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CAP-INDUCED SETTLEMENT EVALUATION

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ONONDAGA LAKE

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
ASTM	American Society of Testing and Materials
FS	Feasibility Study
IDS	Initial Design Submittal
Lake	Onondaga Lake
pcf	pounds per cubic foot
PDI	Pre-Design Investigations
ROD	Record of Decision
SIC	seepage-induced consolidation

1 INTRODUCTION

This memorandum presents an estimate of the amount of consolidation settlement anticipated after placement of capping materials in portions of Onondaga Lake (Lake) (Figure 1). For the purposes of this evaluation, primary and secondary compression settlement was predicted based on the results of consolidation testing performed as part of the Onondaga Lake Pre-Design Investigations (PDI).

The areas evaluated in this memorandum include Remediation Areas A, B, C, and E. Capping is also anticipated in Remediation Area D. Settlement estimates for Remediation Area D (the In-Lake Waste Deposit) are presented in a separate memorandum (Geosyntec 2009).

In each of the Remediation Areas evaluated, the remedial action selected in the Record of Decision [ROD] includes subaqueous capping, either as a stand-alone remedy or following initial dredging. The basis of design for the limits and extents of the remedial actions are detailed in the Capping and Dredge Area and Depth Initial Design Submittal (IDS) and presented on Figure 1.

The remainder of this memorandum is organized as follows:

- Section 2 – Subsurface Conditions
- Section 3 – Sediment Properties
- Section 4 – Settlement Analysis
- Section 5 – Conclusions
- Figures (see List of Figures)
- Attachment A – Consolidation Test Data Summary
- Attachment B – Example Settlement Calculation
- Attachment C – Summary of Modeling Inputs and Results

2 SUBSURFACE CONDITIONS

The subsurface conditions used for this analysis in Remediation Areas A, B, C, and E were based on a review of exploration logs from geotechnical borings and vibracores conducted as part of the PDI, as well as historical explorations by others. In general, representative stratigraphic cross-sections were developed for each Remediation Area (including multiple sections per area, where appropriate) to depict the general subsurface sediment profile. The separations between stratigraphic layers depicted on these cross-sections have been estimated based on visual observations denoted on exploration logs and on index tests performed in the laboratory. These separations are not intended to represent distinct transitions between layers because sediment types and properties often gradually grade from one layer to another in a natural deposit.

The subsurface conditions for each Remediation Area are generally described below and are depicted on Figures 3, 4, 5, 7, 8, 10, 11, 12, 14, 15, and 16. In addition, Attachment C provides a summary of the idealized subsurface stratification assumed for each settlement analysis case. Explorations advanced indicate a layer containing granular material (e.g. sand and/or gravel) is present at depth in most of the Remediation Areas. Although the spatial density of explorations penetrating to these depths is not sufficient to determine with certainty whether the sand layers are continuous across the entire site, they have been observed with enough frequency to be accounted for in assessing the drainage paths during the consolidation analysis, as discussed below. The presence (or absence) of these granular layers has an effect on the time rate of consolidation, but not on the magnitude of settlement.

Remediation Area A: Figure 2 presents the locations of explorations advanced within Remediation Area A. Three cross-sections, depicted on Figures 3 (A-A'), 4 (B-B'), and 5 (C-C'), were developed to illustrate the subsurface stratigraphy in Remediation Area A. The generalized subsurface profile consists primarily of a surface layer of gray silt with little clay, fine sand, and calcareous material. The gray silt layer is underlain by sand which is interbedded with clay in some areas, although this deeper stratum was only observed in some of the deeper nearshore explorations (e.g., 40002, 40003, 40033, and 40036) and one offshore exploration that penetrated deep enough (S305). The thickness

of the silt layer appears to be greatest towards shore, at approximately 35 to 40 feet, and thins offshore to approximately 20 feet thick. In the immediate nearshore region on the eastern side of Remediation Area A, a surficial deposit of sand with some silt was observed overlying the silt layer to a depth of approximately 15 feet (see Figures 3 [A-A'] and 5 [C-C']). This sand deposit was underlain by the gray silt layer, followed by the clay and interbedded sand layer observed elsewhere in Remediation Area A, as described above. Although not observed in explorations in the western half of Remediation Area A, it is assumed that the sand drainage layer observed in the eastern half (40002, 40003, S305, etc.) is also present at deeper depths than sampled in the western half. The presence of interbedded sand layers in the deeper strata is expected to serve as a drainage layer below the overlying consolidating silt layer (i.e., the silt layer will be doubly drained).

Remediation Area B: Figure 6 presents the locations of explorations advanced within Remediation Area B. Two cross-sections illustrating the stratigraphy in Remediation Area B are presented on Figures 7 (D-D') and 8 (E-E'). The generalized subsurface profile consists of a surface layer of Solvay waste ranging in thickness from approximately 5 feet nearshore and far offshore to more than 25 feet in the central portions (e.g., halfway between shore and the offshore limit) of Remediation Area B. The Solvay waste layer is underlain by a layer of silt and clay (Marl). The Marl layer was estimated to be approximately 25 feet thick based on a deep exploration (30033). This exploration also indicated that the Marl was underlain by an approximately 11-foot-thick layer of clay, followed by a silt and fine sand layer (approximately 60 to 70 feet below the mudline) that is expected to act as a subsurface drainage layer (i.e., consolidation of overlying layers would be doubly drained).

Remediation Area C: The assumed subsurface conditions in Remediation Area C are based primarily on borings and cores advanced within the eastern portion of Remediation Area C, as well as two deep borings (20016 and 20017) advanced along the shoreline of Remediation Area C but outside of the proposed capping area (see Figure 9). A deep

boring from Remediation Area B (30003) was used to create the subsurface profile for the westernmost cross-section of Remediation Area C. The generalized soil profiles for Remediation Area C are presented on Figures 10 (F-F'), 11 (G-G'), and 12 (H-H'). The generalized soil profile consists of a 10- to 20-foot-thick layer of black silt overlying soft to stiff brown and gray clay (Marl) extending to approximately 55 to 65 feet below the mudline. Occasional deposits of Solvay waste, ranging from 5 to 20 feet thick, were observed above the Marl and within the black silt layer. Below the Marl deposit, a layer of sand was observed in the three deep borings (20016, 20017, and 30003). This sand material is assumed to not undergo significant consolidation and will serve as a drainage layer below the overlying consolidating layers (i.e., the overlying layers will be doubly drained). In a few nearshore borings, the surficial silt layer contained a significant fraction of sand-sized particles, contributing to a lighter brown color.

Remediation Area E: Figure 13 presents the locations of explorations advanced within Remediation Area E. Three cross-sections, depicted on Figures 14 (I-I'), 15 (J-J'), and 16 (K-K'), were developed to illustrate the subsurface stratigraphy in Remediation Area E. The generalized subsurface profile includes a surficial layer approximately 10- to 20-feet-thick, consisting of fine to medium sand in the nearshore region, which grades to black silt with decreasing amounts of fine sand with distance from shore. The thickness of the sand layer was observed to decrease with distance from shore and grades from primarily sand in the most nearshore explorations to silt with some fine sand, and then eventually to just silt in the offshore portion of Remediation Area E.

Beneath the surficial layer of silt and fine sand is a layer of organic silt and clay that extends to the bottom of most explorations conducted within Remediation Area E (approximately 30 to 40 feet below the mudline). This organic silt layer appears consistent with the lacustrine (natural lake sediments) deposit noted on two historic deep boring logs from Remediation Area D (B-76-1 and B-76-2 – not shown on Figures) and a deep historic boring (TH-305) on the shoreline of Remediation Area E completed for the design of the sewage treatment plant. In boring TH-305, the lacustrine deposit was observed to extend to approximately 130 feet below the shoreline elevation, with

underlying sandy silt. Given that the ground surface near this boring is approximately 20 feet higher than the average mudline within the Lake in Remediation Area E, the depth to the underlying silt and sand layer, which is expected to serve as a subsurface drainage layer (i.e., doubly drained), was assumed to be approximately 110 feet in the eastern portion of Remediation Area E. Based on deep borings advanced in Remediation Area D, the lacustrine deposit on the western side of Remediation Area E (bordering Remediation Area D; see Section I-I' Figure 14) was assumed to extend between approximately 100 and 150 feet below the mudline before transitioning to underlying glacial soils. However, since the underlying glacial soils were described as clay and silt on the historic boring logs, this layer was not assumed to provide for drainage on the western side of Remediation Area E. These assumptions for thickness of the lacustrine deposit are expected to be conservative relative to the time rate of settlement, which is highly dependent on the drainage distance for porewater expelled during consolidation. Therefore, the durations predicted for settlement to occur in Remediation Area E may be overestimated, as discussed in Table 1.

In the western portion of Remediation Area E (along the boundary with Remediation Area D), a thin (approximately 3 feet thick) surficial layer of very soft organic silt overlies the soil profile described above (see Section I-I' on Figure 14).

Several explorations were completed during the PDI in the immediate vicinity of the mouth of Onondaga Creek. It is expected that the near-surface (approximately to 10 feet) sediment conditions at this location may not be representative of other portions of the Remediation Area given the likely increased sedimentation from Onondaga Creek; therefore, these near-surface sediment characteristics were not included in the settlement estimates presented here.

3 SEDIMENT PROPERTIES

The geotechnical properties of the sediments used in this analysis were based on the results of relevant PDI sampling available to date (i.e., through Phase IV). In general, the Lake is considered a net depositional area, and therefore has likely not undergone any significant erosion which could contribute to over-consolidation of the surface sediments. In addition, there is no evidence to suggest that lake levels have been significantly lower in the recent past, subjecting the sediments to higher effective stress or event air-drying (i.e., desiccation), which could also result in the surface sediment becoming over-consolidated. Based on these observations, the surface sediments in most areas of the Lake are expected to be normally consolidated. The exception to this is the Solvay waste deposits, which are in an overconsolidated condition from the presence of an "apparent" pre-consolidation pressure (Geosyntec 2009).

The unit weight of the sediments was either measured in the laboratory or derived from measurements of moisture content and specific gravity on numerous samples collected within each Remediation Area. In general, the bulk density of the natural organic silt sediments ranges from approximately 80 to 90 pounds per cubic foot (pcf) near the surface to approximately 105 to 110 pcf at depth (30 to 50 feet below the mudline). Furthermore, the typical unit weight of the lacustrine deposits (deeper silt and clay layers; Marl) is approximately 96 to 102 pcf. These data indicate considerably higher unit weights than assumed during previous settlement analyses presented in the Feasibility Study (FS), where the unit weight of the organic silt was assumed to range from 74 to 81 pcf. This difference translates into smaller settlement estimates because settlement is a function of the increase in stress due to capping relative to the existing stress. With higher unit weights, the existing stress is larger and therefore the ratio of increased stress to existing stress is smaller.

The consolidation characteristics of the sediments were based on the results of numerous consolidation tests performed on samples collected during the PDI, including traditional oedometer tests (in accordance with American Society for Testing and Materials [ASTM] Method D2435) conducted on samples from Remediation Areas B, C, and D, as well as numerous seepage-induced consolidation (SIC) tests conducted on samples from all Remediation Areas.

Oedometer test samples were collected from sample intervals ranging from 10 feet to nearly 50 feet below the mudline representing the major geologic strata in Remediation Areas B and C (primarily silt, clay, and Marl). Attachment A provides a complete summary of the consolidation test results and index properties for the oedometer test samples.

The sample selection process for SIC testing included a review of index properties for a given stratum followed by establishing the range of characteristics that would be representative of that stratum. SIC testing was performed on samples collected from all major geologic strata including Solvay waste, silt, Marl, clay, and silt/sand ranging in depth from surface (beginning at mudline) to 20 feet below the mudline. Finally, samples were selected for testing to represent the range of index properties within each stratum. Attachment A contains a summary of the oedometer and SIC consolidation test results along with index test results for each sample.

The ranges of cases analyzed in the settlement evaluation presented herein included both SIC and oedometer test data from the various strata. Neither the SIC or oedometer test is preferred over the other; each test has its advantages and applicability to certain sediment conditions and sampling techniques. One advantage of the SIC test (compared to the conventional oedometer test) is the ability to apply relatively small loads in a controlled manner to very soft sediments. The SIC also provides a mathematical equation describing the consolidation characteristics (void ratio and permeability) as a function of stress. In addition, disturbed samples collected from vibracore samples can be used for SIC testing since all samples are homogenized and processed into a slurry prior to testing, whereas conventional oedometer tests are typically conducted on an undisturbed sample collected using a Shelby tube. However, the SIC test does not allow for determination of the pre-consolidation pressure, which can be used to asses the consolidation state (e.g. normally consolidated vs. overconsolidated), since the initial sample is disturbed. The conventional oedometer can be used for this purpose.

The results of the standard oedometer test can be interpreted to determine the compressibility characteristics of the sample, as follows:

$$C_c = \frac{e_1 - e_2}{\log \sigma'_2 - \log \sigma'_1} \tag{3-1}$$

where:

C_c = compression index

e = void ratio

σ' = effective stress

The SIC test is used to develop a relationship between effective stress, void ratio, and permeability through a set of parameters (A, B, C, D, and Z) that define the compressibility and hydraulic conductivity of the sediments given by the following expressions:

Compressibility: $e = A\,(\sigma' + Z)^B$ (3-2)

Hydraulic Conductivity: $k = C\,e^D$ (3-3)

where:

e = void ratio

σ' = effective stress

k = hydraulic conductivity

A, B, C, D, and Z = coefficients determined through the SIC test; dependent on the system of units and presented in Attachment A for SI units

The properties of the cap materials were selected based on typical sand and gravel soils placed using either mechanical or hydraulic techniques. An in situ porosity of 40 percent was assumed for sand and gravel with a specific gravity of 2.65. With these assumptions, the total unit weight of the cap materials was assumed to be approximately 120 pcf.

4 SETTLEMENT ANALYSIS

The compressibility and hydraulic conductivity relationships defined above were used to estimate the amount and rate of primary consolidation expected after the placement of a subaqueous cap. For each Remediation Area and each habitat module within, the specific dredge depth and cap thickness defined in the Capping and Dredge Area and Depth IDS were utilized in the settlement calculations. Geotechnical index tests were used to estimate a secondary compression index for the site sediments, which was used in conjunction with the results of several representative primary consolidation analyses to generate an estimated range of secondary compression settlement (see Section 4.3).

4.1 Cap Induced Load Estimates

The change in stress (i.e., load) resulting from the remedial construction was estimated for each of the cases analyzed with consideration of the reduction in stress from the planned dredging and increase in stress resulting from the cap placement. In areas where dredging will be performed prior to cap placement, the reduction in stress on the subsurface sediments was calculated using the thickness of the dredge cut and the unit weight of the material to be dredged (ranging from approximately 80 to 110 pcf, depending on the material type). The increase in effective stress on the existing or post-dredge sediment surface resulting from the placement of the capping materials was computed using the thickness of the cap and the total unit weight of the capping materials (assumed to be 120 pcf for all caps). It should be noted that the unit weight of the capping materials is approximately 1.1 to 1.5 times larger than the unit weight of the dredge material. Therefore, for a scenario where the dredge depth matches the cap thickness (i.e., no net change in mudline elevation), some amount of settlement would still be predicted since there would be a net increase in stress on the existing sediments.

For cases where a net increase in stress is computed based on the dredge and cap thicknesses, the stress increase was assumed to be constant with depth due to the large spatial extent of the placed caps. This assumption likely results in slightly conservative (over-prediction) estimates of the cap-induced settlement along the very edges of the caps. The change in stress resulting from dredging (where applicable) and subsequent cap placement was used to compute settlement in accordance with the methodology summarized below.

4.2 Settlement Magnitude from Primary Consolidation

The primary consolidation settlement within each geologic layer was estimated using the assumed subsurface profiles described in Section 2 for each remediation area and the equations below. Each layer shown in the subsurface profile was divided into 10 equal sub-layers, and the increase in effective stress (and resulting change in void ratio) for each sub-layer was computed based on the assumed unit weight and thickness of capping material added. The total settlement for a given profile was then estimated as the sum of the settlement of each sub-layer.

Using oedometer test results (see Attachment B for example calculation), settlement was estimated using the following equation:

$$\Delta H = H \frac{C_c}{1+e_o} \log\left(\frac{\sigma'_o + \Delta\sigma'}{\sigma'_o}\right) \tag{4-1}$$

Using SIC test data (see Attachment B for example calculation), settlement was estimated using the following equation:

$$\Delta H = H \frac{e_o - e_f}{1+e_o} \tag{4-2}$$

where:

ΔH	=	settlement of layer
H	=	initial thickness of layer
σ'_o	=	initial effective stress prior to cap placement at mid-height of layer
$\Delta\sigma'$	=	change in effective stress as a result of cap placement at mid-height of layer
e_o	=	initial void ratio at effective stress of existing conditions, as determined from consolidation results
e_f	=	final void ratio at effective stress after capping, as determined from consolidation test results

In the cases where SIC data were used to estimate the settlement of a layer, the initial and final void ratio used in equation 4-2 for a given increase in stress were computed using equation 3-2, which defines the relationship between void ratio and stress, as determined through SIC testing. Attachment B provides a detailed step-by-step example calculation of the settlement estimate using both oedometer and SIC test data.

Based on the field investigations and subsequent lab testing conducted as part of the PDI, some of the geologic units are characterized by a range of thicknesses and/or a range of physical properties over a given Remediation Area. For instance, laboratory consolidation tests were conducted on multiple samples collected from the same geologic unit, indicating varying compressibility and/or permeability. As indicated previously, the SIC test samples were selected to be representative of the anticipated range of parameters for a given stratum. In order to assess the range of settlement estimates resulting from these observed variations, several "cases" were evaluated for each Remediation Area. Each case used a unique set of input parameters (e.g., results of laboratory testing on a given sample), and a unique settlement estimate was developed for each case. The range of results for multiple cases within a given Remediation Area were tabulated, as summarized in Table 1. The example calculation presented in Attachment B represents a single case, and a summary of modeling inputs and results is provided in Attachment C.

Table 1
Estimated Cap-Induced Consolidation Settlement

Remediation Area Habitat Module (Water Depth Range)	Cap Thickness [feet]	Dredge Depth [feet]	Estimated Consolidation After 2 Years [inches]	Estimated Total Primary Consolidation [inches]	Estimated Time to Reach 90% Consolidation [years]
Remediation Area A					
Module 1 (-20 to -30 feet)	2.25	0.0	10 to 13	10 to 14	0.2 to 1.5
Module 2A (-7 to -20 feet)	2.75	0.0	11 to 15	11 to 16	0.2 to 1.5
Module 3A (-3 to -7 feet)	4.25	0.5 to 4.75	7 to 19	7 to 21	0.1 to 1.6
Module 3A (-2 to -3 feet)	5.00	0.5 to 4.5	10 to 22	10 to 23	0.2 to 1.6
Module 5A/6A (-0.5 to -2 feet)	5.0	0.5 to 3.4	12 to 22	12 to 19	0.2 to 1.6
Remediation Area B					
Modules 1 and 2 (-10 to -30 feet)	3.25	0.0	10 to 27	17 to 34	1 to >15
Module 2 (-7 to -10 feet)	3.75	0.0	10 to 30	19 to 38	0.1 to >15
Module 3A (-4 to -7 feet)	5.00	0 to 5.9	11 to 36	21 to 45	1 to >15
Module 3A (-2 to -3 feet)	5.50	1.2 to 5.2	10 to 33	18 to 41	1 to >15
Module 5A	5.50	3.7 to 5.3	10 to 32	18 to 41	1 to >15
Remediation Area C					
Modules 1 and 2 (-10 to -30 feet)	3.25	0.0	4 to 22	6 to 26	1 to >15
Module 2 (-7 to -10 feet)	3.75	0.0	5 to 24	7 to 29	1.3 to >15
Module 3B (-4 to -7 feet)	5.00	0 to 5.8	5 to 28	7 to 34	1.0 to >15
Module 3B (-2 to -3 feet)	5.5	1.8 to 5.1	5 to 23	7 to 27	1 to >15
Module 5B (-0.5 to -2 feet)	5.5	3.6 to 4.6	5 to 24	7 to 26	1.2 to >15

Remediation Area Habitat Module (Water Depth Range)	Cap Thickness [feet]	Dredge Depth [feet]	Estimated Consolidation After 2 Years [inches]	Estimated Total Primary Consolidation [inches]	Estimated Time to Reach 90% Consolidation [years]
Remediation Area E					
Module 1 (-20 to -30 feet)	2.25	0.0	14 to 25	17 to 32	1.5 to 9.0
Module 2 (-7 to -20 feet)	3.25	0.0	19 to 32	22 to 41	1.6 to 9.0
Module 3B (-3 to -7 feet)	5.25	2.5 to 3.2	14 to 22	19 to 34	0.4 to >12
Module 3B (-2 to -3 feet)	4.75	0.5 to 5.6	8 to 29	13 to 49	0.4 to >12
Module 5B (-0.5 to -2 feet)	5.25	1.7 to 5.2	10 to 23	13 to 35	0.4 to >12
Module 6B (+1 to -1 feet)	5.25	3.26 to 3.75	13 to 21	17 to 32	0.4 to >12

Note:
Each individual case that was analyzed to create this table is summarized in Attachment C

4.3 Settlement Magnitude from Secondary Compression

Settlement due to long-term plastic adjustment of the fabric of the soils under constant effective stress (i.e., secondary compression) was evaluated for this analysis. The site-wide average secondary compression index for the Onondaga Lake sediments was estimated to be 0.022 based correlations to index properties (Bowles 1996; Holtz and Kovacs 1981). Based on this secondary compression index, the magnitude of secondary compression settlement will typically be considerably less than the estimated primary consolidation settlement.

The average and range of secondary compression settlements were estimated based on several representative cases from each remediation area across the site, taking into account the varied subsurface geology and variety of dredging and capping situations in each habitat module. For this analysis, secondary compression settlement was estimated for a set of representative cross-sections in the various Remediation Areas over a 15-year period following cap construction. The results of the analysis indicate that secondary compression settlement across the site is estimated to range between 0.5 and 6 inches with an average of approximately 2 inches.

4.4 Settlement Rate

The rate at which the primary consolidation will occur is dependent on a number of factors including the permeability of the compressible sediment, which is used to calculate the coefficient of consolidation, c_v, along with the change in void ratio caused by the placement of the cap, according to the following relationship:

$$c_v = \frac{k(1+e_o)}{\left(\Delta e / \Delta\sigma_v\right)\gamma_w} \tag{4-3}$$

where:

c_v	=	coefficient of consolidation
k	=	permeability
e_o	=	initial void ratio
Δe	=	change in void ratio caused by placement of the cap
$\Delta\sigma_v$	=	change in vertical stress caused by placement of the cap
γ_w	=	unit weight of water

The coefficient of consolidation is related to a non-dimensional number called the time factor, T_v, which is calculated according to the following equation:

$$T_v = \frac{c_v t}{H_{dr}^2} \tag{4-4}$$

where:

T_v	=	time factor
c_v	=	coefficient of consolidation
H_{dr}	=	length of drainage path
T	=	time

The time factor can be calculated for various time intervals for each compressible layer. The time factor is also related to the degree of consolidation (i.e., percent consolidation), U, by the following relationships:

$$\text{For U = 0 to 60\%,} \quad T_v = \frac{\pi}{4}\left(\frac{U\%}{100}\right)^2 \tag{4-5}$$

$$\text{For U > 60\%,} \quad T_v = 1.781 - 0.933\log(100 - U\%) \tag{4-6}$$

By mathematically rearranging these relationships, the degree of consolidation can be estimated from the time factor for a given time as follows:

$$\text{For U = 0 to 60\%,} \quad U\% = 100\sqrt{\frac{4T_v}{\pi}} \tag{4-7}$$

$$\text{For U > 60\%,} \quad U\% = 100 - 10^{\left(\frac{T_v - 1.781}{-0.933}\right)} \tag{4-8}$$

Attachment B provides a detailed step-by-step example calculation of the time rate of settlement estimate.

Table 1 provides a summary of the estimated primary consolidation settlement within habitat modules for each Remediation Area. In addition, the estimated primary settlement 2 years after cap placement is presented, which has been used to support ongoing habitat planning. Finally, the approximate time to achieve 90 percent of the total primary consolidation is also presented for each case. It should be noted that a range of values is presented in most cases, reflecting the range of soil conditions observed in the field and laboratory.

As noted above, a range of results was estimated for most cases based on varying soil conditions. It should be noted that the time rate of primary settlement is highly dependent on the drainage distance (i.e., the distance that porewater expelled during consolidation must flow to a highly permeable layer, such as a sand/gravel layer) within a particular compressible layer. The time rate of settlement is related to the square of the drainage distance. However, it is often difficult to accurately identify minor sand lenses that may act as drainage layers within a natural deposit using traditional exploration techniques (e.g., geotechnical borings with samples collected every 2.5 or 5 feet). Therefore, time rate of settlement estimates could be overestimated if these drainage layers exist, but were not identified during field investigations.

4.5 Total Settlement Results

In general, results of the settlement analysis indicate that primary consolidation settlements predicted across the whole site could vary from 4 to 36 inches within 2 years of placement and from 6 to 49 inches during the lifetime of the cap. An overall site-wide average settlement at the end of primary consolidation is predicted to be 21 inches. Additional settlements due to secondary compression may occur and are predicted to range from 1 to 6 inches with a site-wide average of approximately 2 inches.

Primary consolidation from dredging and capping in Remediation Area A is predicted to result in settlements of 7 to 23 inches. Average settlement for this remediation area is predicted to be 14 inches. Most of this settlement (greater than 90 percent) is expected to occur within the first 2 years after capping. This range of settlements takes into account the maximum and minimum dredge cuts, the varying subsurface lithology, and a range of capping thicknesses for each habitat module (see Appendix C for a summary of each individual case analyzed).

Primary consolidation from dredging and capping in Remediation Area B is predicted to result in settlements of 17 to 45 inches. Average settlement for this remediation area is predicted to be 30 inches. Some of this settlement could take over 15 years to reach 90 percent consolidation, due to the thickness of the compressible deposit and the lack of observed intermediate drainage layers during field investigations. However, as discussed in

Section 4.3, if these intermediate drainage layers do exist, the actual time to reach 90 percent consolidation may be significantly reduced. This range of settlements takes into account the maximum and minimum dredge cuts, the varying subsurface lithology, and a range of capping thicknesses for each habitat module.

Primary consolidation from dredging and capping in Remediation Area C is predicted to result in settlements of 6 to 34 inches. Average settlement for this remediation area is predicted to be 16 inches. Some of this settlement could take over 12 years to reach 90 percent consolidation, due to the thickness of the compressible deposit and the lack of observed intermediate drainage layers during field investigations. Similar to the discussion above for Remediation Area B, the actual rate of settlement may be quicker if intermediate drainage layers that were not identified during field investigations actually exist in the field. This range of settlements takes into account the maximum and minimum dredge cuts, the varying subsurface lithology, and a range of capping thicknesses for each habitat module.

Primary consolidation from dredging and capping in Remediation Area E is predicted to results in settlements of 13 to 49 inches. Average settlement for this remediation area is predicted to be 28 inches. Some of this settlement could take over 15 years to reach 90 percent consolidation. Similar to the discussion above for Remediation Area B, the actual rate of settlement may be quicker if intermediate drainage layers that were not identified during field investigations exist in the field. This range of settlements takes into account the maximum and minimum dredge cuts, the varying subsurface lithology, and a range of capping thicknesses for each habitat module.

Settlements as high as 49 inches are predicted in some areas, mainly in capping-only areas (i.e. no prior dredging). The areas of largest settlement are typically in habitat modules 1, 2, and 3B, where thin-cut or no dredging will take place and thicker caps will be placed. These areas are typically far from shore in deeper water (3 to 20 feet). Settlements of this magnitude are not expected to have adverse impacts on sediment stability or cap effectiveness given the broad areas over which they will occur and the gently sloping bathymetry of the Lake. In addition, these settlement estimates have been accounted for in assessing post-construction water depths as it relates to habitat planning.

4.6 Differential Settlement

Based on calculations, predicted settlements from adjoining habitat modules result in differential settlements ranging from 0 to 18 inches. However, in reality the difference in dredging depths, capping thicknesses, and subsurface stratigraphy will be gradual and not immediately change when a boundary of two habitat modules is encountered. Instead, the dredge depths and final surfaces will progressively change along the lake bottom, and the capping will be naturally graded from one thickness to another. Additionally, the lacustrine natural deposits that comprise the geologic profiles likely will vary gradually as well, from one cross-section to another.

In addition to the gradual variation in natural sediment deposits discussed above, the sand and gravel caps that will be placed are "flexible" and tolerant of significant differential settlements without affecting the cap's functionality or environmental protectiveness. The cap will flow seamlessly from one module to another, sloping along the angle of repose of the cap materials. Furthermore, caps will be constructed with a "run-out" beyond the required limits of capping, where the cap tapers off from its full thickness at the edge of the capping area to zero some distance away. This run-out will prevent excessive differential settlement at the edges of the cap areas.

4.7 Consideration of Field Testing Program for Settlement Assessment

A cap test fill is often used to confirm theoretical calculations such as constructability or settlement. A cap test fill was considered to further evaluate/refine the predicted settlement results. A test cap would be required to cover a large area with a cap and may take several years to obtain beneficial results. If a test was to be done, it would need to be in an area near one of the current cross-sections on which the settlement analyses are based, or additional sample collection would be required to correlate with the field test results. The test cap would ideally span over several of the habitat modules and be constructed at large enough scale to create enough surface pressure to influence the deeper soft soils. It may also be desirable to perform some amount of dredging beforehand in portions of the test area in order to obtain final habitat elevations. Dredging would require disposal and cause potential resuspension issues. A cap test like this would need sufficient monitoring for the results to

be useful as well. A cap test fill to evaluate settlement predictions was not considered further, given the time limitations and the potential impacts described above.

5 CONCLUSIONS

This memorandum presents an estimate of the amount of primary consolidation settlement that may be expected following placement of a subaqueous cap in Remediation Areas A, B, C, and E of Onondaga Lake. In general, the existing sediments within Onondaga Lake are expected to undergo consolidation settlement following placement of capping materials. The magnitude of settlement is governed by the thickness of the planned caps and the amount (thickness) of planned sediment removal (dredging) prior to cap placement. In general, as dredge depth increases, the amount of post-cap settlement decreases for a constant cap thickness.

As discussed herein, cap-induced settlement predictions were made for a number of "cases" representative of each habitat module based on varying sediment properties and dredge depths. Since it is not possible to pinpoint specific properties and design conditions for each and every habitat module, a range of settlement predictions are provided that can be used to support estimates of the post-construction (following dredging, capping, and long-term settlement) mudline.

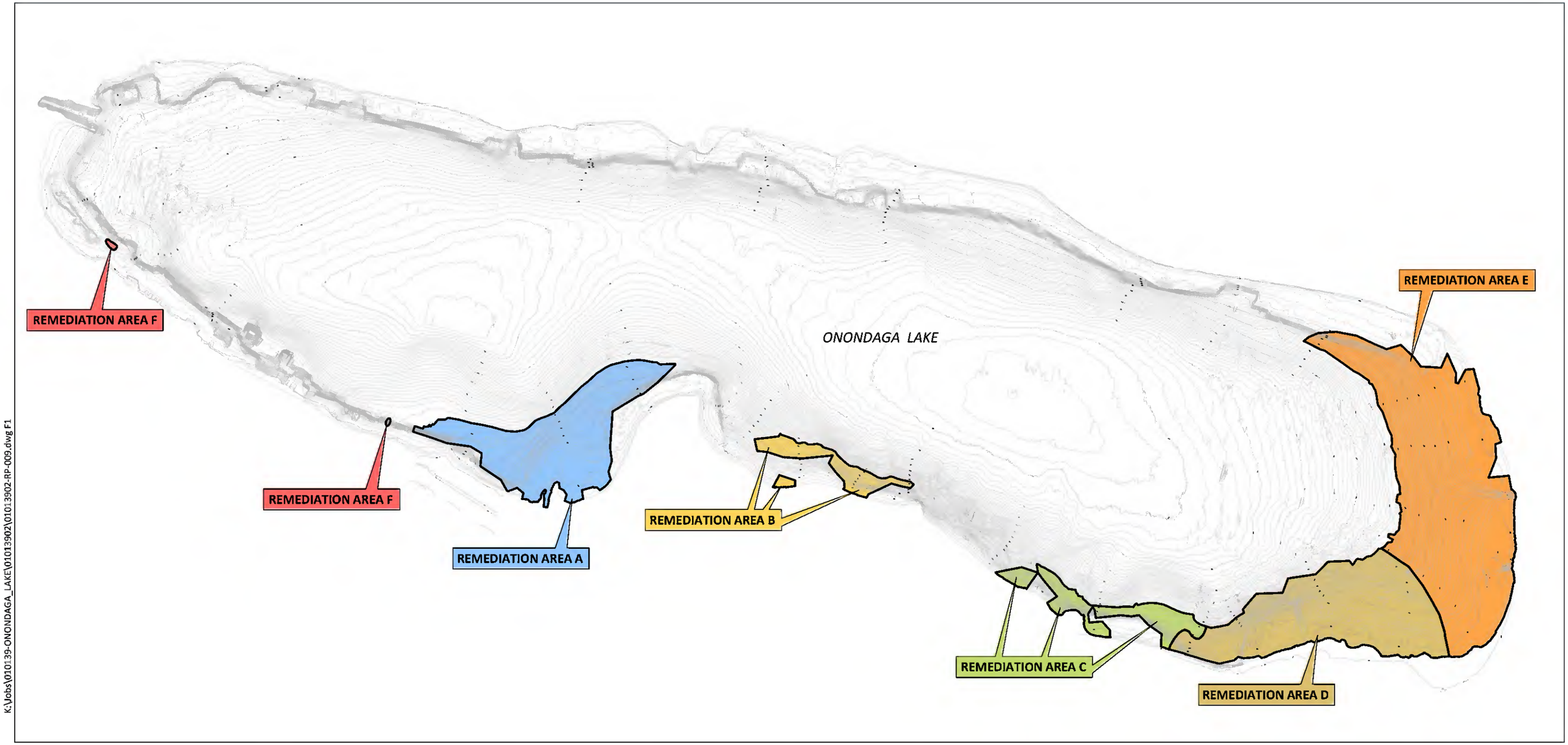
6 REFERENCES

Bowles, Joseph E. .1996. *Foundation Analysis and Design Fifth Edition*. Published by McGraw Hill, 1996.

