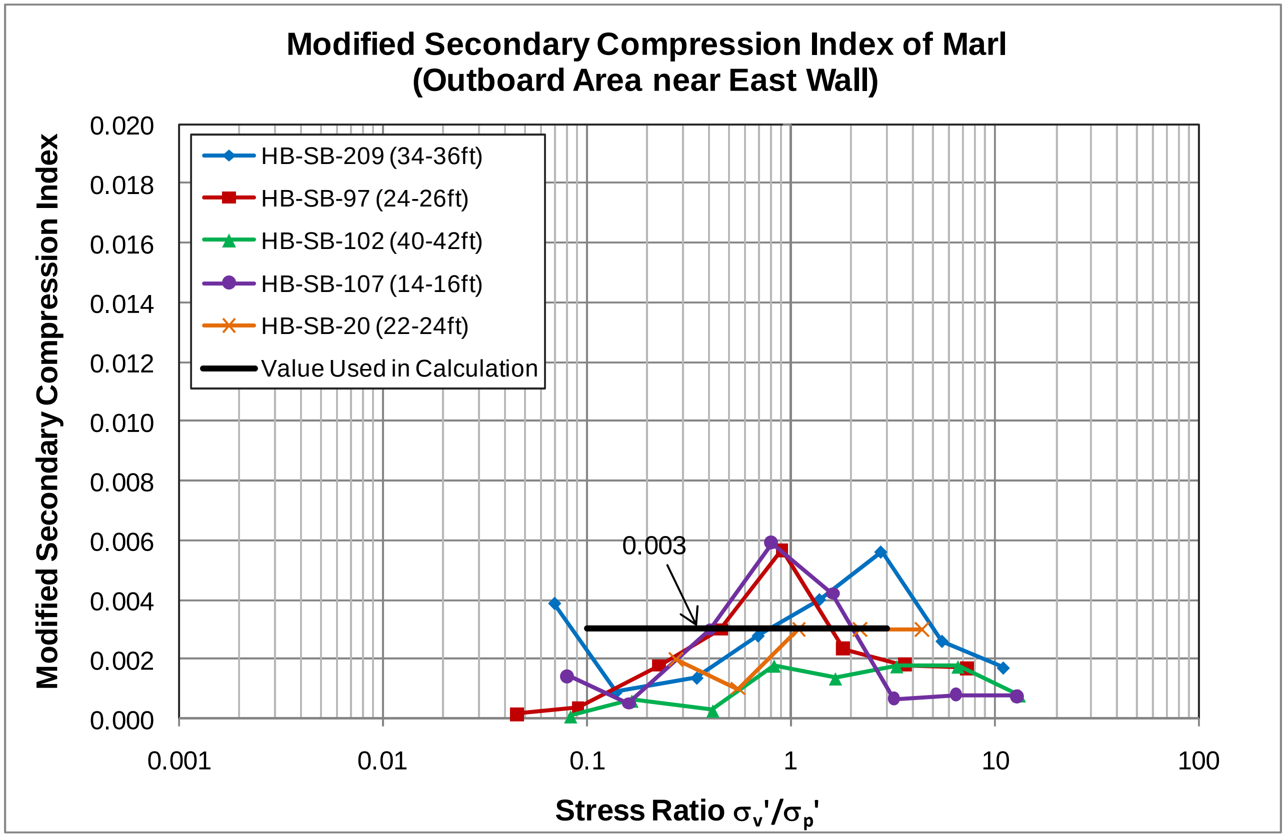



Figure B-9. Interpretation of Modified Secondary Compression Index for Marl (Outboard Area near East Wall)

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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.