Geosyntec Consultants. 2009. *Cap-Induced Settlement Evaluation for Remediation Area D; Onondaga Lake, Syracuse, New York*. Prepared for Parsons.

Holtz, Robert and W. Kovacs. 1981. *An Introduction to Geotechnical Engineering*. Published by Prentice-Hall, Inc.

FIGURES



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Nov 20, 2009 10:32am heriksen

SOURCE: Basemap provided to Anchor QEA by Parsons in September 2008.
VERTICAL DATUM: North American Vertical Datum of 1988 (NAVD88), U.S. Survey Feet.
HORIZONTAL DATUM: New York State Plane, Central Zone, North American Datum of 1983 (NAD83), U.S. Survey Feet.
BATHYMETRIC SURVEY: Performed by CR Environmental, Inc., for Honeywell in 2005.
NOTES:
1. Ground surface contour is two feet.
2. All locations and features are approximate.

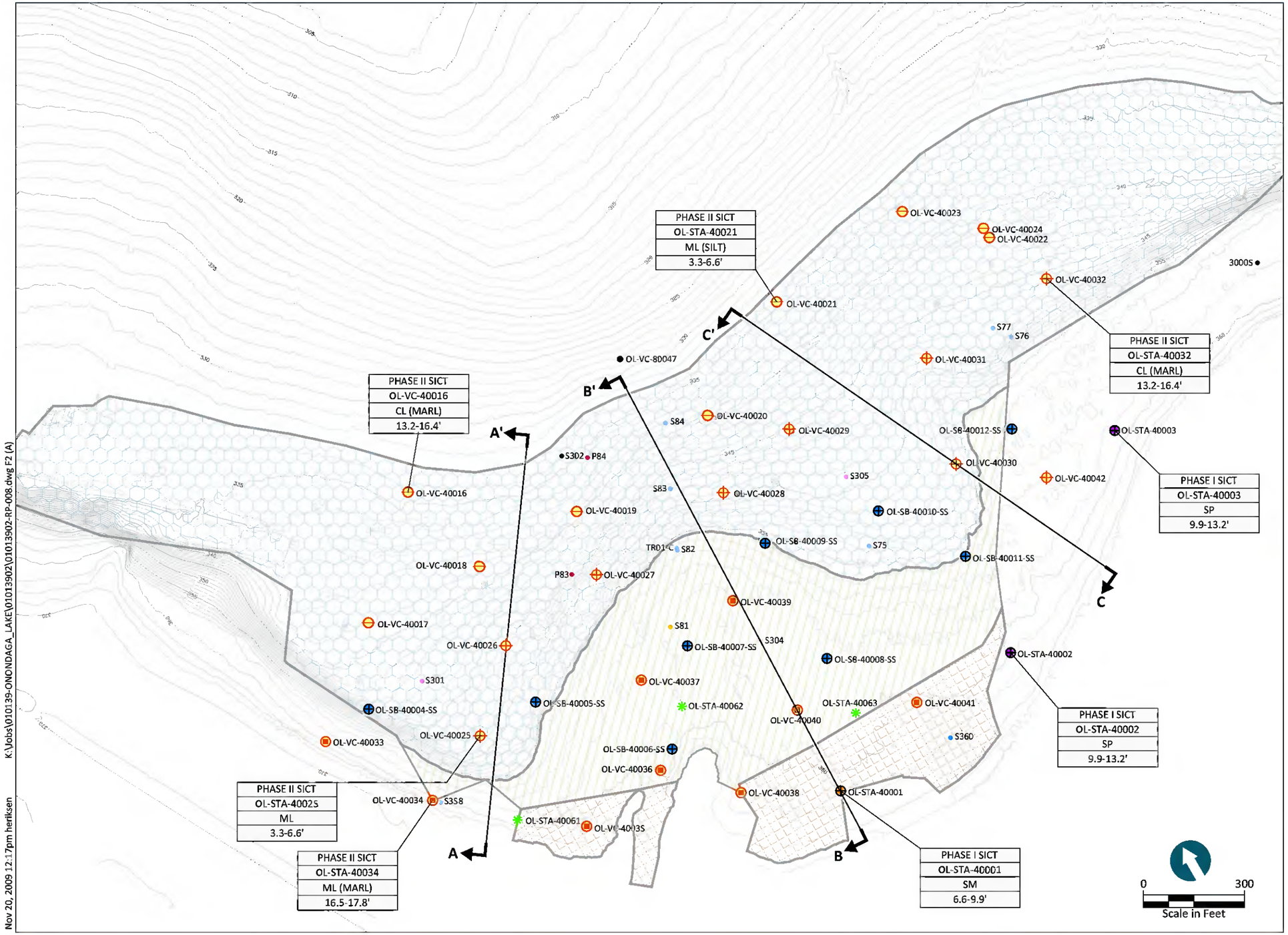
LEGEND:

Existing Bathymetric Contour in Feet

0 1600
Scale in Feet

ANCHOR QEA

Figure 1
Plan View Map of Remediation Areas
Cap-Induced Settlement Evaluation
Onondaga Lake



LEGEND:

- Existing Bathymetric Contour in Feet
- Dredge and Cap
- Dredge Only
- Cap Only
- Cross Section Location and Designation

PHASE II SICT	Test Type
OL-STA-40032	Boring ID
CL (MARL)	Soil Type
13.2-16.4'	Sampling Depth

(SICT - Seepage-Induced Consolidation Test)

PHASE II PDI SAMPLE LOCATIONS

- 20 ft (6m) Core (Sample 0-0.5 ft and 0.5-3.3 ft)
- 20 ft (6m) Core (Sample on 3.3 ft intervals to 10 ft)
- 20 ft (6m) Core (Sample on 3.3 ft intervals to 20 ft)
- Bulk Density Sample

PHASE I PDI SAMPLE LOCATIONS

- 13 ft (4m) Core and Vane Shear/Atterberg Limits
- 33 ft (10m) Boring, 13 ft (4m) Core, Vane Shear/ Atterberg Limits and Porewater Samples (Groundwater Model)
- Vane Shear/Atterberg Limits (No Chemical Analysis)

RI/FS LOCATIONS

- 0.07-0.16 ft (0-5cm)
- 0.17-0.50 ft (5-15cm)
- 0.5-1.0 ft (15-30cm)
- 1.0-3.3 ft (30-100cm)
- 3.3-7.0 ft (1-2m)
- 7.0-13.0 ft (2-4m)
- 13.0-17.0 ft (4-5m)
- 17.0-26.0 ft (5-8m)

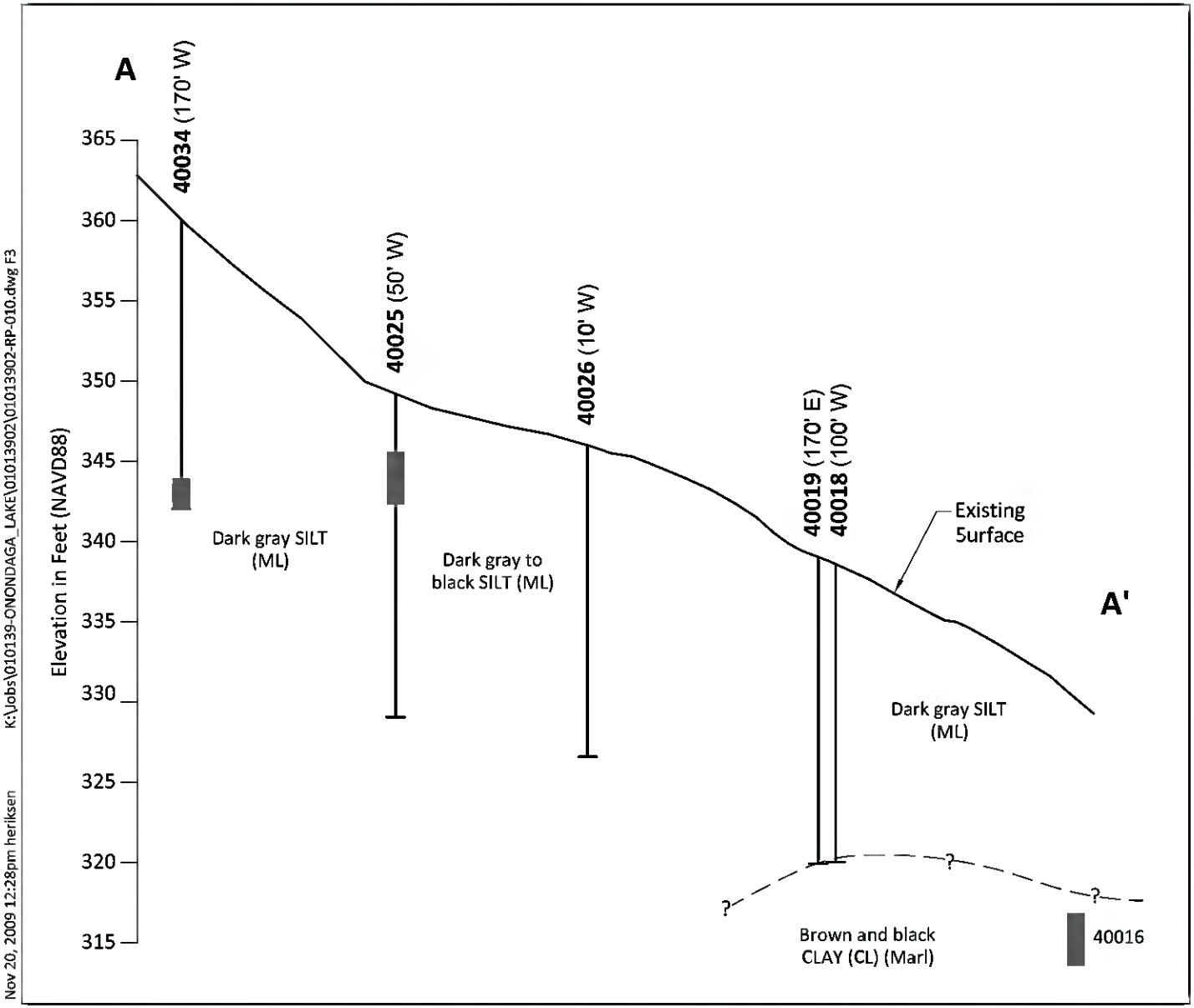
SOURCE:
1. Basemap provided to Anchor QEA by Parsons in September 2008.
2. All samples provided by Parsons, 2006.

VERTICAL DATUM: North American Vertical Datum of 1988 (NAVD88), U.S. Survey Feet.
HORIZONTAL DATUM: New York State Plane, Central Zone, North American Datum of 1983 (NAD83), U.S. Survey Feet.
BATHYMETRIC SURVEY: Performed by CR Environmental, Inc., for Honeywell in 2005.
NOTE:
All locations and features are approximate.

K:\Jobs\010139-ONONDAGA_LAKE\01013902\01013902-RP-008.dwg F2 (A)
Nov 20, 2009 12:17pm heriksen

ANCHOR QEA

Figure 2
Plan View Map of Remediation Area A
Cap-Induced Settlement Evaluation
Onondaga Lake



LEGEND:

40018 (100' W) Sediment Core Number
Offset Distance in Feet

Sediment Core Location

Consolidation Sample Location

Bottom of Sediment Core

Horizontal Scale in Feet
0 200
0 10
Vertical Scale in Feet
Vertical Exaggeration x 20

NOTE:
1. See Figure 2 for cross section location.

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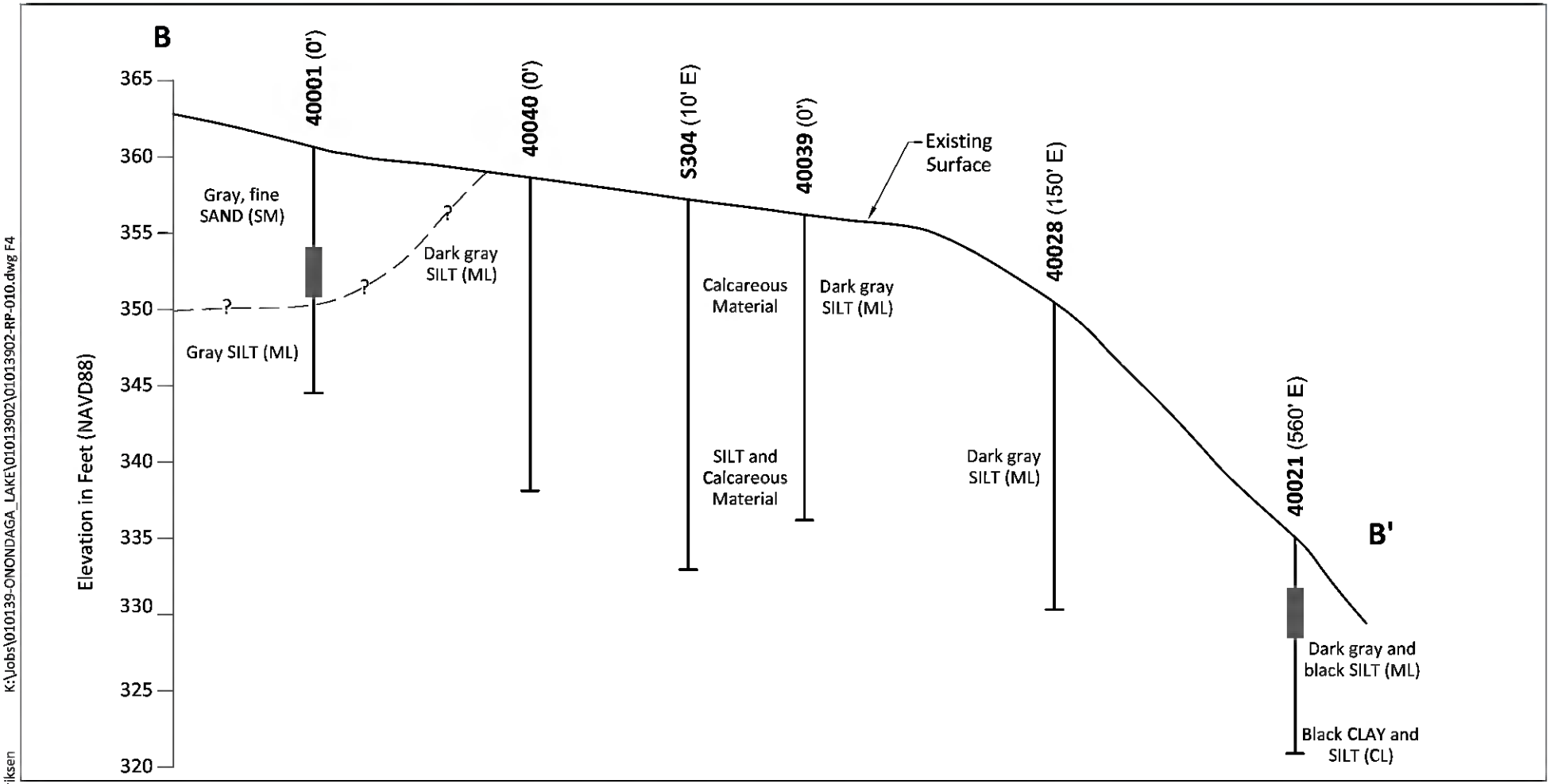
Nov 20, 2009 12:28pm heriksen

ANCHOR QEA

Figure 3
Typical Cross Section A-A' - Remediation Area A
Cap-Induced Settlement Evaluation
Onondaga Lake



LEGEND:

40028 Sediment Core Number
(150' E) Offset Distance in Feet

Sediment Core Location

Consolidation Sample Location

Bottom of Sediment Core

Horizontal Scale in Feet
0 200
0 10
Vertical Scale in Feet
Vertical Exaggeration x 20

NOTE:
1. See Figure 2 for cross section location.

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Nov 20, 2009 12:28pm heriksen

ANCHOR QEA

Figure 4
Typical Cross Section B-B' - Remediation Area A
Cap-Induced Settlement Evaluation
Onondaga Lake

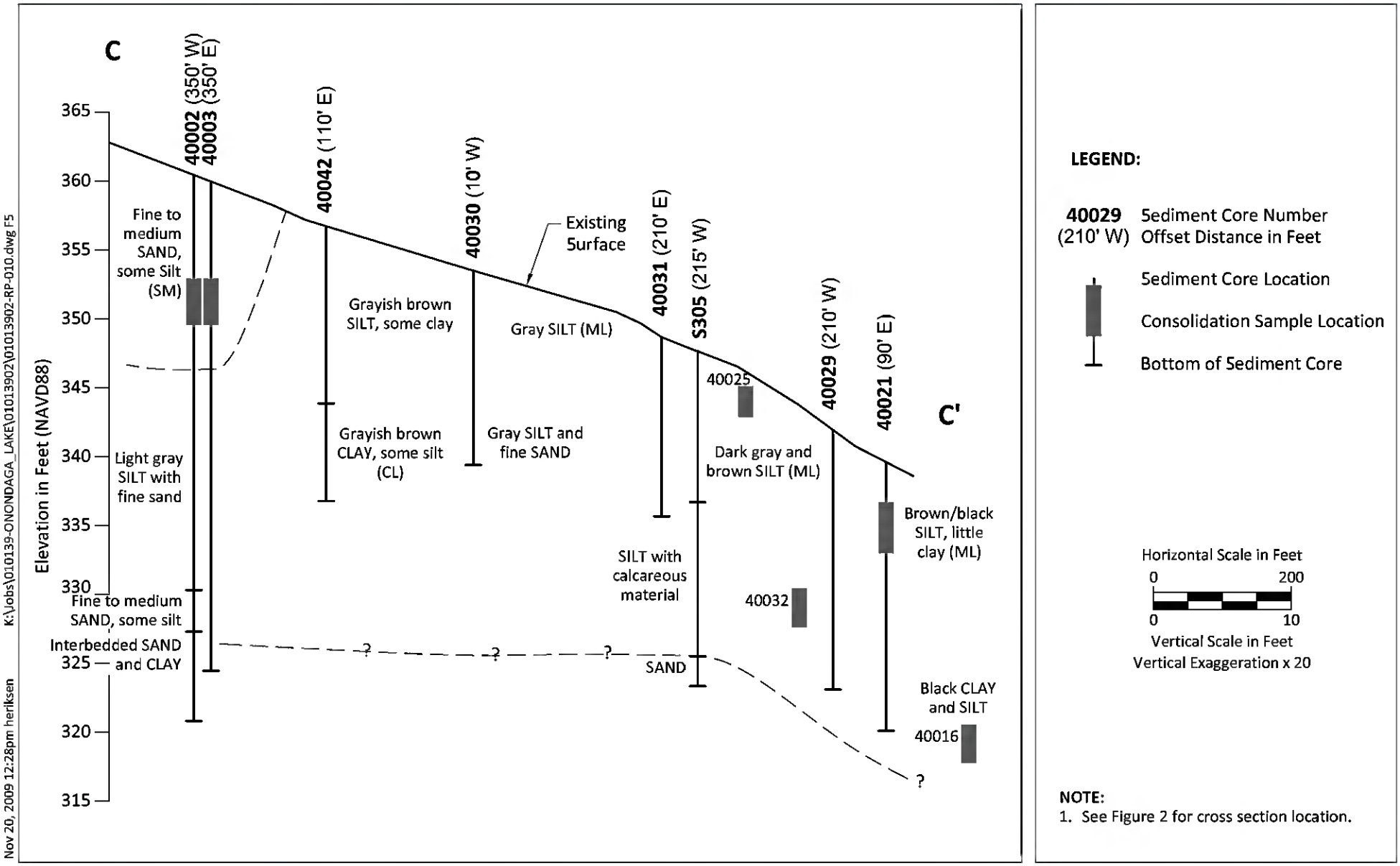
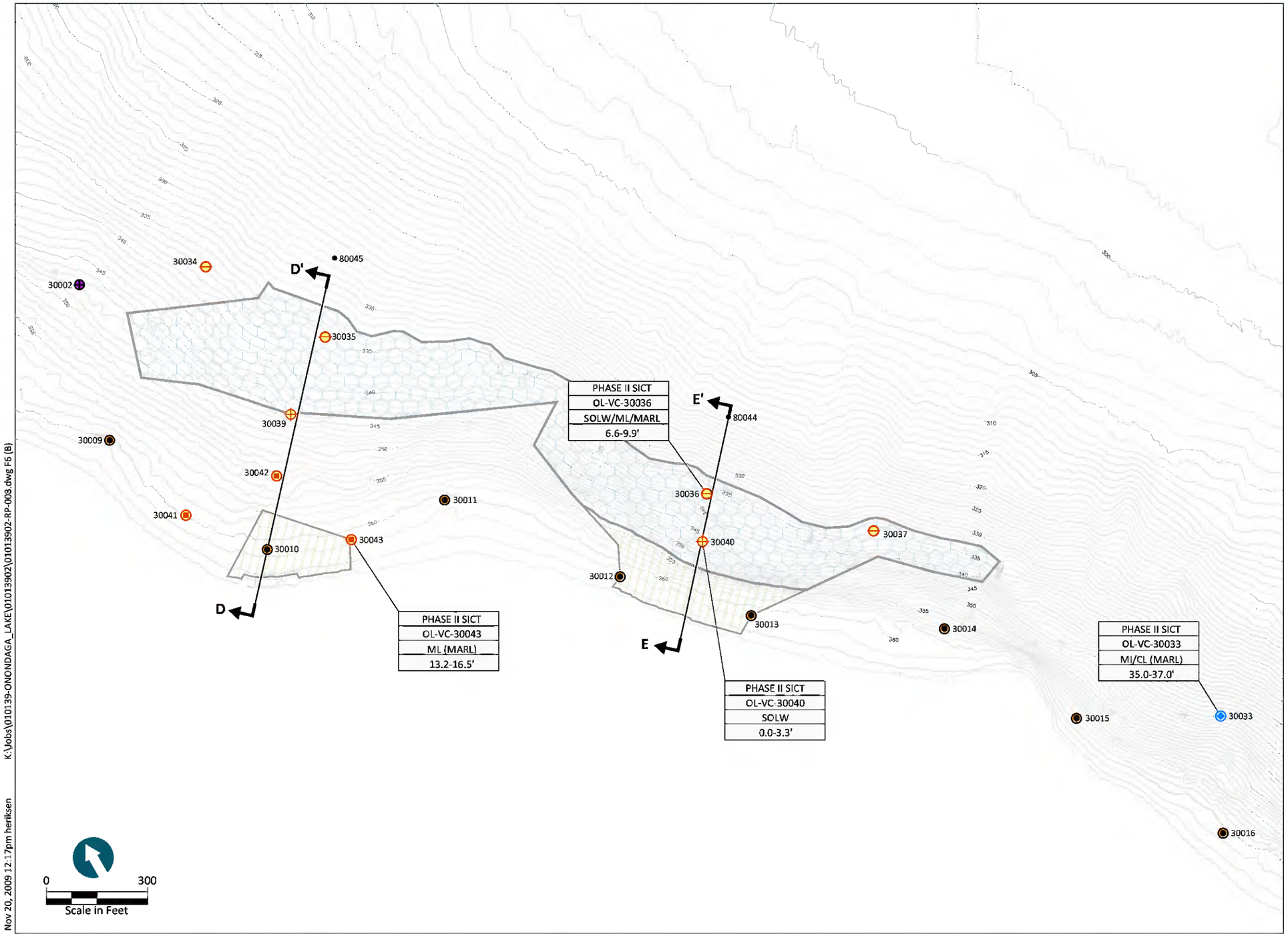


Figure 5
Typical Cross Section C-C' - Remediation Area A
Cap-Induced Settlement Evaluation
Onondaga Lake

ANCHOR QEA



LEGEND:

- Existing Bathymetric Contour in Feet
- Dredge and Cap
- Dredge Only
- Cap Only
- D — Cross Section Location and Designation

PHASE II SICT	Test Type
OL-VC-30036	Boring ID
SOLW/ML/MARL	Soil Type
6.6-9.9'	Sampling Depth

(SICT - Seepage-Induced Consolidation Test)

PHASE II PDI SAMPLE LOCATIONS

- 20 ft (6m) Core (Sample 0-0.S ft and 0.S-3.3 ft)
- 20 ft (6m) Core (Sample on 3.3 ft intervals to 10 ft)
- 20 ft (6m) Core (Sample on 3.3 ft intervals to 20 ft)
- Deep Boring to Till/Top of Bedrock

PHASE I PDI SAMPLE LOCATIONS

- 13 ft (4m) Core and Surface Water Sample
- 33 ft (10m) Boring, 13 ft (4m) Core, Surfae Water Sample
- Vane Shear/Atterberg Limits and Surface Water Sample (No Chemical Analysis)

RI/FS LOCATIONS

- 0.07-0.16 ft (0-Scm)
- 0.17-0.S0 ft (S-1Scm)
- 0.S-1.0 ft (1S-30cm)
- 1.0-3.3 ft (30-100cm)
- 3.3-7.0 ft (1-2m)
- 7.0-13.0 ft (2-4m)
- 13.0-17.0 ft (4-Sm)
- 17.0-26.0 ft (S-Bm)

SOURCE:
1. Basemap provided to Anchor QEA by Parsons in September 2008.
2. All samples provided by Parsons, 2006.

VERTICAL DATUM: North American Vertical Datum of 1988 (NAVD88), U.S. Survey Feet.
HORIZONTAL DATUM: New York State Plane, Central Zone, North American Datum of 1983 (NAD83), U.S. Survey Feet.
BATHYMETRIC SURVEY: Performed by CR Environmental, Inc., for Honeywell in 2005.
NOTE:
All locations and features are approximate.

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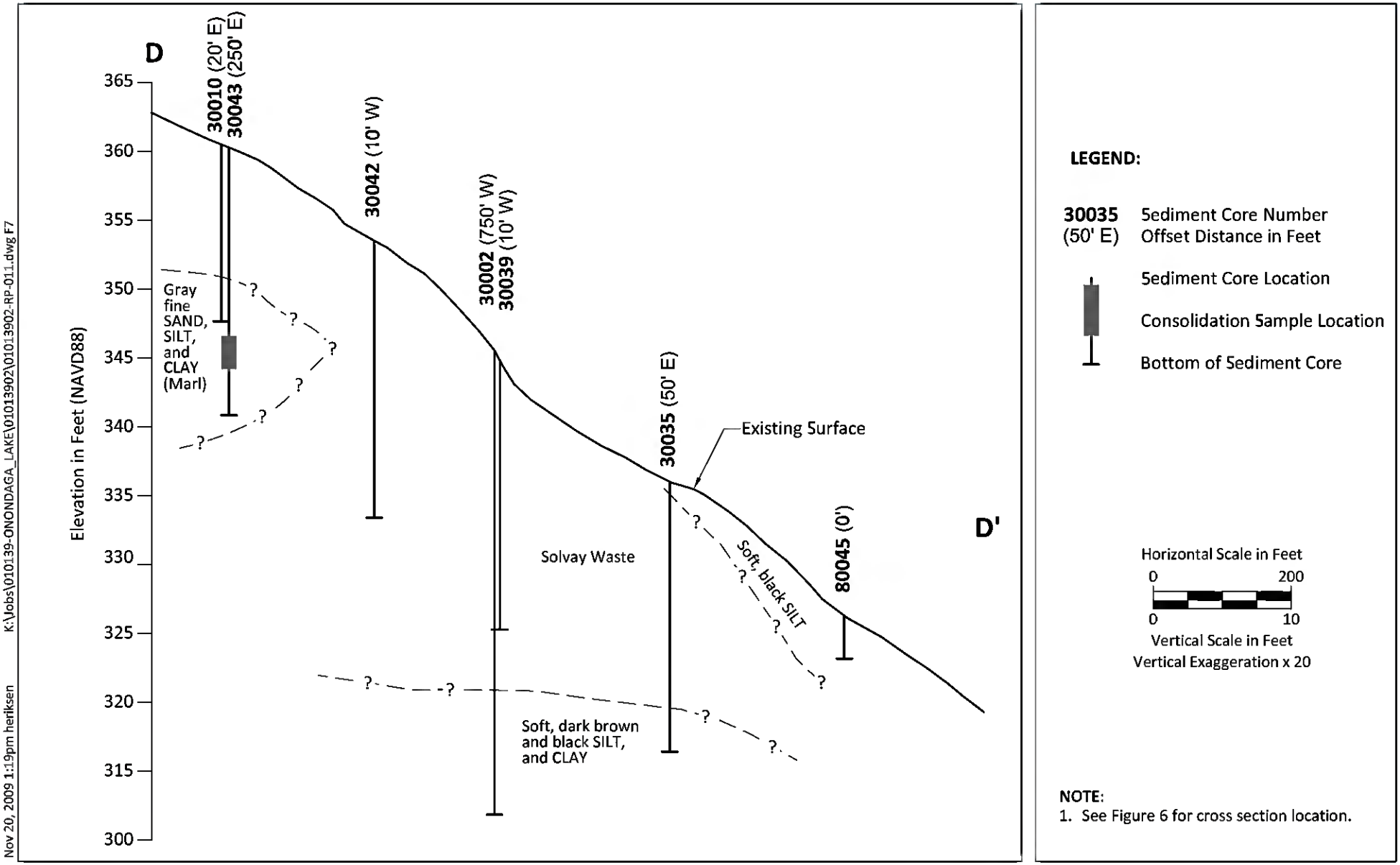
Nov 20, 2009 12:17pm heriksen

ANCHOR QEA

Figure 6
Plan View Map of Remediation Area B
Cap-Induced Settlement Evaluation
Onondaga Lake



Nov 20, 2009 1:19pm heriksen K:\Jobs\010139-ONONDAGA_LAKE\01013902\01013902-RP-011.dwg F7

Figure 7
Typical Cross Section D-D' - Remediation Area B
Cap-Induced Settlement Evaluation
Onondaga Lake

ANCHOR QEA

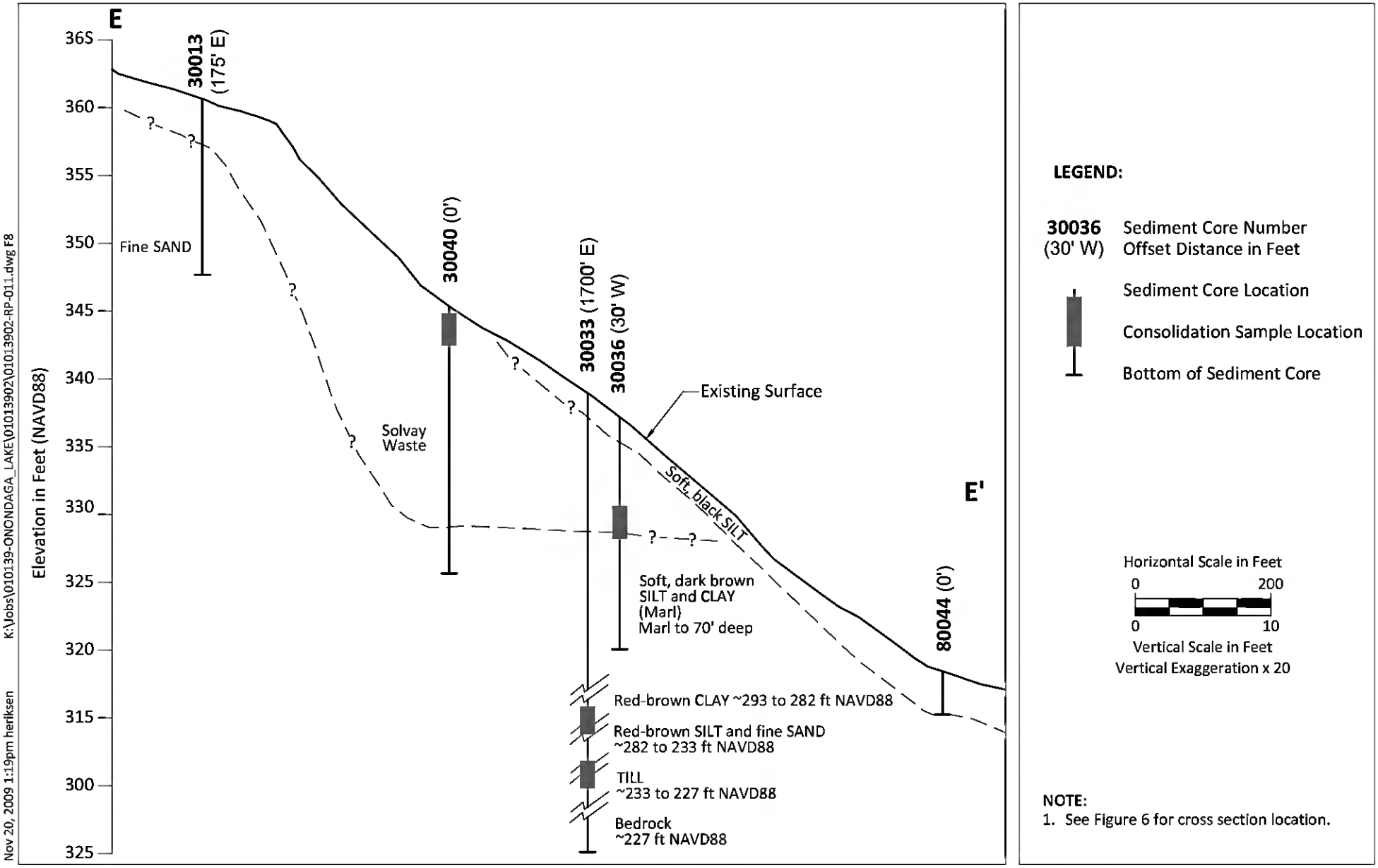


Figure 8
Typical Cross Section E-E' - Remediation Area B
Cap-Induced Settlement Evaluation
Onondaga Lake

ANCHOR QEA

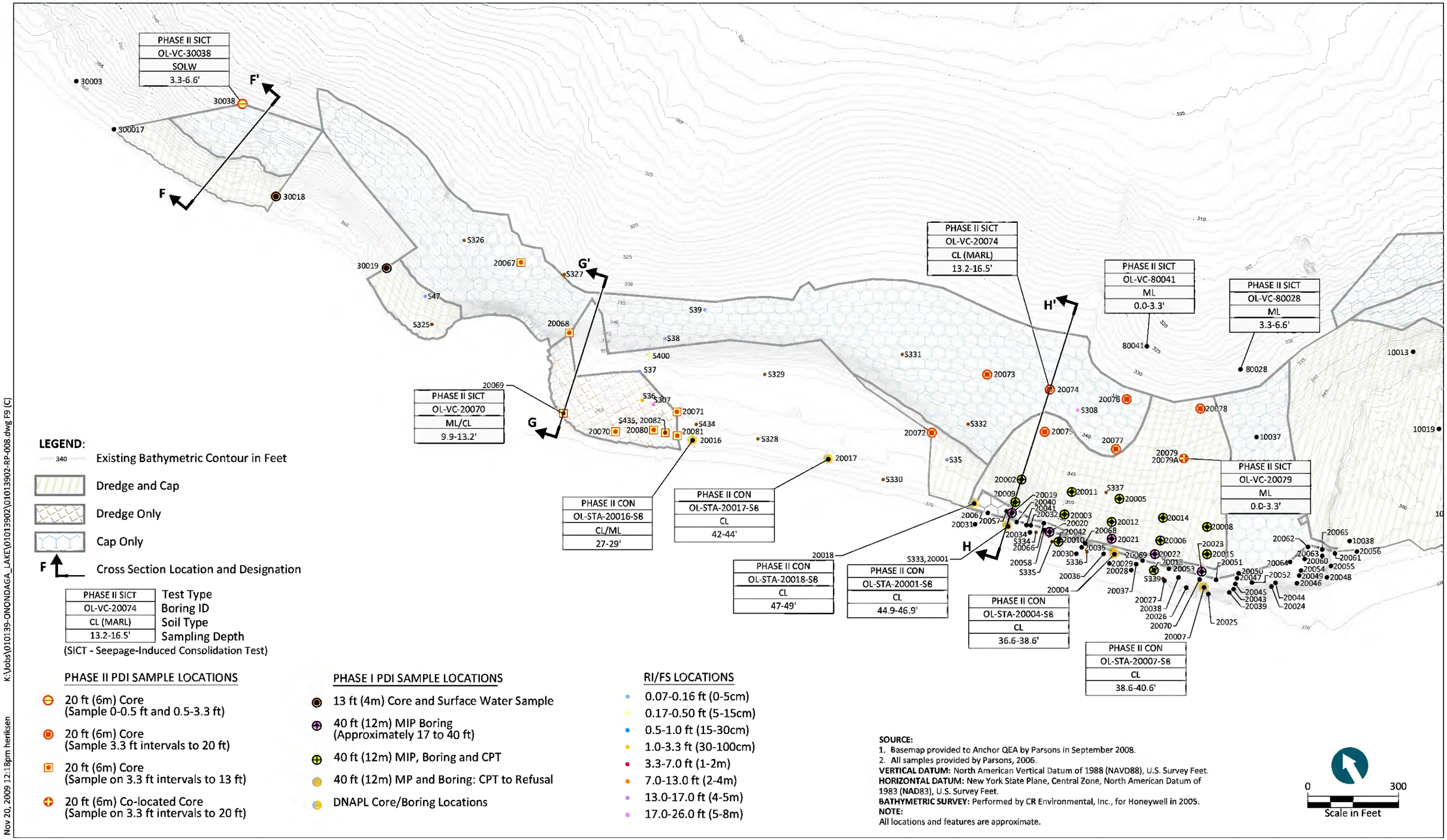
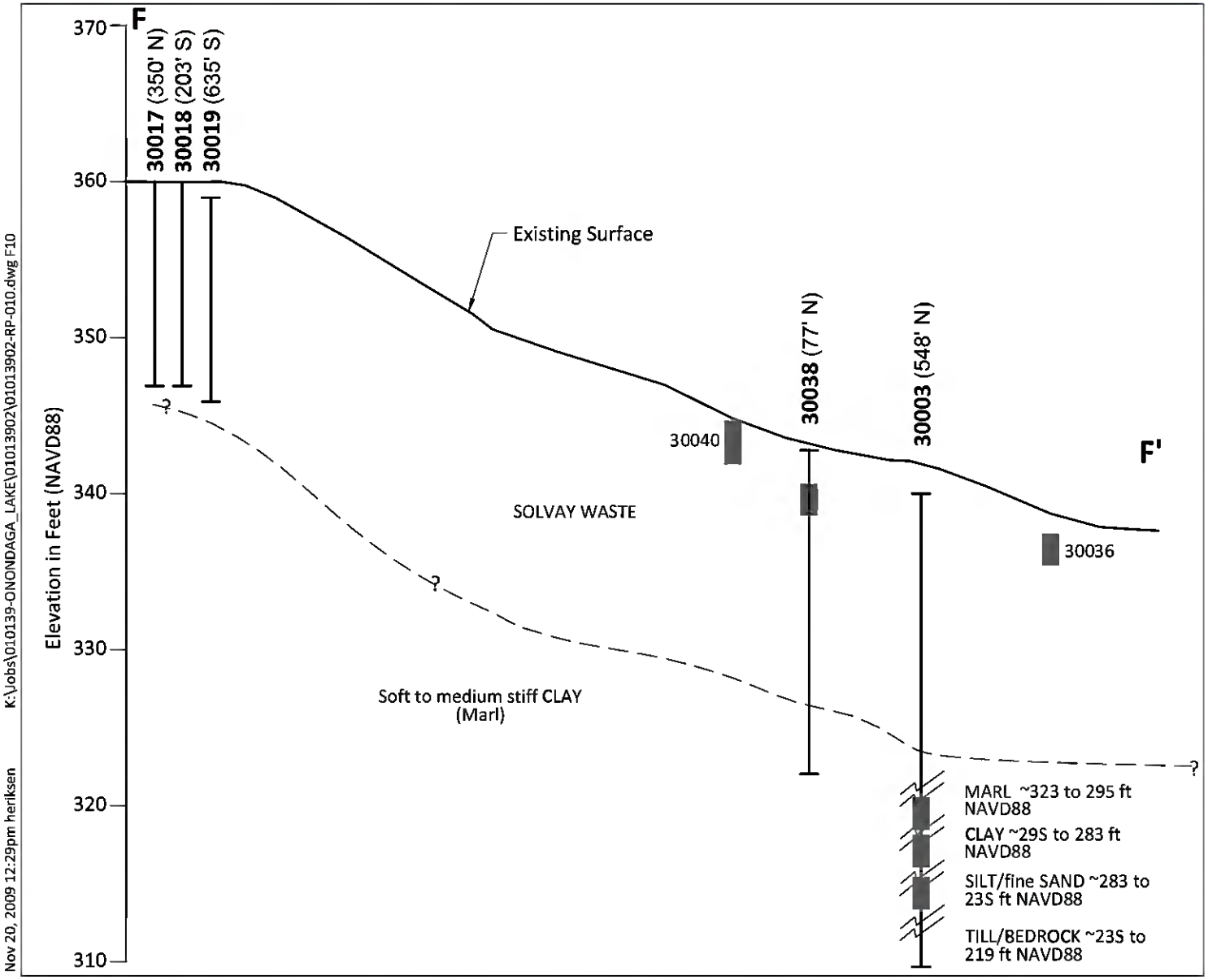


Figure 9
Plan View Map of Remediation Area C
Cap-Induced Settlement Evaluation
Onondaga Lake

ANCHOR QEA



LEGEND:

30038 (77' N) Sediment Core Number
Offset Distance in Feet

Sediment Core Location

Consolidation Sample Location

Bottom of Sediment Core

Horizontal Scale in Feet
0 100
0 10
Vertical Scale in Feet
Vertical Exaggeration x 10

NOTES:
1. See Figure 9 for cross section location.

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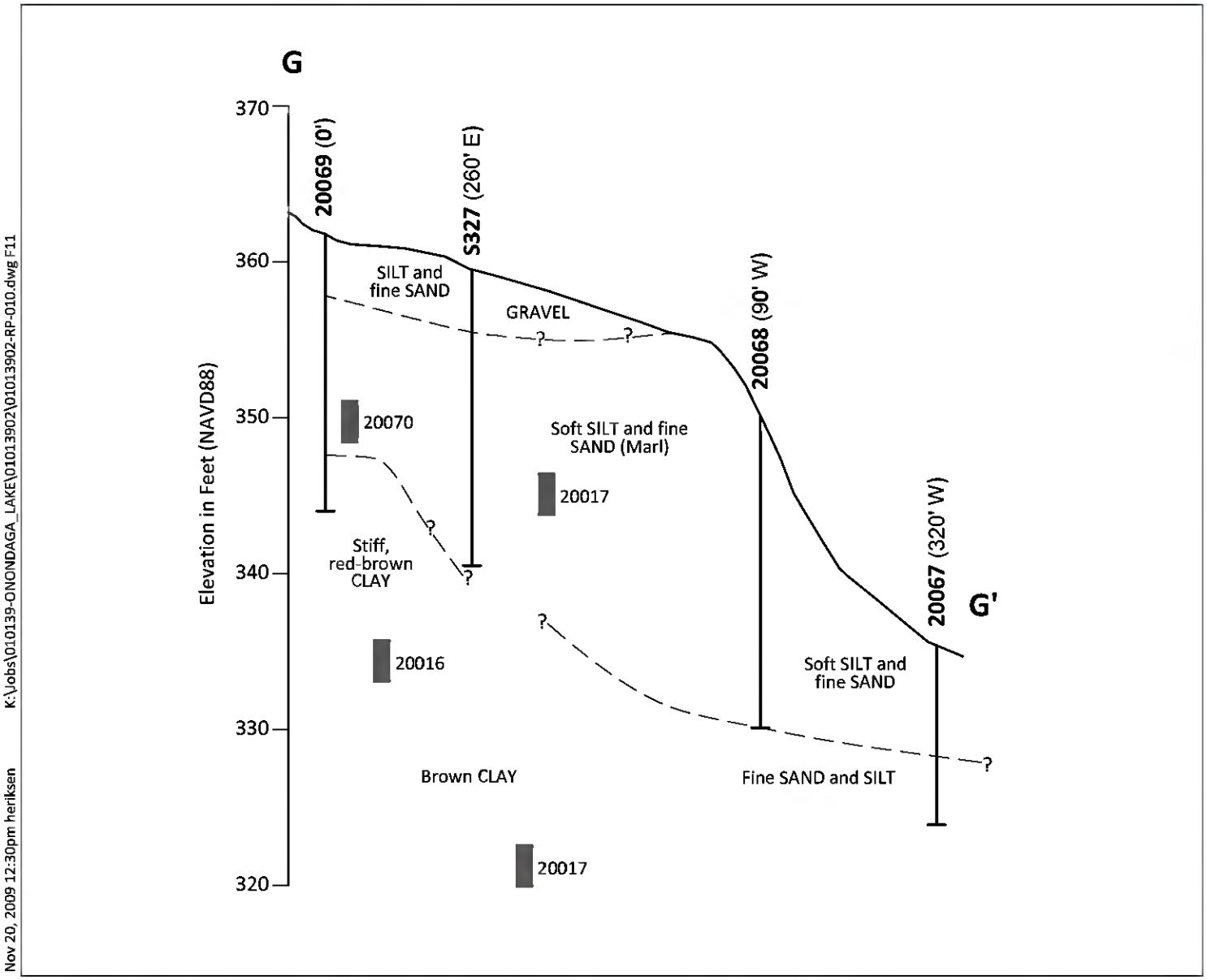
Nov 20, 2009 12:29pm heriksen

ANCHOR QEA

Figure 10
Typical Cross Section F-F' - Remediation Area C
Cap-Induced Settlement Evaluation
Onondaga Lake



LEGEND:

S327 (260' E) Sediment Core Number
Offset Distance in Feet

Sediment Core Location

Consolidation Sample Location

Bottom of Sediment Core

Horizontal Scale in Feet
0 100
0 10
Vertical Scale in Feet
Vertical Exaggeration x 10

NOTES:
1. See Figure 9 for cross section location.

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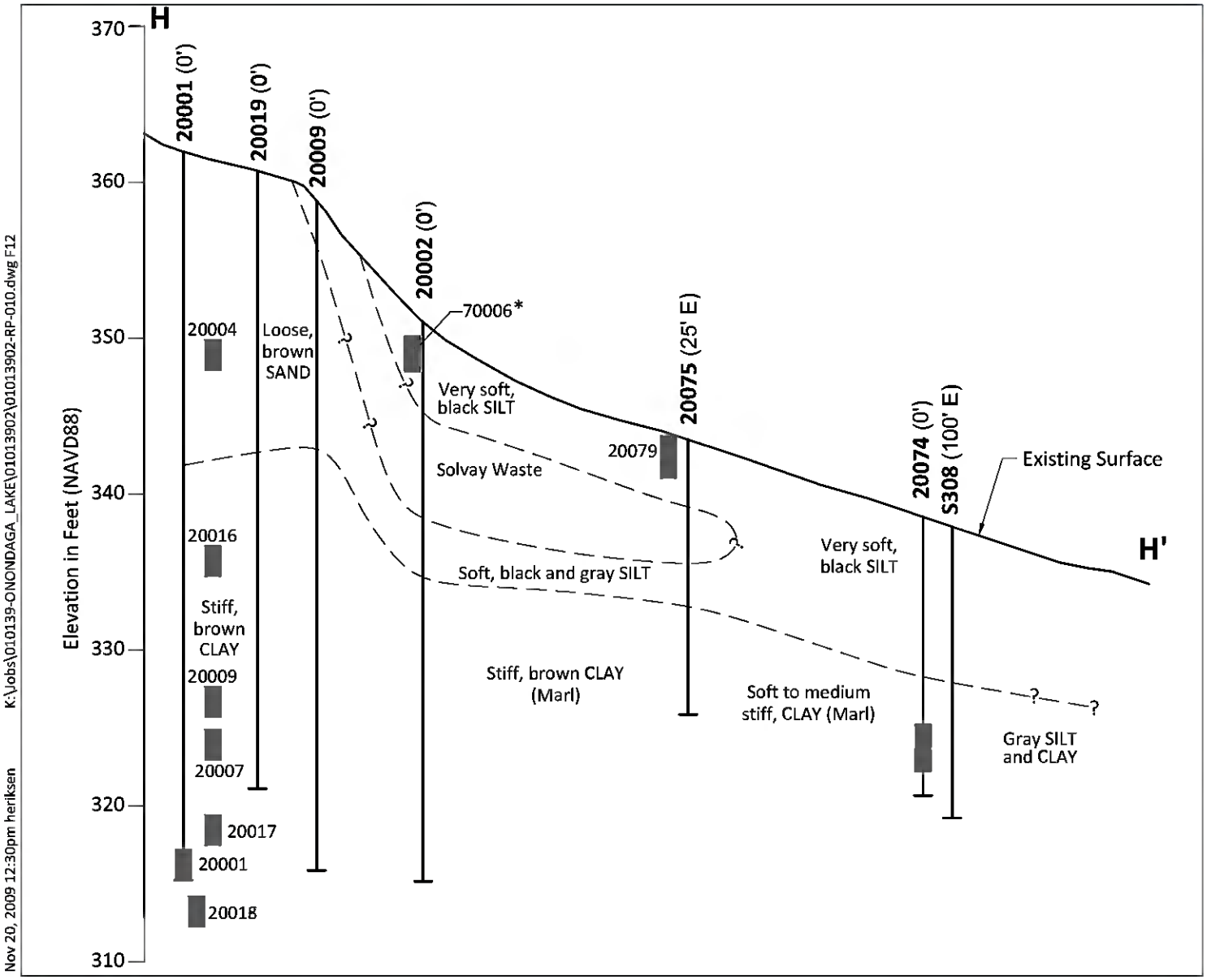
Nov 20, 2009 12:30pm heriksen

ANCHOR QEA

Figure 11
Typical Cross Section G-G' - Remediation Area C
Cap-Induced Settlement Evaluation
Onondaga Lake



LEGEND:

S308 Sediment Core Number
(100' E) Offset Distance in Feet

Sediment Core Location

Consolidation Sample Location

Bottom of Sediment Core

Horizontal Scale in Feet
0 100
0 10
Vertical Scale in Feet
Vertical Exaggeration x 10

NOTES:
1. See Figure 9 for cross section location.
2. Sand observed below CLAY (Marl) layer at 5S' to 6S' deep in borings 20016, 20017, and 20018.

* Comparable unit in Remediation Area E used for Remediation Area C estimate.

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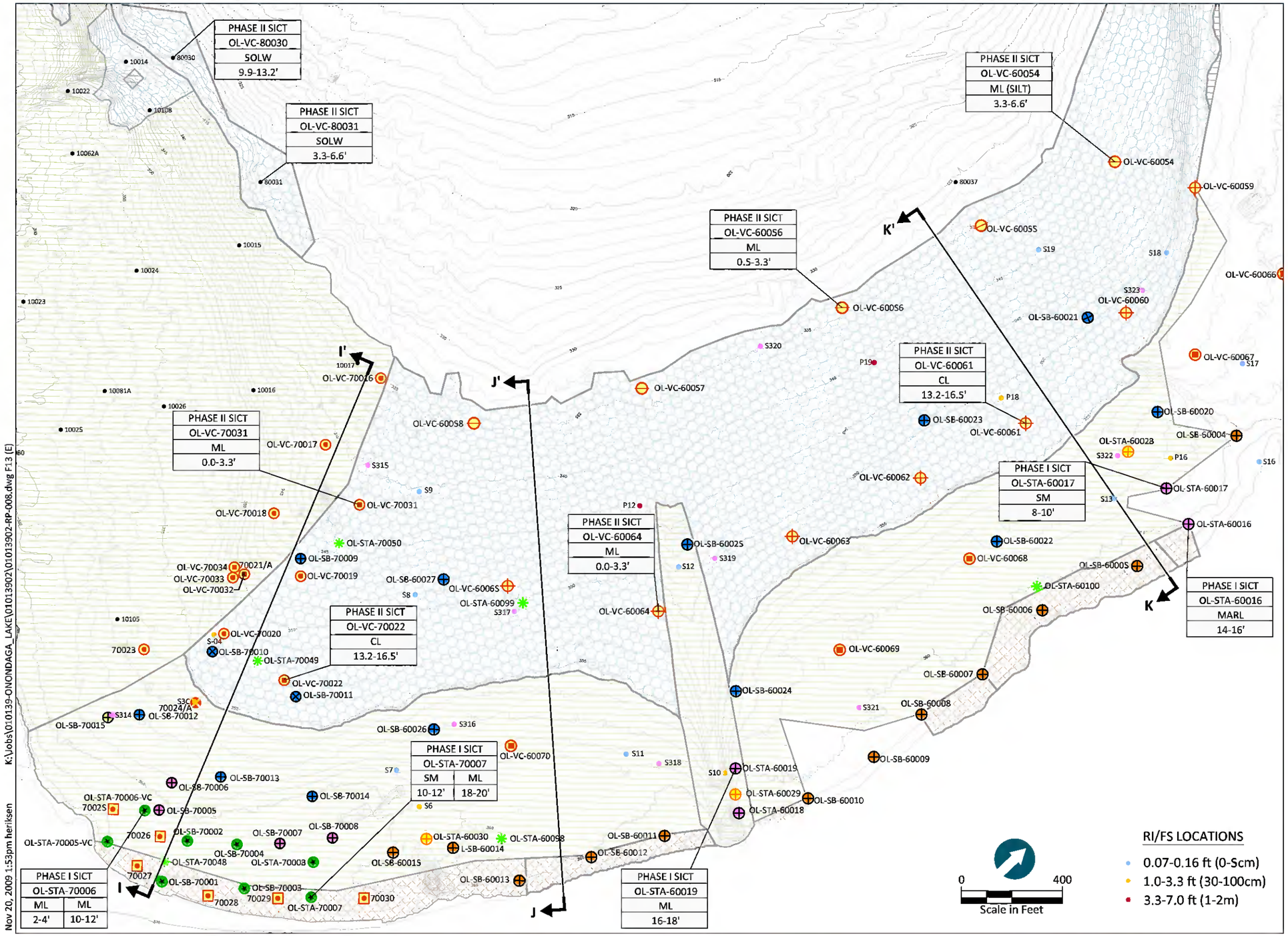
Nov 20, 2009 12:30pm heriksen

Figure 12
Typical Cross Section H-H' - Remediation Area C
Cap-Induced Settlement Evaluation
Onondaga Lake

ANCHOR QEA



LEGEND:

- 340 — Existing Bathymetric Contour in Feet
- Dredge and Cap
- Dredge Only
- Cap Only
- H' — Cross Section Location and Designation

PHASE II SICT	Test Type
OL-STA-40032	Boring ID
CL (MARL)	Soil Type
13.2-16.4'	Sampling Depth

(SICT - Seepage-Induced Consolidation Test)

PHASE II PDI SAMPLE LOCATIONS

- 20 ft (6m) Core (Sample 0-0.5 ft and 0.5-3.3 ft)
- 20 ft (6m) Core (Sample on 3.3 ft intervals to 10 ft)
- 20 ft (6m) Core (Sample on 3.3 ft intervals to 20 ft)
- 20 ft (6m) Co-located Core (Sample on 3.3 ft intervals to 20 ft)
- 20 ft (6m) Core (Sample 3.3 ft intervals to 13 ft)
- Bulk Density Sample

PHASE I PDI SAMPLE LOCATIONS

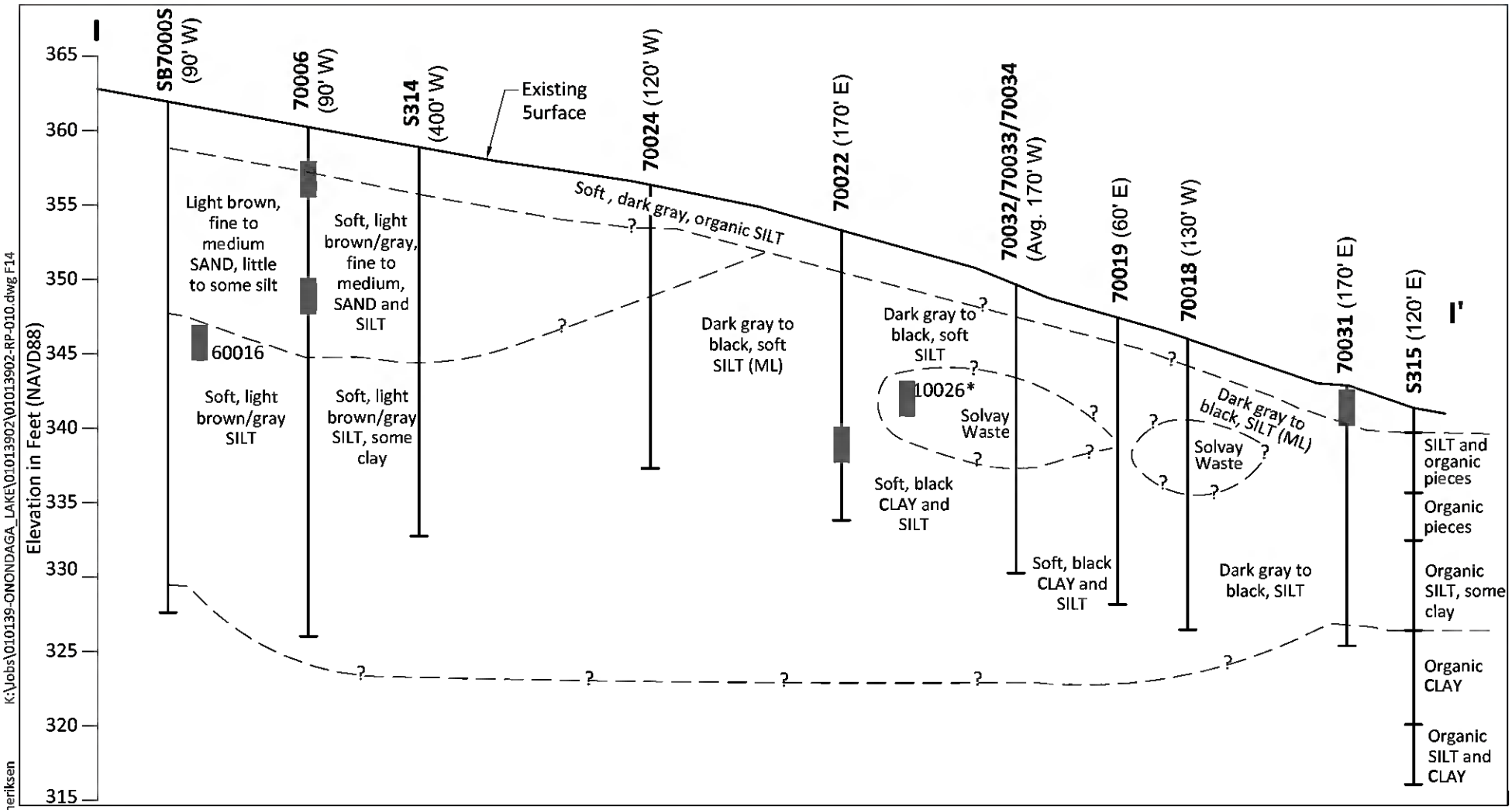
- 13 ft (4m) Core and Vane Shear/Atterberg Limits
- 33 ft (10m) Boring, 13 ft (4m) Core, Vane Shear/ Atterberg Limits and Porewater Samples (Groundwater Model)
- Vane Shear/Atterberg Limits (No Chemical Analysis)
- Bulk Sediment and Water Sample for Emissions, Column Settling, and Effluent Elutrite Testing (3 Locations, 1 Composite)
- Bulk Sediment Sample for Emissions and Odor Testing
- 20 Ft (6m) Core

SOURCE:
1. Basemap provided to Anchor QEA by Parsons in September 2008.
2. All samples provided by Parsons, 2006.

VERTICAL DATUM: North American Vertical Datum of 1988 (NAVD88), U.S. Survey Feet.
HORIZONTAL DATUM: New York State Plane, Central Zone, North American Datum of 1983 (NA083), U.S. Survey Feet.
BATHYMETRIC SURVEY: Performed by CR Environmental, Inc., for Honeywell in 2005.
NOTE:
All locations and features are approximate.

ANCHOR QEA

Figure 13
Plan View Map of Remediation Area E
Cap-Induced Settlement Evaluation
Onondaga Lake



LEGEND:

70006 (90' W) — Sediment Core Number; Offset Distance in Feet

Sediment Core Location

Consolidation Sample Location

Bottom of Sediment Core

Horizontal Scale in Feet: 0 – 200

Vertical Scale in Feet: 0 – 10

Vertical Exaggeration x 20

NOTES:

1. See Figure 14 for cross section location.

* Comparable unit in Remediation Area D used for Remediation Area E estimate. Also used 10080, 10081, and 10105.

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Nov 20, 2009 12:35pm heriksen

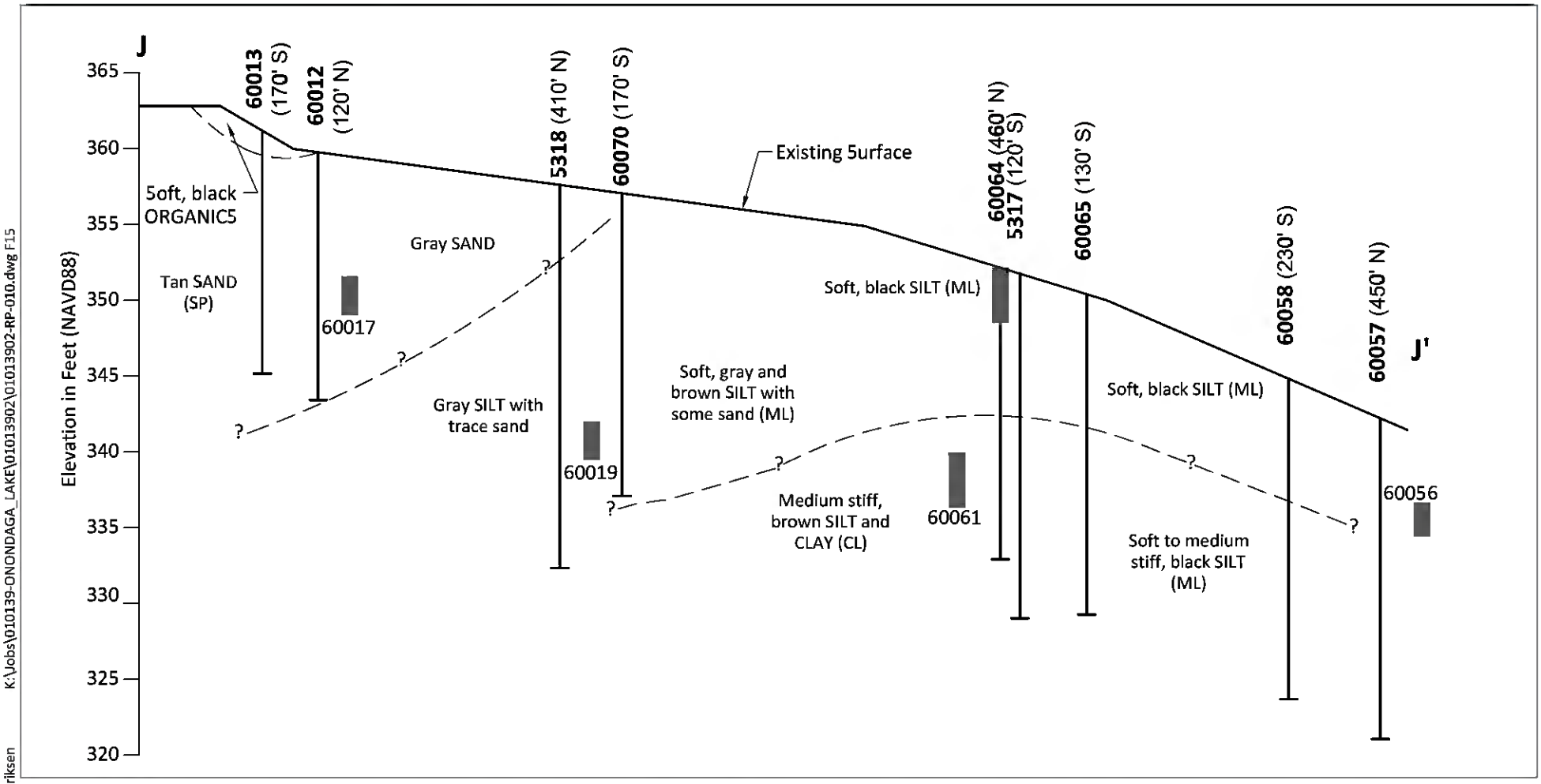
ANCHOR QEA

Figure 14

Typical Cross Section I-I' - Remediation Area E

Cap-Induced Settlement Evaluation

Onondaga Lake



LEGEND:

60065 Sediment Core Number
(130' S) Offset Distance in Feet

Sediment Core Location

Consolidation Sample Location

Bottom of Sediment Core

Horizontal Scale in Feet
0 200
0 10
Vertical Scale in Feet
Vertical Exaggeration x 20

NOTE:
1. See Figure 13 for cross section location.