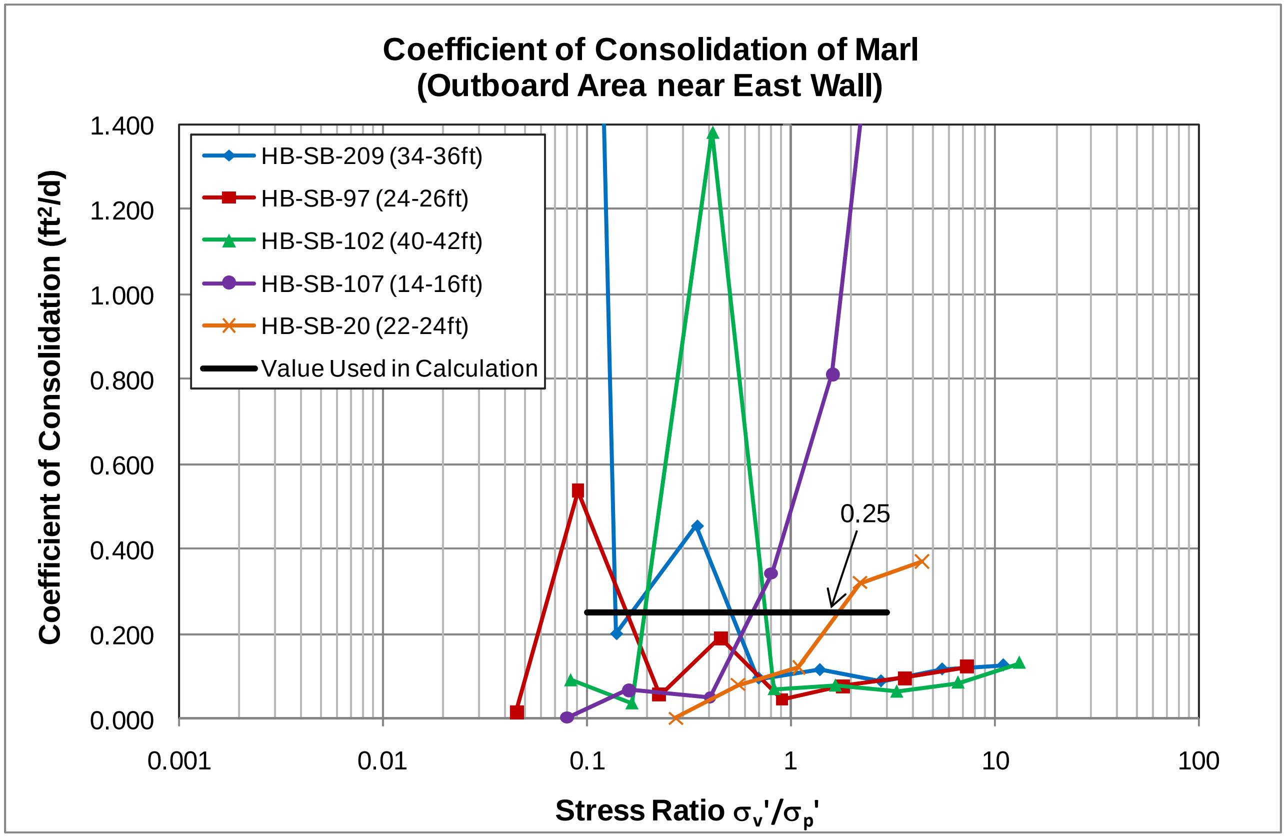



Figure B-10. Interpretation of Coefficient of Consolidation for Marl
(Outboard Area near East Wall)

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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.