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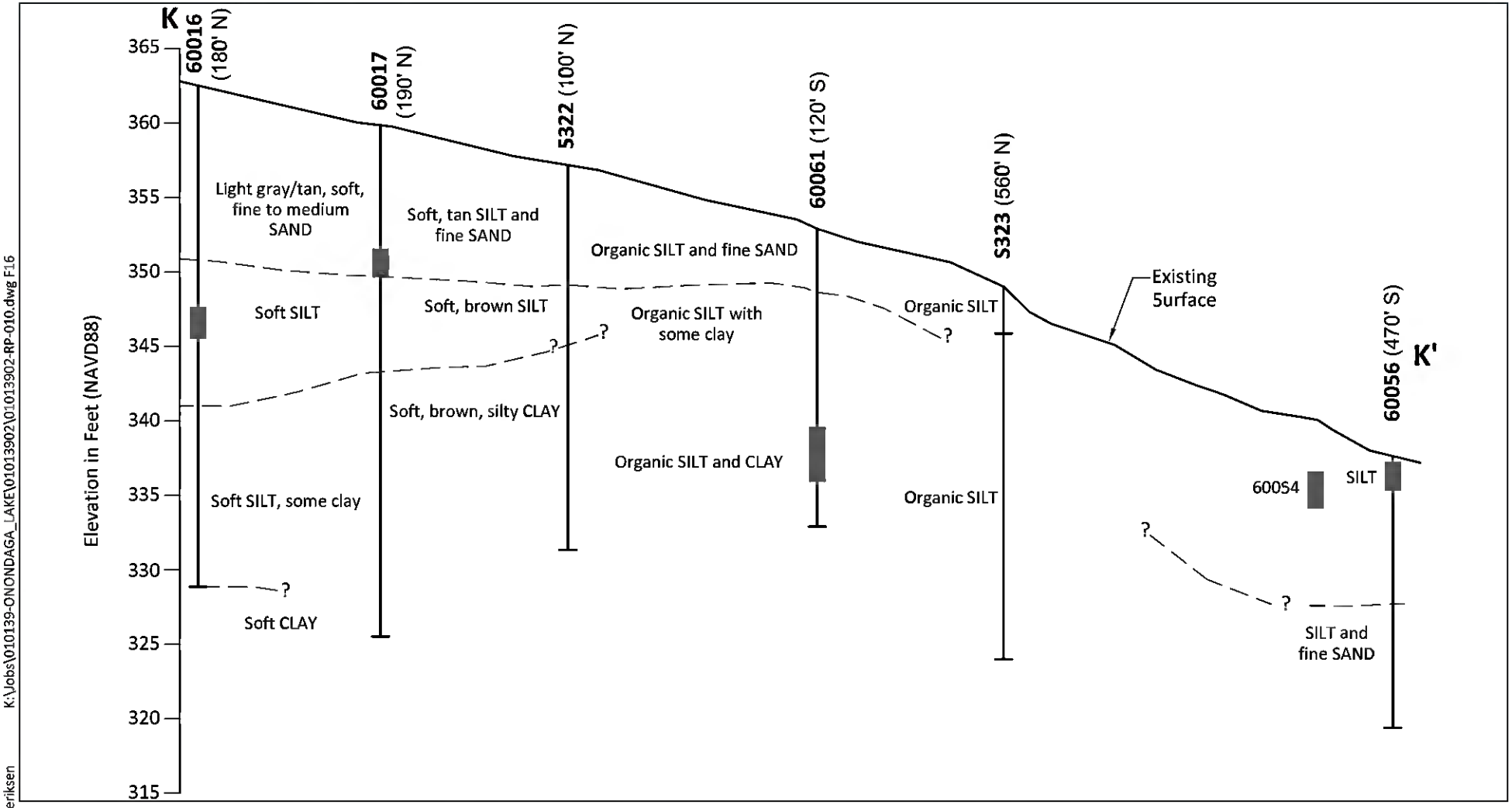
Nov 20, 2009 12:57pm heriksen

ANCHOR QEA

Figure 15
Typical Cross Section J-J' - Remediation Area E
Cap-Induced Settlement Evaluation
Onondaga Lake



LEGEND:

60017 (190' N) Sediment Core Number
Offset Distance in Feet

Sediment Core Location

Consolidation Sample Location

Bottom of Sediment Core

Horizontal Scale in Feet
0 200
0 10
Vertical Scale in Feet
Vertical Exaggeration x 20

NOTE:
1. See Figure 13 for cross section location.

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Nov 20, 2009 1:00pm heriksen

ANCHOR QEA

Figure 16
Typical Cross Section K-K' - Remediation Area E
Cap-Induced Settlement Evaluation
Onondaga Lake

ATTACHMENT A
CONSOLIDATION TEST DATA SUMMARY

Attachment A - Consolidation Data Summary - SIC Test

Location ID	Field Sample ID	Sample Depth	Remediation Area	Soil Stratum	Initial Void Ratio (e_o)	SICT Parameters					Boring/Coring Log Description		Water Content (ASTM D2216)	Atterberg Limits (ASTM D 4318)			Grain Size (ASTM D 422)					Specific Gravity (ASTM D 854)	Soil Classification	Calculated Bulk Density
						A	B	Z	C	D				Liquid Limit	Plastic Limit	Plasticity Index	Percent Gravel	Percent Sand	Percent Fines (clay & silt)	Clay-sized Particle Content (0.005 mm)	Clay-sized Particle Content (0.002 mm)			
		[ft]			[-]	[-]	[-]	[kPa]	[m/sec]	[-]			[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[-]		[pcf]
OL-VC-70022	OL-0297-04	13.2'-16.5'	E	Clay and Silt	5.52	3.28	-0.146	0.028	2.30E-10	4.82	Wet to moist, soft, black, CLAY and SILT, slight petroleum odor, moderate plasticity, one inch long wood fragment at 36 inches.	CL	84	71	36	35	0	3	97	20	16	2.58	MH	93.5
OL-VC-60061	OL-0298-03	13.2' - 16.5'	E	Clay and Silt, Organic Silt, Medium Stiff Clay	5.30	3.46	-0.178	0.091	4.80E-10	4.17	Moist, soft, medium stiff, dark gray to dark brown CLAY, some silt, trace fine sand, moderate to high plasticity, light brown poorly sorted fine sand seam at 37 inches, 1 inch thick piece of wood at 23 inches and wood fragments throughout.	CL	80	75	41	34	0	15.5	84.5	29	19	-	MH	94.3
OL-STA-40001	OL-0113-01	6.6'-9.9'	A	Fine to Medium Sand	2.58	2.11	-0.117	0.179	1.00E-08	3.61	Wet, loose, gray fine SAND, little shells, little fines, sulfur odor.	SM	53	36	26	10	0	23.2	76.8	14	10	2.65	ML	105.2
OL-STA-40002	OL-0113-02	9.9'-13.2'	A	Fine to Medium Sand	3.33	3.86	-0.209	2.005	1.30E-09	5.33	Wet, soft, tan/gray, FM SAND, little to some silt, trace clay	SP	-	-	-	-	-	-	-	-	-	-	-	-
OL-STA-40003	OL-0113-03	9.9'-13.2'	A	Fine to Medium Sand	3.66	4.47	-0.242	2.27	7.50E-10	3.32	Wet, soft, gray FM SAND, little to some silt. Bottom 1 ft is wet, soft, brown SILT and clay	SP	65	59	35	24	0	16.3	83.7	32	19	2.58	MH	99.2
OL-VC-20074	OL-0297-01	13.2'-16.5'	C	Marl	6.05	3.51	-0.13	0.015	1.90E-10	3.56	Moist, soft to medium stiff, gray CLAY, some to little silt, moderate plasticity, trace shells, sulfur odor (MARL)	CL (Marl)	71	77	36	41	0	1	99	70	45	2.69	MH	98.6
OL-VC-30043	OL-0302-05	13.2'-16.5'	B	Marl	5.30	3.3	-0.149	0.041	2.50E-09	4.11	Wet, soft, gray SILT, little clay, little fine sand, little shells, trace organics, low plasticity, sulfur odor (MARL)	ML (Marl)	0.76	62	38	24	0	0.255	0.745	-	-	2.45	MH	94.0
OL-VC-40016	OL-0302-06	13.2'-16.5'	A	Marl	5.91	3.73	-0.184	0.082	2.50E-10	3.09	Moist, brown, soft CLAY, some silt, trace shells, moderate plasticity (MARL)	CL (Marl)	80	86	39	47	0	0.6	99.4	72	48	-	MH	94.3
OL-VC-40032	OL-0302-09	13.2'-16.5'	A	Marl	5.97	3.88	-0.167	0.076	8.00E-11	5.17	Moist, stiff, brown CLAY, little silt, trace organics, trace shells, slight decomposing odor, high plasticity	CL (Marl)	-				0	17.3	82.7	28	23	2.53	N/A	157.9
OL-STA-30033	OL-0298-01	35.0' - 37.0'	C	Marl	4.78	4.95	-0.247	1.153	2.00E-09	2.49	Wet, very soft, dark gray to black SILT and CLAY, slight sulfur odor, medium plasticity	MI/CL (Marl)	0.73	63	36	27	0	0.004	0.996	-	-	2.74	MH	98.6
OL-VC-30036	OL-0302-02	6.6'-9.9'	B	Marl, Solvay Waste	8.90	4.92	-0.149	0.018	1.80E-10	4.19	0-27 inches is wet, soft to stiff grayish-green to bluish-green silt-like grains, trace fine sand mothball and ammonia odor (SOLW). 27 in to 31 inches is wet, soft, black SILT, little fine sand, slight mothball odor (ML). 31 inches is wet, soft, black SILT, little fine sand, slight mothball odor (ML). 31 inches to rest of core is wet, soft, dark brown silt and clay, moderate plasticity, trace shells, sulfur odor (MARL)	SOLW/ML/ MARL	-	-	-	-	-	-	-	-	-	-	-	-
OL-STA-70006	OL-0112-04	2'-4'	C, E	Organic Silt	2.67	2.64	-0.194	0.943	6.90E-09	4.05	Boring: Wet, soft, black F SAND, some Silt Core: Wet, soft, black SILT, trace F Sand	ML	61	58	33	25	0.3	26.2	73.5	26	16	2.52	MH	99.8
OL-VC-20079	OL-0297-02	0.0'-3.3'	B, C	Organic Silt	4.34	4.17	-0.205	0.823	7.90E-09	2.29	Wet, very soft, black to dark gray SILT, trace organics, petroleum-like odor	ML	105	55	36	19	0	0.7	99.3	11	7	2.58	MH	89.0
OL-VC-70031	OL-0297-03	0.0'- 3.3'	E	Organic Silt	7.22	4.7	-0.194	0.109	8.10E-11	3.74	Wet, very soft to soft, black SILT, trace clay, trace fine sand, organic odor	ML	131	103	45	58	0	2.2	97.8	29	19	-	MH	84.7
OL-STA-60016	OL-0112-01	14'-16'	E	Organic Silt, Soft Silt	3.00	3.49	-0.195	2.19	5.30E-09	3.34	Wet, light gray SILT and F Sand (Marl)	Marl	-	-	-	-	-	-	-	-	-	-	-	-
OL-VC-40021	OL-0302-07	3.3'-6.6'	A	Silt	3.81	2.64	-0.146	0.081	2.40E-09	3.28	Wet, soft, grayish brown and black, little clay, trace organics, low plasticity, trace fine angular gravel	ML (Silt)	73	53	29	24	0	1.2	98.8	45	24	2.67	CH	97.7
OL-VC-40025	OL-0302-08	3.3'-6.6'	A	Silt	4.84	3.76	-0.099	0.077	3.90E-09	3.63	Wet, very soft, dark gray SILT, trace clay, trace organics, ammonia-like odor	ML	103	57	36	21	0	0.5	99.5	18	11	-	MH	89.1
OL-VC-40034	OL-0302-10	16.5'-17.8'	A	Silt	3.32	2.29	-0.127	0.054	1.60E-09	3.44	Wet, soft, grayish-brown, SILT, little clay, little fine sand, trace organics, slight sulfur odor, trace shells (MARL)	ML (Marl)	69	44	28	16	0	24.3	75.7	44	33	-	ML	97.6
OL-STA-60017	OL-0112-03	8'-10'	E	Silt and Fine Sand	3.11	2.85	-0.134	0.524	2.00E-09	3.71	Wet, soft, tan SILT and F Sand	SM	74	53	34	19	0	11.2	88.8	22	14	2.61	MH	96.7
OL-STA-70006	OL-0112-05	10'-12'	E	Silt and Fine Sand	3.51	2.74	-0.091	0.065	5.60E-09	3.25	Boring: Wet, soft, tan/lt gray SILT, some F SAND Core: Wet, loose, lt brown F SAND, trace fines	ML	-	-	-	-	-	-	-	-	-	-	-	-
OL-VC-60054	OL-0298-04	3.3' - 6.6'	E	Silt and Fine Sand	6.69	4.13	-0.218	0.11	1.70E-10	3.67	Wet, soft, black SILT, some clay, trace fine sand, low plasticity, strong petroleum odor	ML (Silt)	135	90	40	50	0	4.2	95.8	22	18	-	MH	84.2
OL-STA-60019	OL-0112-02	16'-18'	E	Soft Silt	3.32	4.31	-0.239	2.98	2.00E-09	2.85	Wet, soft, brown SILT, little F Sand	ML	-	-	-	-	-	-	-	-	-	-	-	-
OL-VC-60064	OL-0298-06	0.0' – 3.3'	E	Soft Silt	4.56	3.1	-0.17	0.031	3.10E-10	3.9	Wet, soft, black, SILT, little to some clay, low plasticity, trace fine sand, trace organics, petroleum-like odor.	ML	94	74	37	37	0	8.9	91.1	28	20	2.53	MH	90.7
OL-VC-20070	OL-0302-01	9.9'-13.2'	C	Soft Silt and Clay	2.66	1.77	-0.137	0.051	1.70E-08	2.65	0 to 11 inches is wet, soft, gray SILT, little clay, trace fine sand, 11 inches to 26 inches is moist, dense, gray to red-brown, fine SAND and SILT, black organic discoloration at 22 inches. Rest of core is moist, stiff, red-brown, CLAY, some silt, high plasticity	ML/CL	0.48	42	26	16	0.005	0.168	0.827	-	-	-	ML	0.0
OL-VC-60056	OL-0298-02	0.5' - 3.3'	E	Soft Silt, and Silt and Fine Sand	6.09	4.15	-0.202	0.15	1.70E-10	3.79	Wet, soft, black SILT, some clay, little fine sand, low plasticity	ML	143	95	36	59	0	1.3	98.7	29	19	-	CH	83.3
OL-STA-10026-VC	OL-0119-03	3.3'-6.6'	E	Solvay Waste	12.34	4.68	-0.087	0.00001	4.00E-10	4.55	Wet, stiff, gray to light gray, very coarse sandstone-like grains (SOLW)	SOLW	0.89	69	45	24	0	0.553	0.447	-	-	-	SM	#REF!
OL-VC-10080	OL-0296-04	9.9'-13.2'	E	Solvay Waste	9.38	8.5	-0.114	0.424	1.80E-10	4.44	Wet, soft to medium stiff, gray white, silt-like grains, trace fine sand in top half of core, tan discoloration in top 2 inches of core, mothball odor.	SOLW	-	-	-	-	-	-	-	-	-	-	-	-
OL-VC-10081A	OL-0296-05	13.2'-16.5'	E	Solvay Waste	13.49	8.19	-0.104	0.008	1.30E-11	5.2	Wet, medium stiff to hard, silt-like grains, little fine sand, black fine sand seam at 36 inches, mothball odor.	SOLW	1.66	117	82	35	0.048	0.071	0.881	-	-	2.58	MH	81.1
OL-VC-10105	OL-0296-06	0-3.3'	E	Solvay Waste	8.68	6.62	-0.104	0.073	4.90E-10	4.4	0 to 5 inches is wet, soft, blue gray, wilt-like grains. Rest of core is wet, soft, gray, silt-like grains, trace fine sand, 12-inch thick Solvay chunks in lower half of core, moth ball odor.	SOLW	1.62	89	55	34	0	0.117	0.883	-	-	2.6	MH	81.6
OL-VC-30040	OL-0302-04	0.0'-3.3'	B	Solvay Waste	10.50	7.23	-0.114	0.039	9.60E-12	6.33	Wet, soft, grayish-green to grayish-white, silt-like grains, trace fine sand, mothball odor.	SOLW	1.27	90	52	38	0	0.016	0.984	-	-	2.18	MH	81.9

Attachment A - Consolidation Data Summary - Oedometer Test

Location ID	Field Sample ID	Sample Depth [ft]	Remediation Area	Soil Stratum	Compression Index (C_c) [-]	Recompression Index (C_r) [-]	Initial Void Ratio (e_o) [-]	Preconsolidation Pressure [tsf]	Coefficient of Consolidation (C_v) [1] [in^2/sec]	Water Content (ASTM D2216) [%]	Atterberg Limits (ASTM D 4318)			Grain Size (ASTM D 422)					Specific Gravity (ASTM D 854) [-]	Soil Classification	Bulk Density (ASTM D 2937) [pcf]	Organic Content (ASTM D 2974) (%)	Carbonate Content (ASTM D 4373) (%)
											Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	Percent Gravel [%]	Percent Sand [%]	Percent Fines (clay & silt) [%]	Clay-sized Particle Content (0.005 mm) [%]	Clay-sized Particle Content (0.002 mm) [%]					
OL-STA-10013	OL-0110-05	41-43	B	Brown Silt (Marl)	0.51	0.06	1.60	0.6	3E-04	79	83	35	48	0	0.3	99.7	-	-	2.61	CH	99	3.1	
OL-STA-10018	OL-0110-27	48-50	B	Brown Silt (Marl)	0.36	0.03	1.06	0.7	5E-04	34	33	18	15	0	0.5	99.5	-	-	2.79	CL	114	0.6	9
OL-STA-10022	OL-0110-49	64-66	B	Brown Silt (Marl)	0.70	0.06	1.85	0.8	8E-04	60	66	32	34	0	0.1	99.9	-	-		CH	-		
OL-STA-10024	OL-0052-12	64-66	B	Brown Silt (Marl)	0.57	0.09	1.81	0.6	2E-04	70	90	40	50	0	1.2	98.8	-	-	2.66	MH	97.9	6.8	48
OL-STA-10025	OL-0052-16	52-54	B	Brown Silt (Marl)	0.65	0.08	1.88	0.7	3E-04	67	94	38	56	0	0.5	99.5	-	-	2.61	CH	98	3.6	43
OL-STA-10026	OL-0052-22	50-52	B	Brown Silt (Marl)	0.69	0.09	1.99	0.7	1E-04	71	90	41	49	0	0.3	99.7	-	-	2.59	MH	96.4	5.7	43
OL-STA-30033	-	47-49	B, C	Marl	0.40	-	1.23	-	2E-07	-	-	-	-	-	-	-	-	-	-	ML	-	-	-
OL-STA-30033	-	51-53	B, C	Marl	0.16	-	0.70	-	8E-04	-	-	-	-	-	-	-	-	-	-	ML	-	-	-
OL-STA-20016	OL-0110-52	27-29	C	Brown Clay	0.19	0.04	0.89	0.4	3E-04	29	NP			0.1	0.2	99.7	-	-	2.75	ML	-		
OL-STA-20017	OL-0110-57	10-12	C	Soft Silt and Clay	0.51	0.01	1.42	0.4	3E-04	79	NP			0	15.7	84.3	-	-	2.67	ML	-	3	
OL-STA-20004	OL-0072-01	12-14	C	Clay and Silt	0.72	0.01	2.91	0.3	4E-03	108	77	51	26	0	2.6	97.4	43	30	-	MH	89.4	4.8	87
OL-STA-20001	OL-0072-09	44.9-46.9	C	Red/Brown Clay and Silt	0.26	0.04	0.95	0.5	2E-04	29	27	16	11	0	0.1	99.9	50	35	-	CL	122	1	78
OL-STA-20004	OL-0072-02	36.6-38.6	C	Red/Brown Clay and Silt	0.16	0.02	0.90	0.4	4E-04	27	26	14	12	0	0.6	99.4	46	34	-	CL	121	1.3	78
OL-STA-20007	OL-0072-05	38.6-40.6	C	Red/Brown Clay and Silt	0.49	0.05	1.33	0.5	1E-04	67	67	38	29	0	1.4	98.6	58	39	-	MH	106	2.5	9
OL-STA-20016	OL-0110-52	27-29	C	Red/Brown Clay and Silt	0.19	0.04	0.89	0.4	3E-04	29	Non-Plastic			0.1	0.2	99.7	11	8	2.75	ML	-	-	-
OL-STA-20017	OL-0110-59	42-44	C	Red/Brown Clay and Silt	0.22	0.03	0.87	0.6	1E-06	28	23	13	10	0	0.1	99.9	50	35	-	CL	127	-	-
OL-STA-20018	OL-0110-55	47-49	C	Red/Brown Clay and Silt	0.23	0.02	0.91	0.7	6E-04	33	35	16	19	0.1	0.3	99.6	53	36	-	CL	-	-	-

Notes:

1. Estimated average for range of stress induced during testing.

ATTACHMENT B
EXAMPLE SETTLEMENT CALCULATION

Module 2A (-7 to -10 ft)
Settlement Estimate For Onondaga Lake - Remediation Area C
Generalized Soil Profile F- Remediation Area C G-G'
(Dredge Plan Section 14)
Dredge Depth: 0 Enter 0
Cross Section G-G'

Cap Thickness (ft)	3.75
Buoyant Surcharge Thickness (ft)	0
Unit Wt. of Capping Material (pcf)	120
Unit Wt. of Layer 1 (pcf)	106
Unit Wt. of Layer 2 (pcf)	127
Unit Wt. of Water (pcf)	62.4

Hd max 32.5 ft Double drainage due to Sand at 65'

Assumed Cap (ft):		
	1.25	Habitat sand
	1	Gravel erosion protection
	1.5	Sand - chemical isolation
total	3.75	

Balance Dredge & Cap		
Dredge Cut	0.00	ft
Settlement	1.03	ft
Net Change	2.72	ft
Balance	#NAME?	ft

Summary of Results	
Dredge Cut Thickness	Net Change
0	3.88
1	3.10
2	2.25
3	1.37
4	0.47
5	-0.44
6	-1.36

Physical Parameters

	Water	Cap	20070 (9.9'-13.2') Soft silt and clay	20016 (27-29') Brown Clay		Sand
A	-		1.77			
B			-0.137			
Z (kPa)			0.051			
C (m/s)			1.70E-08			
D	-		2.65			
e_o	-			0.89		
c_c				0.19		
c_v (ft^2/day)				0.2		
Top Elevation in feet	362.8	362.1	358.3	343.3		
Thickness in feet*	4.5	3.8	15.0	50.0		
Bouyant unit weight in pcf:	-	57.6	44	65		
Total Estimated Settlement in inches:	12					

$e=A*(\sigma_v'+Z)^B$ [SI Units]
$k = C(e^D)$ [SI Units]
$\Delta H = Hc_v/(1+e_o)*\log((P_o+\Delta P)/P_o)$

Unit	Thickness in feet	Pre Cap in psf	Pre Cap in kPa	Pre Cap Void Ratio	Pre Cap Permeability k (m/s)	Delta Stress from Cap in psf	Delta Stress from Cap in kPa	Post Cap in psf	Post Cap kPa	Post Cap Void Ratio	Settlement in inches	Layer Total in inches
Soft silt and clay	1.50	32.73	1.57	1.66	6.48E-08	216.00	10.34	248.73	11.91	1.26	2.7	
	1.50	98.18	4.70	1.43	4.38E-08	216.00	10.34	314.18	15.04	1.22	1.6	
	1.50	163.64	7.84	1.33	3.65E-08	216.00	10.34	379.64	18.18	1.19	1.1	
	1.50	229.09	10.97	1.27	3.23E-08	216.00	10.34	445.09	21.31	1.16	0.9	
	1.50	294.55	14.10	1.23	2.95E-08	216.00	10.34	510.55	24.45	1.14	0.7	
	1.50	360.00	17.24	1.20	2.74E-08	216.00	10.34	576.00	27.58	1.12	0.6	
	1.50	425.46	20.37	1.17	2.58E-08	216.00	10.34	641.46	30.71	1.11	0.5	
	1.50	490.91	23.51	1.15	2.45E-08	216.00	10.34	706.91	33.85	1.09	0.5	
	1.50	556.37	26.64	1.13	2.34E-08	216.00	10.34	772.37	36.98	1.08	0.4	
15.00	1.50	621.82	29.77	1.11	2.25E-08	216.00	10.34	837.82	40.12	1.07	0.4	9.4
Brown Clay	5.00	816.05	39.07			216.00	10.34	1032.05	49.41		0.6	
	5.00	1139.05	54.54			216.00	10.34	1355.05	64.88		0.5	
	5.00	1462.05	70.00			216.00	10.34	1678.05	80.35		0.4	
	5.00	1785.05	85.47			216.00	10.34	2001.05	95.81		0.3	
	5.00	2108.05	100.93			216.00	10.34	2324.05	111.28		0.3	
	5.00	2431.05	116.40			216.00	10.34	2647.05	126.74		0.2	
	5.00	2754.05	131.86			216.00	10.34	2970.05	142.21		0.2	
	5.00	3077.05	147.33			216.00	10.34	3293.05	157.67		0.2	
	5.00	3400.05	162.80			216.00	10.34	3616.05	173.14		0.2	
50.00	5.00	3723.05	178.26			216.00	10.34	3939.05	188.60		0.2	3.0
Total Estimated Settlement										Inches	12.3	
				Avg.	3.31E-08					Feet	1.03	

Unit	Permeability k m/s	m_v kPa	m_v psf	cv m^2/s	cv ft2/day	cv converted ft^2/day	Hd ft	Time days	Tv
Soft silt and clay	3.14E-08	0.0145	0.0007	2.21E-07	2.06E-01	0.2057333	0.75	30	10.98
	2.88E-08	0.0083	0.0004	3.53E-07	3.28E-01	0.3280118	2.25	30	1.94
	2.69E-08	0.0060	0.0003	4.58E-07	4.26E-01	0.425834	3.75	30	0.91
	2.54E-08	0.0047	0.0002	5.52E-07	5.13E-01	0.512986	5.25	30	0.56
	2.42E-08	0.0039	0.0002	6.38E-07	5.94E-01	0.593489	6.75	30	0.39
	2.31E-08	0.0033	0.0002	7.20E-07	6.69E-01	0.6692362	8.25	30	0.30
	2.23E-08	0.0028	0.0001	7.97E-07	7.42E-01	0.7413185	9.75	30	0.23
	2.15E-08	0.0025	0.0001	8.71E-07	8.11E-01	0.8104416	11.25	30	0.19
	2.08E-08	0.0022	0.0001	9.43E-07	8.77E-01	0.8770972	12.75	30	0.16
15.00	2.02E-08	0.0020	0.0001	1.01E-06	9.42E-01	0.941646	14.25	30	0.14
Brown Clay					0.18		17.50	30	0.02
					0.18		22.50	30	0.01
					0.18		27.50	30	0.01
					0.18		32.50	30	0.01
					0.18		27.50	30	0.01
					0.18		22.50	30	0.01
					0.18		17.50	30	0.02
					0.18		12.50	30	0.03
					0.18		7.50	30	0.10
50.00					0.18		2.50	30	0.86
				avg	2.45E-08				

% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time
%	in inches	days		%	in inches	days		%	in inches	days		%	in inches	days		%	in inches	days		%	in inches	days		%	in inches	days
100.000	2.7	60	21.95	100.000	2.7	90	32.93	100.000	2.7	180	65.86	100.000	2.7	360	131.71	100.000	2.7	540	197.57	100.000	2.7	720	263.43	100.000	2.7	900
99.332	1.5	60	3.89	99.994	1.6	90	5.83	100.000	1.6	180	11.67	100.000	1.6	360	23.33	100.000	1.6	540	35.00	100.000	1.6	720	46.67	100.000	1.6	900
91.392	1.0	60	1.82	99.086	1.1	90	2.73	99.903	1.1	180	5.45	100.000	1.1	360	10.91	100.000	1.1	540	16.36	100.000	1.1	720	21.81	100.000	1.1	900
79.571	0.7	60	1.12	94.853	0.8	90	1.68	98.703	0.9	180	3.35	99.979	0.9	360	6.70	100.000	0.9	540	10.05	100.000	0.9	720	13.41	100.000	0.9	900
69.103	0.5	60	0.78	88.226	0.6	90	1.17	95.513	0.7	180	2.35	99.752	0.7	360	4.69	99.999	0.7	540	7.04	100.000	0.7	720	9.38	100.000	0.7	900
60.860	0.4	60	0.59	81.105	0.5	90	0.89	90.878	0.6	180	1.77	98.974	0.6	360	3.54	99.987	0.6	540	5.31	100.000	0.6	720	7.08	100.000	0.6	900
54.587	0.3	60	0.47	74.459	0.4	90	0.70	85.665	0.5	180	1.40	97.465	0.5	360	2.81	99.921	0.5	540	4.21	99.998	0.5	720	5.62	100.000	0.5	900
49.465	0.2	60	0.38	68.598	0.3	90	0.58	80.457	0.4	180	1.15	95.289	0.4	360	2.31	99.726	0.5	540	3.46	99.984	0.5	720	4.61	99.999	0.5	900
45.405	0.2	60	0.32	63.541	0.3	90	0.49	75.551	0.3	180	0.97	92.627	0.4	360	1.94	99.330	0.4	540	2.91	99.939	0.4	720	3.89	99.994	0.4	900
42.094	0.2	60	0.28	59.530	0.2	90	0.42	71.065	0.3	180	0.83	89.674	0.3	360	1.67	98.685	0.4	540	2.50	99.832	0.4	720	3.34	99.979	0.4	900
14.984	0.1	60	0.04	21.190	0.1	90	0.05	25.952	0.2	180	0.11	36.702	0.2	360	0.21	51.904	0.3	540	0.32	62.956	0.4	720	0.42	71.469	0.4	900
11.654	0.1	60	0.02	16.481	0.1	90	0.03	20.185	0.1	180	0.06	28.546	0.1	360	0.13	40.370	0.2	540	0.19	49.443	0.2	720	0.26	57.092	0.3	900
9.535	0.0	60	0.01	13.484	0.0	90	0.02	16.515	0.1	180	0.04	23.356	0.1	360	0.09	33.030	0.1	540	0.13	40.453	0.1	720	0.17	46.712	0.2	900
8.068	0.0	60	0.01	11.410	0.0	90	0.02	13.974	0.0	180	0.03	19.763	0.1	360	0.06	27.949	0.1	540	0.09	34.230	0.1	720	0.12	39.525	0.1	900
9.535	0.0	60	0.01	13.484	0.0	90	0.02	16.515	0.0	180	0.04	23.356	0.1	360	0.09	33.030	0.1	540	0.13	40.453	0.1	720	0.17	46.712	0.1	900
11.654	0.0	60	0.02	16.481	0.0	90	0.03	20.185	0.0	180	0.06	28.546	0.1	360	0.13	40.370	0.1	540	0.19	49.443	0.1	720	0.26	57.092	0.1	900
14.984	0.0	60	0.04	21.190	0.0	90	0.05	25.952	0.1	180	0.11	36.702	0.1	360	0.21	51.904	0.1	540	0.32	62.956	0.1	720	0.42	71.469	0.1	900
20.977	0.0	60	0.07	29.666	0.1	90	0.10	36.333	0.1	180	0.21	51.383	0.1	360	0.41	70.866	0.1	540	0.62	82.536	0.2	720	0.83	89.531	0.2	900
34.962	0.1	60	0.19	49.443	0.1	90	0.29	60.170	0.1	180	0.58	80.433	0.1	360	1.15	95.278	0.2	540	1.73	98.860	0.2	720	2.30	99.725	0.2	900
90.387	0.1	60	1.73	98.860	0.1	90	2.59	99.865	0.2	180	5.18	100.000	0.2	360	10.37	100.000	0.2	540	15.55	100.000	0.2	720	20.74	100.000	0.2	900
Total	8.2				9.2				9.7				10.3				10.8				11.0				11.2	

Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement
	%	in inches	days		%	in inches	days		%	in inches	days		%	in inches	days		%	in inches	days		%	in inches	days		%	in inches	days		%	in inches
329.29	100.000	2.7	1080	395.14	100.000	2.7	1260	461.00	100.000	2.7	1440	526.86	100.000	2.7	1620	592.71	100.000	2.7	1800	658.57	100.000	2.7	2520	922.00	100.000	2.7	4140	1514.71	100.000	2.7
58.33	100.000	1.6	1080	70.00	100.000	1.6	1260	81.67	100.000	1.6	1440	93.33	100.000	1.6	1620	105.00	100.000	1.6	1800	116.67	100.000	1.6	2520	163.33	100.000	1.6	4140	268.33	100.000	1.6
27.26	100.000	1.1	1080	32.72	100.000	1.1	1260	38.17	100.000	1.1	1440	43.62	100.000	1.1	1620	49.07	100.000	1.1	1800	54.53	100.000	1.1	2520	76.34	100.000	1.1	4140	125.41	100.000	1.1
16.76	100.000	0.9	1080	20.11	100.000	0.9	1260	23.46	100.000	0.9	1440	26.81	100.000	0.9	1620	30.16	100.000	0.9	1800	33.51	100.000	0.9	2520	46.92	100.000	0.9	4140	77.08	100.000	0.9
11.73	100.000	0.7	1080	14.07	100.000	0.7	1260	16.42	100.000	0.7	1440	18.76	100.000	0.7	1620	21.11	100.000	0.7	1800	23.45	100.000	0.7	2520	32.84	100.000	0.7	4140	53.95	100.000	0.7
8.85	100.000	0.6	1080	10.62	100.000	0.6	1260	12.39	100.000	0.6	1440	14.16	100.000	0.6	1620	15.93	100.000	0.6	1800	17.70	100.000	0.6	2520	24.79	100.000	0.6	4140	40.72	100.000	0.6
7.02	100.000	0.5	1080	8.42	100.000	0.5	1260	9.83	100.000	0.5	1440	11.23	100.000	0.5	1620	12.64	100.000	0.5	1800	14.04	100.000	0.5	2520	19.66	100.000	0.5	4140	32.30	100.000	0.5
5.77	100.000	0.5	1080	6.92	100.000	0.5	1260	8.07	100.000	0.5	1440	9.22	100.000	0.5	1620	10.38	100.000	0.5	1800	11.53	100.000	0.5	2520	16.14	100.000	0.5	4140	26.52	100.000	0.5
4.86	99.999	0.4	1080	5.83	100.000	0.4	1260	6.80	100.000	0.4	1440	7.77	100.000	0.4	1620	8.74	100.000	0.4	1800	9.72	100.000	0.4	2520	13.60	100.000	0.4	4140	22.34	100.000	0.4
4.17	99.997	0.4	1080	5.01	100.000	0.4	1260	5.84	100.000	0.4	1440	6.68	100.000	0.4	1620	7.51	100.000	0.4	1800	8.35	100.000	0.4	2520	11.69	100.000	0.4	4140	19.20	100.000	0.4
0.53	78.025	0.5	1080	0.63	83.075	0.5	1260	0.74	86.964	0.5	1440	0.85	89.960	0.6	1620	0.95	92.267	0.6	1800	1.06	94.044	0.6	2520	1.48	97.904	0.6	4140	2.43	99.800	0.6
0.32	63.194	0.3	1080	0.38	68.572	0.3	1260	0.45	73.164	0.3	1440	0.51	77.085	0.4	1620	0.58	80.433	0.4	1800	0.64	83.292	0.4	2520	0.90	91.117	0.4	4140	1.47	97.856	0.5
0.21	52.225	0.2	1080	0.26	57.210	0.2	1260	0.30	61.322	0.2	1440	0.34	65.203	0.2	1620	0.39	68.695	0.3	1800	0.43	71.836	0.3	2520	0.60	81.549	0.3	4140	0.99	92.876	0.3
0.15	44.191	0.1	1080	0.18	48.408	0.1	1260	0.21	52.287	0.2	1440	0.25	55.897	0.2	1620	0.28	59.288	0.2	1800	0.31	61.970	0.2	2520	0.43	71.906	0.2	4140	0.71	85.786	0.3
0.21	52.225	0.1	1080	0.26	57.210	0.1	1260	0.30	61.322	0.2	1440	0.34	65.203	0.2	1620	0.39	68.695	0.2	1800	0.43	71.836	0.2	2520	0.60	81.549	0.2	4140	0.99	92.876	0.2
0.32	63.194	0.1	1080	0.38	68.572	0.2	1260	0.45	73.164	0.2	1440	0.51	77.085	0.2	1620	0.58	80.433	0.2	1800	0.64	83.292	0.2	2520	0.90	91.117	0.2	4140	1.47	97.856	0.2
0.53	78.025	0.2	1080	0.63	83.075	0.2	1260	0.74	86.964	0.2	1440	0.85	89.960	0.2	1620	0.95	92.267	0.2	1800	1.06	94.044	0.2	2520	1.48	97.904	0.2	4140	2.43	99.800	0.2
1.04	93.725	0.2	1080	1.24	96.238	0.2	1260	1.45	97.745	0.2	1440	1.66	98.648	0.2	1620	1.87	99.190	0.2	1800	2.07	99.514	0.2	2520	2.90	99.937	0.2	4140	4.77	99.999	0.2
2.88	99.934	0.2	1080	3.46	99.984	0.2	1260	4.03	99.996	0.2	1440	4.61	99.999	0.2	1620	5.18	100.000	0.2	1800	5.76	100.000	0.2	2520	8.06	100.000	0.2	4140	13.25	100.000	0.2
25.92	100.000	0.2	1080	31.10	100.000	0.2	1260	36.29	100.000	0.2	1440	41.47	100.000	0.2	1620	46.66	100.000	0.2	1800	51.84	100.000	0.2	2520	72.58	100.000	0.2	4140	119.23	100.000	0.2
		11.4				11.5				11.6				11.7				11.8				11.9				12.0				12.2

ATTACHMENT C
SUMMARY OF MODELING INPUTS AND RESULTS

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 0.5 yr	2 yr	10 yr
A	1 (-20 to -30 ft)	C-C'	1	0	2.25	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	12	<0.1	0.2	0.7	0.7	87%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	0	2.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	9.9	<0.1	<0.1	0.36	0.36	92%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	0	2.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	9.8	<0.1	<0.1	0.16	0.16	95%	100%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
			4	0	2.25	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	11.7	<0.1	0.5	1.5	1.5	75%	93%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
			5	0	2.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	13.6	<0.1	<0.1	0.5	0.5	90%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
		B-B'	1	0	2.25	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	11.7	<0.1	0.5	1.5	1.5	75%	93%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
			2	0	2.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	13.6	<0.1	<0.1	0.5	0.5	90%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
		A-A'	1	0	2.25	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	12	<0.1	0.2	0.7	0.7	87%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	0	2.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	9.9	<0.1	<0.1	0.36	0.36	92%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	0	2.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	9.8	<0.1	<0.1	0.16	0.16	95%	100%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
	2A (-7 to -20 ft)	A-A'	1	0	2.75	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	13.8	<0.1	0.2	0.7	0.7	87%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	0	2.75	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	11.5	<0.1	<0.1	0.4	0.4	91%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	0	2.75	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	11.3	<0.1	<0.1	0.2	0.2	95%	99%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
		B-B'	1	0	2.75	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	13.6	0.1	0.6	1.5	1.5	74%	92%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
			2	0	2.75	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	15.8	<0.1	<0.1	0.5	0.5	89%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
		C-C'	1	0	2.75	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	13.8	<0.1	0.2	0.7	0.7	87%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	0	2.75	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	11.5	<0.1	<0.1	0.4	0.4	91%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	0	2.75	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	11.3	<0.1	<0.1	0.2	0.2	95%	99%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
			4	0	2.75	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	13.6	0.1	0.6	1.5	1.5	74%	92%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
			5	0	2.75	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	15.8	<0.1	<0.1	0.5	0.5	89%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
	3A (-3 to -7 ft)	C-C'	1	0.5 to 4.75	4.25	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	8.2	<0.1	0.2	0.7	0.7	88%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	0.5 to 4.75	4.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	6.7	<0.1	<0.1	0.3	0.3	92%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	0.5 to 4.75	4.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	6.6	<0.1	<0.1	0.1	0.1	96%	100%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
			4	0.5 to 4.75	4.25	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	7.9	<0.1	0.4	1.4	1.4	76%	93%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			15	31.9								
			5	0.5 to 4.75	4.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	12.7	<0.1	<0.1	0.5	0.5	90%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
		A-A'	1	0.5 to 2.6	4.25	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	13.5	<0.1	0.2	0.7	0.7	87%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	0.5 to 2.6	4.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	11.2	<0.1	<0.1	0.4	0.4	91%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	0.5 to 2.6	4.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	11	<0.1	<0.1	0.1	0.1	95%	99%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
		B-B'	1	0.5 to 1.75	4.25	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	15.1	0.1	0.6	1.6	1.6	74%	92%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			15	31.9								
			2	0.5 to 1.75	4.25	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	18.4	<0.1	<0.1	0.7	0.7	89%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 0.5 yr	2 yr	10 yr
	3A (-2 to -3 ft)	C-C'	1	4.5 to 4.5	5	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	12	<0.1	0.2	0.7	0.7	87%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	4.5 to 4.5	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	9.9	<0.1	<0.1	0.4	0.4	92%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	4.5 to 4.5	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	9.7	<0.1	<0.1	0.2	0.2	95%	99%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
			4	4.5 to 4.5	5	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	11.7	0.1	0.5	1.6	1.6	75%	93%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			15	31.9								
			5	4.5 to 4.5	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	16.4	<0.1	<0.1	0.6	0.6	89%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
		A-A'	1	0.5 to 2.8	5	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	15.5	<0.1	0.2	0.7	0.7	87%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	0.5 to 2.8	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	12.9	<0.1	<0.1	0.4	0.4	91%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	0.5 to 2.8	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	9.7	<0.1	<0.1	0.2	0.2	95%	99%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
		B-B'	1	0.5 to 1.8	5	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	17.4	0.1	0.5	1.6	1.6	74%	92%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			15	31.9								
			2	0.5 to 1.8	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	21	<0.1	<0.1	0.6	0.6	89%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
	5A-6A (-0.5 to -2 ft)	C-C'	1	2.5 to 3.4	5	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	14.3	<0.1	0.2	0.7	0.7	87%	98%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	2.5 to 3.4	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	11.9	<0.1	<0.1	0.4	0.4	91%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	2.5 to 3.4	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	11.7	<0.1	<0.1	0.2	0.2	95%	99%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
			4	2.5 to 3.4	5	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	14.2	0.1	0.6	1.6	1.6	74%	92%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			15	31.9								
			5	2.5 to 3.4	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	18.4	<0.1	<0.1	0.7	0.7	89%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
		A-A'	1	1.2 to 2	5	SILT	40021 (3.3-6.6')	2.64	-0.146	0.081	2.40E-09	3.28			15	35.3	17	<0.1	0.2	0.7	0.7	86%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			10	31.9								
			2	1.2 to 2	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	14.2	<0.1	<0.1	0.6	0.6	91%	97%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			10	31.9								
			3	1.2 to 2	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			15	35.3	14	<0.1	<0.1	0.2	0.2	95%	99%	100%
						Marl	40032 (13.2-16.5')	3.88	-0.167	0.076	8.00E-11	5.17			10	35.2								
		B-B'	1	0.5 to 1.8	5	SILT	40034 (16.5-17.8')	2.29	-0.127	0.054	1.60E-09	3.44			25	35.2	15.3	0.1	0.6	1.6	1.6	74%	92%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.5E-10	3.09			15	31.9								
			2	0.5 to 1.8	5	SILT	40025 (3.3-6.6')	3.76	-0.099	0.077	3.90E-09	3.63			25	26.7	19.2	<0.1	<0.1	0.7	0.7	88%	95%	100%
						Marl	40016 (13.2-16.5')	3.73	-0.184	0.082	2.50E-10	3.09			15	31.9								
		D-D'	1	0	3.25	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	31.3	<0.1	1.5	13	13	68%	76%	87%
						Gray SILT/CLAY/Fine SAND	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	106	38.65								
			2	0	3.25	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	29.6	<0.1	>15	>15	>15	67%	71%	71%
						Gray SILT/CLAY/Fine SAND	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	106	38.65								
			3	0	3.25	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	34.0	<0.1	0.5	>15	>15	77%	81%	86%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	90	38.7								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 0.5 yr	2 yr	10 yr
	1-2 (-10 to -30 ft)		4	0	3.25	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	32.6	<0.1	0.5	>15	>15	77%	78%	78%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	90	38.7								
			5	0	3.25	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	29.1	<0.1	0.1	1	1	88%	92%	95%
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	90	38.7								
		E-E'	1	0	3.25	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	17.1	<0.1	0.7	4.2	4.2	72%	84%	93%
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	125	38.7								
			2	0	3.25	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	26.6	0.4	4	>15	>15	52%	67%	82%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	125	38.7								
			3	0	3.25	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	23.8	>15	>15	>15	>15	41%	41%	42%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	125	38.7								
			4	0	3.25	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	26.2	0.2	4	15	15	56%	68%	86%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	123	38.65								
			5	0	3.25	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	17.9	<0.1	0.5	4	4	75%	85%	96%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	123	38.65								
			6	0	3.25	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	23.7	13	>15	>15	>15	49%	49%	50%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	123	38.65								
	2 (-7 to -10 ft)	D-D'	1	0	3.75	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	34.6	<0.1	2	15	15	67%	75%	87%
						Gray SILT/CLAY/Fine SAND	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	106	38.65								
			2	0	3.75	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	32.6	<0.1	>15	>15	>15	66%	70%	70%
						Gray	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	106	38.65								
			3	0	3.75	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	37.8	<0.1	0.5	>15	>15	76%	80%	85%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	90	38.7								
			4	0	3.75	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	36.1	<0.1	0.5	>15	>15	76%	77%	77%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	90	38.7								
			5	0	3.75	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	32.2	<0.1	<0.1	1.2	1.2	88%	91%	95%
						Brown SILT & CLAY (Marl)	30033 (51-53')								90	38.7								
			1	0	3.75	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	18.6	<0.1	0.8	5	5	71%	83%	92%
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	125	38.7								
			2	0	3.75	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	29.5	0.3	4	>15	>15	51%	66%	81%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	125	38.7								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 0.5 yr	2 yr	10 yr
B	3A (-4 to -7 ft)	E-E'	3	0	3.75	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	26.3	>15	>15	>15	>15	39%	40%	40%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	125	38.7								
			4	0	3.75	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	29.1	0.3	4	12	12	55%	67%	85%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	123	38.65								
			5	0	3.75	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	19.7	<0.1	0.5	4	4	74%	85%	96%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	123	38.65								
			6	0	3.75	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	26.3	<0.1	<0.1	<0.1	0.1	47%	48%	48%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	123	38.65								
		D-D'	1	0.5 to 5.9	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	29.6	<0.1	1.4	13	13	69%	77%	88%
						Gray SILT/CLAY/Fine SAND	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	106	38.65								
			2	0.5 to 5.9	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	28	<0.1	>15	>15	>15	68%	72%	72%
						Gray SILT/CLAY/Fine SAND	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	106	38.65								
			3	0.5 to 5.9	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	32.1	<0.1	0.3	>15	>15	77%	81%	86%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	90	38.7								
			4	0.5 to 5.9	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	30.7	<0.1	0.3	>15	>15	78%	79%	79%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	90	38.7								
			5	0.5 to 5.9	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	27.6	<0.1	0.1	1	1	88%	92%	95%
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	90	38.7								
		E-E'	1	0 to 1.5	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	20.8	<0.1	1	5	5	70%	83%	92%
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	125	38.7								
			2	0 to 1.5	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	33.5	0.5	4.2	>15	>15	49%	65%	80%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	125	38.7								
			3	0 to 1.5	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	29.7	>15	>15	>15	>15	38%	38%	38%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	125	38.7								
			4	0 to 1.5	5	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	32.1	0.3	4	15	15	54%	67%	85%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	123	38.65								
			5	0 to 1.5	5	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	21.5	<0.1	0.7	4.3	4.3	73%	84%	95%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	123	38.65								
			6	0 to 1.5	5	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	29	>15	>15	>15	>15	46%	47%	47%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 0.5 yr	2 yr	10 yr
			0	0 to 1.5	5	Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	123	38.65	25	>15	>15	>15	>15	46%	47%	47%
	Module 3A (-2 to -3 ft)	D-D'	1	3.8 to 5.2	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	34.5	<0.1	1.9	14	14	67%	75%	87%
						Gray SILT/CLAY/Fine SAND	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	106	38.65								
			2	3.8 to 5.2	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	32.5	<0.1	>15	>15	>15	66%	70%	70%
						Gray SILT/CLAY/Fine SAND	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	106	38.65								
			3	3.8 to 5.2	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	37.7	<0.1	0.4	>15	>15	76%	80%	85%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	90	38.7								
			4	3.8 to 5.2	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	36	<0.1	0.4	>15	>15	76%	77%	77%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	90	38.7								
			5	3.8 to 5.2	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	32.1	<0.1	0.1	1.2	1.2	88%	91%	95%
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	90	38.7								
		E-E'	1	1.2 to 5	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	18.8	<0.1	0.8	4.8	4.8	71%	83%	92%
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	125	38.7								
			2	1.2 to 5	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	29.8	0.5	4.2	>15	>15	51%	66%	80%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	125	38.7								
			3	1.2 to 5	5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	26.5	>15	>15	>15	>15	39%	39%	40%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	125	38.7								
			4	1.2 to 5	5	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	25.8	0.2	3.6	14	14	56%	68%	85%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	123	38.65								
			5	1.2 to 5	5	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	17.7	<0.1	0.4	3.8	3.8	76%	86%	96%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	123	38.65								
			6	1.2 to 5	5	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	23.4	11	>15	>15	>15	49%	49%	50%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	123	38.65								
			1	3.9 to 5.3	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	34.3	<0.1	1.9	14	14	67%	76%	87%
						Gray SILT/CLAY/Fine SAND	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	106	38.65								
			2	3.9 to 5.3	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			12	19.5	32.3	<0.1	>15	>15	>15	66%	70%	70%
						Gray SILT/CLAY/Fine SAND	30043 (13.2-16.5')	3.3	-0.149	0.041	2.50E-09	4.11			12	31.6								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 0.5 yr	2 yr	10 yr
	Module 5A	D-D'				Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	106	38.65								
			3	3.9 to 5.3	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	37.4	<0.1	0.4	>15	>15	76%	80%	85%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	90	38.7								
			4	3.9 to 5.3	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	35.8	<0.1	0.4	>15	>15	76%	77%	77%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	90	38.7								
			5	3.9 to 5.3	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			40	19.5	31.9	<0.1	0.1	1.2	1.2	88%	92%	95%
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	90	38.7								
		E-E'	1	3.7 to 5	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	18.8	<0.1	0.8	4.7	4.7	71%	83%	92%
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	125	38.7								
			2	3.7 to 5	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	29.8	0.5	4.2	>15	>15	51%	66%	80%
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	125	38.7								
			3	3.7 to 5	5.5	Solvay Waste	30040 (0-3.3')	7.23	-0.114	0.039	9.60E-12	6.33			5	19.5	26.5	>15	>15	>15	>15	39%	39%	40%
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	125	38.7								
			4	3.7 to 5	5.5	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	25.8	0.2	3.6	15	15	56%	68%	85%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	10013 (41-43') 10018 (48-50') 10022 (64-66') 10024 (64-66') 10025 (52-54') 10026 (50-52')						0.58	1.7	123	38.65								
			5	3.7 to 5	5.5	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	17.7	<0.1	0.4	3.8	3.8	76%	86%	96%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	30033 (51-53')						0.16	0.7	123	38.65								
			6	3.7 to 5	5.5	Organic Silt	20079 (0-3.3")	4.17	-0.205	0.823	7.90E-09	2.29			2	26.6	23.4	10	>15	>15	>15	49%	49%	50%
						Solvay Waste	30036 (6.6-9.9')	4.92	-0.149	0.018	1.80E-10	4.19			5	35.3								
						Brown SILT & CLAY (Marl)	30033 (47-49')						0.4	1.3	123	38.65								
	1-2 (-10 to -30 ft)	F-F'	1	0	3.25	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	17.6	0.8	2.4	4.8	4.8	44%	71%	96%
						Marl	30033 (35.5-37.0')	4.95	-0.247	1.153	2E-09	2.49			50	36								
			2	0	3.25	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	5.8	0.6	2.2	4.8	4.8	46%	73%	98%
						Marl	30033 (47-49') 30033 (51-53')						0.28	0.97	50	56								
		G-G'	1	0	3.25	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	11.2	<0.1	0.15	1.5	1.5	84%	92%	98%
						Brown Clay	20016 (27-29')						0.19	0.89	50	65								
			2	0	3.25	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	11.8	<0.1	>12	>12	>12	72%	74%	76%
						Brown Clay	20017 (42-44')						0.22	0.87	50	56								
			3	0	3.25	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	14.2	<0.1	0.4	1.8	1.8	78%	91%	99%
						Brown Clay	20016 (27-29')						0.19	0.89	50	56								
			4	0	3.25	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	14.4	<0.1	1.2	>15	>15	70%	78%	81%
						Brown Clay	20017 (42-44')						0.22	0.87	50	65								
			5	0	3.25	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	15	<0.1	0.4	2	2	76%	90%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	50	56								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 0.5 yr	2 yr	10 yr
			6	0	3.25	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	12.1	<0.1	0.2	2.1	2.1	80%	90%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	50	56									
		H-H'	1	0	3.25	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.90E-09	4.05			10	37	15.6	<0.1	0.2	1.6	1.6	82%	91%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56									
			2	0	3.25	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	21	<0.1	0.1	1.3	1.3	85%	93%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56									
			3	0	3.25	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	26.1	<0.1	0.7	3.7	3.7	74%	84%	97%
						CLAY (Marl)	20074 (13.2-16.5')	3.51	-0.13	0.015	1.90E-10	3.56			55	36								
	2 (-7 to -10 ft)	F-F'	1	0	3.75	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	19.8	0.8	2.4	4.8	4.8	44%	71%	96%
						Marl	30033 (35.5-37.0')	4.95	-0.247	1.153	2E-09	2.49			50	36								
			2	0	3.75	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	6.6	0.6	2.2	4.8	4.8	46%	73%	98%
						Marl	30033 (47-49') 30033 (51-53')						0.28	0.97	50	56								
		G-G'	1	0	3.75	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	12.3	<0.1	0.15	1.5	1.5	84%	92%	98%
						Brown Clay	20016 (27-29')						0.19	0.89	50	65								
			2	0	3.75	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	13.1	<0.1	11	>12	>12	71%	73%	75%
						Brown Clay	20017 (42-44')						0.22	0.87	50	56								
			3	0	3.75	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	15.7	<0.1	0.4	1.8	1.8	77%	91%	99%
						Brown Clay	20016 (27-29')						0.19	0.89	50	56								
			4	0	3.75	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	16	<0.1	1.2	>15	>15	67%	77%	80%
						Brown Clay	20017 (42-44')						0.22	0.87	50	65								
		H-H'	1	0	3.75	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.90E-09	4.05			10	37	17.2	<0.1	0.2	1.6	1.6	81%	91%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56									
			2	0	3.75	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	23	<0.1	0.1	1.3	1.3	85%	93%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56									
			3	0	3.75	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	28.7	<0.1	0.8	3.7	3.7	73%	84%	97%
						CLAY (Marl)	20074 (13.2-16.5')	3.51	-0.13	0.015	1.90E-10	3.56			55	36								
		F-F'	1	0 to 2.5	5	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	21.8	0.8	2.4	4.8	4.8	44%	71%	96%
						Marl	30033 (35.5-37.0')	4.95	-0.247	1.153	2E-09	2.49			50	36								
			2	0 to 2.5	5	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	7.3	0.6	2.2	4.7	4.7	46%	73%	97%
						Marl	30033 (47-49') 30033 (51-53')						0.28	0.97	50	56								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 0.5 yr	2 yr	10 yr
C	3B (-4 to -7 ft)	G-G'	1	0 to 2.5	5	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	10.8	<0.1	0.15	1.5	1.5	85%	92%	98%
						Brown Clay	20016 (27-29')						0.19	0.89	50	65								
			2	0 to 2.5	5	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	11.4	<0.1	4.8	>12	>12	73%	74%	76%
						Brown Clay	20017 (42-44')						0.19	0.89	50	56								
			3	0 to 2.5	5	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	14.3	<0.1	0.4	1.8	1.8	78%	91%	99%
						Brown Clay	20016 (27-29')						0.22	0.87	50	56								
			4	0 to 2.5	5	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	14.5	<0.1	1.2	>15	>15	69%	78%	80%
						Brown Clay	20017 (42-44')						0.22	0.87	50	65								
		H-H'	1	0.5 to 5.8	5	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.90E-09	4.05			10	37	7.6	<0.1	0.1	1.3	1.3	85%	93%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56								
			2	0.5 to 5.8	5	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	16.9	<0.1	0.1	1	1	86%	94%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56								
			3	0.5 to 5.8	5	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	20.6	<0.1	0.4	3.4	3.4	76%	85%	98%
						CLAY (Marl)	20074 (13.2-16.5')	3.51	-0.13	0.015	1.90E-10	3.56			55	36								
	3B (-2 to -3 ft)	F-F'	1	1.8 to 5.1	5	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	20.3	0.8	2.4	4.8	4.8	44%	71%	98%
						Marl	30033 (35.5-37.0')	4.95	-0.247	1.153	2E-09	2.49			50	36								
			2	1.8 to 5.1	5	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	6.8	0.6	2.2	4.7	4.7	46%	73%	97%
						Marl	30033 (47-49') 30033 (51-53')						0.28	0.97	50	56								
		G-G'	1	1.8 to 5.1	5.5	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	6.8	<0.1	0.15	1.2	1.2	87%	93%	99%
						Brown Clay	20016 (27-29')						0.19	0.89	50	65								
			2	1.8 to 5.1	5.5	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	7.1	<0.1	0.4	>12	>12	76%	78%	79%
						Brown Clay	20017 (42-44')						0.22	0.87	50	56								
			3	1.8 to 5.1	5.5	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	9.9	<0.1	0.4	1.6	1.6	80%	92%	99%
						Brown Clay	20016 (27-29')						0.19	0.89	50	56								
			4	1.8 to 5.1	5.5	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	10.1	<0.1	0.8	>15	>15	72%	80%	82%
						Brown Clay	20017 (42-44')						0.22	0.87	50	65								
		H-H'	1	4.6 to 5	5.5	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.90E-09	4.05			10	37	12	<0.1	0.2	1.4	1.4	84%	92%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56								
			2	4.6 to 5	5.5	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	20.8	<0.1	0.1	1.2	1.2	85%	93%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56								
			3	4.6 to 5	5.5	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	25.8	<0.1	0.6	3.7	3.7	74%	85%	98%
						CLAY (Marl)	20074 (13.2-16.5')	3.51	-0.13	0.015	1.90E-10	3.56			55	36								
		F-F'	1	4.1 to 4.6	5.5	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	21	0.8	2.4	4.8	4.8	44%	71%	98%
						Marl	30033 (35.5-37.0')	4.95	-0.247	1.153	2E-09	2.49			50	36								
			2	4.1 to 4.6	5.5	Solvay Waste	AVG from Geosyntec report						0.03	3.77	15	19	7	0.7	2.2	4.7	4.7	46%	73%	97%
						Marl	30033 (47-49') 30033 (51-53')						0.28	0.97	50	56								
			1	4.1 to 4.6	5.5	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	7.9	<0.1	0.15	1.2	1.2	86%	92%	99%
						Brown Clay	20016 (27-29')						0.19	0.89	50	65								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 0.5 yr	2 yr	10 yr
	5B (-0.5 to -2 ft)	G-G'	2	4.1 to 4.6	5.5	Soft silt and clay	20070 (9.9'-13.2')	1.77	-0.137	0.051	1.70E-08	2.65			15	44	8.3	<0.1	0.5	>12	>12	75%	77%	78%
						Brown Clay	20017 (42-44')						0.22	0.87	50	56								
			3	4.1 to 4.6	5.5	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	11.2	<0.1	0.4	1.6	1.6	79%	92%	99%
						Brown Clay	20016 (27-29')						0.19	0.89	50	56								
			4	4.1 to 4.6	5.5	Soft silt and clay	20017 (10-12')						0.51	1.42	15	40	11.4	<0.1	0.8	>15	>15	71%	80%	82%
						Brown Clay	20017 (42-44')						0.22	0.87	50	65								
		H-H'	1	3.6 to 4.4	5.5	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.90E-09	4.05			10	37	13.5	<0.1	0.2	1.5	1.5	83%	92%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56								
			2	3.6 to 4.4	5.5	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	21.9	<0.1	0.1	1.2	1.2	85%	93%	99%
						Red/Brown CLAY & SILT	20001 (44.9-46.9') 20004 (36.6-38.6') 20007 (38.6-40.6') 20016 (27-29') 20017 (42-44') 20018 (47-49')						0.26	0.98	55	56								
			3	3.6 to 4.4	5.5	Organic SILT	20079 (0-3.3')	4.17	-0.205	0.823	7.90E-09	2.29			10	27	27.2	<0.1	0.6	3.7	3.7	74%	84%	98%
						CLAY (Marl)	20074 (13.2-16.5')	3.51	-0.13	0.015	1.90E-10	3.56			55	36								
	Module 1 (-20 to -30 ft)	I-I'	1	0	2.25	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	16.6	<0.1	0.3	1.8	1.8	79%	91%	100%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			30	33.17								
						Organic SILT	60016 (14-16')	3.49	-0.195	2.19	5.3E-09	3.34			97	36.19								
			2	0	2.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.3	22.4	<0.1	0.4	1.5	1.5	77%	93%	100%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			15	33.17								
						Organic SILT	60016 (14-16')	3.49	-0.195	2.19	5.3E-09	3.34			112	36.19								
			3	0	2.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.3	21.8	0.1	1.5	7	7	66%	78%	93%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.1								
			4	0	2.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.34	23.6	0.3	1.6	6.7	6.7	59%	78%	94%
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			124.8	31.1								
			5	0	2.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			6	22.3	26.9	0.2	1.6	6	6	60%	78%	94%
						Solvay Waste	10026 (3.3-6.6') 10080 (9.9-13.2') 10081A (13.2-16.5') 10105 (0-3.3')	7	-0.102	0.126	2.708E-10	4.65			6	22.5								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			118	31.12907								
		J-J'	1	0	2.25	Soft SILT	60056 (0.5-3.3')	4.15	-0.202	0.15	1.7E-10	3.79			10	20.9	30.6	0.4	2.3	8	8	52%	73%	93%
						Medium Stiff CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			115	31.9								
			2	0	2.25	Soft SILT	60064 (0.0-3.3')	3.1	-0.17	0.031	3.1E-10	3.9			10	28.3	24.5	0.4	2.4	9	9	52%	72%	92%
						Medium Stiff CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			115	31.9								
			3	0	2.25	Soft SILT	60019 (16-18')	4.31	-0.239	2.98	2E-09	2.85			10	34.3	22	0.3	2.4	9	9	57%	73%	92%
						Medium Stiff CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			115	31.9								
		K-K'	1	0	2.25	SILT & Fine SAND	60017 (8-10')	2.85	-0.134	0.524	2.00E-09	3.71			5	34.3	20.3	0.2	2.7	8	8	57%	71%	91%
						Soft SILT	60016 (14-16')	3.49	-0.195	2.19	5.30E-09	3.34			5	34.27								
						SILT & CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.80E-10	4.17			115	31.9								
			2	0	2.25	SILT & Fine SAND	60054 (3.3-6.6')	4.13	-0.218	0.11	1.7E-10	3.67			5	21.8	28.6	0.4	1.9	7	7	55%	76%	93%
						Organic SILT	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			120	31.9								
			3	0	2.25	SILT & Fine SAND	60056 (0.5-3.3')	4.15	-0.202	0.15	1.7E-10	3.79			15	20.9	32	0.4	1.7	3.9	3.9	54%	78%	99%
						Organic SILT	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			110	31.9								
			1	0	3.25	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	22.2	<0.1	0.4	1.9	1.9	78%	91%	100%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			30	33.17								
						Organic SILT	60016 (14-16')	3.49	-0.195	2.19	5.3E-09	3.34			97	28.34								
			2	0	3.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.3	29	<0.1	0.5	1.6	1.6	76%	92%	100%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			15	33.17								
						Organic SILT	60016 (14-16')	3.49	-0.195	2.19	5.3E-09	3.34			112	36.19								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters A [-]	B [-]	Z [kPa]	C [m/sec]	D [-]	Oedometer Parameters Cc	eo	Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs] 50%	75%	90%	Time after Cap Placement vs. Amount of Consolidation (in) 90%	0.5 yr	2 yr	10 yr
E	Module 2 (-7 to -20 ft)	I-I'	3	0	3.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.3	28.1	0.1	1.9	8	8	62%	76%	92%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.13								
			4	0	3.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.34	30.6	0.3	1.8	7	7	56%	76%	93%
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			123.8	31.1								
			5	0	3.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			6	22.3	34.6	0.25	1.9	6.9	6.9	58%	76%	93%
						Solvay Waste	10026 (3.3-6.6') 10080 (9.9-13.2') 10081A (13.2-16.5') 10105 (0-3.3')	7	-0.102	0.126	2.708E-10	4.65			6	22.5								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			118	31.12907								
		J-J'	1	0	3.25	Soft SILT	60056 (0.5-3.3')	4.15	-0.202	0.15	1.7E-10	3.79			10	20.9	39.5	0.5	2.6	8	8	50%	71%	92%
						Medium Stiff CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			115	31.9								
			2	0	3.25	Soft SILT	60064 (0.0-3.3')	3.1	-0.17	0.031	3.1E-10	3.9			10	28.3	32.1	0.6	2.7	9	9	49%	70%	91%
						Medium Stiff CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			115	31.9								
			3	0	3.25	Soft SILT	60019 (16-18')	4.31	-0.239	2.98	2E-09	2.85			10	34.3	29.7	0.3	2.5	9	9	56%	72%	91%
						Medium Stiff CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			115	31.9								
		K-K'	1	0	3.25	SILT & Fine SAND	60017 (8-10')	2.85	-0.134	0.524	2.00E-09	3.71			5	34.3	27.3	0.3	2.9	9	9	55%	70%	91%
						Soft SILT	60016 (14-16')	3.49	-0.195	2.19	5.30E-09	3.34			5	34.27								
						SILT & CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.80E-10	4.17			115	31.9								
			2	0	3.25	SILT & Fine SAND	60054 (3.3-6.6')	4.13	-0.218	0.11	1.7E-10	3.67			5	21.8	36.9	0.4	2.1	8	8	52%	74%	93%
						Organic SILT	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			120	31.9								
			3	0	3.25	SILT & Fine SAND	60056 (0.5-3.3')	4.15	-0.202	0.15	1.7E-10	3.79			15	20.9	41.4	0.4	1.9	4	4	52%	77%	99%
						Organic SILT	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			110	31.9								
	3B (-3 to -7 ft)	I-I'	1	0.5 to 2.9	4.75	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	20.8	0.2	6	>12	>12	54%	63%	81%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.1								
			2	0.5 to 2.9	4.75	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.3	30.2	0.2	4.8	>12	>12	57%	67%	81%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.1								
			3	0.5 to 2.9	4.75	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	17.7	<0.1	0.1	0.4	0.4	92%	99%	100%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						Organic SILT	60016 (14-16')	3.66	-0.09	0.027	2.8E-09	3.98			115	28.34								
		J-J'	1	0.5 to 5.3	4.75	Soft SILT	60064 (0.0-3.3')	3.1	-0.17	0.031	3.1E-10	3.9			10	28.3	23.6	0.7	4.4	>11	>11	45%	64%	85%
						SILT & CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			115	31.9								
			2	0.5 to 5.3	4.75	Soft SILT	60019 (16-18')	4.31	-0.239	2.98	2E-09	2.85			18	28.3	23.8	0.4	3.5	>11	>11	52%	69%	85%
						SILT & CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			107	31.9								
			3	0.5 to 5.3	4.75	Soft SILT	60056 (0.5-3.3')	4.15	-0.202	0.15	1.7E-10	3.79			7	20.9	34.4	0.8	4.3	>11	>11	45%	65%	85%
						SILT & CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.80E-10	4.17			118	31.9								
		K-K'	1	0.5 to 5.6	4.75	SILT & Fine SAND	60017 (8-10')	2.85	-0.134	0.524	2.00E-09	3.71			6	34.3	13.1	0.1	0.8	2.5	2.5	66%	87%	>98.5%
						Organic SILT	60016 (14-16')	3.49	-0.195	2.19	5.30E-09	3.34			119	35.8								
			2	0.5 to 5.6	4.75	SILT & Fine SAND	60017 (8-10')	2.85	-0.134	0.524	2.00E-09	3.71			6	34.3	13.5	0.18	4	14	14	59%	68%	85%
						Soft SILT	60016 (14-16')	3.49	-0.195	2.19	5.30E-09	3.34			10	35.78								
						SILT & CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.80E-10	4.17			109	31.9								
			3	0.5 to 5.6	4.75	SILT & Fine SAND	60017 (8-10')	2.85	-0.134	0.524	2.00E-09	3.71			6	34.3	13.7	0.8	5	>7	>7	46%	60%	>76%
						SILT & CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.80E-10	4.17			119	31.9								
			4	0.5 to 5.6	4.75	Soft SILT	60056 (0.5-3.3')	4.15	-0.202	0.15	1.7E-10	3.79			8	20.9	34	0.8	4	>7	>7	45%	65%	>80%
						SILT & CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.80E-10	4.17			117	31.9								
			5	0.5 to 5.6	4.75	Soft SILT	60054 (3.3-6.6')	4.13	-0.218	0.11	1.7E-10	3.67			8	21.8	33.8	0.8	4	>7	>7	43%	64%	>83%
						SILT & CLAY	60061 (13.2-16.5')	3.46	-0.178	0.091	4.8E-10	4.17			117	31.9								
	3B (-2 to -3 ft)	I-I'	1	2.5 to 3.2	5.25	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	14.8	0.1	6	>12	>12	57%	65%	81%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.1								
			2	2.5 to 3.2	5.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.3	28	0.2	4.6	>12	>12	58%	68%	83%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.1								