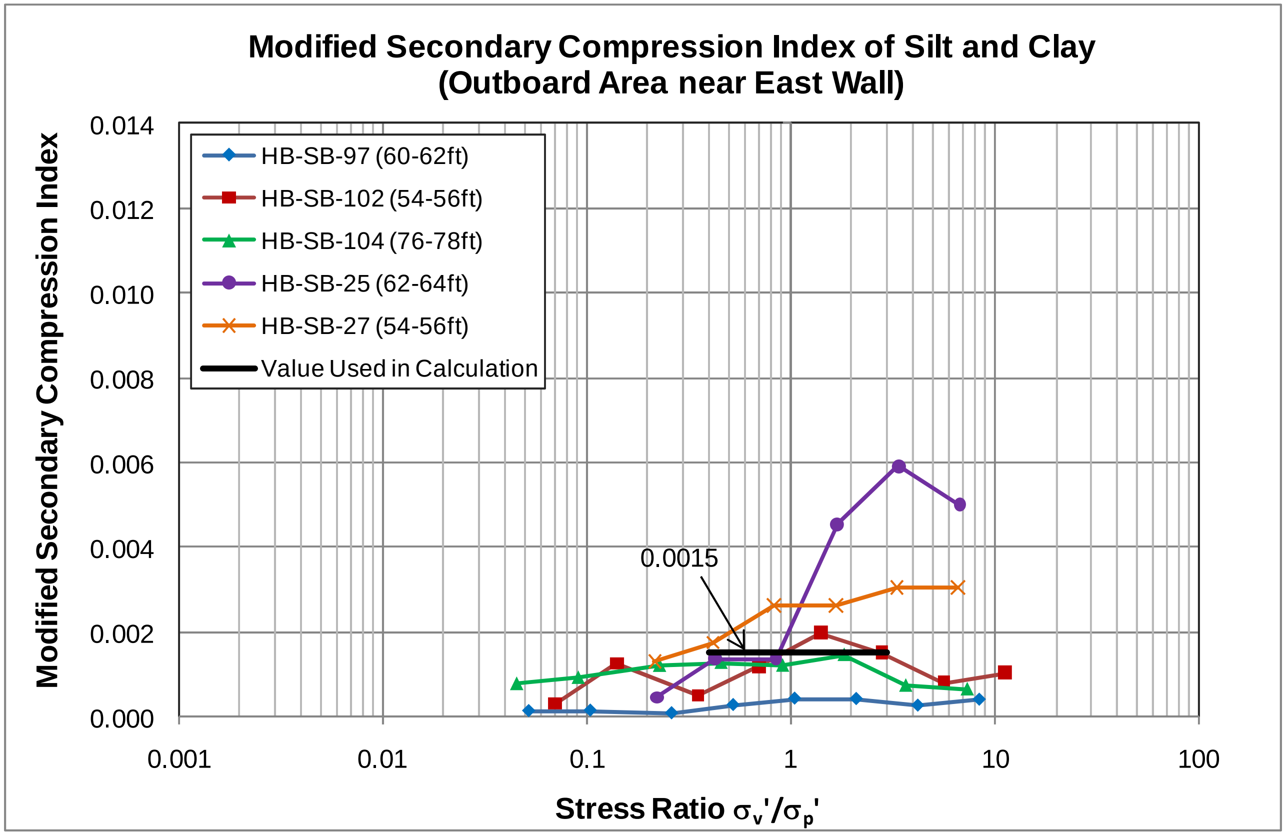



Figure B-11. Interpretation of Modified Secondary Compression Index for Silt and Clay (Outboard Area near East Wall)

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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.

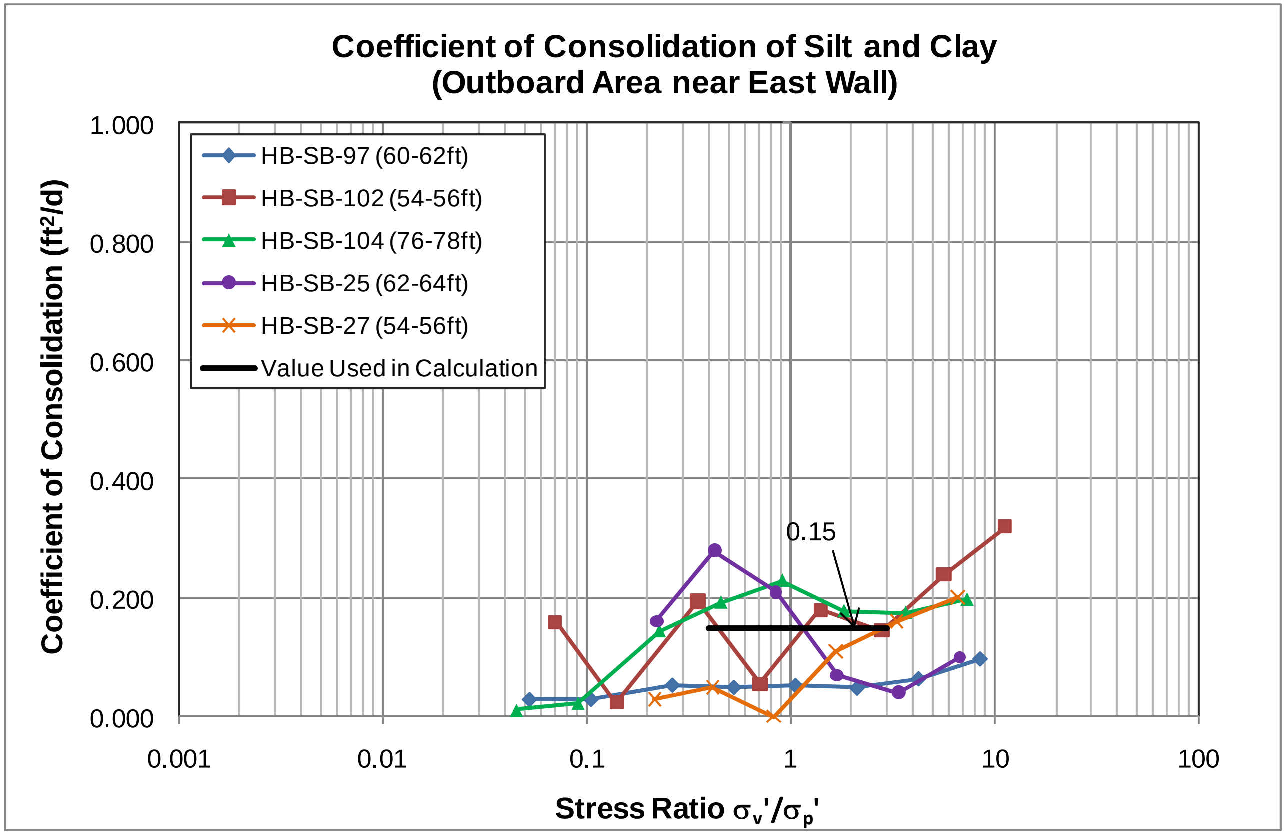



Figure B-12. Interpretation of Coefficient of Consolidation for Silt and Clay (Outboard Area near East Wall)

Note:

The ratio of $\sigma_v'/\sigma_p'$ 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 | $C_{c\varepsilon}$ | $C_{r\varepsilon}$ | $C_{\alpha}$ | 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. | 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. | 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. | 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 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 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 No. | 7 |
|---|---|---|---|
| Layer Thickness, m / ft | 1E-10 | Layer Thickness, m / ft | 1E-10 |
| Midpoint Depth from Removal Bot, m/ft | 6.5E-10 | Midpoint Depth from T. of SLOW/Removal Bot, m/ft | 6.5E-10 |
| Midpoint Depth from Ori Ground Surface, m/ft | 3 | Midpoint Depth from Ori Ground Surface, m/ft | 10 |
| Effective Stress Before Removal, KPa/psf | 151.2 | Effective Stress Before Removal, KPa/psf | 358.4 |
| Initial Effective Stress, KPa/psf | 1.924E-08 | Initial Effective Stress, KPa/psf | 207.2 |
| Final Effective Stress, KPa/psf | 105.6 | Final Effective Stress, KPa/psf | 562.4 |
| OCR | 2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 302.4 | 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) | 0.000 | Primary Settlement, (m / ft) | 0.000 |
| Secondary Settlement (m / ft) | 0.000 | Secondary Settlement (m / ft) | 0.000 |
| Total Settlement (m / ft) | 0.000 | Total Settlement (m / ft) | 0.000 |

| Layer No. | 8 | Layer No. | 8 |
|---|---|---|---|
| Layer Thickness, m / ft | 1E-10 | Layer Thickness, m / ft | 1E-10 |
| Midpoint Depth from Removal Bot, m/ft | 7.5E-10 | Midpoint Depth from T. of SLOW/Removal Bot, m/ft | 7.5E-10 |
| Midpoint Depth from Ori Ground Surface, m/ft | 3 | Midpoint Depth from Ori Ground Surface, m/ft | 10 |
| Effective Stress Before Removal, KPa/psf | 151.2 | Effective Stress Before Removal, KPa/psf | 358.4 |
| Initial Effective Stress, KPa/psf | 2.22E-08 | Initial Effective Stress, KPa/psf | 207.2 |
| Final Effective Stress, KPa/psf | 105.6 | Final Effective Stress, KPa/psf | 562.4 |
| OCR | 2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 302.4 | 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) | 0.000 | Primary Settlement, (m / ft) | 0.000 |
| Secondary Settlement (m / ft) | 0.000 | Secondary Settlement (m / ft) | 0.000 |
| Total Settlement (m / ft) | 0.000 | Total Settlement (m / ft) | 0.000 |