Attachment C
Table 1 - Summary of Geologic Sections For Consolidation Estimates

Remediation Area	Habitat Module	Cross Section	Case	Dredge Depth [ft]	Cap Thickness [ft]	Sediment Units	Sample Location (depth) for Consolidation Parameters	SICT Parameters					Oedometer Parameters		Thickness (ft)	Buoyant Weight[a] (pcf)	Predicted Primary Consolidation (in)	Percent Consolidation vs. Time [yrs]				Time after Cap Placement vs. Amount of Consolidation (in)		
								A	B	Z	C	D	Cc	eo				50%	75%	90%	90%	0.5 yr	2 yr	10 yr
								[-]	[-]	[kPa]	[m/sec]	[-]												
			3	2.5 to 3.2	5.25	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	12.7	<0.1	0.1	0.4	0.4	92%	99%	100%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						Organic SILT	60016 (14-16')	3.66	-0.09	0.027	2.8E-09	3.98			115	28.34								
	5B (-0.5 to -2 ft)	I-I'	1	1.7 to 5.2	5.25	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	14.8	0.1	6	>12	>12	57%	65%	81%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.1								
			2	1.7 to 5.2	5.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.3	28	0.2	4.7	>12	>12	58%	68%	82%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.1								
			3	1.7 to 5.2	5.25	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	12.7	<0.1	0.1	0.4	0.4	92%	99%	100%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						Organic SILT	60016 (14-16')	3.66	-0.09	0.027	2.8E-09	3.98			115	28.34								
	6B (+1 to -1 ft)	I-I'	1	3.26 to 4.75	5.25	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	20.5	0.2	6.2	>12	>12	54%	63%	80%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.1								
			2	3.26 to 4.75	5.25	Organic SILT	70031 (0-3.3')	4.7	-0.194	0.109	8.1E-11	3.74			3	22.3	31.2	0.2	5	>12	>12	56%	66%	83%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						SILT & CLAY	70022 (13.2-16.5')	3.28	-0.146	0.028	2.3E-10	4.82			115	31.1								
			3	3.26 to 4.75	5.25	Organic SILT	70006 (2-4')	2.64	-0.194	0.943	6.9E-09	4.05			3	37.4	17.5	<0.1	0.1	0.4	0.4	92%	99%	100%
						SILT & Fine SAND	70006 (10-12')	2.74	-0.091	0.065	5.6E-09	3.25			12	33.17								
						Organic SILT	60016 (14-16')	3.66	-0.09	0.027	2.8E-09	3.98			115	28.34								

E.2

CAP-INDUCED SETTLEMENT EVALUATION FOR REMEDIATION AREA D

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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. A preliminary dredging plan and the potential maximum and minimum cap thicknesses in Remediation Area D were provided to Geosyntec by Parsons to facilitate settlement evaluations and are shown in Figures 2 and 3, respectively.

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 H of the Draft Capping and Dredge Area and Depth Initial Design Submittal (IDS), 2009]. 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 4. 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 results are presented in Phase I and Phase II Pre-Design Investigation Data Summary Report [Parsons 2007 and 2009]. A summary of those results is presented in Attachment B.

(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 5. 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 5. 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 6 through 13. 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 6 through 13).

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 4.95×10^{-6} cm/s to 2.78×10^{-5} cm/s. The measured hydraulic conductivity of Silt and Clay varies from 4.9×10^{-8} cm/s to 4.41×10^{-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 1×10^{-5} cm/s and 1×10^{-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.

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

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

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

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

Secondary Settlement

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

Total Settlement

$$S = S_p + S_s \tag{4}$$

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;
σ'_{vo} = initial effective overburden stress;
σ'_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:

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

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

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

It was assumed that, T is approximately equal to 1 at the end of primary compression (i.e., U = 93%, using Equation 6B). Therefore, t_1 can be calculated using the following equation:

$$t_1 = \frac{H_{dr}^2}{c_v} \tag{7}$$

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:

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

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.

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.

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

Where,

u = excess pore water pressure;

t = time;
k = hydraulic conductivity;
γ_w = unit weight of water; and
m_v = compressibility.

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 14. The FDM equations for a node in a homogeneous layer and at a layer interface are presented in Equations 11A and 11B, respectively.

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

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

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):

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

$$B = \frac{2k_1}{k_1 + k_2} \tag{12B}$$

$$C = \frac{2k_2}{k_1 + k_2} \tag{12C}$$

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

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

4.2 Dredge Cut Depths and Cap Thicknesses Considered

The dredging plan and the maximum and minimum cap thickness in Remediation Area D were provided to Geosyntec by Parsons, as shown in Figures 2 and 3 respectively. In summary, 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 ft to 5.5 ft. 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 4.

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 15. 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 16.

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 15 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 17. 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.

REFERENCES

Das, Braja M. (2008). "Advanced Soil Mechanics". 3rd Edition. Taylor & Francis, Inc.

Holtz and Kovacs. (1981). "An Introduction to Geotechnical Engineering". Prentice-Hall, Inc., Englewood Cliffs, N. J., 733 p.

Geosyntec Consultants. (2009). Appendix H of the Draft Capping and Dredge Area and Depth Initial Design Submittal, "Summary of Subsurface Stratigraphy and Material Properties". A report summarizing the subsurface condition and material properties in ILWD.

Geosyntec Consultants. (2009). "Summary of Subsurface Stratigraphy and Material Properties". A report summarizing the subsurface condition and material properties in SMU 1 and WB-B/HB area.

Parsons. (2007). "Onondaga Lake Pre-Design Investigation: Phase I Data Summary Report". May 2007.

Parsons. (2009). "Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report". August 2009.

Znidarcic, D., Abu-Hejleh, A.N., Fairbanks, T. and Robertson A. (1992). "Seepage-Induced Consolidation Test; Equipment Description and Users Manual". Prepared for Florida Institute of Phosphate Research, University of Colorado, Boulder.

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	1×10^{-5}
Marl	98	0.117	0.0099	0.0050	0.090 (SMU 1) 0.100 (SMU 2)[2]	1×10^{-7}
Silt and Clay (SMU 1)	108	0.223	0.0250	0.0100	0.090	1×10^{-7}
Silt and Clay (SMU 2)	108	0.154	0.0179	0.0050	0.100	1×10^{-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 11. 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.

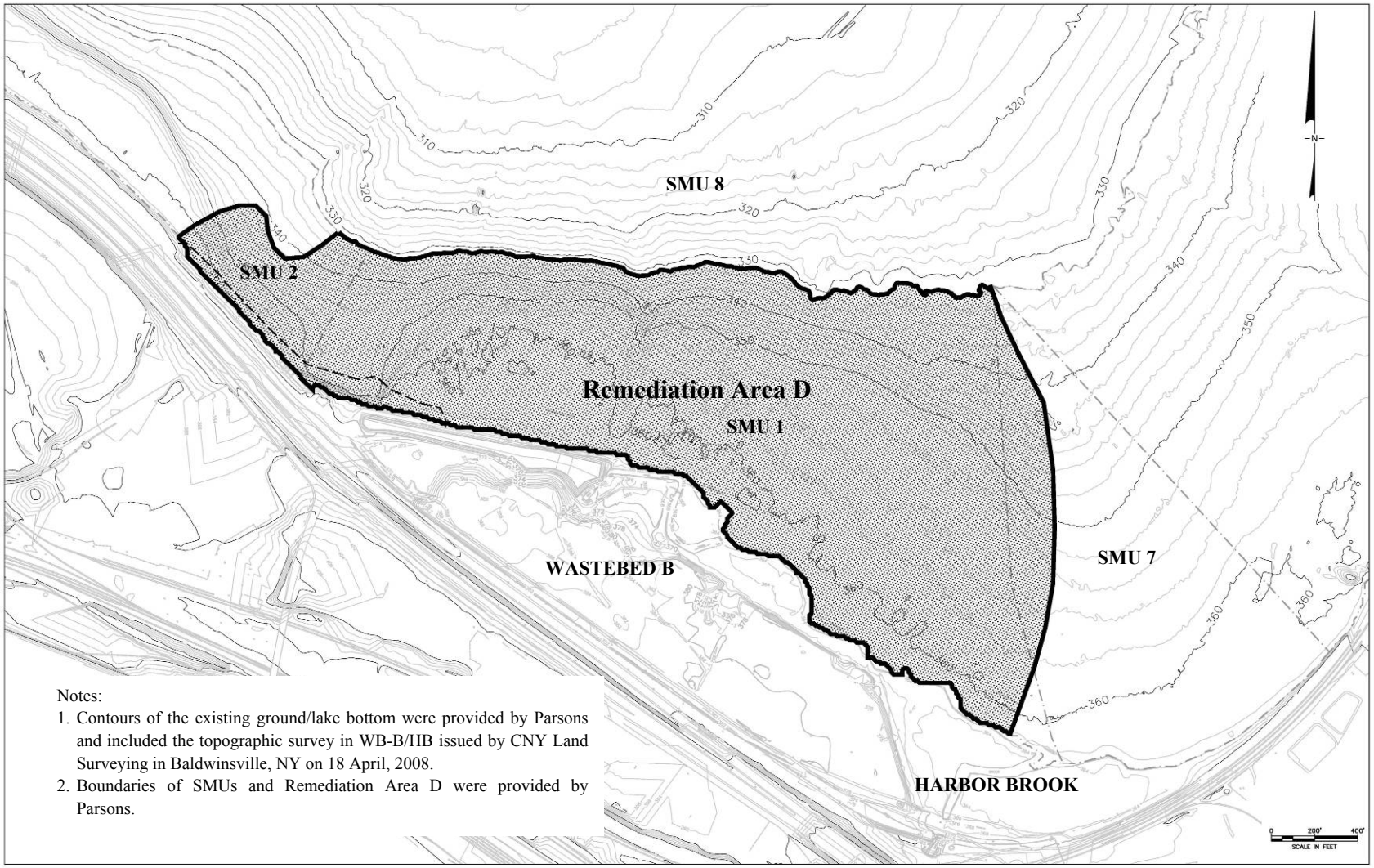
Material	$C_{c\varepsilon}$	$C_{r\varepsilon}$	$C_{\alpha\varepsilon}$	c_v (ft^2/d)
Selected Reasonable Upper Bound Values				
SOLW	0.045	0.0059	0.0030	7.000
Marl	0.142	0.0110	0.0080	0.130 (SMU 1) 0.230 (SMU 2)[1]
Silt and Clay (SMU 1)	0.251	0.0317	0.0130	0.130
Silt and Clay (SMU 2)	0.203	0.0220	0.0070	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 11. 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 10 and 11. 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



Notes:
1. Contours of the existing ground/lake bottom were provided by Parsons and included the topographic survey in WB-B/HB issued by CNY Land Surveying in Baldwinsville, NY on 18 April, 2008.
2. Boundaries of SMUs and Remediation Area D were provided by Parsons.

Figure 1. Remediation Area D.

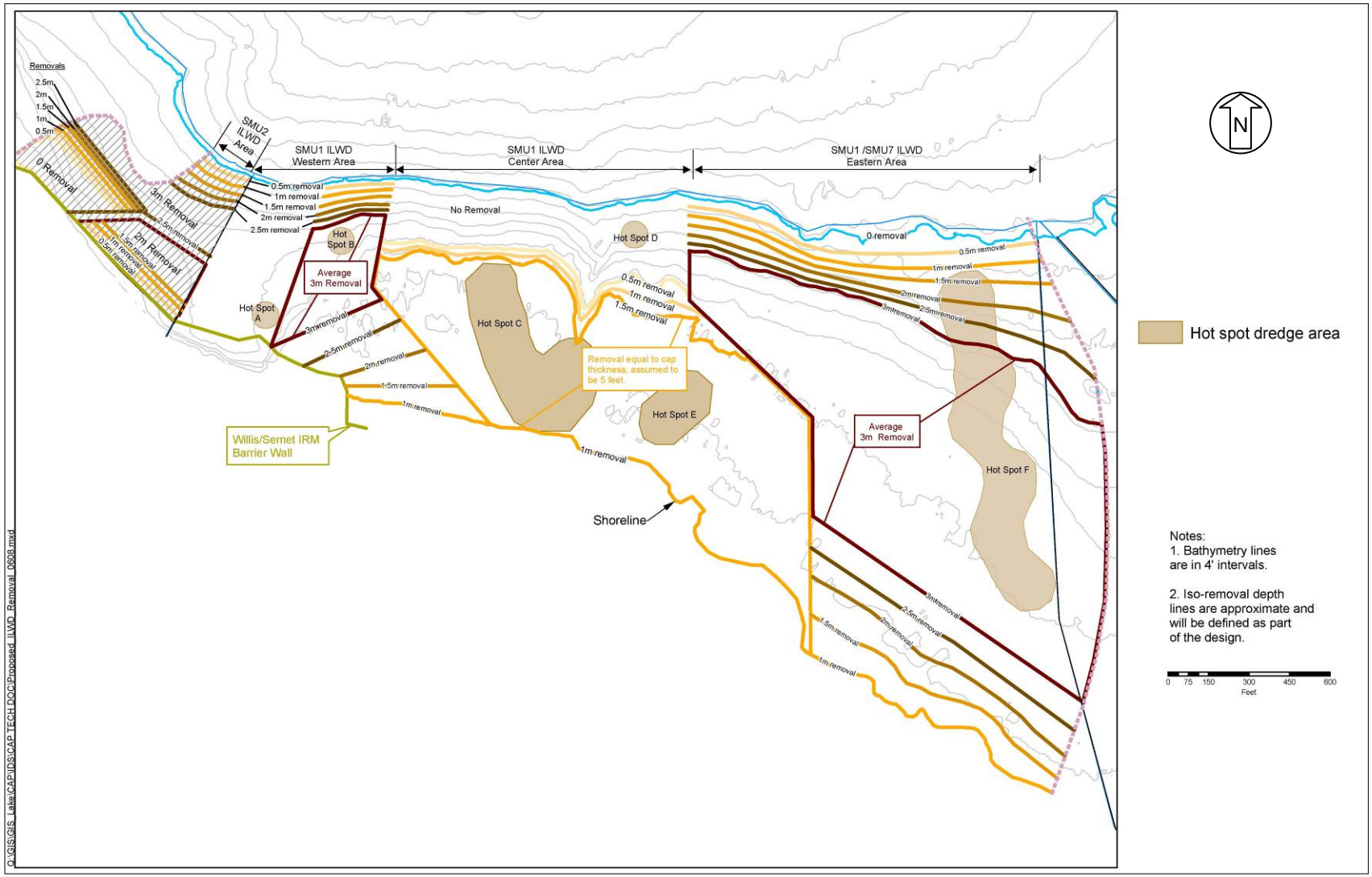


Figure 2. Remediation Area D Preliminary Dredging Plan (Figure provided by Parsons to Geosyntec).

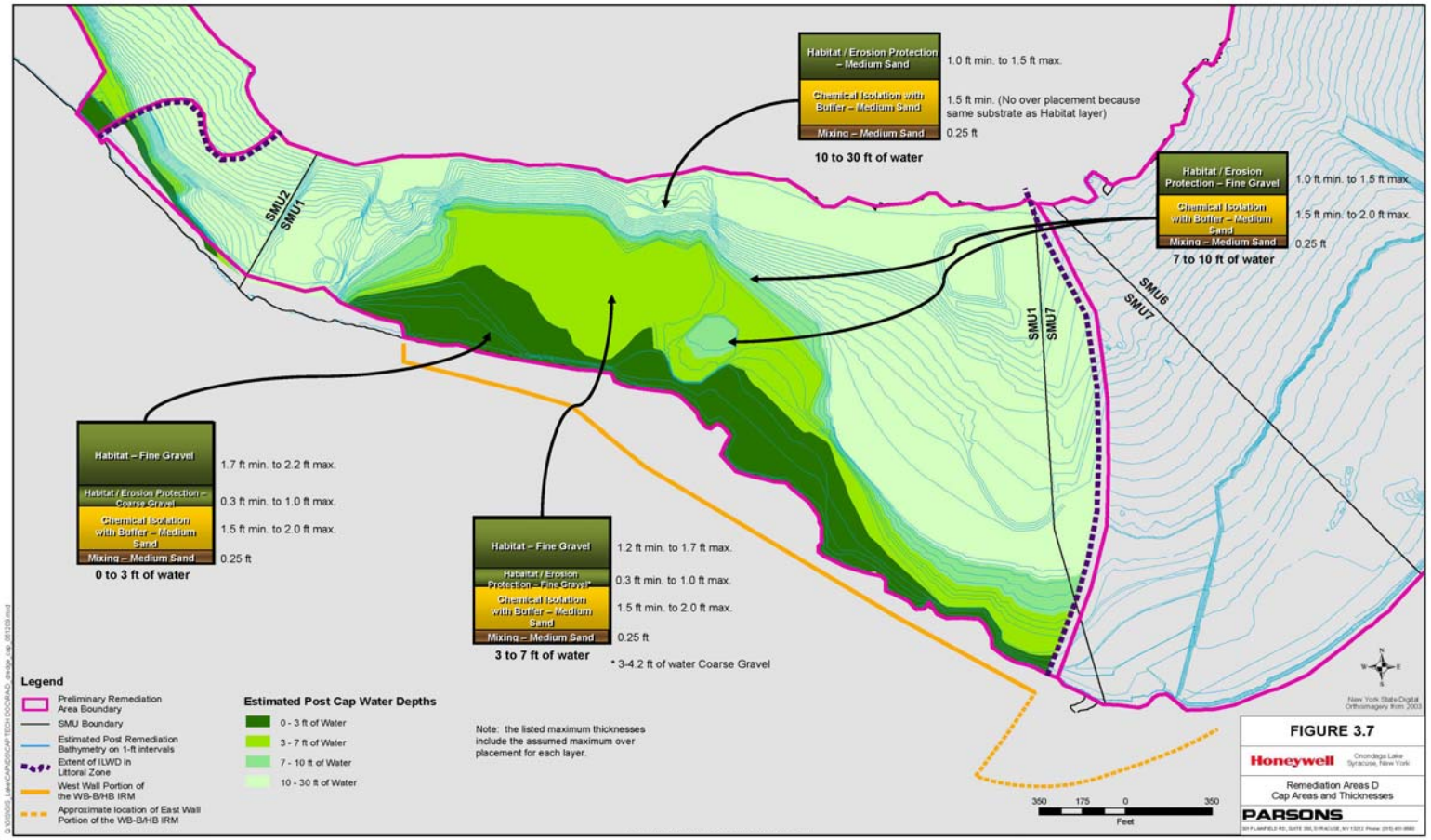
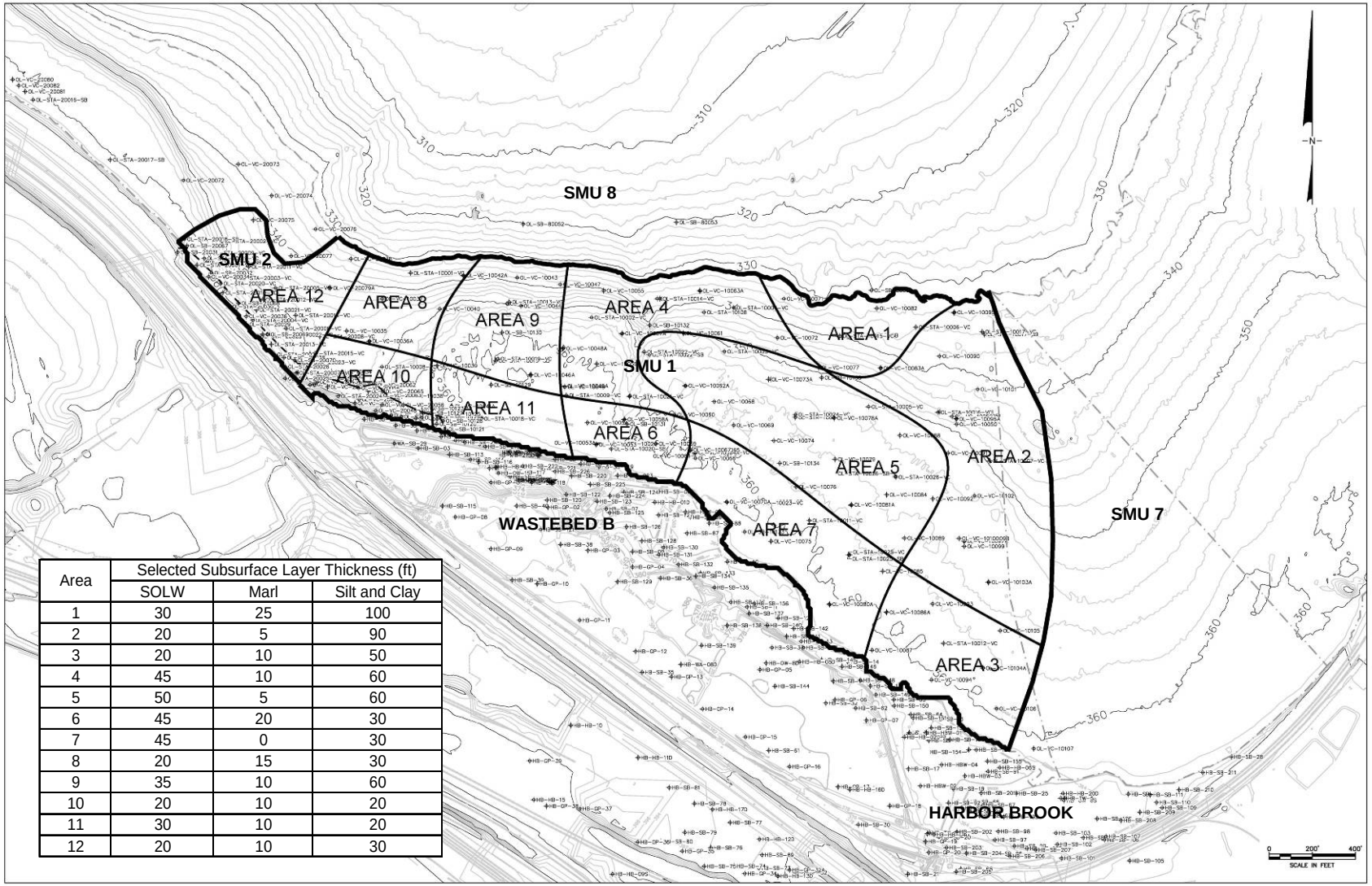


Figure 3. Cap Thickness in Remediation Area D
(Figure provided to Geosyntec by Parsons).

Note:

The above cap configuration was assumed for the purposes of the analyses presented herein. Slight modifications to cap thickness should not impact the outcome of the analyses. As necessary, changes to the cap configuration will be addressed in subsequent design submittals.



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 4. Areas and Subsurface Layer Thicknesses.

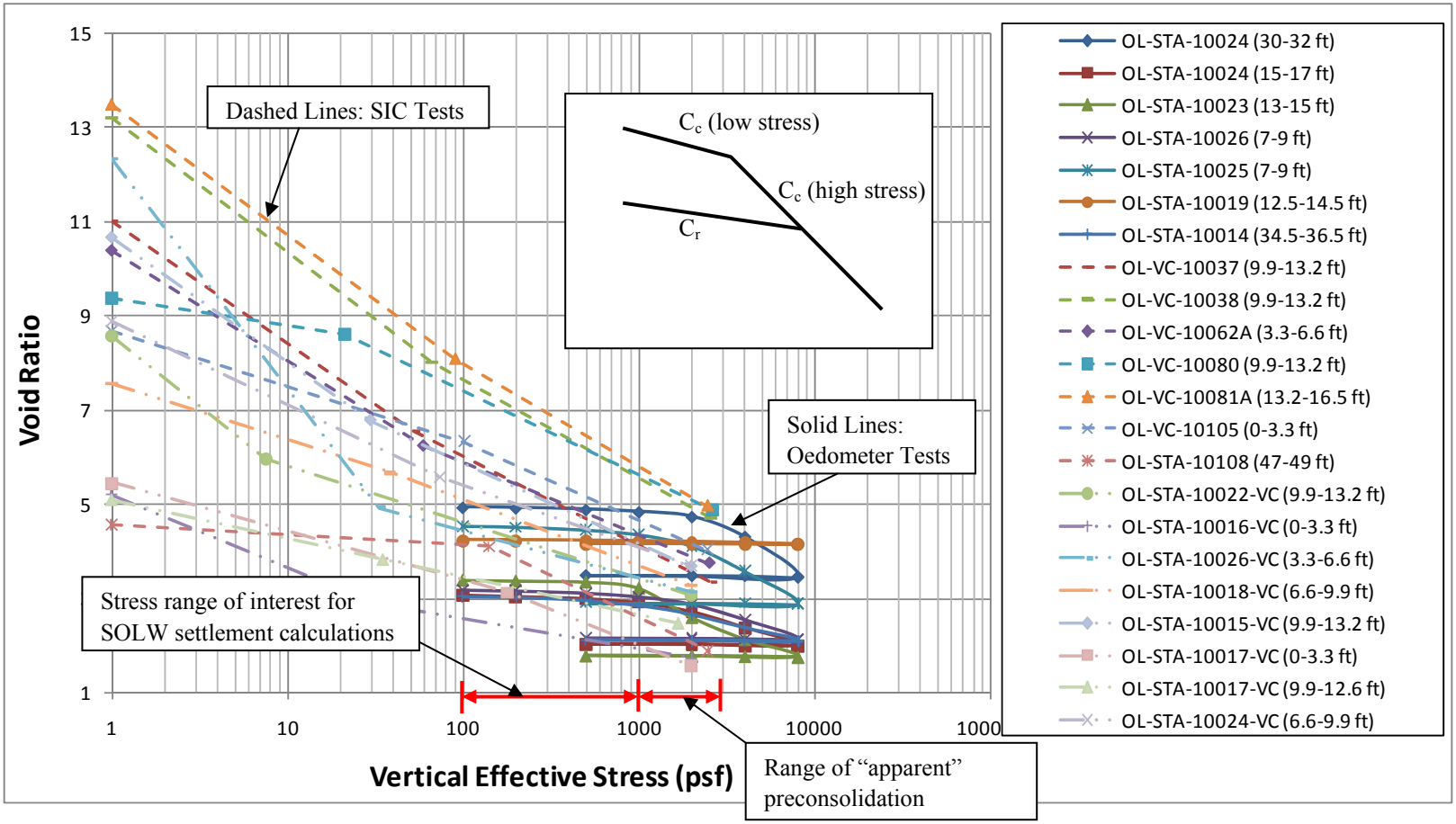


Figure 5. Comparison of Results from Conventional Oedometer Tests and SIC Tests.

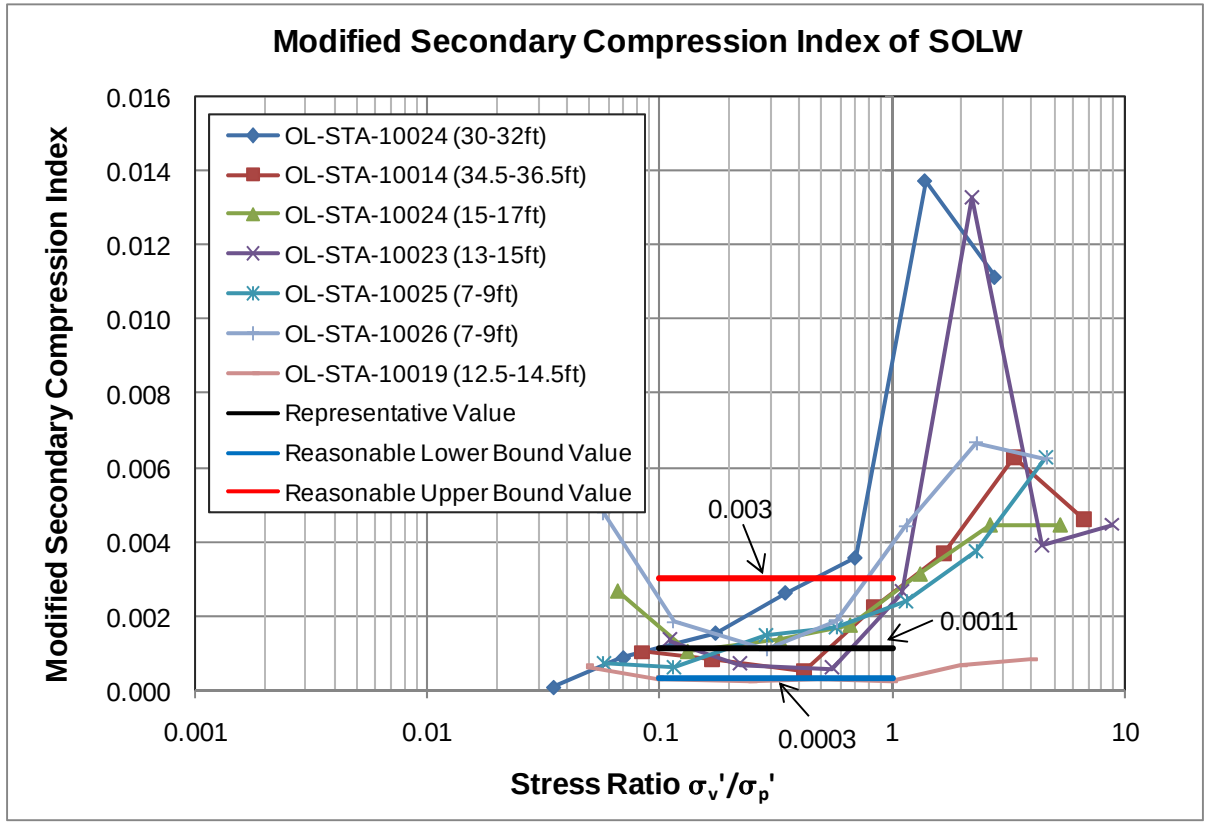


Figure 6. Interpretation of Modified Secondary Compression Index for SOLW.