| Layer No. | 9 | Layer No. | 9 |
|---|---|---|---|
| Layer Thickness, m / ft | 1E-10 | Layer Thickness, m / ft | 1E-10 |
| Midpoint Depth from Removal Bot, m/ft | 8.5E-10 | Midpoint Depth from T. of SLOW/Removal Bot, m/ft | 8.5E-10 |
| Midpoint Depth from Ori Ground Surface, m/ft | 3 | Midpoint Depth from Ori Ground Surface, m/ft | 10 |
| Effective Stress Before Removal, KPa/psf | 151.2 | Effective Stress Before Removal, KPa/psf | 358.4 |
| Initial Effective Stress, KPa/psf | 2.516E-08 | Initial Effective Stress, KPa/psf | 207.2 |
| Final Effective Stress, KPa/psf | 105.6 | Final Effective Stress, KPa/psf | 562.4 |
| OCR | 2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 302.4 | 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) | 0.000 | Primary Settlement, (m / ft) | 0.000 |
| Secondary Settlement (m / ft) | 0.000 | Secondary Settlement (m / ft) | 0.000 |
| Total 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 No. | 13 |
| Layer Thickness, m / ft | 1E-10 | | Layer Thickness, m / ft | 1E-10 |
| Midpoint Depth from Removal Bot, m/ft | 1.25E-09 | | Midpoint Depth from T. of SLOW/Removal Bot, m/ft | 1.25E-09 |
| Midpoint Depth from Ori Ground Surface, m/ft | 3 | | Midpoint Depth from Ori Ground Surface, m/ft | 10 |
| Effective Stress Before Removal, KPa/psf | 151.2 | | Effective Stress Before Removal, KPa/psf | 358.4 |
| Initial Effective Stress, KPa/psf | 3.7E-08 | | Initial Effective Stress, KPa/psf | 207.2 |
| Final Effective Stress, KPa/psf | 105.6 | | Final Effective Stress, KPa/psf | 562.4 |
| OCR | 2 | | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 302.4 | | 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) | 0.000 | | Primary Settlement, (m / ft) | 0.000 |
| Secondary Settlement (m / ft) | 0.000 | | Secondary Settlement (m / ft) | 0.000 |
| Total Settlement (m / ft) | 0.000 | | Total Settlement (m / ft) | 0.000 |
| | | | | |
| Layer No. | 14 | | Layer No. | 14 |
| Layer Thickness, m / ft | 1E-10 | | Layer Thickness, m / ft | 1E-10 |
| Midpoint Depth from Removal Bot, m/ft | 1.35E-09 | | Midpoint Depth from T. of SLOW/Removal Bot, m/ft | 1.35E-09 |
| Midpoint Depth from Ori Ground Surface, m/ft | 3 | | Midpoint Depth from Ori Ground Surface, m/ft | 10 |
| Effective Stress Before Removal, KPa/psf | 151.2 | | Effective Stress Before Removal, KPa/psf | 358.4 |
| Initial Effective Stress, KPa/psf | 3.996E-08 | | Initial Effective Stress, KPa/psf | 207.2 |
| Final Effective Stress, KPa/psf | 105.6 | | Final Effective Stress, KPa/psf | 562.4 |
| OCR | 2 | | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 302.4 | | 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) | 0.000 | | Primary Settlement, (m / ft) | 0.000 |
| Secondary Settlement (m / ft) | 0.000 | | Secondary Settlement (m / ft) | 0.000 |
| Total Settlement (m / ft) | 0.000 | | Total Settlement (m / ft) | 0.000 |
| | | | | |
| Layer No. | 15 | | Layer No. | 15 |
| Layer Thickness, m / ft | 1E-10 | | Layer Thickness, m / ft | 1E-10 |
| Midpoint Depth from Removal Bot, m/ft | 1.45E-09 | | Midpoint Depth from T. of SLOW/Removal Bot, m/ft | 1.45E-09 |
| Midpoint Depth from Ori Ground Surface, m/ft | 3 | | Midpoint Depth from Ori Ground Surface, m/ft | 10 |
| Effective Stress Before Removal, KPa/psf | 151.2 | | Effective Stress Before Removal, KPa/psf | 358.4 |
| Initial Effective Stress, KPa/psf | 4.292E-08 | | Initial Effective Stress, KPa/psf | 207.2 |
| Final Effective Stress, KPa/psf | 105.6 | | Final Effective Stress, KPa/psf | 562.4 |
| OCR | 2 | | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 302.4 | | 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) | 0.000 | | Primary Settlement, (m / ft) | 0.000 |
| Secondary Settlement (m / ft) | 0.000 | | Secondary Settlement (m / ft) | 0.000 |
| Total 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 No. | 4 |
| Layer Thickness, m / ft | 2.5 | Layer Thickness, m / ft | 5 |