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

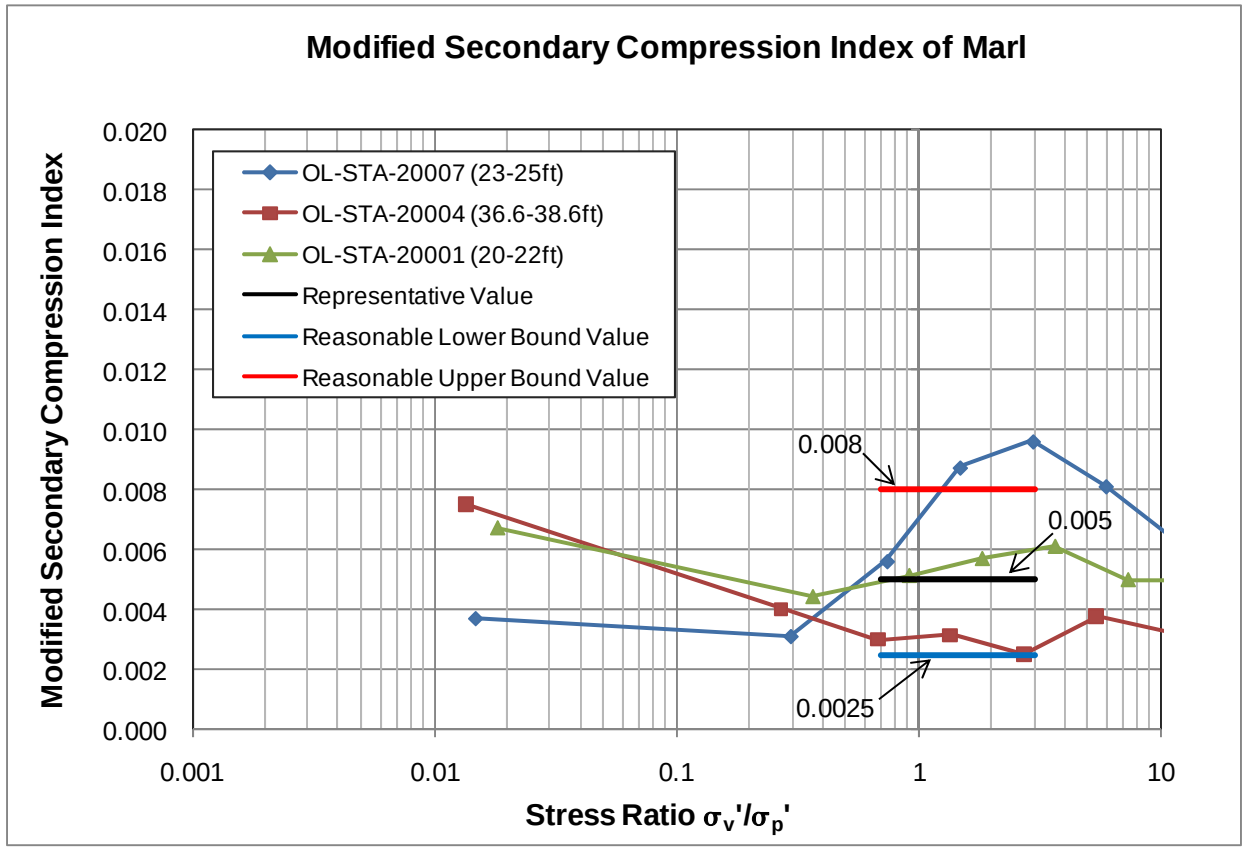


Figure 7. Interpretation of Modified Secondary Compression Index for Marl.

Note:
The ratio of σ_v'/σ_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.

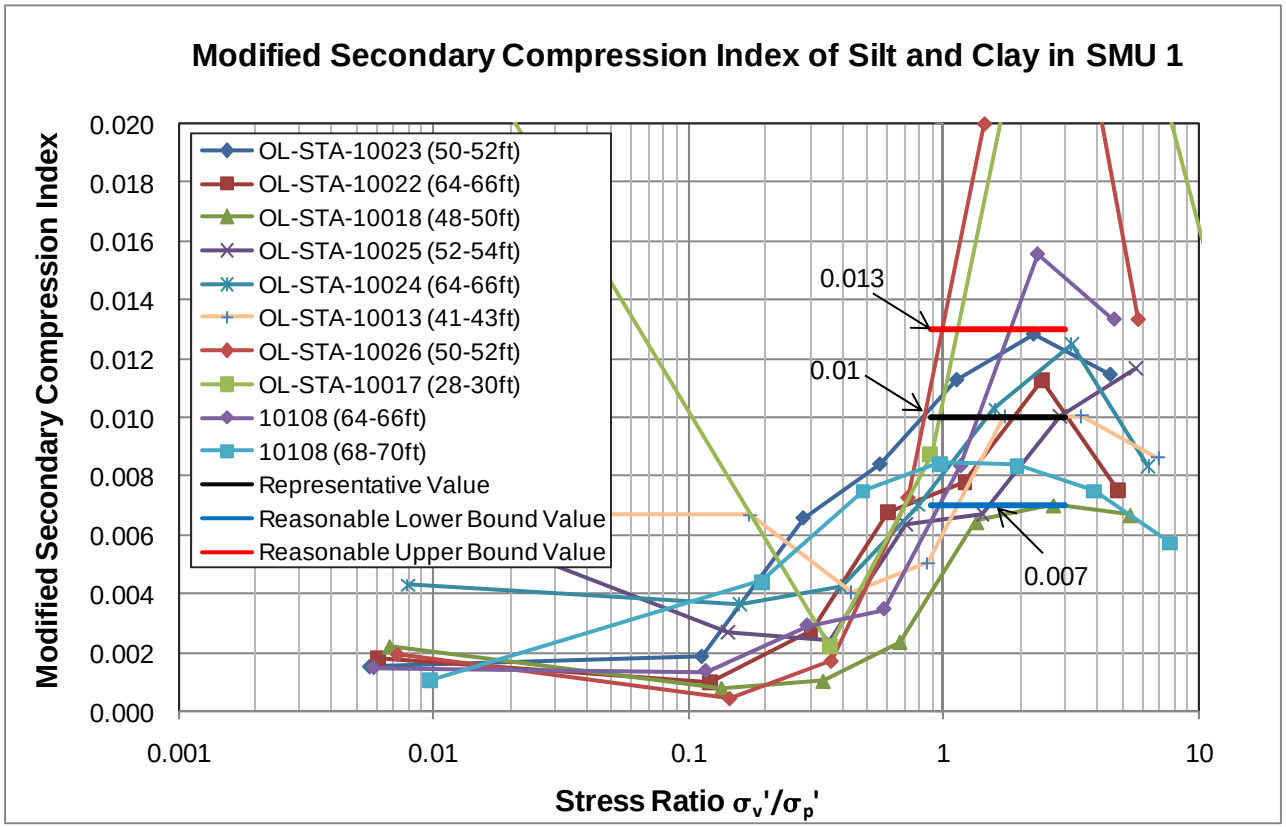


Figure 8. Interpretation of Modified Secondary Compression Index for Silt and Clay in SMU 1.

Note:
The ratio of σ_v'/σ_p' of Silt and Clay in the field before and after capping was estimated to be between 0.9 and 3 according to the assumed subsurface layer thicknesses.

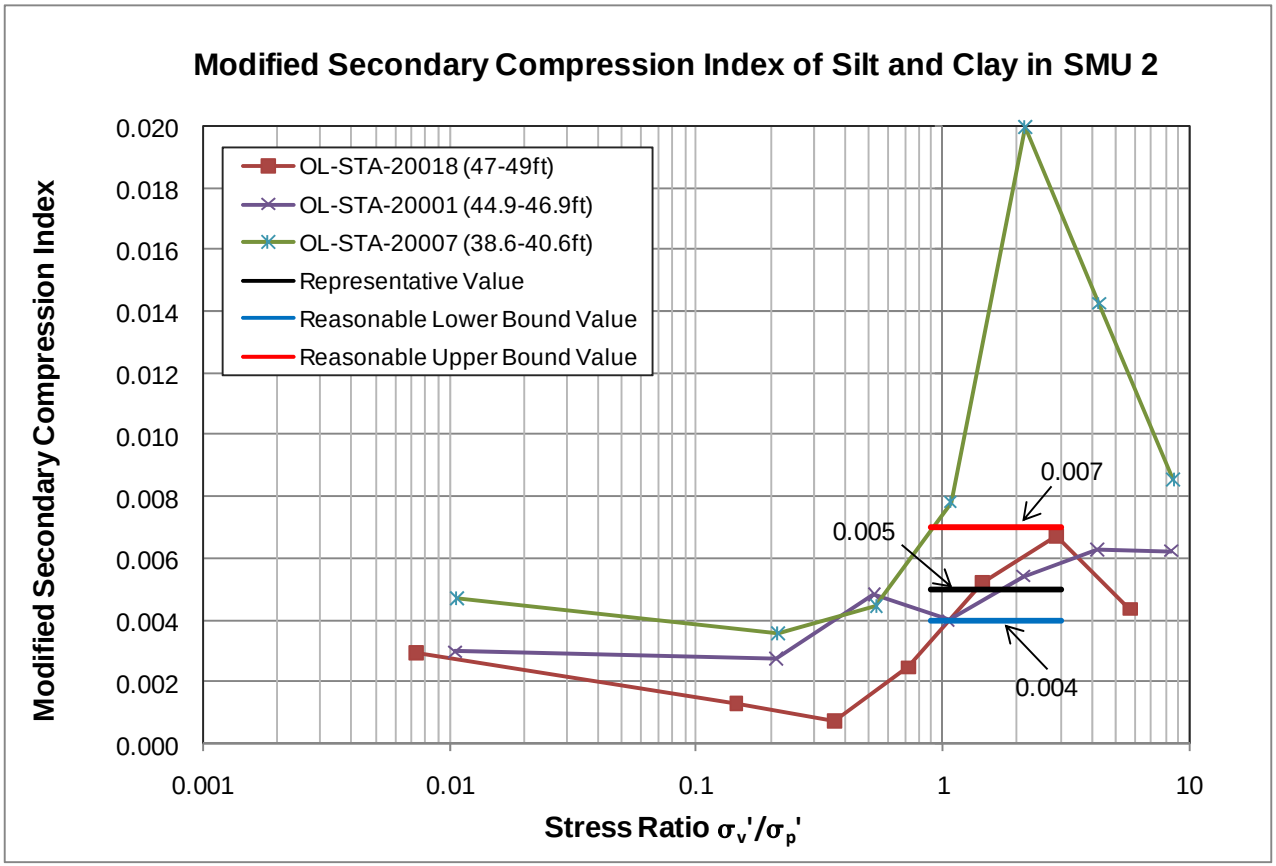


Figure 9. Interpretation of Modified Secondary Compression Index for Silt and Clay in SMU 2.

Note:

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

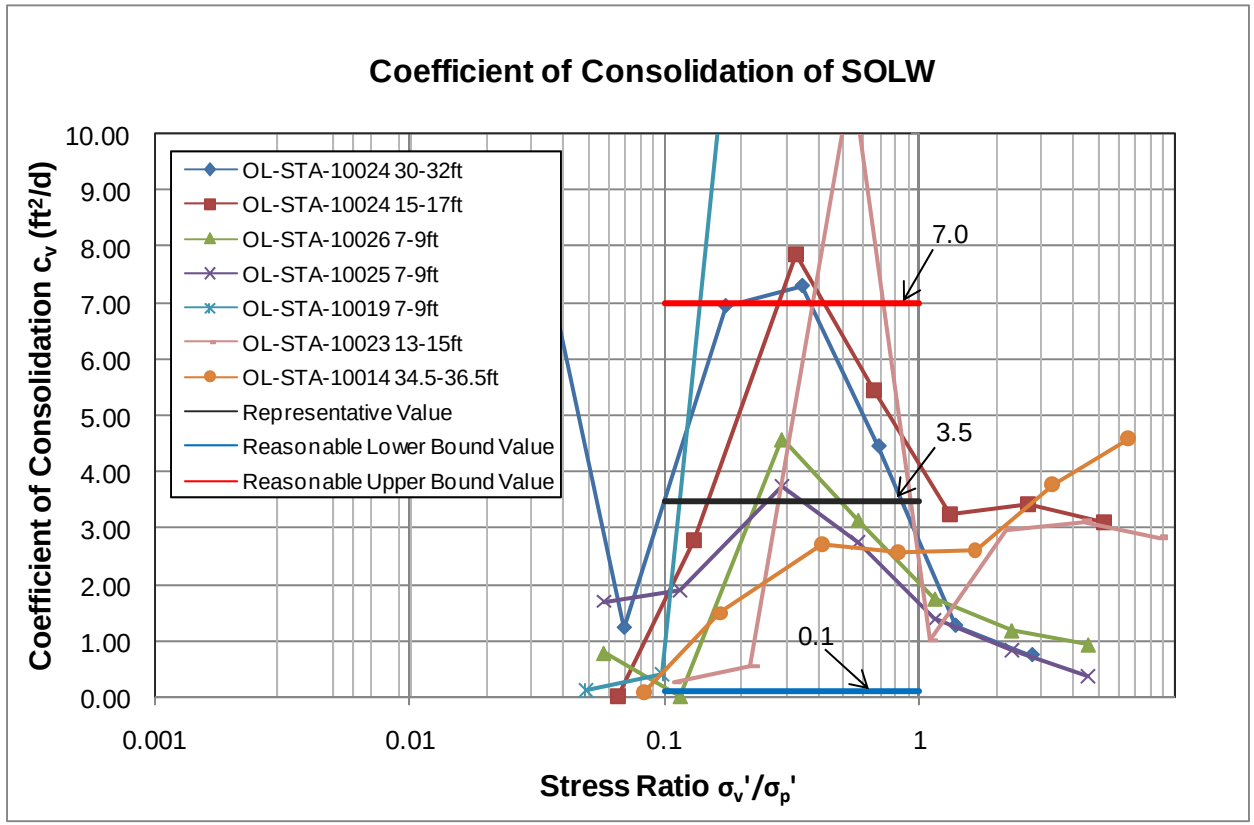


Figure 10. Interpretation of Coefficient of Consolidation Index for SOLW.

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

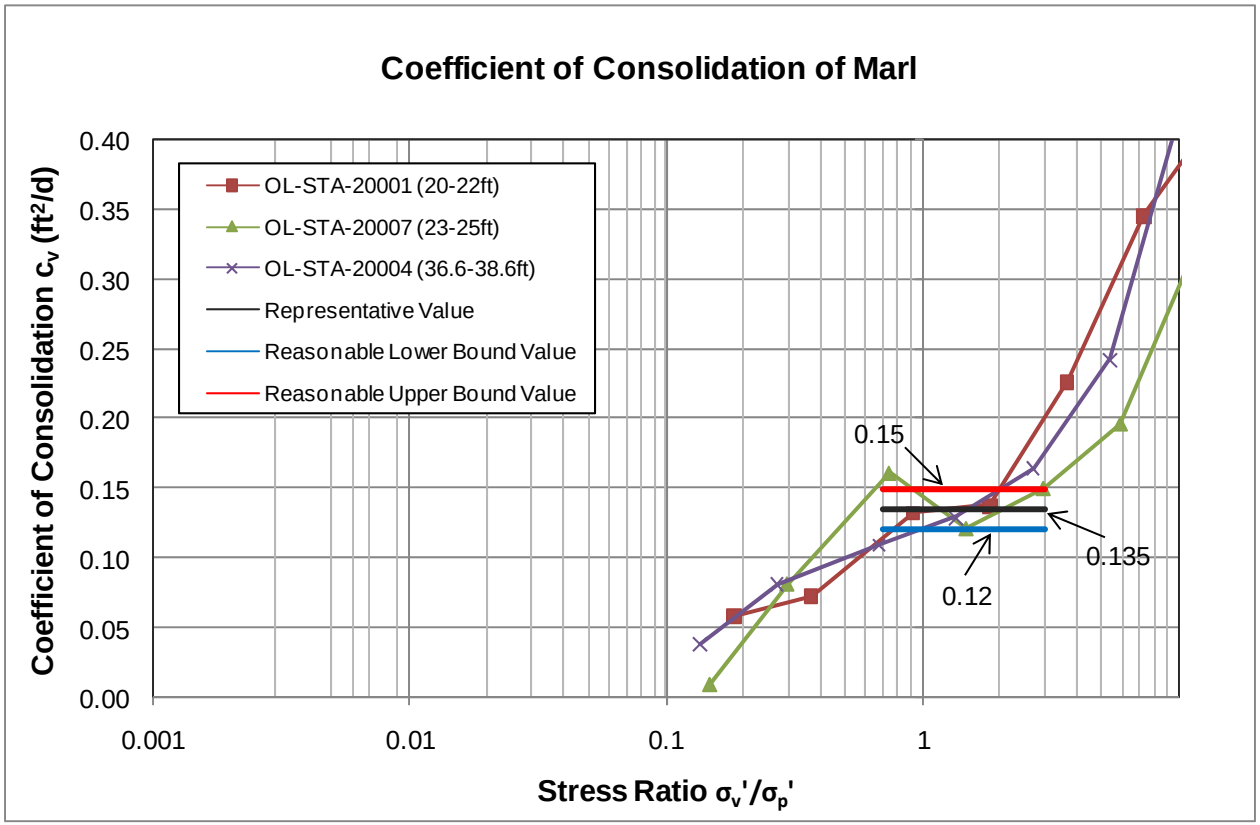


Figure 11. Interpretation of Coefficient of Consolidation Index for Marl.

Note:
The ratio of σ_v'/σ_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.

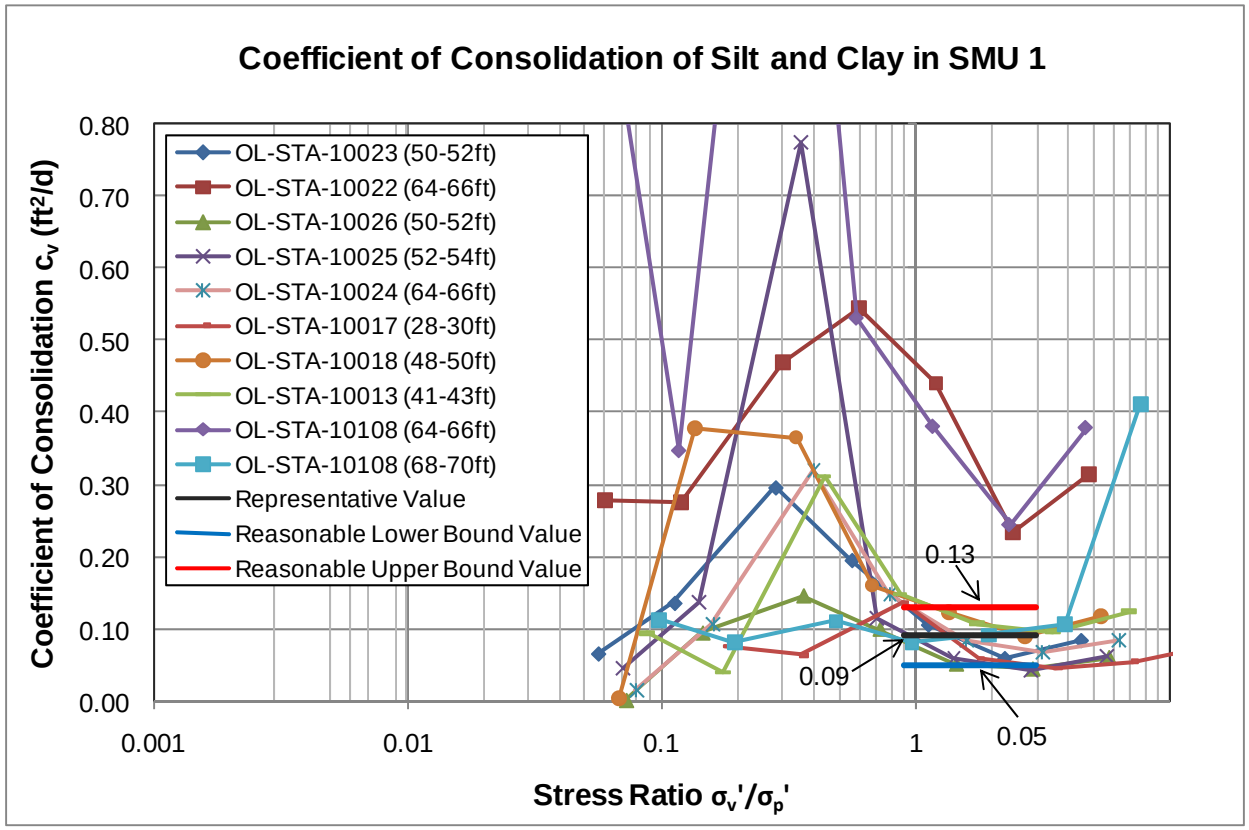


Figure 12. Interpretation of Coefficient of Consolidation Index for Silt and Clay in SMU 1.

Note:

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

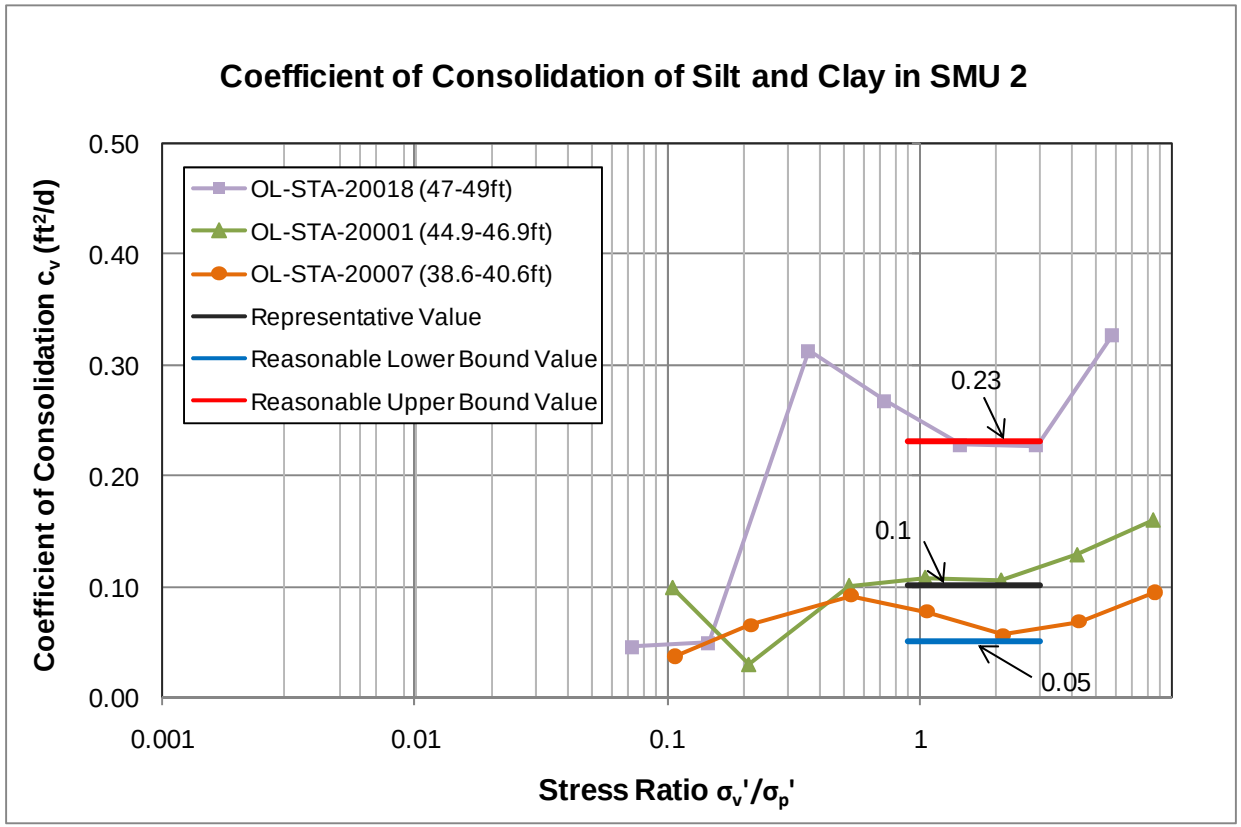
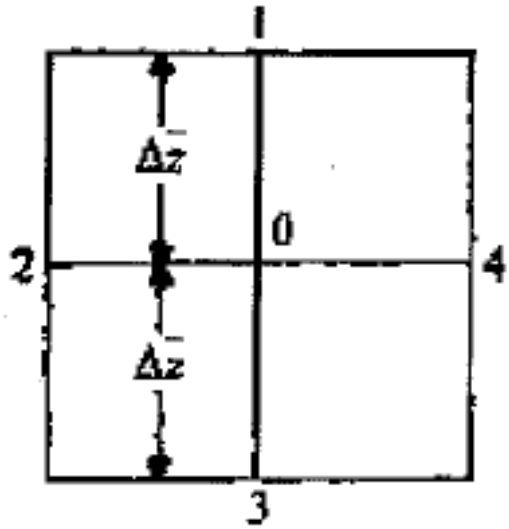


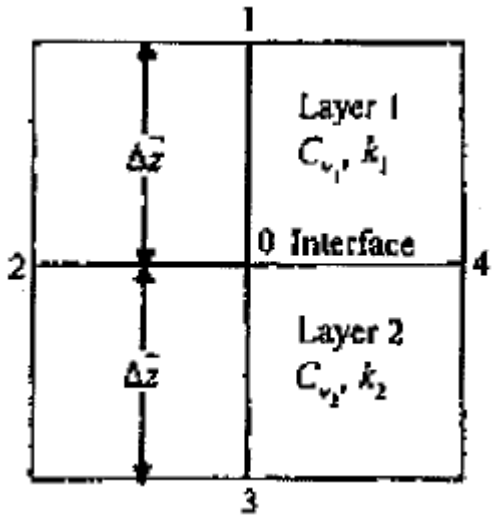
Figure 13. Interpretation of Coefficient of Consolidation Index for Silt and Clay in SMU 2.

Note:

The ratio of σ_v'/σ_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 14. 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)

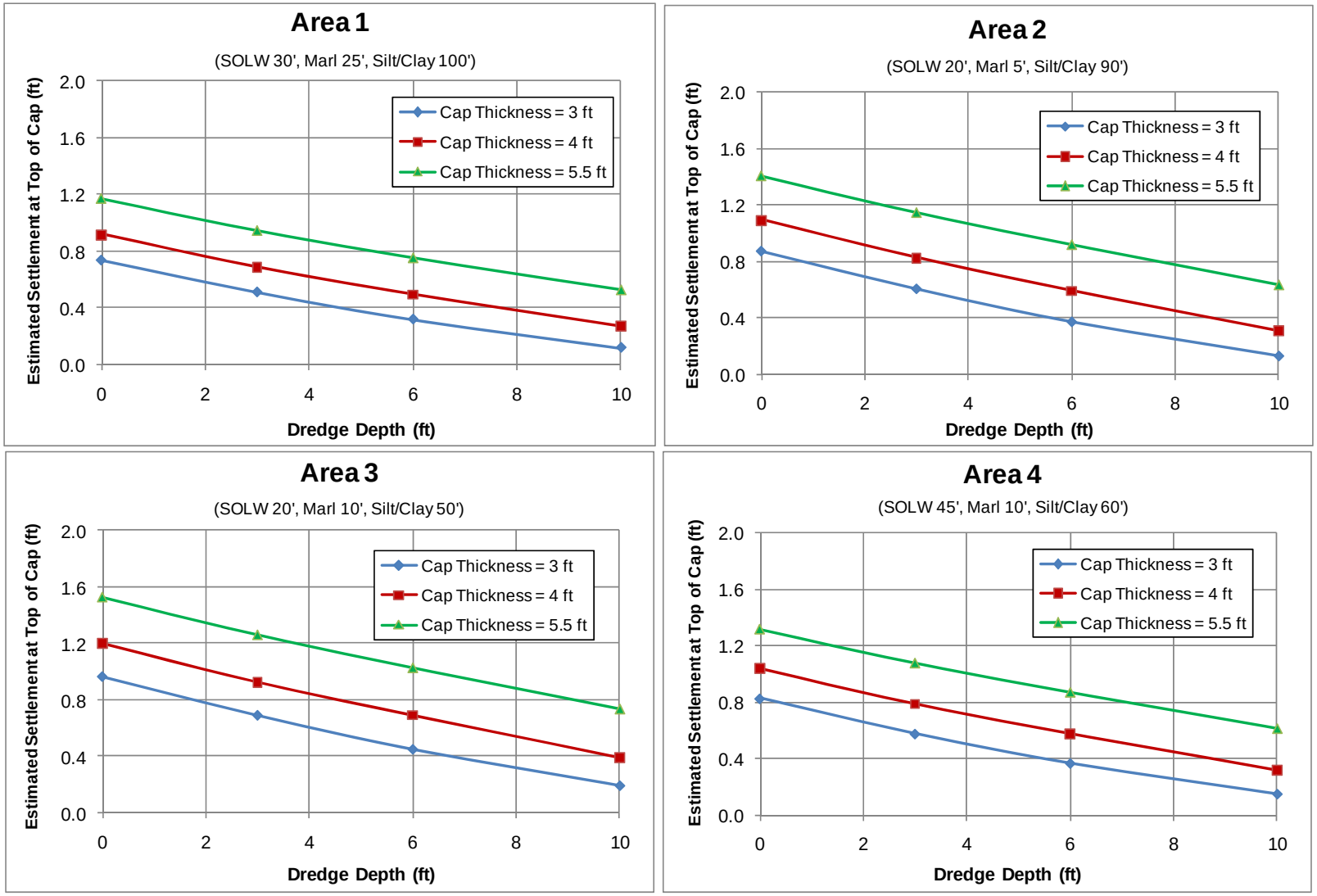


Figure 15. Settlement Analysis Results for Areas 1 to 12 for 30-Year Period.

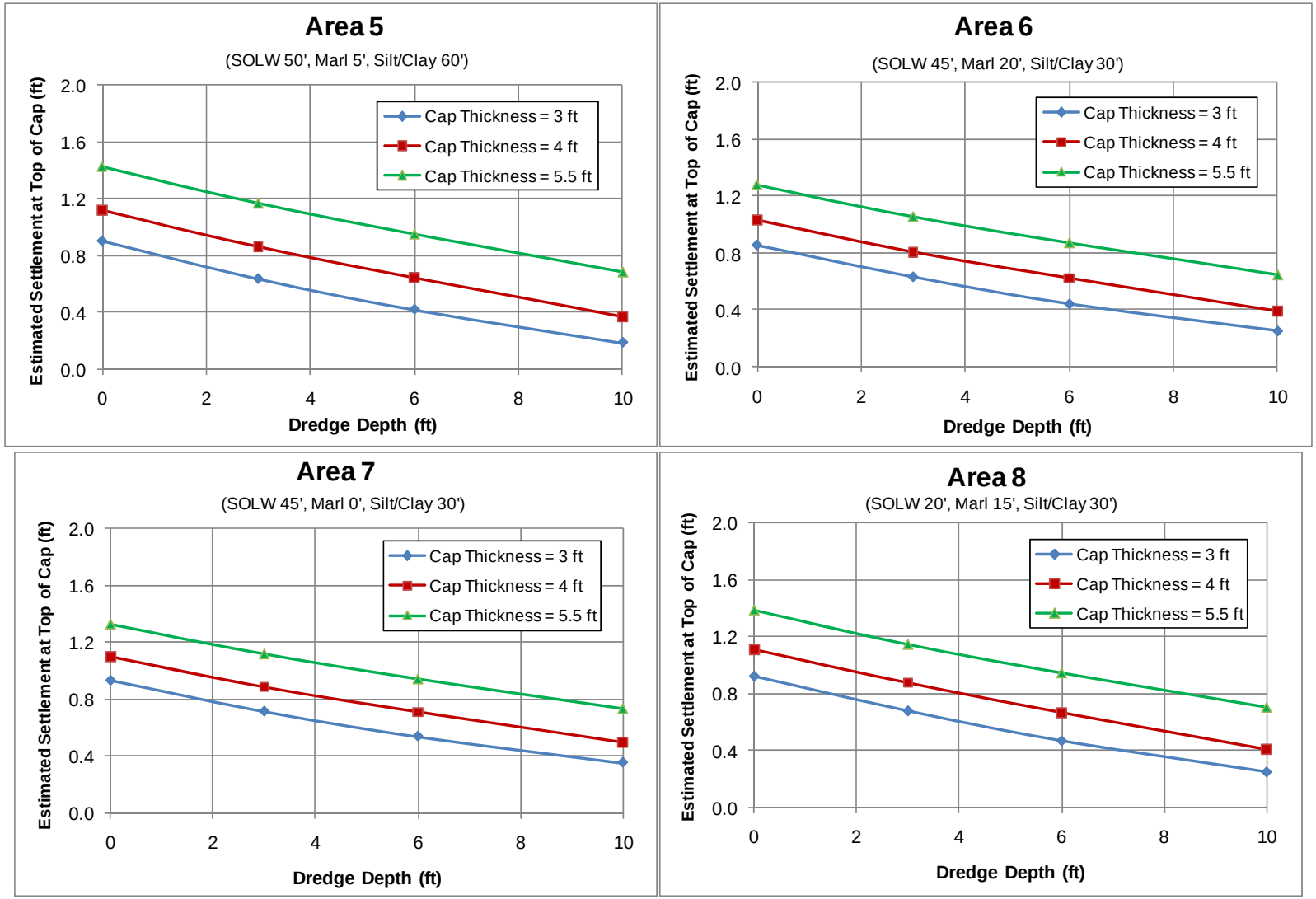


Figure 15. Settlement Analysis Results for Areas 1 to 12 for 30-Year Period (continued).