| Midpoint Depth from T. of Marl/Removal Bot, m/f | 8.75 | Midpoint Depth from T. of Silt/Clay, m/ft | 17.5 |
| Midpoint Depth from Ori Ground Surface, m/ft | 18.75 | Midpoint Depth from Ori Ground Surface, m/ft | 62.5 |
| Effective Stress Before Removal, KPa/psf | 661.15 | Effective Stress Before Removal, KPa/psf | 2419.9 |
| Initial Effective Stress, KPa/psf | 509.95 | Initial Effective Stress, KPa/psf | 2268.7 |
| Final Effective Stress, KPa/psf | 865.15 | Final Effective Stress, KPa/psf | 2623.9 |
| OCR | 1.2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 793.38 | Preconsolidation Pressure, KPa/psf | 2419.9 |
| 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) | 0.021 | Primary Settlement, (m / ft) | 0.024 |
| Secondary Settlement (m / ft) | 0.001 | Secondary Settlement (m / ft) | 0.001 |
| Total Settlement (m / ft) | 0.022 | Total Settlement (m / ft) | 0.026 |
| | | | |
| Layer No. | 5 | Layer No. | 5 |
| Layer Thickness, m / ft | 2.5 | Layer Thickness, m / ft | 5 |
| Midpoint Depth from T. of Marl/Removal Bot, m/f | 11.25 | Midpoint Depth from T. of Silt/Clay, m/ft | 22.5 |
| Midpoint Depth from Ori Ground Surface, m/ft | 21.25 | Midpoint Depth from Ori Ground Surface, m/ft | 67.5 |
| Effective Stress Before Removal, KPa/psf | 747.65 | Effective Stress Before Removal, KPa/psf | 2662.9 |
| Initial Effective Stress, KPa/psf | 596.45 | Initial Effective Stress, KPa/psf | 2511.7 |
| Final Effective Stress, KPa/psf | 951.65 | Final Effective Stress, KPa/psf | 2866.9 |
| OCR | 1.2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 897.18 | Preconsolidation Pressure, KPa/psf | 2662.9 |
| 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) | 0.016 | Primary Settlement, (m / ft) | 0.022 |
| Secondary Settlement (m / ft) | 0.001 | Secondary Settlement (m / ft) | 0.001 |
| Total Settlement (m / ft) | 0.017 | Total Settlement (m / ft) | 0.023 |
| | | | |
| Layer No. | 6 | Layer No. | 6 |
| Layer Thickness, m / ft | 2.5 | Layer Thickness, m / ft | 5 |
| Midpoint Depth from T. of Marl/Removal Bot, m/f | 13.75 | Midpoint Depth from T. of Silt/Clay, m/ft | 27.5 |
| Midpoint Depth from Ori Ground Surface, m/ft | 23.75 | Midpoint Depth from Ori Ground Surface, m/ft | 72.5 |
| Effective Stress Before Removal, KPa/psf | 834.15 | Effective Stress Before Removal, KPa/psf | 2905.9 |
| Initial Effective Stress, KPa/psf | 682.95 | Initial Effective Stress, KPa/psf | 2754.7 |
| Final Effective Stress, KPa/psf | 1038.15 | Final Effective Stress, KPa/psf | 3109.9 |
| OCR | 1.2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1000.98 | Preconsolidation Pressure, KPa/psf | 2905.9 |
| 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) | 0.011 | Primary Settlement, (m / ft) | 0.021 |
| Secondary Settlement (m / ft) | 0.001 | Secondary Settlement (m / ft) | 0.001 |
| Total Settlement (m / ft) | 0.012 | 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 No. | 10 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.5 | Layer Thickness, m / ft | 5 |
| Midpoint Depth from T. of Marl/Removal Bot, m/f | 23.75 | Midpoint Depth from T. of Silt/Clay, m/ft | 47.5 |
| Midpoint Depth from Ori Ground Surface, m/ft | 33.75 | Midpoint Depth from Ori Ground Surface, m/ft | 92.5 |
| Effective Stress Before Removal, KPa/psf | 1180.15 | Effective Stress Before Removal, KPa/psf | 3877.9 |
| Initial Effective Stress, KPa/psf | 1028.95 | Initial Effective Stress, KPa/psf | 3726.7 |
| Final Effective Stress, KPa/psf | 1384.15 | Final Effective Stress, KPa/psf | 4081.9 |
| OCR | 1.2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1416.18 | Preconsolidation Pressure, KPa/psf | 3877.9 |
| 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) | 0.003 | Primary Settlement, (m / ft) | 0.015 |
| Secondary Settlement (m / ft) | 0.001 | Secondary Settlement (m / ft) | 0.001 |
| Total Settlement (m / ft) | 0.004 | Total Settlement (m / ft) | 0.017 |