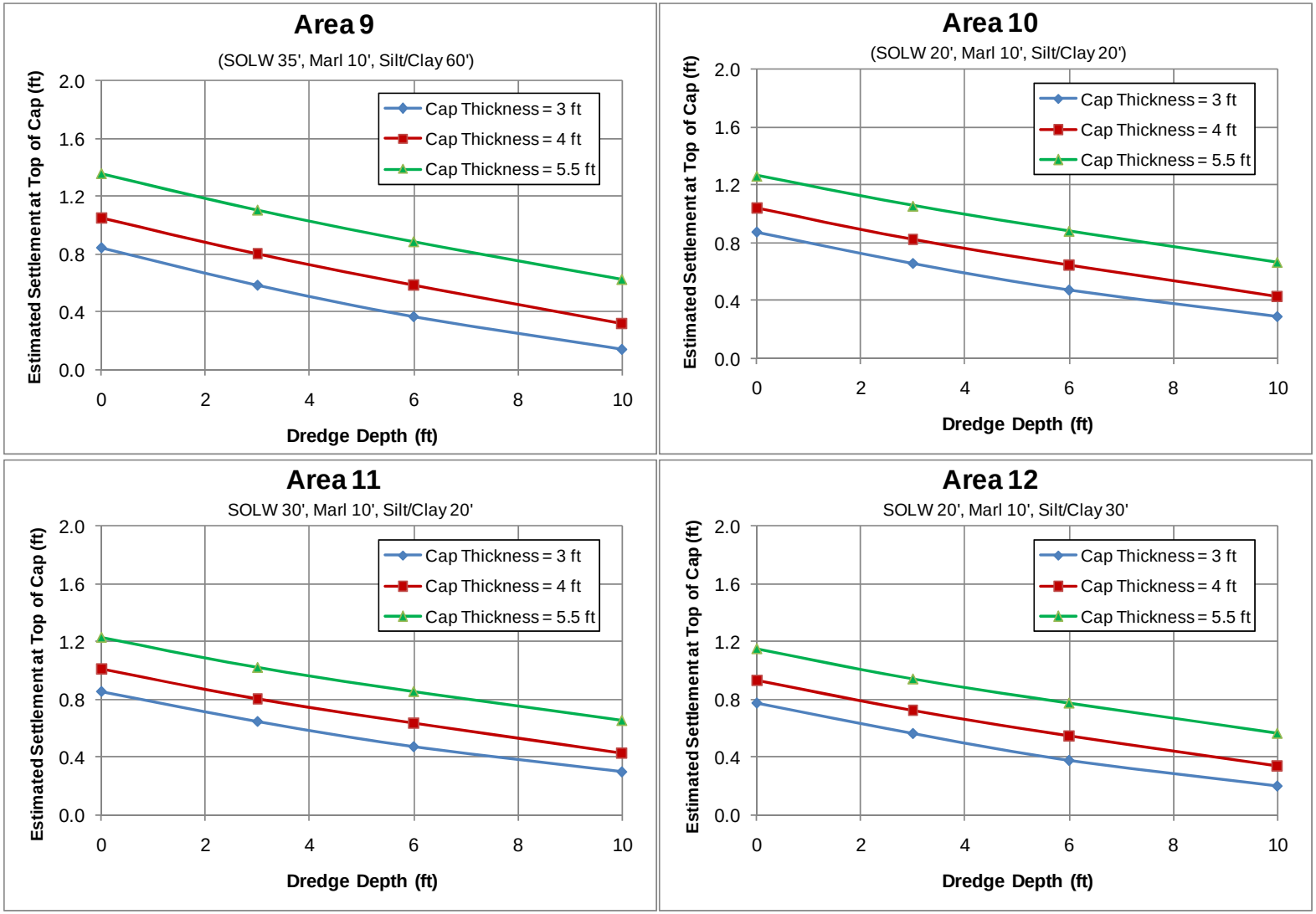


Figure 15. Settlement Analysis Results for Areas 1 to 12 for 30-Year Period (continued).

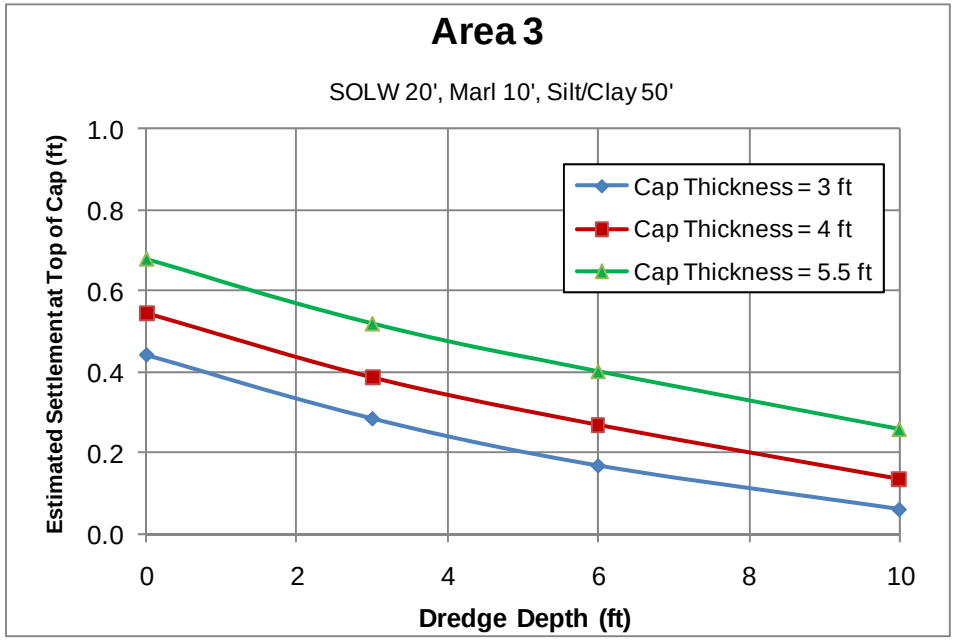


Figure 16. Settlement Analysis Results for Area 3 for 2-Year Period.

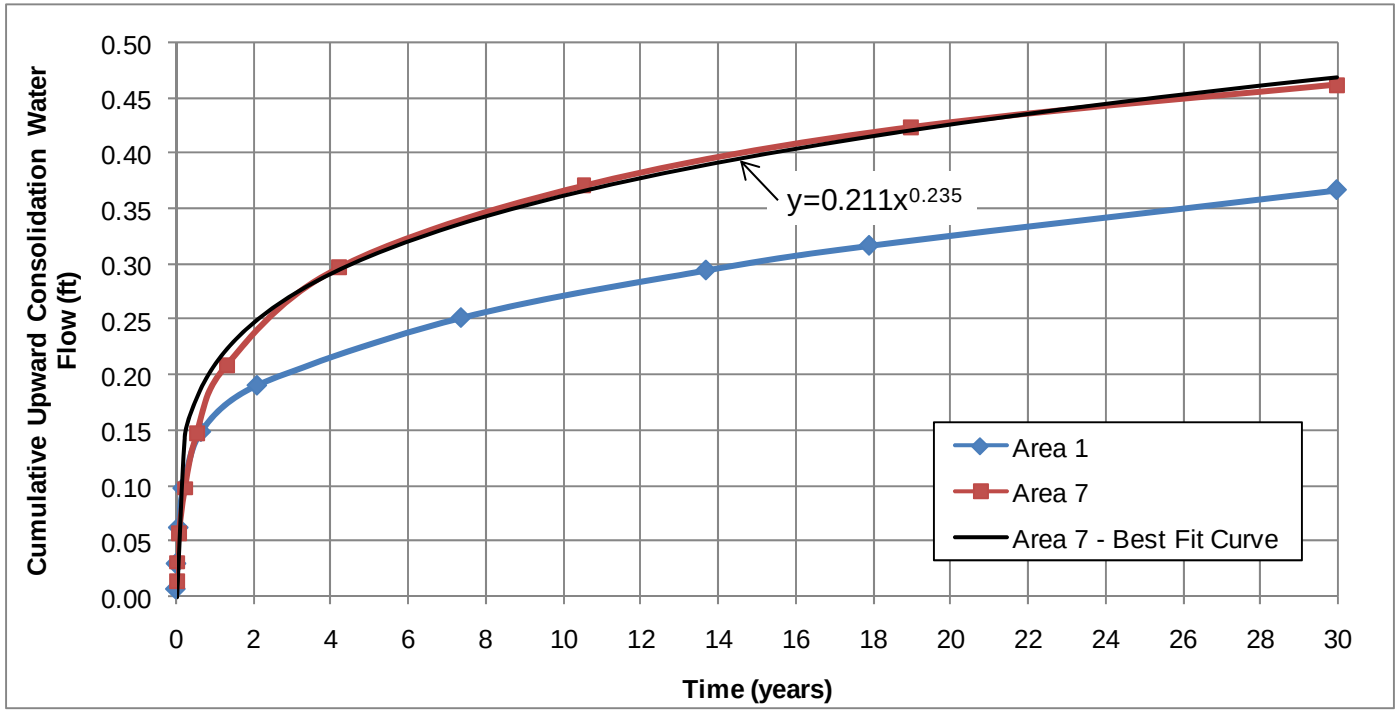


Figure 17. Calculated Cumulative Consolidation Water Flow.

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

ATTACHMENT A

SUBSURFACE LAYER THICKNESS CONTOURS

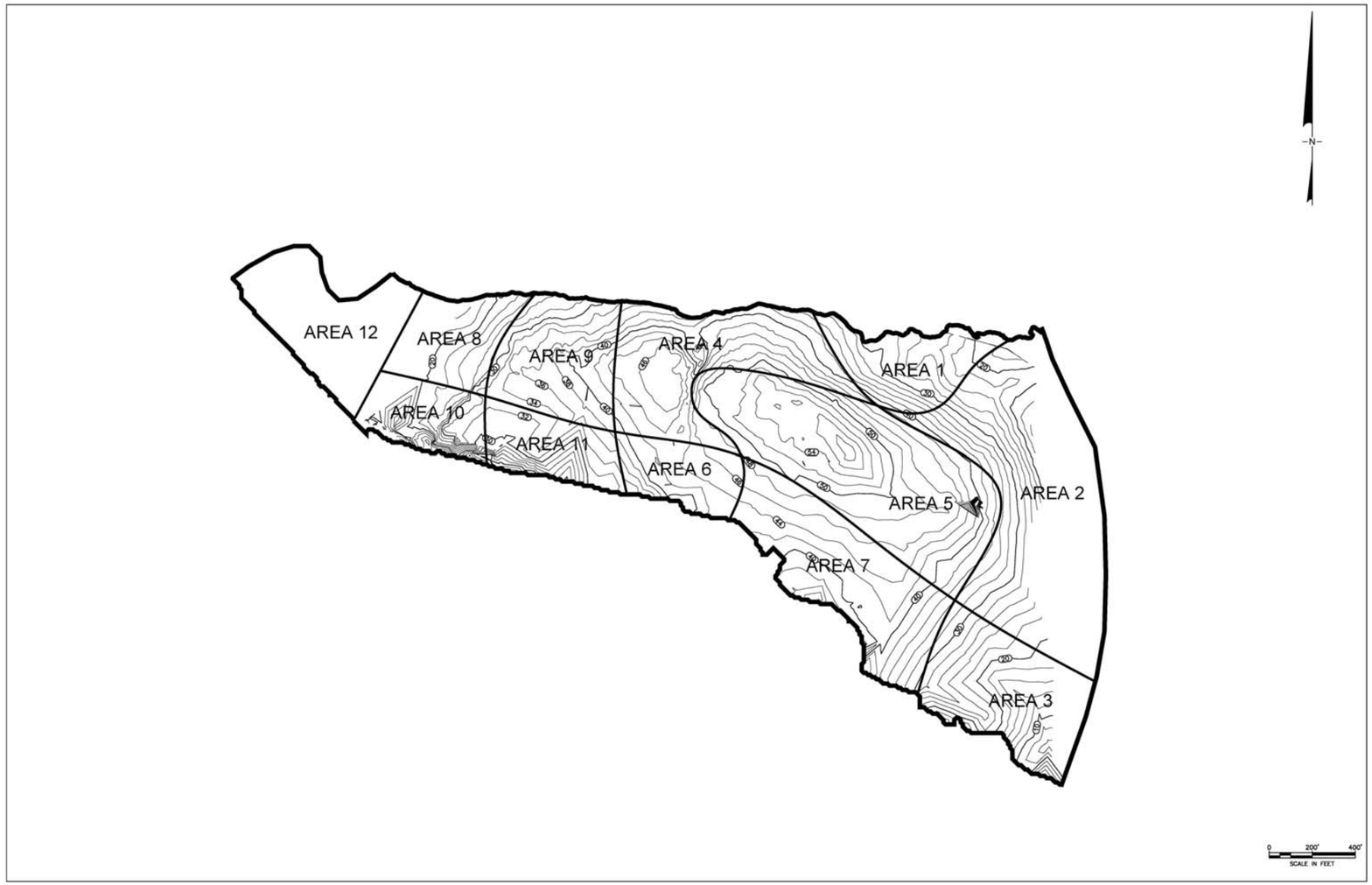


Figure A1. The Thickness of SOLW in Remediation Area D

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.

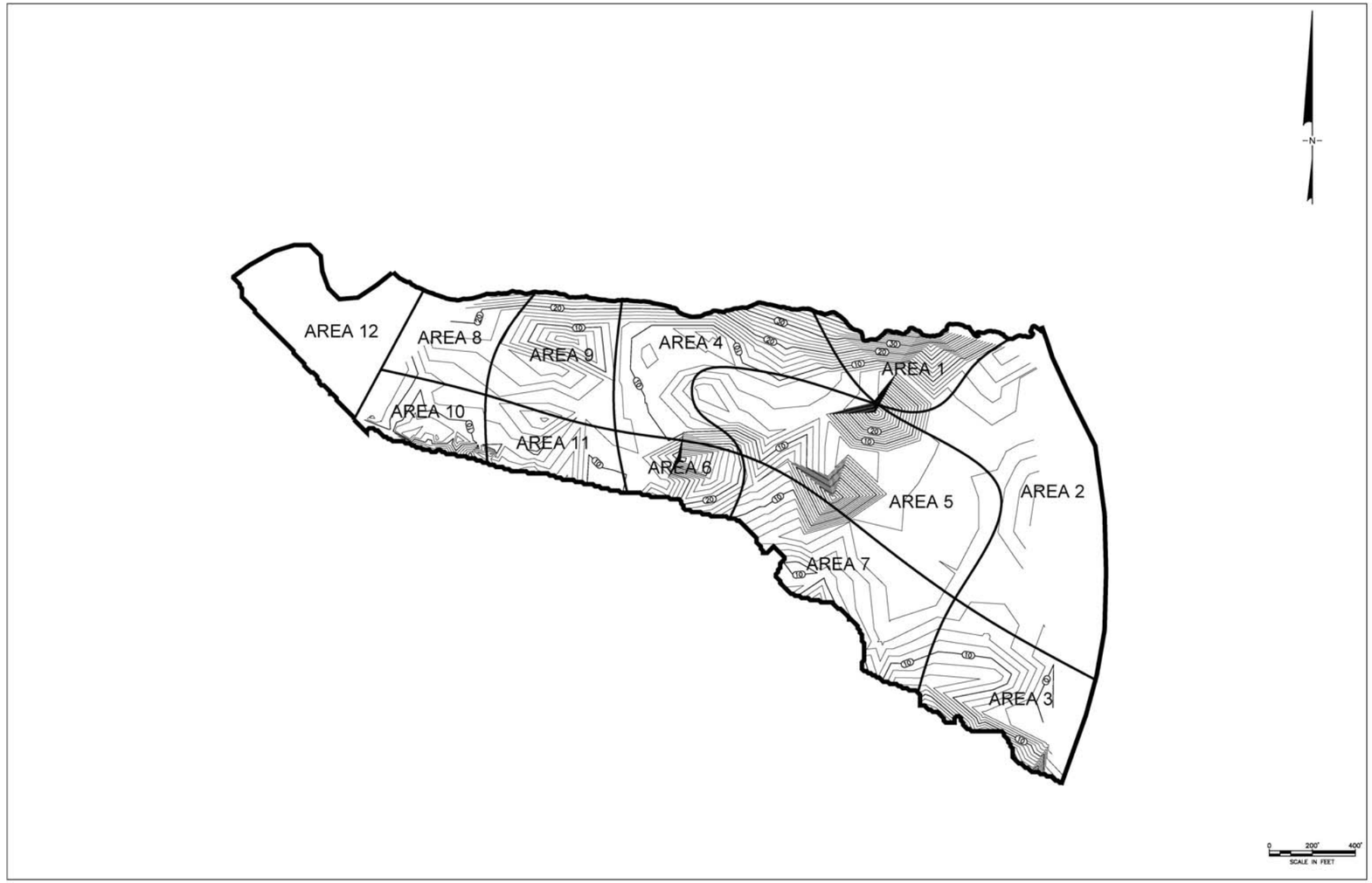


Figure A2. The Thickness of Marl in Remediation Area D

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.

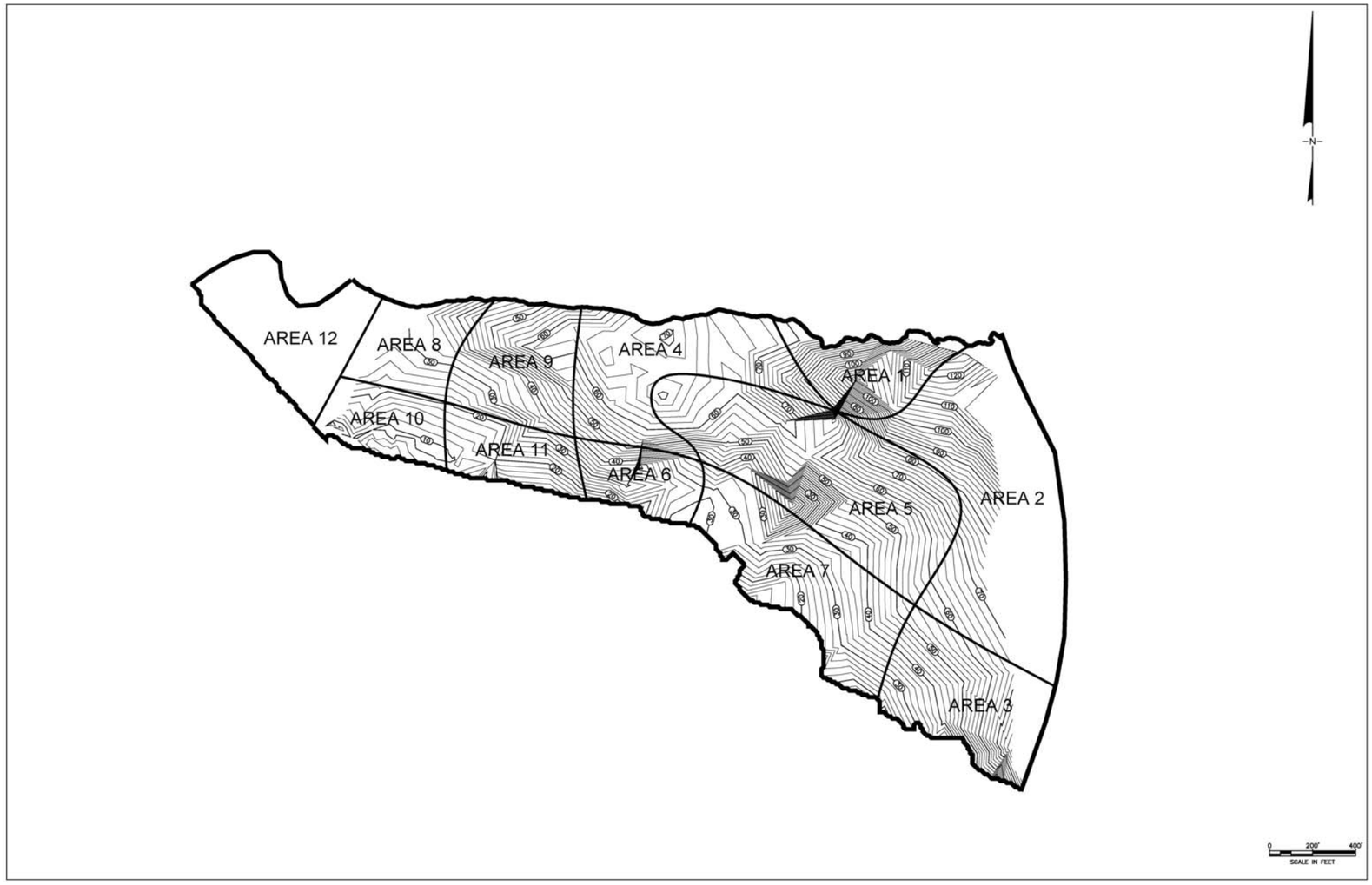


Figure A3. The Thickness of Silt and Clay in Remediation Area D

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_{α}	Coef. of Con. c_v (ft^2/d)	Time of 90% primary con. (y)	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 No.	4
Layer Thickness, m / ft	5	Layer Thickness, m / ft	5
Midpoint Depth from Top of Silt/Clay, m/ft	2.5	Midpoint Depth from Top of Silt/Clay, m/ft	17.5
Effective Stress Before Dredging, KPa/psf	951	Effective Stress Before Dredging, KPa/psf	1635
Initial Effective Stress, KPa/psf	828.24	Initial Effective Stress, KPa/psf	1512.24
Final Effective Stress, KPa/psf	1058.64	Final Effective Stress, KPa/psf	1742.64
OCR	1	OCR	1
Preconsolidation Pressure, KPa/psf	951	Preconsolidation Pressure, KPa/psf	1635
Modified Primary Compression Index, $C_{c\varepsilon}$	0.223	Modified Primary Compression Index, $C_{c\varepsilon}$	0.223
Modified Recompression Index, $C_{r\varepsilon}$	0.025	Modified Recompression Index, $C_{r\varepsilon}$	0.025
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.01	Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.01
ratio of t2 / t1	5.2	ratio of t2 / t1	5.2
Settlements		Settlements	
Primary Settlement, (m / ft)	0.059	Primary Settlement, (m / ft)	0.035
Secondary Settlement (m / ft)	0.036	Secondary Settlement (m / ft)	0.036
Total Settlement (m / ft)	0.095	Total Settlement (m / ft)	0.071

Layer No.	2	Layer No.	5
Layer Thickness, m / ft	5	Layer Thickness, m / ft	5
Midpoint Depth from Top of Silt/Clay, m/ft	7.5	Midpoint Depth from Top of Silt/Clay, m/ft	22.5
Effective Stress Before Dredging, KPa/psf	1179	Effective Stress Before Dredging, KPa/psf	1863
Initial Effective Stress, KPa/psf	1056.24	Initial Effective Stress, KPa/psf	1740.24
Final Effective Stress, KPa/psf	1286.64	Final Effective Stress, KPa/psf	1970.64
OCR	1	OCR	1
Preconsolidation Pressure, KPa/psf	1179	Preconsolidation Pressure, KPa/psf	1863
Modified Primary Compression Index, $C_{c\varepsilon}$	0.223	Modified Primary Compression Index, $C_{c\varepsilon}$	0.223
Modified Recompression Index, $C_{r\varepsilon}$	0.025	Modified Recompression Index, $C_{r\varepsilon}$	0.025
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.01	Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.01
ratio of t2 / t1	5.2	ratio of t2 / t1	5.2
Settlements		Settlements	
Primary Settlement, (m / ft)	0.048	Primary Settlement, (m / ft)	0.031
Secondary Settlement (m / ft)	0.036	Secondary Settlement (m / ft)	0.036
Total Settlement (m / ft)	0.084	Total Settlement (m / ft)	0.067

Layer No.	3	Layer No.	6
Layer Thickness, m / ft	5	Layer Thickness, m / ft	5
Midpoint Depth from Top of Silt/Clay, m/ft	12.5	Midpoint Depth from Top of Silt/Clay, m/ft	27.5
Effective Stress Before Dredging, KPa/psf	1407	Effective Stress Before Dredging, KPa/psf	2091
Initial Effective Stress, KPa/psf	1284.24	Initial Effective Stress, KPa/psf	1968.24
Final Effective Stress, KPa/psf	1514.64	Final Effective Stress, KPa/psf	2198.64
OCR	1	OCR	1
Preconsolidation Pressure, KPa/psf	1407	Preconsolidation Pressure, KPa/psf	2091
Modified Primary Compression Index, $C_{c\varepsilon}$	0.223	Modified Primary Compression Index, $C_{c\varepsilon}$	0.223
Modified Recompression Index, $C_{r\varepsilon}$	0.025	Modified Recompression Index, $C_{r\varepsilon}$	0.025
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.01	Modified Secondary Compression Index, $C_{\alpha\varepsilon}$	0.01
ratio of t2 / t1	5.2	ratio of t2 / t1	5.2
Settlements		Settlements	
Primary Settlement, (m / ft)	0.041	Primary Settlement, (m / ft)	0.028
Secondary Settlement (m / ft)	0.036	Secondary Settlement (m / ft)	0.036
Total Settlement (m / ft)	0.076	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 δt to ensure convergence of solution

	δt =	0.0030	0.0030	years
		1	1	days
	δt-bar =	8.05E-04	2.07E-05	
	δz =	3	3	ft
	δz-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																
	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
Z (ft)	z-bar s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s10	s10	s10	s10	s10	s10	s10	
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.

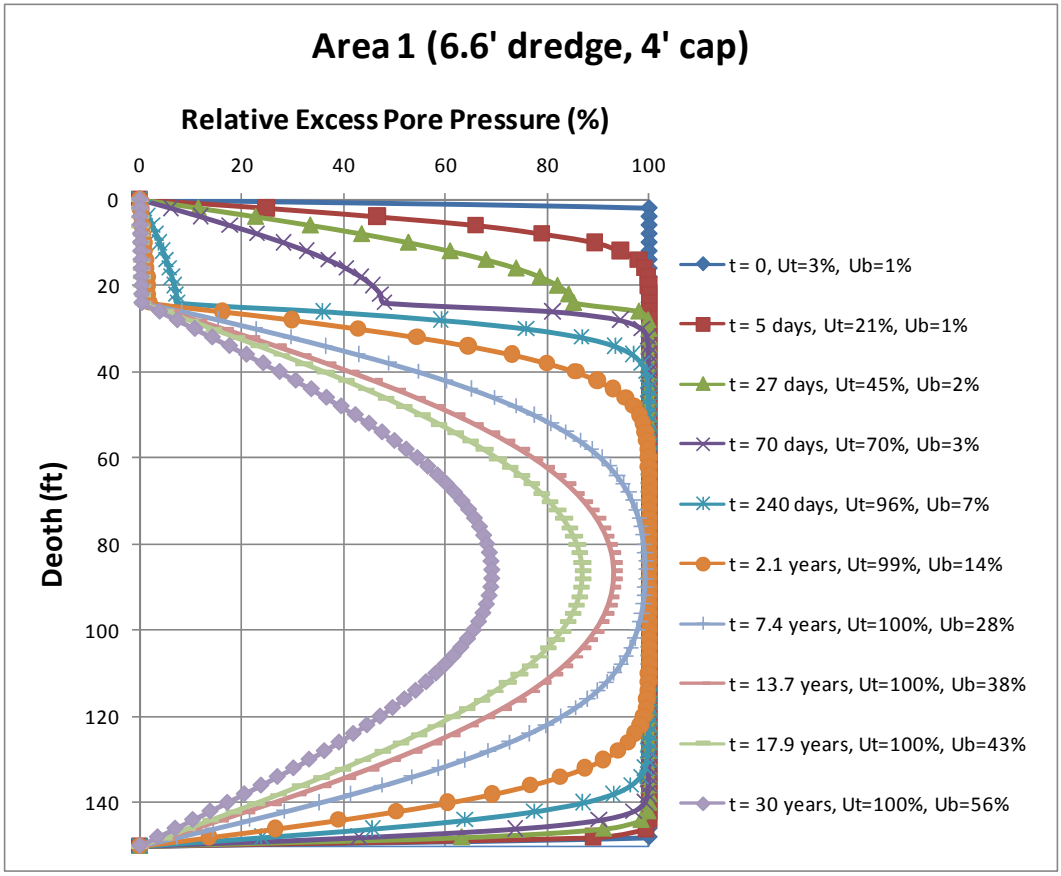
U bar and settlement results summary

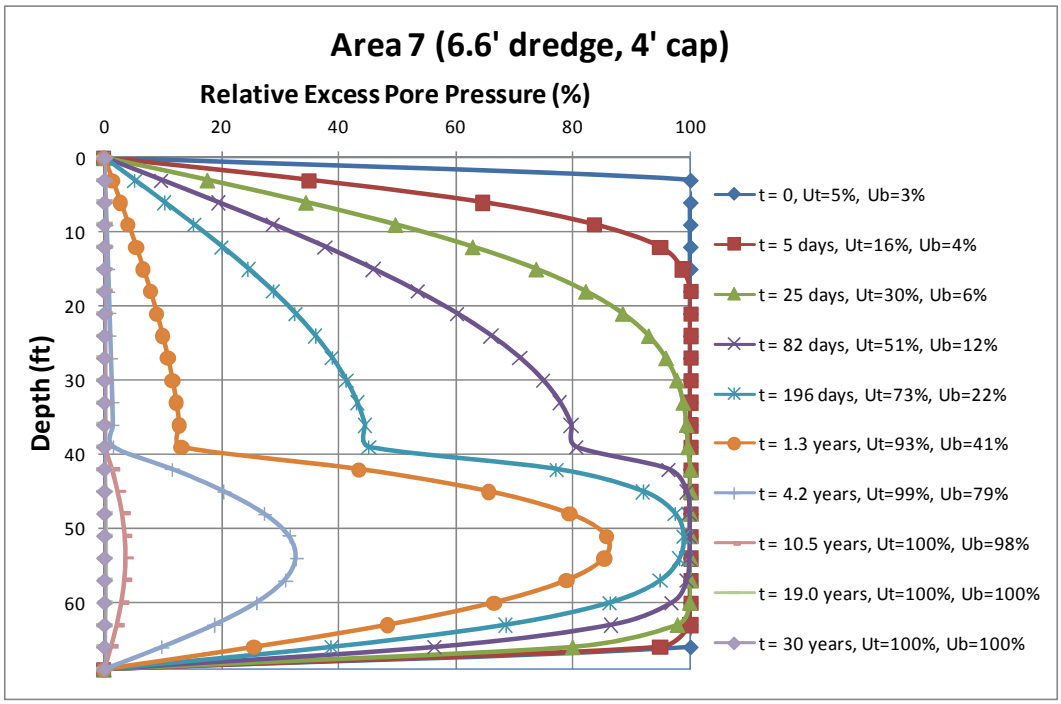
Uave top	5%	16%	30%	51%	73%	93%	99%	100%	100%	100%
Uave bot	3%	4%	6%	12%	22%	41%	79%	98%	100%	100%
t (years)	0.00	0.02	0.07	0.23	0.54	1.29	4.21	10.54	18.97	30.00
t (days)	0.00	5.48	25.19	82.13	196.01	469.75	1536.29	3845.64	6924.78	10950.00
Z (ft)	t = 0, Ut=5%, Ub=	t = 5 days, Ut=16%, Ub	t = 25 days, Ut=30%, Ub=ℓ	t = 82 days, Ut=	t = 196 days, L	t = 1.3 years, Ut	t = 4.2 years, Ut	t = 10.5 years, ℓ	t = 19.0 years, ℓ	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%