| Layer No. | 11 | Layer No. | 11 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.5 | Layer Thickness, m / ft | 5 |
| Midpoint Depth from T. of Marl/Removal Bot, m/f | 26.25 | Midpoint Depth from T. of Silt/Clay, m/ft | 52.5 |
| Midpoint Depth from Ori Ground Surface, m/ft | 36.25 | Midpoint Depth from Ori Ground Surface, m/ft | 97.5 |
| Effective Stress Before Removal, KPa/psf | 1266.65 | Effective Stress Before Removal, KPa/psf | 4120.9 |
| Initial Effective Stress, KPa/psf | 1115.45 | Initial Effective Stress, KPa/psf | 3969.7 |
| Final Effective Stress, KPa/psf | 1470.65 | Final Effective Stress, KPa/psf | 4324.9 |
| OCR | 1.2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1519.98 | Preconsolidation Pressure, KPa/psf | 4120.9 |
| 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) | 0.003 | Primary Settlement, (m / ft) | 0.015 |
| Secondary Settlement (m / ft) | 0.001 | Secondary Settlement (m / ft) | 0.001 |
| Total Settlement (m / ft) | 0.004 | Total Settlement (m / ft) | 0.016 |

| Layer No. | 12 | Layer No. | 12 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.5 | Layer Thickness, m / ft | 5 |
| Midpoint Depth from T. of Marl/Removal Bot, m/f | 28.75 | Midpoint Depth from T. of Silt/Clay, m/ft | 57.5 |
| Midpoint Depth from Ori Ground Surface, m/ft | 38.75 | Midpoint Depth from Ori Ground Surface, m/ft | 102.5 |
| Effective Stress Before Removal, KPa/psf | 1353.15 | Effective Stress Before Removal, KPa/psf | 4363.9 |
| Initial Effective Stress, KPa/psf | 1201.95 | Initial Effective Stress, KPa/psf | 4212.7 |
| Final Effective Stress, KPa/psf | 1557.15 | Final Effective Stress, KPa/psf | 4567.9 |
| OCR | 1.2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1623.78 | Preconsolidation Pressure, KPa/psf | 4363.9 |
| 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) | 0.003 | Primary Settlement, (m / ft) | 0.014 |
| Secondary Settlement (m / ft) | 0.001 | Secondary Settlement (m / ft) | 0.001 |
| Total Settlement (m / ft) | 0.004 | Total Settlement (m / ft) | 0.015 |

| Layer No. | 13 | Layer No. | 13 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.5 | Layer Thickness, m / ft | 1E-10 |
| Midpoint Depth from T. of Marl/Removal Bot, m/f | 31.25 | Midpoint Depth from T. of Silt/Clay, m/ft | 1.25E-09 |
| Midpoint Depth from Ori Ground Surface, m/ft | 41.25 | Midpoint Depth from Ori Ground Surface, m/ft | 45 |
| Effective Stress Before Removal, KPa/psf | 1439.65 | Effective Stress Before Removal, KPa/psf | 1569.4 |
| Initial Effective Stress, KPa/psf | 1288.45 | Initial Effective Stress, KPa/psf | 1418.2 |
| Final Effective Stress, KPa/psf | 1643.65 | Final Effective Stress, KPa/psf | 1773.4 |
| OCR | 1.2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1727.58 | Preconsolidation Pressure, KPa/psf | 1569.4 |
| 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) | 0.003 | Primary Settlement, (m / ft) | 0.000 |
| Secondary Settlement (m / ft) | 0.001 | Secondary Settlement (m / ft) | 0.000 |
| Total Settlement (m / ft) | 0.004 | Total Settlement (m / ft) | 0.000 |

| Layer No. | 14 | Layer No. | 14 |
|---|---|---|---|
| Layer Thickness, m / ft | 2.5 | Layer Thickness, m / ft | 1E-10 |
| Midpoint Depth from T. of Marl/Removal Bot, m/f | 33.75 | Midpoint Depth from T. of Silt/Clay, m/ft | 1.35E-09 |
| Midpoint Depth from Ori Ground Surface, m/ft | 43.75 | Midpoint Depth from Ori Ground Surface, m/ft | 45 |
| Effective Stress Before Removal, KPa/psf | 1526.15 | Effective Stress Before Removal, KPa/psf | 1569.4 |
| Initial Effective Stress, KPa/psf | 1374.95 | Initial Effective Stress, KPa/psf | 1418.2 |
| Final Effective Stress, KPa/psf | 1730.15 | Final Effective Stress, KPa/psf | 1773.4 |
| OCR | 1.2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 1831.38 | Preconsolidation Pressure, KPa/psf | 1569.4 |
| 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) | 0.002 | Primary Settlement, (m / ft) | 0.000 |
| Secondary Settlement (m / ft) | 0.001 | Secondary Settlement (m / ft) | 0.000 |
| Total Settlement (m / ft) | 0.004 | Total Settlement (m / ft) | 0.000 |

| Layer No. | 15 | Layer No. | 15 |
|---|---|---|---|
| Layer Thickness, m / ft | 1E-10 | Layer Thickness, m / ft | 1E-10 |
| Midpoint Depth from T. of Marl/Removal Bot, m/f | 1.45E-09 | Midpoint Depth from T. of Silt/Clay, m/ft | 1.45E-09 |
| Midpoint Depth from Ori Ground Surface, m/ft | 10 | Midpoint Depth from Ori Ground Surface, m/ft | 45 |
| Effective Stress Before Removal, KPa/psf | 358.4 | Effective Stress Before Removal, KPa/psf | 1569.4 |
| Initial Effective Stress, KPa/psf | 207.2 | Initial Effective Stress, KPa/psf | 1418.2 |
| Final Effective Stress, KPa/psf | 562.4 | Final Effective Stress, KPa/psf | 1773.4 |
| OCR | 1.2 | OCR | 1 |
| Preconsolidation Pressure, KPa/psf | 430.08 | Preconsolidation Pressure, KPa/psf | 1569.4 |
| 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) | 0.000 | Primary Settlement, (m / ft) | 0.000 |
| Secondary Settlement (m / ft) | 0.000 | Secondary Settlement (m / ft) | 0.000 |
| Total Settlement (m / ft) | 0.000 | Total Settlement (m / ft) | 0.000 |